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POTASSIUM SUPEROXIDE CANISTER EVALUATION FOR MANNED SPACE VEHICLES

TECHNICAL DOCUMENTARY REPORT NO. ASD-TDR-62-583

September 1962

Flight Accessories Laboratory
Aeronautical Systems Division
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio

Project No. 6146, Task No. 614608

(Prepared under Contract No. AF 33(616)-8323
Los Angeles Division of North American Aviation, Los Angeles, California.
Author: A. W. Optican.)

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1. Breathing apparatus
2. Environmental control
3. Oxygen equipment
4. Carbon dioxide removal
5. Atmospheric composition control

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FOREWORD

This report* summarizes an open duct potassium superoxide (KO_2) canister test program which was performed during the second phase of work on a study of thermal and atmospheric control systems for manned and unmanned space vehicles. The study was conducted over a period of 18 months by the Space and Information Systems Division (S&ID) of North American Aviation, Inc., under contract AF 33(616)-8323 and was sponsored by the Flight Accessories Laboratory of Aeronautical Systems Division. The Los Angeles Division (LAD) of North American Aviation and AiResearch Manufacturing Company were subcontractors in the study effort.

The purpose of the program is to study the problems associated with the control of temperature and atmospheres in military space vehicles. Several hypothetical vehicles have been analyzed and designed to define potential problems of environmental control. These problems are being solved by analytical and laboratory investigation, and their solutions optimized by the physical integration of components and by other means.

This document represents a part of the total program, procedures, designs, and test associated with the selection of space vehicle thermal and atmospheric control systems based on equipment and physiological criteria. The total effort includes the formulation of several hypothetical space vehicles (including supporting systems), the study and selection of compatible and promising thermal and atmospheric control systems, the development of improved methods of analysis and the presentation of a set of specific examples to illustrate supporting background and data, or present other aspects of the equipment and physiological criteria study program. The other reports issued as a result of the second phase study are as follows:

ASD TR 61-164 (PART II) ** Environmental Control Systems Selection for Unmanned Space Vehicle.Secret Report

ASD TR 61-240 (PART II) ** Environmental Control Systems Selection for Manned Space Vehicles, Volume I (unclassified) and Volume II·Secret Report

*Contractor's number NA-62-283

**Unclassified Title

ASD TR 61-161 (PART II)	Space Vehicles Environmental Control Requirements Based on Equipment and Physiological Criteria
ASD TR 61-119 (PART II)	Radiation Heat Transfer Analysis for Space Vehicles
ASD TR 61-30 (PART II)	Space Radiator Analysis and Design
ASD TR 61-176 (PART II)	Integration and Optimization Concepts for Space Vehicle Environmental Control Systems
ASD TR 62- (PART I)	Temperature Control Systems for Space Vehicles
ASD TR 61-162 (PART II)	Analytical Methods for Space Vehicle Atmospheric Control Processes
ASD TR 62- (PART I)	Atmospheric Control Systems for Space Vehicles

During the third phase of the program, the above listed reports will be supplemented as new information is made available. Also, additional reports will be prepared on new subjects of interest for thermal and atmospheric control systems.

The thermal and atmospheric control study program was under the direction of Mr. A. L. Ingelfinger and Mr. A. Gross of the Environment Control Section, Flight Accessories Laboratory. Mr. J. P. Allen of the Environment Control Section acted as monitor of this report, and Mr. R. E. Sexton served as the Project Manager at S & I D.

The author gratefully acknowledges the contributions of the following persons from the Engineering Laboratory in carrying out the test program: J. Dunham, C. Hansen, A. McKinstry, D. Rinehart, L. Martens, and S. Tobey. Appreciation is also expressed to M. A. Sulkin, G. W. Campbell, R. A. Paselk, R. A. Sturgill, and J. B. Truett, of the Aero-Thermo Development Group at LAD, and A. Bialecki of S & I D, for their assistance. All drawings and art work in this report were prepared by E. Rush at LAD.

ABSTRACT

New experimental techniques, and their results, used to develop and evaluate the effects of simultaneous multiple operating parameters on potassium superoxide (KO_2) canisters for life support systems in manned space vehicles, are presented in this document. Actual experiments using rodents, men, and simulated-man, are described and compared. Experimental characteristics of single and dual canister (demand) atmosphere composition control systems are analyzed. The best method for experimental definitive Respiratory Quotient matching is described. A new annular screen device for a chemical canister which prevents blocking of the airflow in a granular solid chemical bed due to high absolute humidity is shown and described. A canister design method was developed to determine basic KO_2 canister sizes for atmosphere composition control system tests on a real-time, one-man basis. The dominant role of PCO_2 in establishing the CO_2 adsorption rate and the O_2 generation rate is shown, as well as the roles of absolute humidity and catalysts in establishing the O_2 generation rate. Empirical induction was used to try and substantiate (unsuccessfully) a previously accepted theoretical equation of a KO_2 bed. A series of comparative tables and curves has been analytically and experimentally derived for O_2-CO_2 generation and adsorption support levels for one man.

PUBLICATION REVIEW

This report has been reviewed and approved.

FOR THE COMMANDER:

Frederick W. Thompson (signature)
William C. Savage
Chief, Environmental Branch
Flight Accessories Laboratory

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SECTION I

INTRODUCTION

This document presents the experimental methods, and results, of an open duct test program conducted at the Los Angeles Division of North American Aviation, Inc. to develop and evaluate potassium superoxide canisters for life support systems in manned space vehicles. The contracted open duct KO_2 canister test program was accomplished between July 1961 and February 1962. Results of earlier experimental programs at the Los Angeles Division of North American Aviation, Inc., using KO_2 and KOH in dual-canister closed-circuit life support systems for animals and men, were utilized to orient this research, and are also discussed herein. These earlier tests were conducted between April 1960 and August 1961.

Under the present contract, an open duct solid chemical test facility was developed at LAD, and the difficulties in instrumentation peculiar to these experiments were solved. A new technique for studying the effects of simultaneous multiple operating parameters on solid chemicals for life support systems has been developed in conjunction with the open duct test facility. The open duct solid chemical test facility makes possible full-scale whole-man tests in real time, allows changing of many operating parameters, and the observance of response rates to changing conditions. It also allows for the simultaneous testing and comparison of three different solid chemical canisters against a standard control canister. Such experiments result in the near-optimum operating conditions becoming known for various canisters and chemicals, and provides rapid design evolution for these canisters. An analytical canister design method was also developed to determine basic KO_2 canister sizes for atmosphere composition control system tests on a real-time, one-man basis.

Under the present contract the program provided a new annular screen design for a solid chemical canister which assures alternative air flow paths around used or fused portions of a chemical bed, and through all unused portions of the chemical bed. Useful lifetime of this new annular screen KO_2 canister was extended at least 250% over that of a straight-through axial flow canister. On a weight basis, the availability of oxygen from the KO_2 canister was increased at least 125% by use of the annular screen device. Whereas this device is mainly intended for use in closed-circuit

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respiratory systems for life support of men in sealed cabins, submarines, pressure suits, fire-fighting, and rescue breathing apparatus, it may also be very useful in any chemical process where a gaseous stream is passed through or over, a solid granular chemical bed. In the successful canister (with the annular screen device), the air-flow was maintained for almost 30 hours with almost no increase in pressure drop across the canister. In KO_2 canisters without the annular screen device, the airflow was completely blocked after a few hours by the formation of a solid plug across the inlet of the canister.

Also, under the present contract, a series of comparative tables and curves have been experimentally derived for O_2-CO_2 generation and adsorption support levels (with KO_2) on a one man basis. The role of absolute humidity in establishing the rate of O_2 evolution was shown in the reactions of the KO_2 bed. The dominant role of CO_2 partial pressure in establishing the CO_2 adsorption rate, and the O_2 generation rate, was experimentally shown by means of the test data. The performance of KO_2 canisters when KO_2 is mixed with a hydrophilic physical adsorber, a CO_2 chemical adsorber (chemisorption) and/or a porous mechanical separator was shown by means of the test data with many interesting results not previously demonstrated. Also, a well-known theoretical equation showing KO_2 alone will match man's R.Q. could not be substantiated by empirical induction from the results of these extensive tests.

Man-rate support level graphs were plotted with the man-rate production, or adsorption, as a function of time, from the results of integrating (geometrically) the areas under the experimentally derived curves for O_2 generation and CO_2 adsorption. The results show that the ability of a KO_2 canister to support the respiratory requirements of a man is mainly dependent on the bed packing configuration, inlet CO_2 partial pressure, and inlet absolute humidity.

BACKGROUND

In 1960, the USAF Ballistic Missile Division, indicated to North American Aviation, Inc., that they were seeking proposals concerned with placing a recoverable monkey-occupied satellite in circular orbit for at least 72 hours. A research program was designed and carried out by the author in 1960 for the evaluation (with animals) of a closed-loop sealed cabin air renewal system utilizing solid chemical sources. (Reference 1). The results of that experimental study demonstrated the ability of a composite solid chemical system (potassium superoxide, potassium hydroxide, and activated charcoal) to renew the air in a sealed cabin with the chemicals in individual canisters. Two female white rats were sustained in excellent health for twenty-five days in a completely sealed enclosure equipped with the solid chemical air renewal system. (Figures 1, 2, 3 and 4). During the twenty-five day test the pressure within the sealed system remained at or near one atmosphere, and the air temperature in the rat enclosure was maintained at 75 ± 9 °F. Control of atmospheric composition (with respect to O_2 and CO_2) was accomplished with a manual system by limiting the air flow to the potassium superoxide canister in accordance with O_2 demand, and increasing a portion of the air flow to the potassium hydroxide canister when the CO_2 level rose above the desired limit. A desired relative humidity of 30 to 50% could not be maintained using manual control of a chilled-water heat exchanger, and the average daily relative humidity gradually increased from about 30% at the start of the test to about 80% at the conclusion of the twenty-five days. Also, intermittent failure of the refrigeration system caused the chemical canisters to inadvertently be used for water removal, which resulted in the formulation of a caustic liquid in the KOH canister. Entrainment of the liquid into the downstream connections and aluminum tubing caused considerable corrosion of the aluminum and a buildup of salt deposits. An example is shown in Figure 5. Airflow was thus restricted and the test was discontinued after the twenty-fifth day.

In September of 1961, at the Los Angeles Division, three men were maintained in a sealed chamber for 14 days as part of an investigation of a life support system of the Space and Information Systems Division of North American Aviation, Inc. (Reference 2 and Figures 6 and 7). During this test, two separate atmospheric composition control systems were utilized. The primary system, consisting of stored gaseous oxygen, and lithium hydroxide for CO_2 removal, operated satisfactorily. The secondary system consisted of the same composite solid chemicals used in the rat test, (KO_2, KOH, and activated charcoal). This system operated satisfactorily until a caustic liquid formed in the (vertical) KOH bed, drained into the canister sump, and filled it to the overflow point within 8 hours; on cooling in the sump, the liquid crystallized and plugged the drain line causing shutdown of this unit. No liquid was formed in the KO_2 canister. However, a 2-3 inch hard plug of salt crystals formed at the top of the (vertical) KO_2 bed, restricting the airflow, and

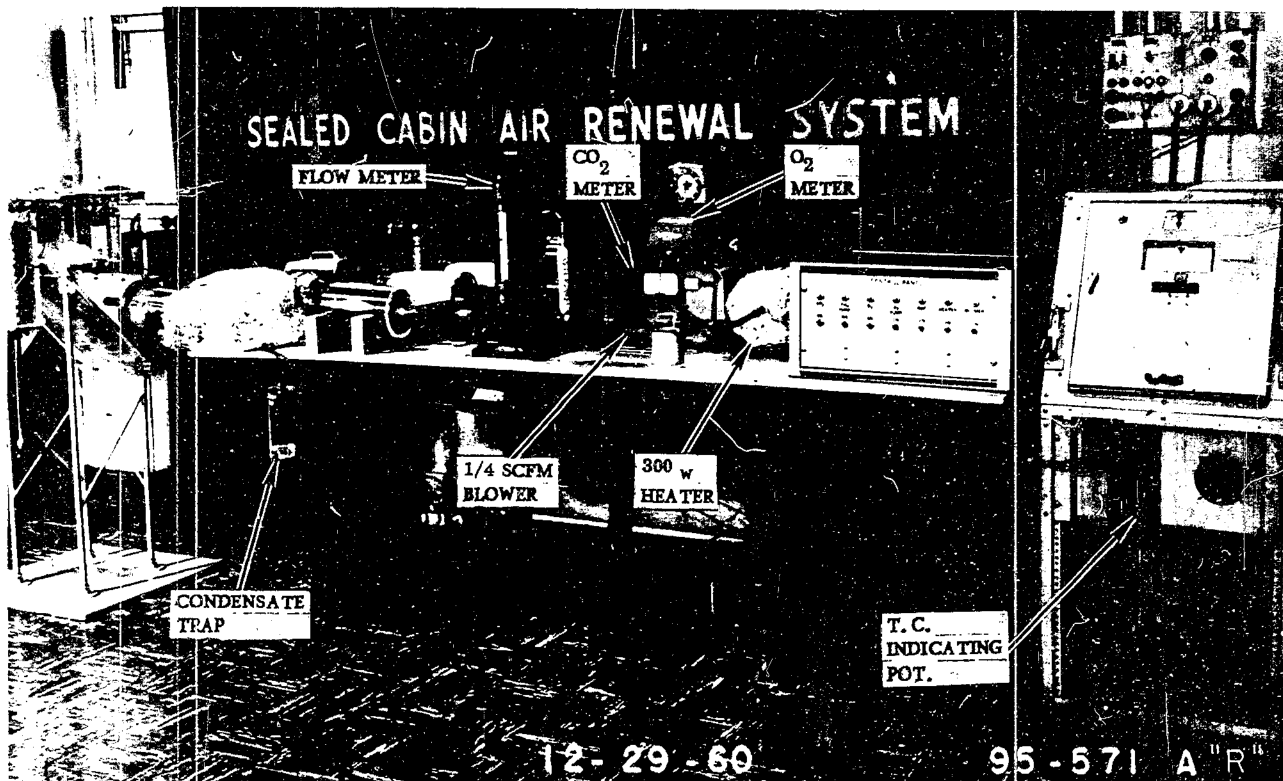


Figure 1 Test Facility, Sealed Cabin Air Renewal System

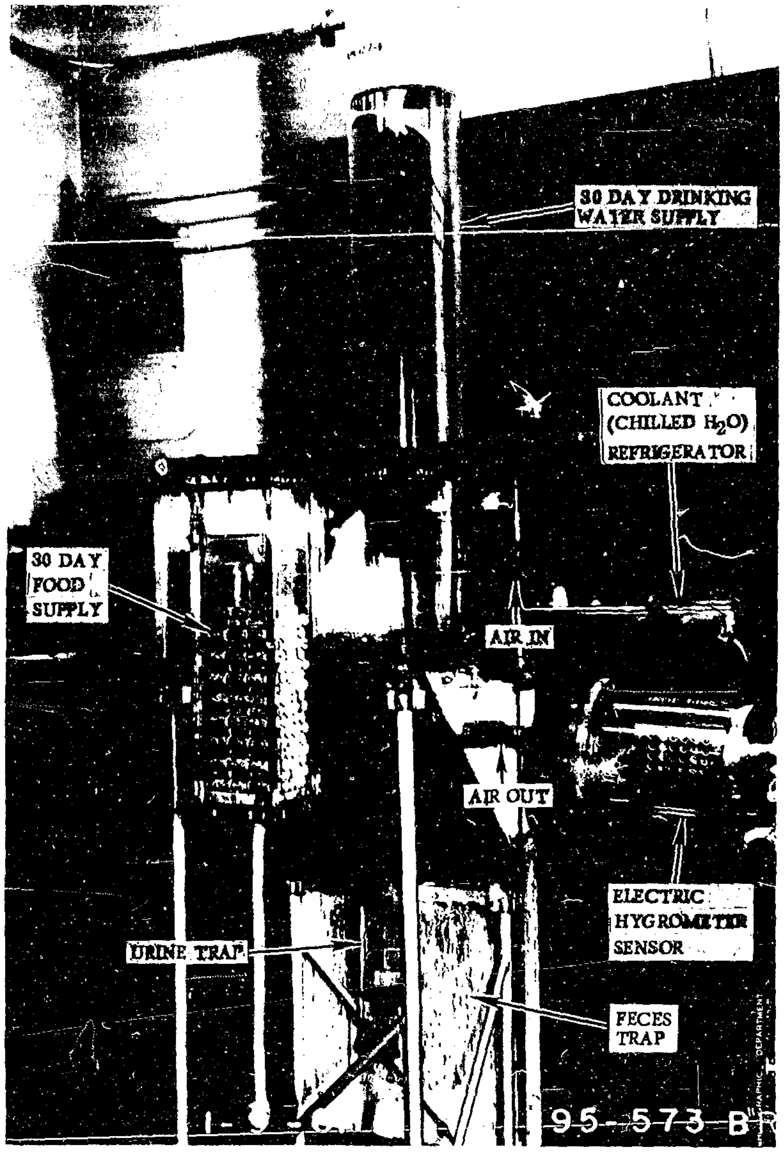


Figure 2 Rat Enclosure Showing Food and Water Water Supply, and Waste Disposal

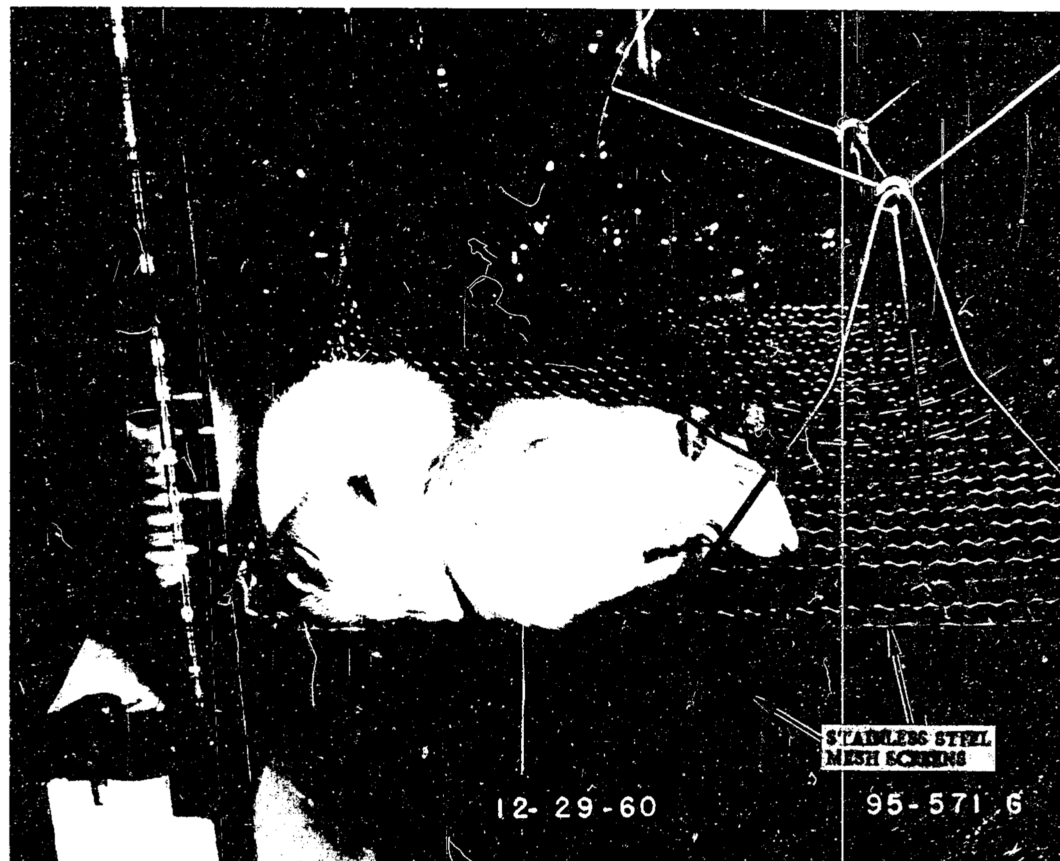


Figure 3 Rat Enclosure Showing Water Feeder, Exercise Wheel, and Mesh Screens

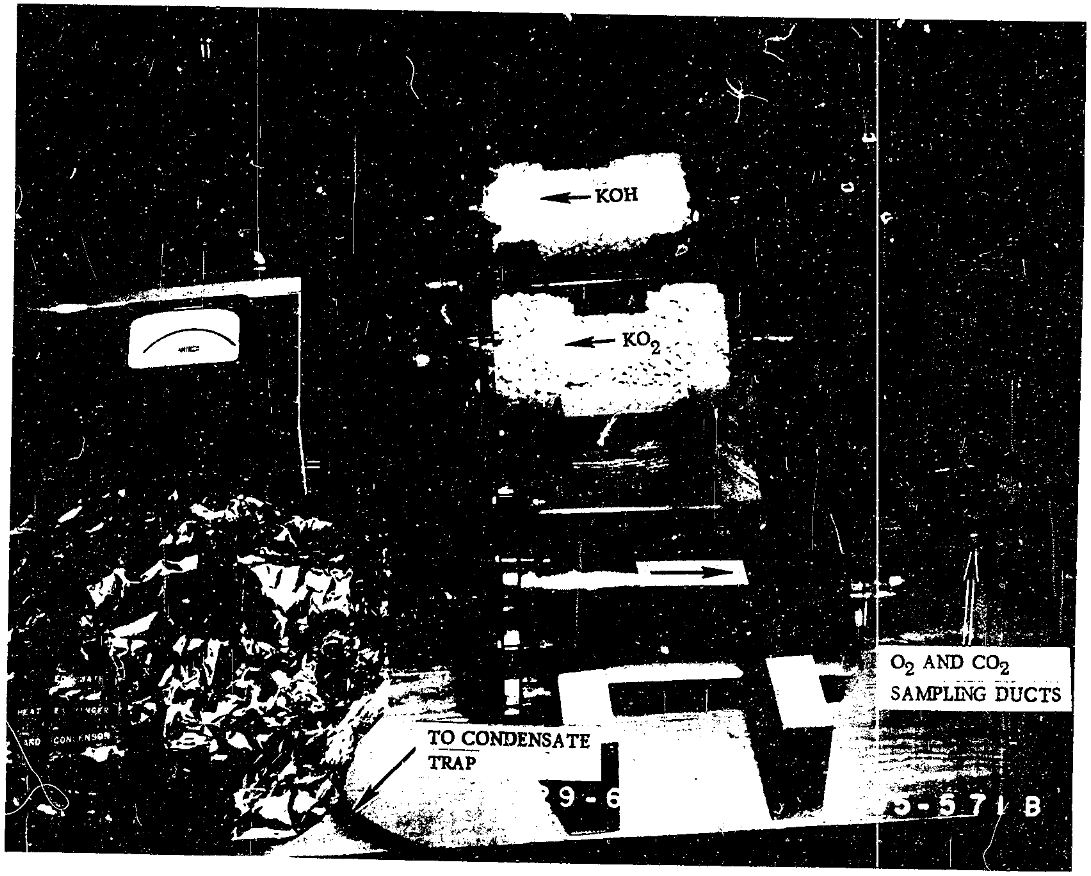


Figure 4 Chemical Canisters for Rat Test

Figure 5 Salt Deposition and Corrosion In Tubing After Rat Test

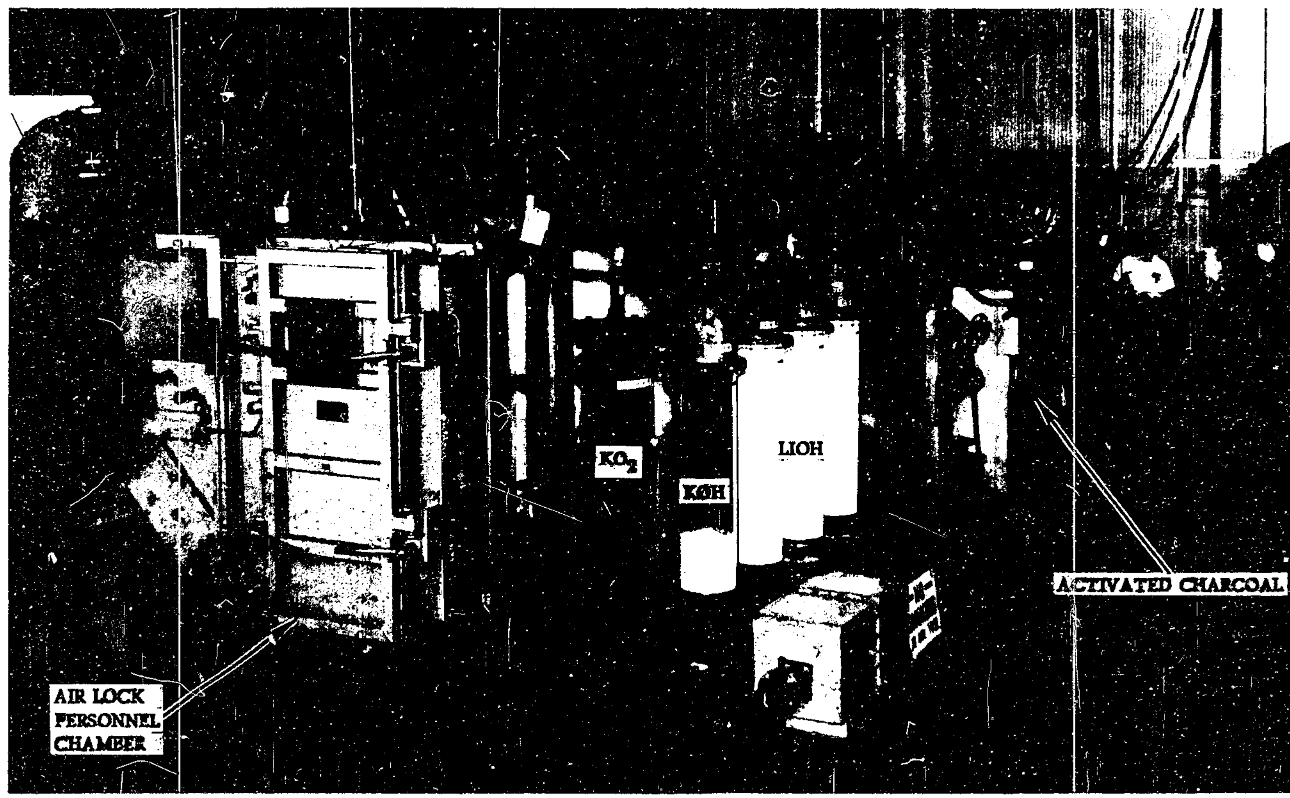


Figure 6 Atmospheric Composition Control System and Personnel Chamber Installation

Figure 7   Interior View of Personnel Chamber

causing shut-down of this unit in about 22 hours. It was thought that the plugging of these canisters was due to excessive moisture content of the air passing through the canisters, and further it was believed that the CO_2 level in the system was so low that there was insufficient CO_2 available to convert all the very hygroscopic KOH (produced in the KO_2 bed from the reaction between KO_2 and H_2O) to carbonate.

NATURE OF THE PROBLEM

Whereas the closed-loop sealed cabin air renewal system test with the rats successfully demonstrated the ability of a composite solid chemical system to revitalize the air, it did not demonstrate this capability for a single solid chemical (such as KO_2) to both absorb CO_2 and generate O_2 in the proper proportion to match the animal's respiratory quotient. A deliberate attempt was made to maintain constant operating parameters (such as temperature, relative humidity, partial pressures, gas velocity and gas residence time in the canisters). Also, only one KO_2 canister design was used. Therefore, information on the effects of changing the operating parameters, canister dimensions, and/or bed packing configurations (upon CO_2 adsorption and O_2 generation characteristics of the KO_2 bed) could not be readily obtained. It was also hoped that further tests would show what mechanisms caused the plugging of the KO_2 canister in the manned test. This called for investigation of various CO_2 concentrations and absolute humidities in the (supply) air to KO_2 canisters, and investigation of improved KO_2 canister designs.

ADSORPTION AND ABSORPTION

In this report, the terms adsorption and absorption are used synonymously. In a strict sense, however, absorption is a physical taking up of matter in bulk by other matter, or penetration of substances into the bulk of a solid or a liquid. Adsorption is either physical or chemical (chemisorption). Physical adsorption is reversible by physical forces only (no chemical reaction), and is a characteristic surface or interface phenomenon. Chemisorption is an irreversible adsorption by both physical and chemical forces; reaction occurs between the surface of the adsorbent and the adsorbate. Examples of physically adsorptive materials are molecular sieves and activated alumina. Examples of chemically adsorptive materials are KO_2 and LiOH.

SECTION II

OBJECTIVES OF THE PROGRAM

There were several objectives to the open duct KO_2 canister test program, as follows:

1. To attempt to prove or disprove the feasibility of using a single chemical, KO_2, for both CO_2 adsorption and O_2 generation in a mol volume ratio which will match man's R.Q. (respiratory quotient).

2. To determine operating parameter control requirements necessary for matching man's R.Q. with a single solid chemical, if possible, or with a mixed (single canister) solid chemical system in lieu of a composite (dual canister) solid chemical system.

3. To provide experimental data on the effects of operating parameters (temperature, humidity, partial pressures, linear gas velocity, and gas residence time) upon the CO_2 adsorption and O_2 generation characteristics of KO_2 beds.

4. To provide test data for the development of design criteria - both dimensional and bed packing configuration - for a KO_2 canister which will assure alternative air flow paths around used or plugged portions of the chemical bed, and through all unused portions.

5. To investigate the performance of KO_2 canisters when the KO_2 is mixed with other chemicals such as a hydrophilic physical adsorber, or a carbon dioxide chemical adsorber.

6. To investigate various CO_2 concentrations and absolute humidities in the (supply) air to the KO_2 canisters in an effort to show what mechanisms may have caused plugging of the KO_2 canister in the manned life support system test (Reference 2).

SECTION III

CONCLUSIONS

The objectives of the open duct KO_2 canister test program were answered as follows:

1. The attempt to prove the feasibility of using KO_2 alone for both CO_2 adsorption and O_2 generation in a volume ratio matching man's R.Q. was not successful. However, such a feasibility cannot be ruled out completely because as yet unknown procedures, processes, or catalysts (see page 59) may eventually offer a successful solution.

2. It was not possible to determine operating parameter control requirements for matching man's R.Q. with KO_2 alone, or with a mixed solid chemical system (i.e., mixed in a single canister). All indications are, however, that a dual-canister system (see page 16) operating in a closed ecological system (see page 59) would furnish the operating parameter control requirements for matching man's R.Q.

3. The test program did provide a great deal of experimental data on the effects of the operating parameters upon the CO_2 adsorption and O_2 generation characteristics of KO_2 beds. (Appendix B).

4. The program provided a new design - both dimensional and bed packing configuration - for a solid chemical canister which assures alternative air flow paths around used or fused portions of a chemical bed, and through all unused portions. (See pages 40, 46, 89).

5. The performance of KO_2 canisters when KO_2 is mixed with a hydrophilic physical adsorber, a carbon dioxide chemical adsorber (chemisorption), and/or an inert porous mechanical separator (see pages 39 and 40), was investigated with many interesting results not previously demonstrated.

6. The test program was successful in showing what mechanisms caused the plugging of the KO_2 canister in the manned life support system test. (See pages 101 and 103).

7. An open duct solid chemical test facility was developed, and the difficulties in instrumentation peculiar to these experiments have been solved.

8. A new technique for studying the effects of simultaneous multiple operating parameters on solid chemicals for life support systems has been developed.

9. A series of comparative tables and curves have been experimentally derived for oxygen-carbon dioxide generation and adsorption support levels (with KO_2) for one man. (Appendix B).

10. The dominant role of CO_2 partial pressure in establishing the CO_2 adsorption rate, and the O_2 generation rate, was experimentally shown in the reactions of the KO_2 bed. (See pages 59 and 60).

11. The role of absolute humidity in establishing the rate of O_2 evolution was shown in the reactions of the KO_2 bed. (See pages 59 and 60).

12. A well-known theoretical equation showing KO_2 alone will match man's R.Q. could not be substantiated by empirical induction from the results of these extensive tests. (Pages 74, 75, and 76).

13. An analytical canister design method was developed to determine basic KO_2 canister sizes for atmosphere composition control system tests on a real-time, one-man basis. (Appendix A).

14. A theoretical physico-chemical process for KO_2 with H_2O and CO_2 was developed. (Page 60).

15. A chemical utilization index was developed for KO_2 canisters. (Page 66).

Section IV

RECOMMENDATIONS

ADDITIONAL TEST PROGRAMS

Further test programs are recommended on the basis of the results obtained so far in this experimental development and evaluation of composite solid chemical canisters for atmospheric composition control in manned space vehicles.

<u>The Open Duct Canister Test Facility</u>

Using the same open duct canister test facility, the following approaches should be taken:

1. The effects of several reduced absolute pressures on the performance of KO_2 canisters (the "A" configuration) should be investigated at several levels of temperature, absolute humidity, and % CO_2. The performance parameters which should be measured are the inlet O_2 and CO_2 concentrations, the inlet absolute humidity, and the static pressures at the inlet and outlet of each canister.

2. The effect of various catalysts on the chemical R.Q. of KO_2 should be investigated in an effort to find out whether or not a catalyst can be selected that will control the CO_2 absorption - O_2 generation of KO_2 to match man's R.Q.

3. Using the existing open duct canister test facility, and a test procedure similar to that of the KO_2 tests, investigations should be made of,

   (a) the operational parameters of lithium peroxide (Li_2O_2) as an O_2 generator and CO_2 absorber for use in atmospheric composition control systems.

   (b) the feasibility and advantages of combining Li_2O_2 with lithium superoxide (LiO_2).

Such tests would be concerned primarily with the acquisition of basic operational data to evaluate performance and R.Q. matching ability of the lithium oxides.

The open duct solid chemical test facility makes possible full-scale whole-man tests in real time, allows changing of many operating parameters, and the observance of response rates to changing conditions. It also allows for the simultaneous testing and comparison of three different solid chemical canisters against a standard control canister. Such experiments result in the near-optimum operating conditions becoming known for various canisters and chemicals, and provides rapid design evolution for these canisters.

The Sealed Cabin Air Renewal System Test Facility

Using the sealed cabin air renewal system test facility (page 4), the following approaches should be taken:

1. In order to obtain more definitive R.Q. determinations, a sealed cabin test should be conducted utilizing small animals to demonstrate the feasibility (and reliability) of a dual-canister solid chemical system to support animal life over a long period of time, up to 30 days. This closed system test would utilize the "A" canister configuration (annular screen device) as one canister of the dual-canister atmosphere composition control system. The "A" canister would contain KO_2 with catalyst, supported by the annular screen technique. The other of the two canisters making up the dual-canister system would contain LiOH only.

2. If the Li_2O_2 proves superior to KO_2, it may be substituted for KO_2 in the dual-canister system above.

Section V

TEST DESIGN

BACKGROUND

A solid chemical system was proposed for atmospheric composition control of a sealed cabin. Compared to gas or cryogenic storage, algal, or chemo-electrolytic regenerative systems, a solid chemical system offers the following operational advantages: lower power consumption, ambient cabin gas pressures, minimum (or no) insulation, low leakage rate, no boil-off, and greater reliability. The open duct KO_2 canister test program was proposed to furnish critical design information needed for KO_2 oxygen generating - carbon dioxide absorbing canister beds intended for long duration use in manned space vehicles.

Potassium superoxide, in common with other solid chemicals used for atmospheric composition control, possesses the advantage of room temperature operation without the requirement of high pressure equipment. Unlike many other solid chemicals, KO_2 may serve a dual function of CO_2 removal and O_2 production. The use of KO_2 for atmospheric control is not new. Units employing KO_2 are produced commercially for emergency use in submarines, ships, aircraft, and in mines. Results of the closed-loop sealed cabin air renewal system test suggested the need for more (canister) tests of improved KO_2 bed packing configurations, with the operating parameters controlled in an attempt to prevent channeling of the airflow through the canister bed, caking of the superoxide, slugging of the ductwork by caustic liquid, and over- or underproduction of oxygen with consequent mismatching of man's R.Q. A survey of the available literature revealed a lack of the information required to answer these design and performance problems. The manned test (Reference 2) further indicated the need for such information.

A number of variables could be expected to effect the performance of a KO_2 canister in an atmospheric system. These include:

1. Temperature of the inlet air.
2. Dewpoint of the inlet air (as a measure of absolute moisture content).
3. CO_2 concentration at the inlet.

4. Air flowrate (bed velocity).

5. KO_2 bed length and diameter (ratio).

6. KO_2 bed-packing configuration.

7. Mixture of KO_2 with reactive or non-reactive chemicals.

8. Grain size of the KO_2.

9. Ratio of O_2 to inert gases in the inlet air.

10. Total (atmospheric) pressure at the inlet.

Due to limitations in time and funds it was decided to evaluate only the effects of items 1 through 7, which were considered to have the strongest influence upon canister performance. If all possible combinations of all ten variables at three levels were considered, about 59,000 tests would have had to be conducted. Seven variables at three levels would still have required over 2,000 individual tests if all possible combinations were tested. Therefore, we reduced (by intuitive judgement) the plan for testing all possible combinations to a reasonable number of individual tests (i.e., 67 tests in the original plan) which we believed would satisfactorily indicate the effects of all test parameters on canister performance. It was decided, at that time, to perform the tests in two phases, i.e., the first phase would consist of 66 short run individual tests (conducted three at a time by paralleling canisters), and the second phase would be a single larger individual canister tested for an extended period of time. After the basic effects of all test parameters were observed in the short run tests, a near-optimum set of operating levels would be selected for the extended duration test of the "best" (selected) canister design. This final canister was to be run to the point of exhaustion to investigate practical design criteria such as channeling, and effective yield of the bed, and to identify problems that might occur during extended operation. During the first phase tests, some of these canisters were to be run to breakthrough. Sequential testing was to be applied throughout, and thus the experimenters could stop after any change of operating conditions, or change of canister design, and examine the accumulated results (to date), before deciding whether to continue the experiment as outlined above, or make changes in the original test plan. In this way, the experimenters were allowed freedom to alter any operating conditions or canister designs (as the test program progressed), which definitely appeared to be leading us away from near-optimum operating conditions or near-optimum canister design.

GENERAL DESCRIPTION

A test was considered to consist of passing room air at controlled levels of temperature and absolute humidity, gas velocity, and CO_2 concentration through four KO_2 canisters in parallel, for a specified length of time. Three of the canisters were to be test units whose design (bed dimensions and internal packing) were to be varied from one test to the next; the fourth canister was to be a small commerical emergency unit used as a control standard in all tests. First phase testing was to consist of short-run tests of 4 to 5 hours duration, with a portion of these short tests run to exhaustion (about 8 to 10 hours), for various combinations of values for the operating parameters (temperature, dew point, gas velocity, and CO_2 concentration). The design parameters (internal packing configuration, and bed length to bed diameter ratio) were to be varied from one test to the next. (See Table 3). Measurements were to be taken intermittently throughout all tests to determine O_2 and CO_2 concentration, humidity, and static pressure at the inlet and outlet of each canister, thereby permitting canister performance to be associated with time as well as with values of the test parameters.

THEORETICAL CONSIDERATIONS

The existing literature gives many theoretical reactions of a KO_2 bed with water and carbon dioxide. Some of these are indicated in Table 1. The extent to which these reactions occur is not well known, particularly the hydration of KOH and K_2CO_3. The chemical equilibria of an active KO_2 bed are very complex. The major parameters appear to be the input absolute humidity and % CO_2 concentration, the air mass-flow, and the temperature of the chemical bed. Several of the most likely reactions from Table 1 can be combined into the following overall equation:

$$4\ KO_2 + 3\ H_2O + 2\ CO_2 = 2\ K_2CO_3 \cdot 3\ H_2O + 3\ O_2$$

Water may be absorbed in the KO_2 bed without equivalent O_2 evolution, possibly due to hydrate formation. The chemical literature indicates the formation of H_2O_2 in a KO_2 bed provided there is no catalyst present to decompose the peroxide. This peroxide decomposition is highly exothermic

Table 1 Chemical Reactions of KO_2 Bed

$$4\ KO_2 + 2\ H_2O = 4\ KOH + 3\ O_2$$

$$2\ KOH + CO_2 = K_2CO_3 + H_2O$$

$$KOH + CO_2 = KHCO_3$$

$$KHCO_3 + KOH = K_2CO_3 + H_2O$$

$$KOH + 3/4\ H_2O = KOH \cdot 3/4\ H_2O$$

$$KOH + H_2O = KOH \cdot H_2O$$

$$KOH + 2\ H_2O = KOH \cdot 2\ H_2O$$

$$2\ KOH \cdot 2\ H_2O + CO_2 = K_2CO_3 \cdot 3/2\ H_2O + 7/2\ H_2O$$

$$K_2CO_3 + 1/2\ H_2O = K_2CO_3 \cdot 1/2\ H_2O$$

$$K_2CO_3 + 3/2\ H_2O = K_2CO_3 \cdot 3/2\ H_2O$$

$$2\ KO_2 + 2\ H_2O = 2\ KOH + H_2O_2 + O_2$$

$$H_2O_2 \xrightarrow{\text{cat.}} H_2O + 1/2\ O_2$$

$$KO_2 + CO_2 \xrightarrow{0\text{-}10°C} K_2CO_4$$

$$K_2CO_4 + CO_2 \xrightarrow{0\text{-}10°C} K_2C_2O_5 + 1/2\ O_2$$

$$K_2CO_4 + CO_2 \xrightarrow{0\text{-}10°C} K_2C_2O_6$$

$$K_2CO_4 \xrightarrow{\text{heat}} K_2CO_3 + 1/2\ O_2$$

and readily catalyzed by heavy metal oxides. Therefore, to provide a high O_2 generation rate, an H_2O_2 catalyst should be incorporated into the KO_2 bed.

Section VI

TEST SET-UP AND INSTRUMENTATION

DESCRIPTION OF TEST FACILITY AND TEST INSTRUMENTATION

Test Set-Up

Three axial blowers were used to supply room air to the test system. These blowers together had a capacity of about 19 SCFM at 18 inches of H_2O, which was sufficient to compensate for all impedance in the test system, and provide the required airflows through the canisters. The first stage blower was wrapped with a copper coil through which cold tap water flowed carrying away some of the heat of compression. (Figures 8, 9, and 10). Downstream of the third stage blower an aluminum water jacket was welded around the aluminum air duct, and cold tap water passed into, and out of, this cold water jacket further reducing the heat of compression. (Figure 10).

The air next entered the chilled water aircraft-type heat exchanger (Figure 11) where it was cooled to a predetermined dewpoint, and any condensation removed through a condensate drain and trap. The water which circulated through this heat exchanger contained ethylene glycol to depress the freezing point of the liquid coolant (to $< 32°F$), and prevented freeze-up of the chilled water refrigeration units (Figure 11) which was the cause of the intermittent failure of the refrigeration units in the animal test (page 3). The liquid coolant loop contained a pump, a 3-way valve, and a sump. Originally, the sump was included with the intention of passing liquid CO_2 through methyl alcohol (in this sump) for a coolant, but when this idea was discarded (so as not to increase the normal PCO_2 in the room) in favor of vapor-cycle (Freon) refrigeration units, the sump thereafter served no real purpose. The 3-way valve was modulated (manually) to provide the required dew-point in tests calling for absolute humidities less than that of the room air. If an absolute humidity was required which was greater than that of the room air, steam was generated at the inlet of the first stage blower. When the absolute humidity was reduced, the excess moisture condensed in the heat exchanger was removed by the trap.

Immediately downstream of the chilled water heat exchanger, CO_2 gas was resulated and metered into the air duct from a pressure bottle. This bottle was charged from a plant liquid CO_2 line to 300 psig before each test run.

Air of the required dew point and % CO_2 concentration was then passed through a 1500 watt finned-strip heater which was activated and regulated by a thermostat as required to provide the proper dry bulb temperature and % relative humidity.

Downstream from the heater was located the sensing element of the electric hygrometer after which the air entered a distribution manifold. From the manifold it was distributed through the aluminum ducting to the four canisters, and also through a by-pass bleed line, to ambient. The air passing through the canisters was discharged into stainless steel ducting from the outlet of each canister (or its stainless steel transition piece) and was vented to ambient. Orifice meters were located in the ducts between the distribution manifold and each canister.

Pressure Instrumentation

Pressure taps connected to water manometers were used throughout the system. Monitored points included:

P_1 - upstream of hygrometer sensing element

P_2 - upstream of orifice, canister No. 1

ΔP_3 - differential of orifice, canister No. 1

P_{10} - upstream of canister No. 1

ΔP_{11} - differential of canister No. 1

P_4 - upstream of orifice, canister No. 2

ΔP_5 - differential of orifice, canister No. 2

P_{12} - upstream of canister No. 2

ΔP_{13} - differential of canister No. 2

P_6 - upstream of orifice, canister No. 3

ΔP_7 - differential of orifice, canister No. 3

P_{14} - upstream of canister No. 3

ΔP_{15} - differential of canister No. 3

P_8 - upstream of orifice, canister No. 4

ΔP_9 - differential of orifice, canister No. 4

P_{16} - upstream of canister No. 4

ΔP_{17} - differential of canister No. 4

Temperature Instrumentation

Iron-Constantan thermocouples connected to a Brown-Electronik recorder were used to indicate wet bulb and dry bulb temperatures throughout the system. Temperature rise across the canisters was monitored by a Honeywell Brown Electronik Potentiometer Pyrometer. Monitored points included:

T_1 - upstream dry bulb of canister No. 1

T_2 - downstream dry bulb of canister No. 1

T_3 - downstream wet bulb of canister No. 1

ΔT_1 - temperature rise across canister No. 1

T_4 - upstream dry bulb of canister No. 2

T_5 - downstream dry bulb of canister No. 2

T_6 - downstream wet bulb of canister No. 2

ΔT_2 - temperature rise across canister No. 2

T_7 - upstream dry bulb of canister No. 3

T_8 - downstream dry bulb of canister No. 3

T_9 - downstream wet bulb of canister No. 3

ΔT_3 - temperature rise across canister No. 3

T_{10} - upstream dry bulb of canister No. 4

T_{11} - downstream dry bulb of canister No. 4

T_{12} - downstream wet bulb of canister No. 4

ΔT_4 - temperature rise across canister No. 4

T_{13} - dry bulb downstream of electric hygrometer

T_{14} - coolant temperature at 3-way control valve

T_{15} - by-pass dry bulb

T_{16} - by-pass wet bulb

Water Analysis

The water content of the inlet air was monitored with an electric hygrometer, dry bulb and wet bulb thermocouples in the by-pass line, and a Hygrophil wet bulb-dry bulb "gun". The water content of the outlet air was monitored by dry bulb and wet bulb thermocouples located in the exit ducts, and by the Hygrophil "gun".

Oxygen and Carbon Dioxide Analysis

Through a series of sampling valves and lines, the inlet air, outlet air, and standardizing bottled gases could be directed through Drierite rubes, Fisher & Porter Rotometers, and the sensing elements of the gas analyzers. A Beckman Model E2 oxygen analyzer, and a Beckman Model 15A infrared carbon dioxide analyzer were used for the gas analysis.

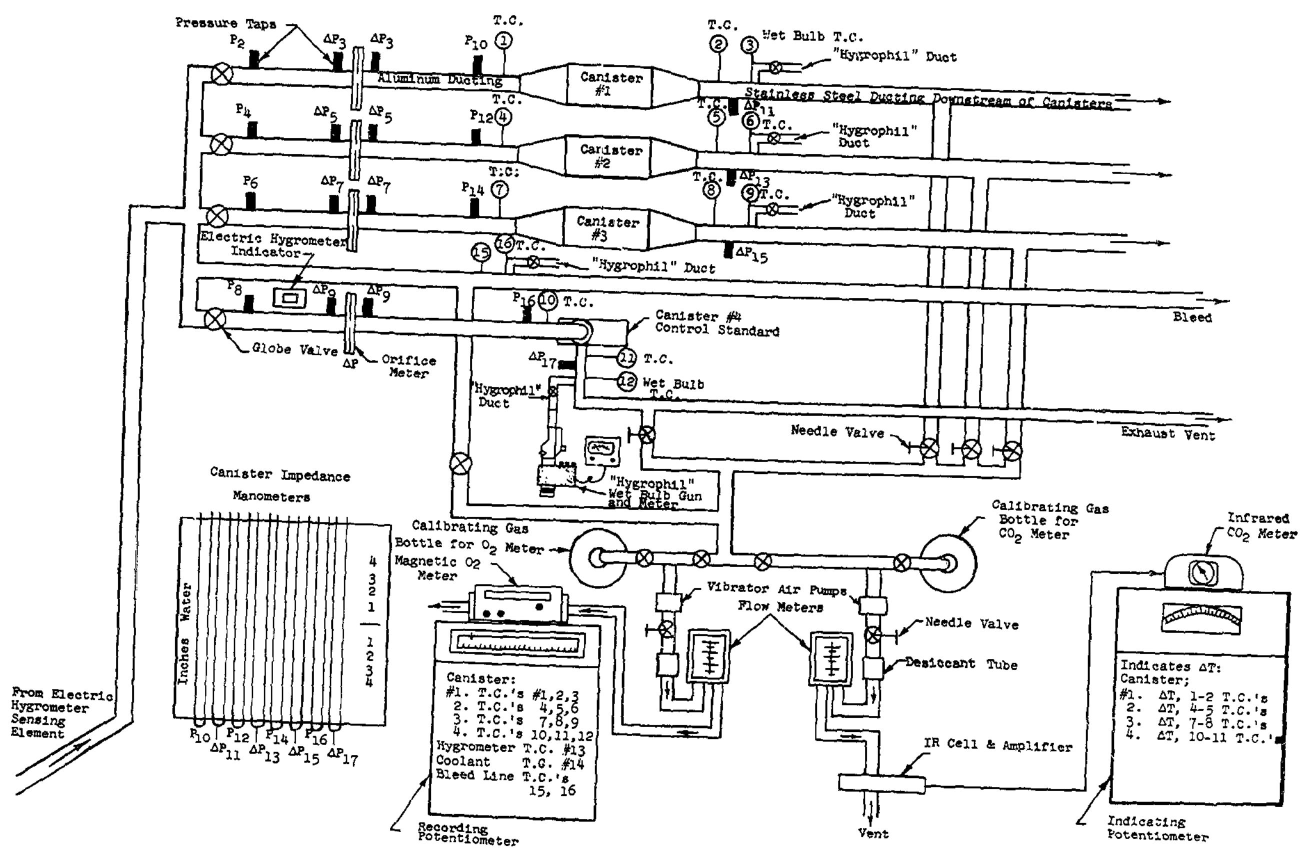


Figure 8 (cont.) Schematic of Open Duct KO_2 Canister Test Facility

Table 2 Test Instrumentation

Recorder:	Honeywell Brown Electronik Model 153X89-CS-II-III-16A4 S/N 834684 Range - 100 to +1100°F Chart No. 6608 FLS 4795 NAA N-241-525
ΔT Indicator:	Honeywell Brown Electronik Potentiometer Pyrometer Model 156X15V S/N 725352 Range 0 to 5mv ELS 2990 TSC 16453
Oxygen Analyzer:	Beckman Model E2 Ranges 0-3, 0-6,0-30% ELS 4829 NAA S-252-998
CO_2 Analyzer:	Beckman Infrared Model 15A ELS 4209 TSC 34006
Hygrometer:	American Instrument Company "Electric Hygrometer" Cat. No. 4-5171 S/N 1075 ELS 3782 NAA 219261
Gun:	Atkins Technical Inc. "A+ Hygrophil Gun" Model 4450 Range 14 to 176° F S/N A-0934 ELS 4848
Sling:	Bacharach Ind. Inst. Co. Sling Psychrometer

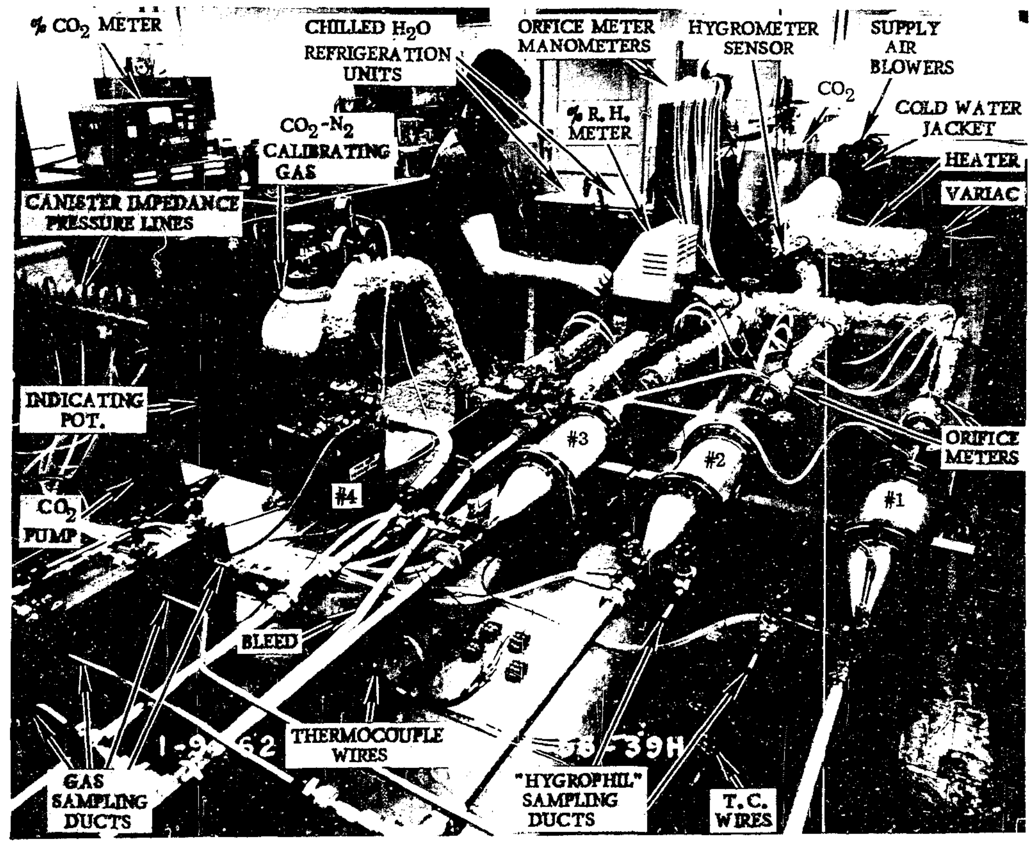


Figure 9 General View of Open Duct KO_2 Canister Test Facility

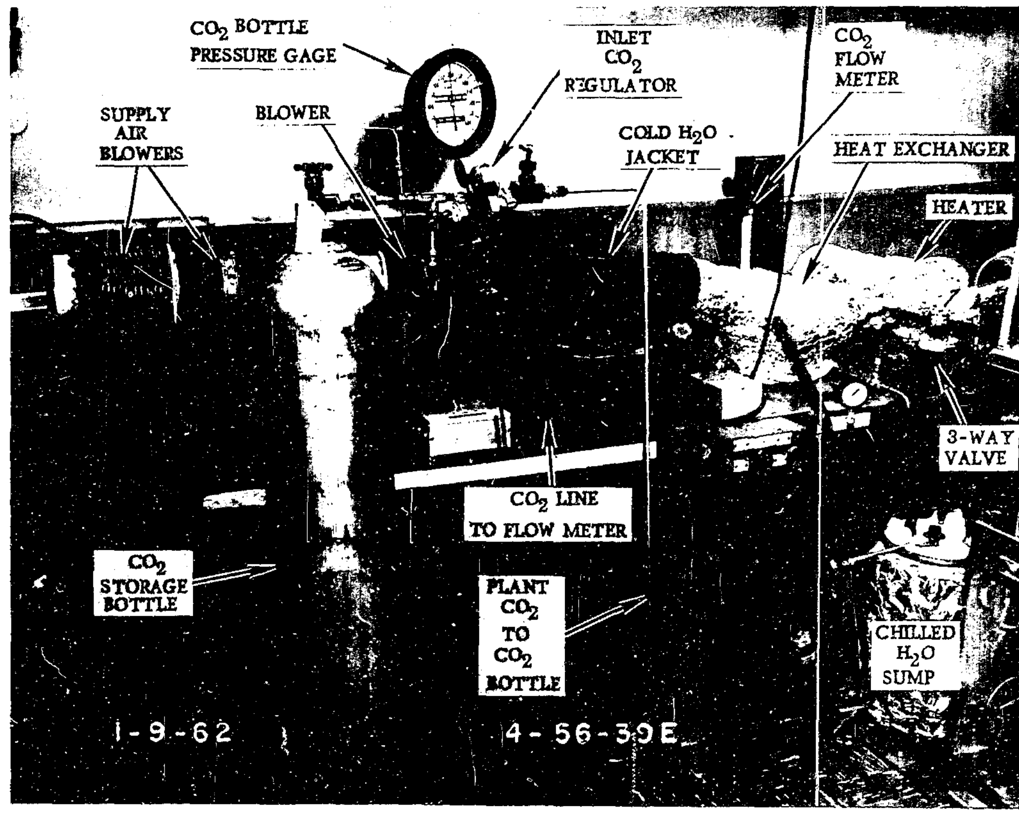


Figure 10 Supply Air Blowers

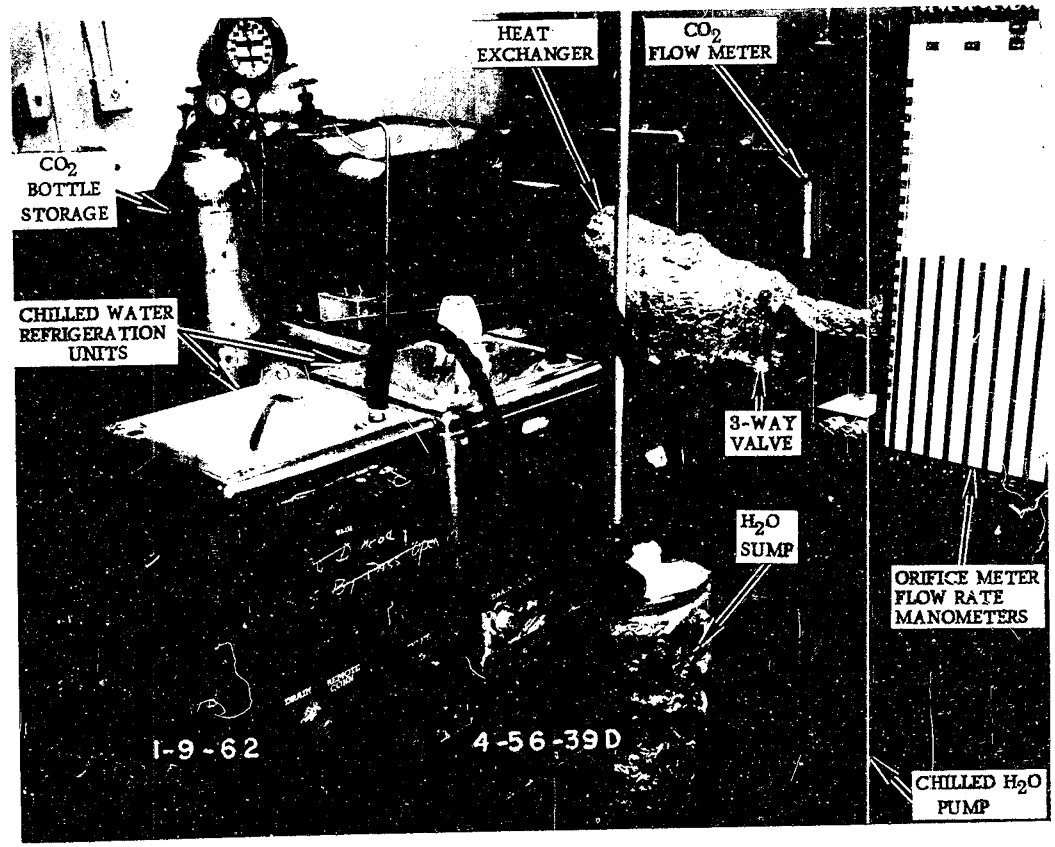


Figure 11 Chilled Water Refrigeration Units

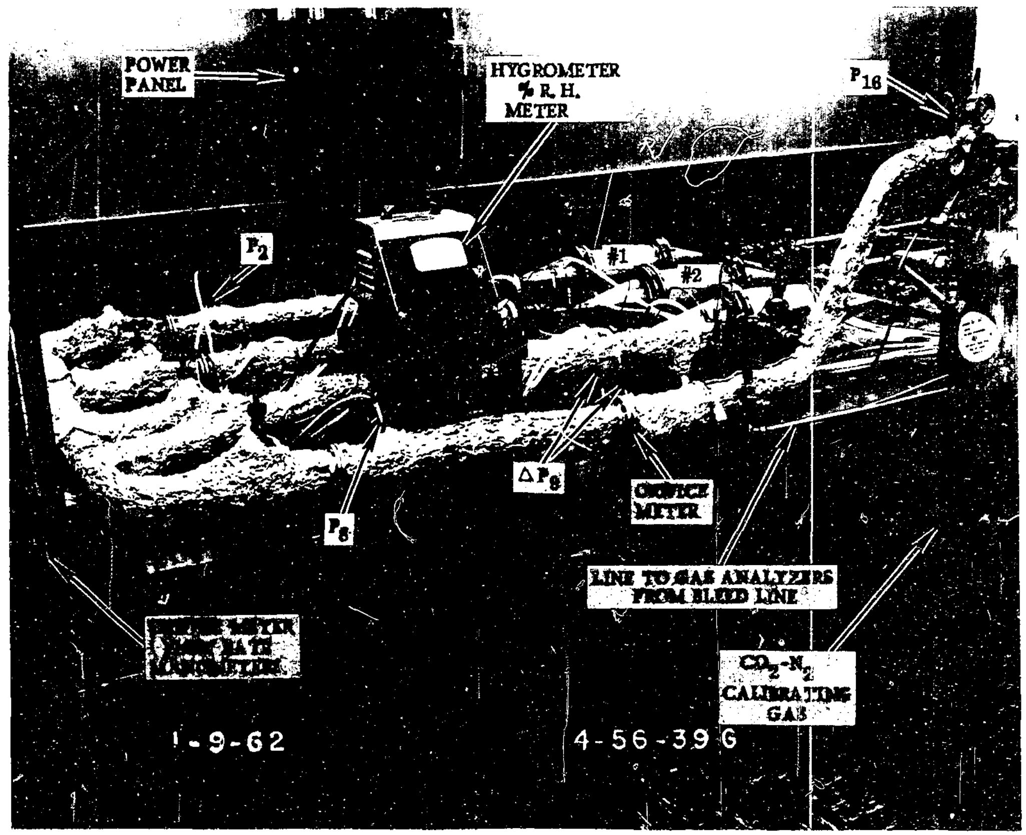


Figure 12 Ducting to Canisters

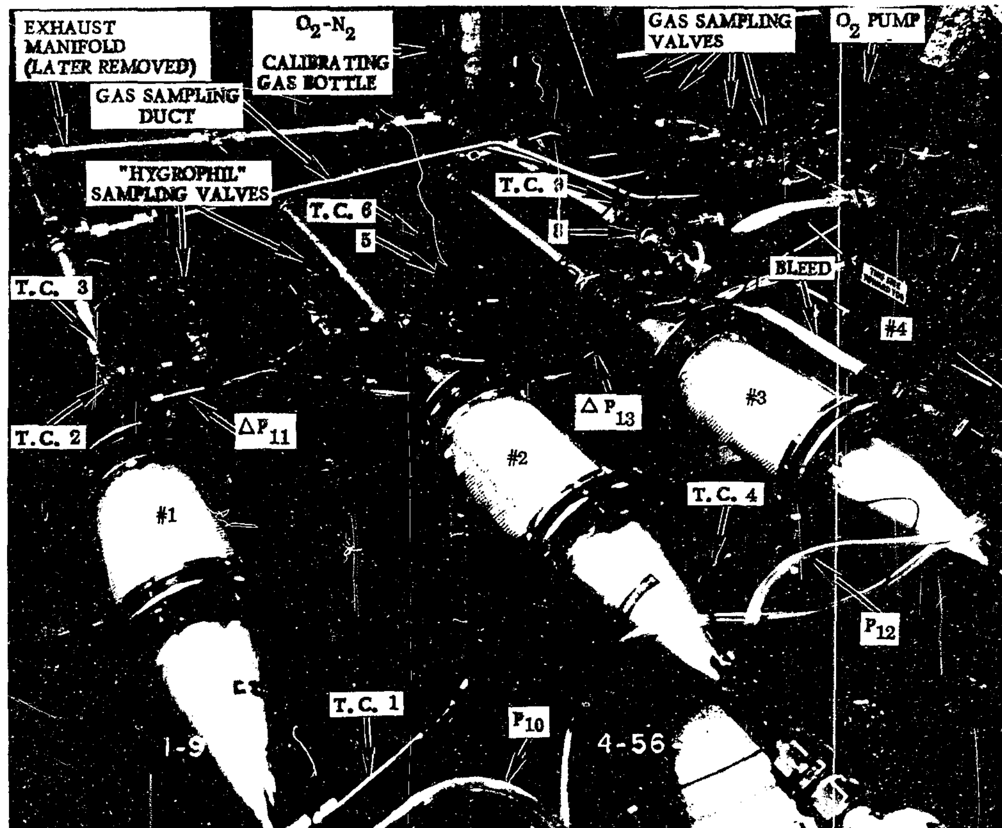


Figure 13 Test Canisters and Control Standard Canister In Test Facility

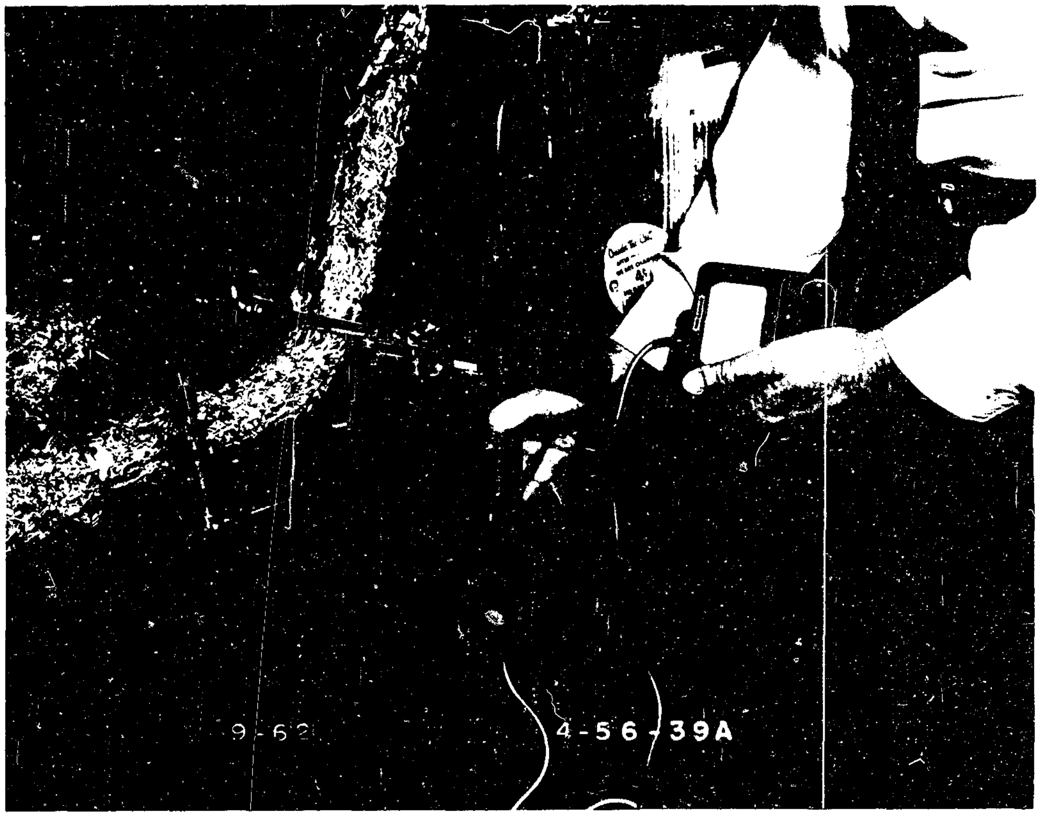


Figure 14   Taking a Wet Bulb Reading with the Hygrophil "Gun"

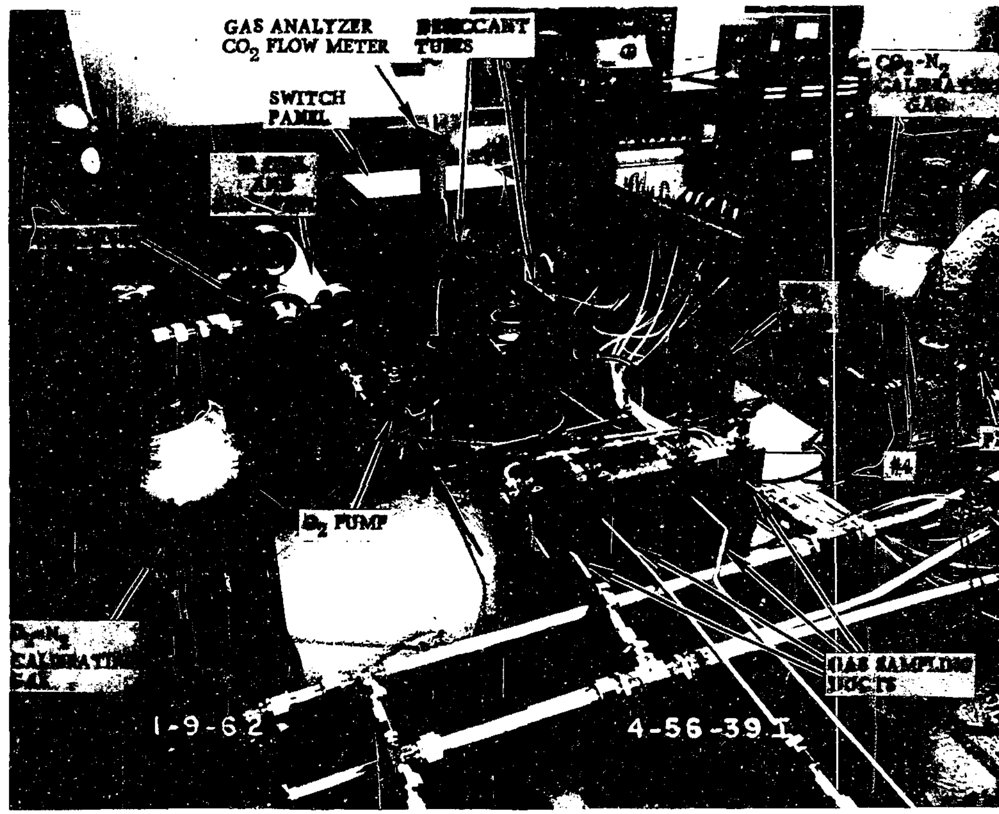


Figure 15   Gas Sampling Ducts

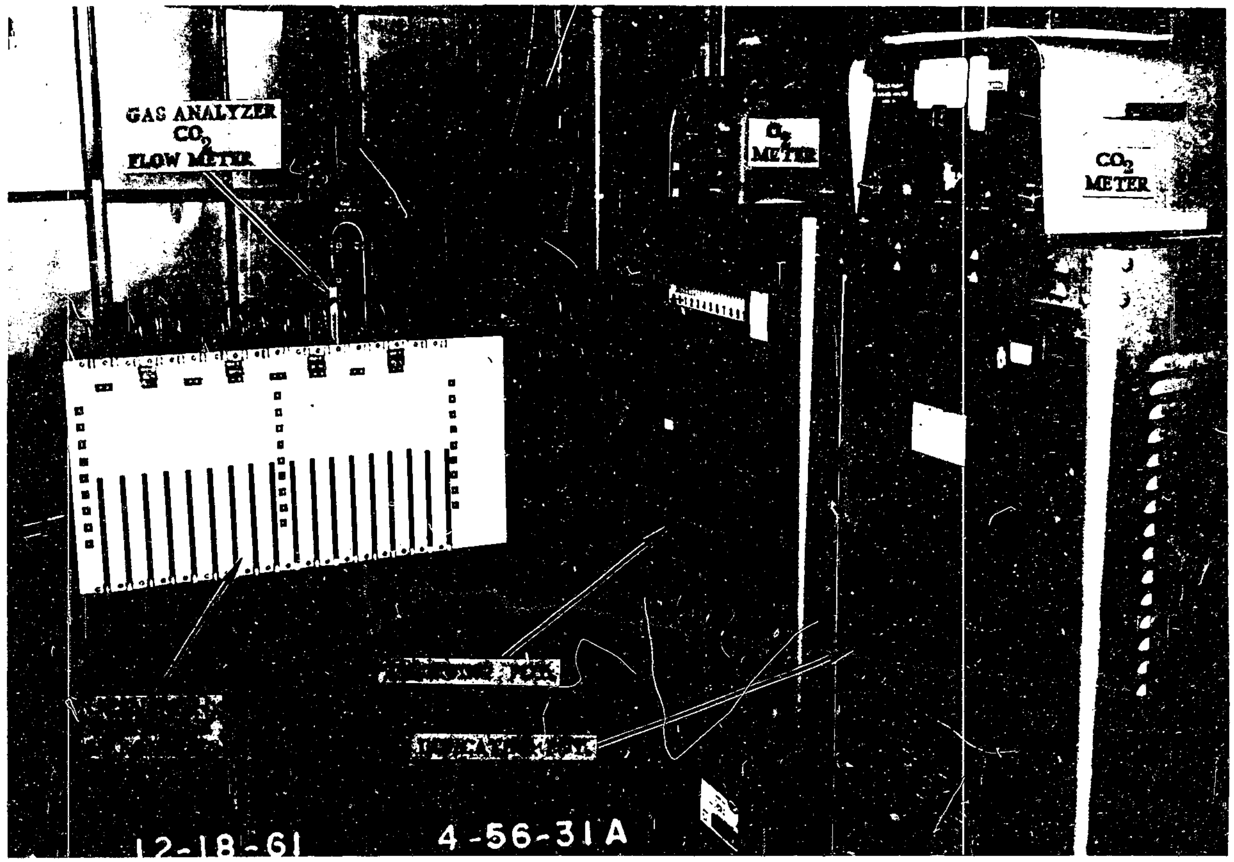


Figure 16 Gas Analyzers and Potentiometers

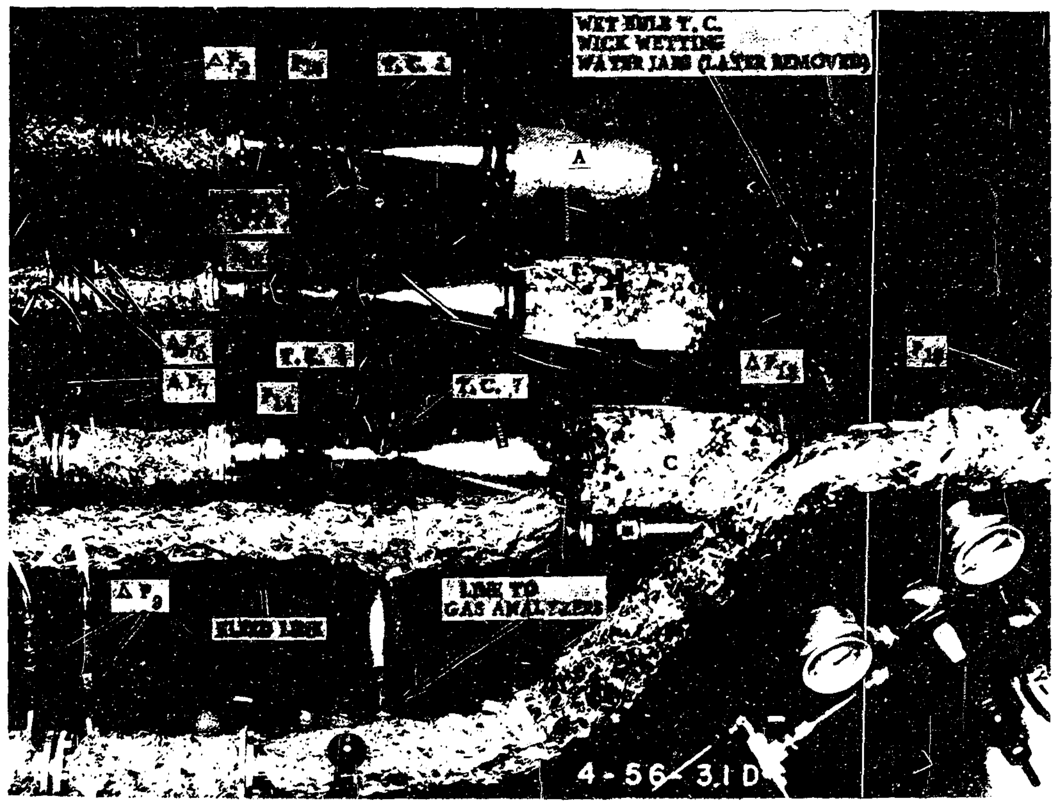


Figure 17 Canisters A, B, and C (Test P-1) in Test Facility

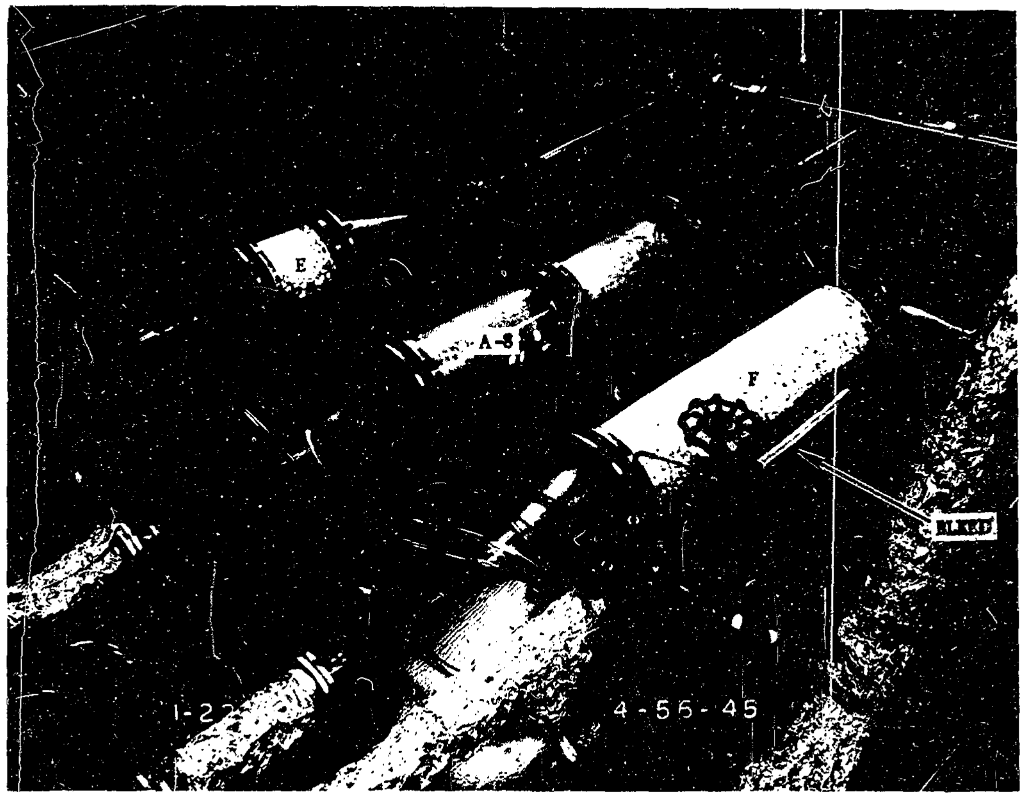


Figure 18   Canisters E, A-8, and F (Test P-10) In Test Facility

Section VII

MATERIALS AND EQUIPMENT TESTED

CANISTER CONFIGURATIONS

Canisters of various packing and dimensional configurations were tested. Table 3 describes these canisters. (See Appendix A for derivation of canister sizes, gas flow rates, chemical weights, etc.). Figure 19 shows the Lucite canister shells in modular sizes. Figure 20 shows a typical 10" module with the "A" configuration, while Figure 21 is a sectional view of the same canister with its transitional ducts. Figures 22 and 23 are exploded views of the "A" configuration, and Figures 24 and 25 are view of A-8 canister which consisted of two 10" "A" modules joined in tandem. Figure 26 is typical of the 5" module in either the E or C-2 configuration. Figure 27 is a view of the 10" module in D configuration (four slotted inlet brass probes, and one slotted outlet brass probe). The annular screen is present in all "A" configurations, activated alumina is present in the single "B" configuration, and LiOH is present in all "C" configurations. LiOH is also present in other configurations, but in those cases it is not the dominant design consideration. "D" is a single configuration utilizing the slotted brass probes in conjunction with LiOH. Corrosion is seen on the brass probes. The plugging of "E" and "F" configurations was extremely important in the final evaluation of the role of the annular screen in the successful A and A-8 configurations.

The contents of each canister were packed by a manual loading operation in the proportions indicated in Table 3. The catalyst, copper and manganese oxides, had been impregnated in a portion of the KO_2 granules during their manufacture by the Mine Safety Appliances Company. The purpose of the catalyst is apparently to decompose H_2O_2 formed, and thus increase the rate of O_2 production from the KO_2.

The yellow KO_2 granules were of 2 to 4 mesh size with a density of $\sim$40 lbs/ft^3. The black lava rock was a porous volcanic cinder of about 2 to 4 mesh, and had a density of $\sim$ 51 lbs/ft^3. The purpose of the lava rock was to act as a porous inert mechanical separator whose action (it was hoped) would slow down the rate of increase of canister impedance during operation of a canister. This was not too successful as can be seen in the ΔP columns (for the "C" canister configuration) of the partially reduced data sheets for tests P-1, P-2, P-3, P-4, and its use was abandoned.

The activated alumina (density = 60.6 lbs/ft^3) was chosen for test purposes as a hydrophilic adsorber on the assumption that its use would prevent an excessive collection of either water-of-reaction or atmospheric water in the canisters with resultant slugging and plug formation. From comparison of the ΔP columns of the partially reduced data sheets (P-1, P-2, P-3, and P-4) it was seen that its effectiveness was rather limited, as was LiOH (density = 35.4 lbs/ft^3) when used for the same purpose. LiOH had the additional advantage of being a CO_2 adsorber, but it too was unsatisfactory (as a single device) for controlling slugging in the KO_2 bed.

The molecular sieve (Linde X13, density = 43.0 lbs/ft^3) was tried for the same purpose of water control in the canister bed, but its true value as a single controlling device was obscured by the fact that the annular screen was also present in every configuration that contained the molecular sieve. However, since the annular screen by itself (configuration "A") was so successful in controlling plugging, the elimination of the molecular sieve during the development program was substantiated on a least-weight optimization basis alone. Also, the use of molecular sieve was contra-indicated by the fact that the adsorption of water by the molecular sieve inhibited the evolution of O_2 from the KO_2. A short study was made of other hydrophilic adsorbers, and some promise was indicated for diatomaceous earth, silica gel, Perlite (expanded silica), vermiculite (expanded mica), Drierite (calcium sulfate), chopped blotter-paper, and chopped egg-carton paper. The same consideration for least-weight optimization, as applied to the molecular sieve, might also rule out the above materials.

Although a description of all canister configurations can be found in Table 3, the following paragraphs describe the "A" canisters in detail because the "A" configuration was the most successful design tested, and also the most promising for practical application.

STRUCTURE OF THE "A" CANISTERS

The canister consisted of a 5" inside diameter Lucite cylinder of 10" (and also 20") overall length. The cylinder was made with flanges at both ends to fit in the open duct system, and between transition pieces with 15° half-angles. Inside the Lucite cylinder there was positioned (by means of a flange on the outer screen, and grooves in the cylinder flanges) a nested cylindrical double-screen insert. The inner screen formed the core. Between the core and the outer screen, the granular chemical was packed. The inlet end of the double-screen was closed by means of a plate which had four annular slots (with a total cross-sectional free area equal to the 1" duct leading to the transition piece) and which allowed the air to pass into the annulus formed between the Lucite shell and the outer screen. The outlet end of the double screen was closed by a circular screen mounted across the spider and flange which positioned it within the shell. This end-piece screen was welded to the cylindrical double screen.

OPERATION OF THE "A" CANISTER

The air flowed through the annular slots, passed axially down the annulus between shell and outer screen, flowed transversely and radially across the packed chemical bed into the core, and thence to the outlet. The air could also flow axially through the packed chemical bed directly to the outlet. Its construction provided for a very large area of the chemical bed being exposed to a very low velocity flow of the airstream, instead of the usual small cross-sectional face area presented to the air path in straight-through canisters.

The double canister (see Figure 24) was an example of how the modular feature of the canister can be exploited. Two 10" long canisters were joined in tandem. The inlet plate was not used in the second 10" canister, but was replaced by a circular screen with a rubber plug to force annular flow in the second shell, (see Figure 25).

COMPOSITION OF THE "A" CANISTER MATERIALS

The outside shell of the canister was made of Lucite for viewing the chemical bed during the tests, but can be made of any non-corrosive material. The mesh screen and inlet plate was used for certain test purposes, but the plate may be solid in the center with no opening for a plug.

CALCULATED WEIGHTS OF KO_2

The weight differences of the KO_2 in various canisters, as given below, must be taken into account for any final comparison of the effects of operating parameters upon the O_2-CO_2 generating and adsorbing rate characteristics of KO_2 canisters.

CONFIGURATION	KO_2 lbs
A-3	1.05
B, C	1.47
C-2	1.47
MSA	2.00
D, A-4, A-5, A-6, A-7	2.11
E	2.20
A, A-2	3.16
A-8	6.32
F	8.80

These calculations were made on the basis that a 5" x 10" canister filled entirely with KO_2 (with or without catalyst) contained 4.4 lbs of KO_2. (See Appendix A, paragraph 11). Also, the assumption was made that 30% of the volume available for KO_2 was taken up by the annular screen device, and the same for the one canister with the brass probes. The bulk density of the KO_2 was taken as 41 lbs/ft^3. The weight of KO_2 in the MSA canister was measured, not calculated.

Table 3 Canister Configurations

Canister	Description
A.	KO_2 + Catalyst + Annular Screen
B.	1/3 KO_2 + Cat. + 1/3 Lava Rock + 1/3 Act. Alumina
C.	1/3 KO_2 + Cat. + 1/3 Lava Rock + 1/3 LiOH
MSA.	Mine Safety Appliance Standard "Chemox" Canister; KO_2 + Cat. + Flat Screens
A-2.	KO_2 (No Cat.) + Annular Screen
A-3.	1/3 KO_2 + Cat. + 1/3 Lava Rock + 1/3 Molecular Sieve + Ann. Screen
D.	2/3 KO_2 + Cat. + 1/3 LiOH + Brass Probes
A-4.	2/3 KO_2 (No Cat.) + 1/3 M.S. + Ann. Screen
A-5.	2/3 KO_2 (No Cat.) + 1/3 LiOH + Ann. Screen
A-6.	2/3 KO_2 + Cat. + 1/3 M.S. + Ann. Screen
A-7.	2/3 KO_2 + Cat. + 1/3 LiOH + Ann. Screen
E.	KO_2 + Cat., in 5" long canister (no screen)
A-8.	KO_2 + Cat., in two 10" long canisters in tandem, with screens, and slotted plate at inlet only.
F.	KO_2 + Cat., in 20" long canister (no screen)
C-2.	2/3 KO_2 + Cat. + 1/3 LiOH, in 5" canister (no screen)

NOTE: All canisters 10" long except as noted in E, A-8, F, and C-2.

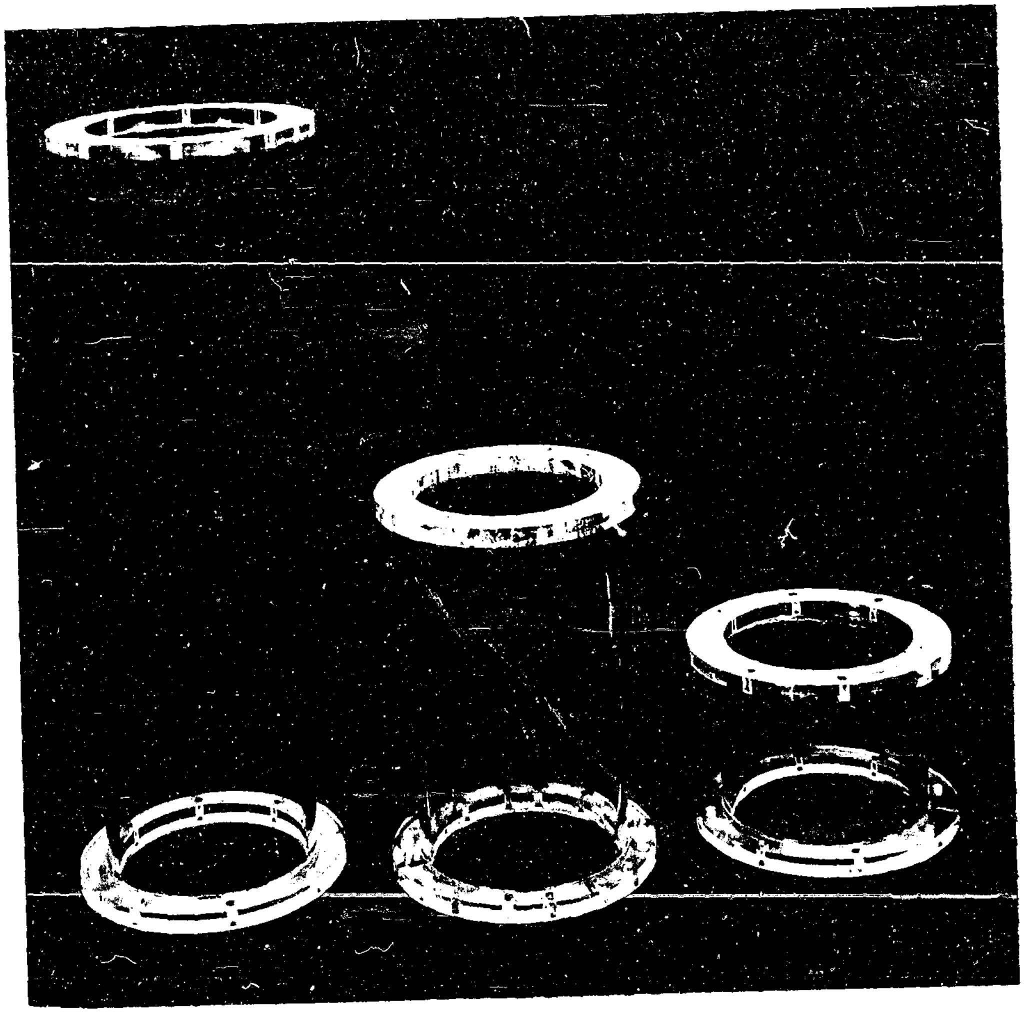


Figure 19 20", 10"and 5" Lucite Canister Shells

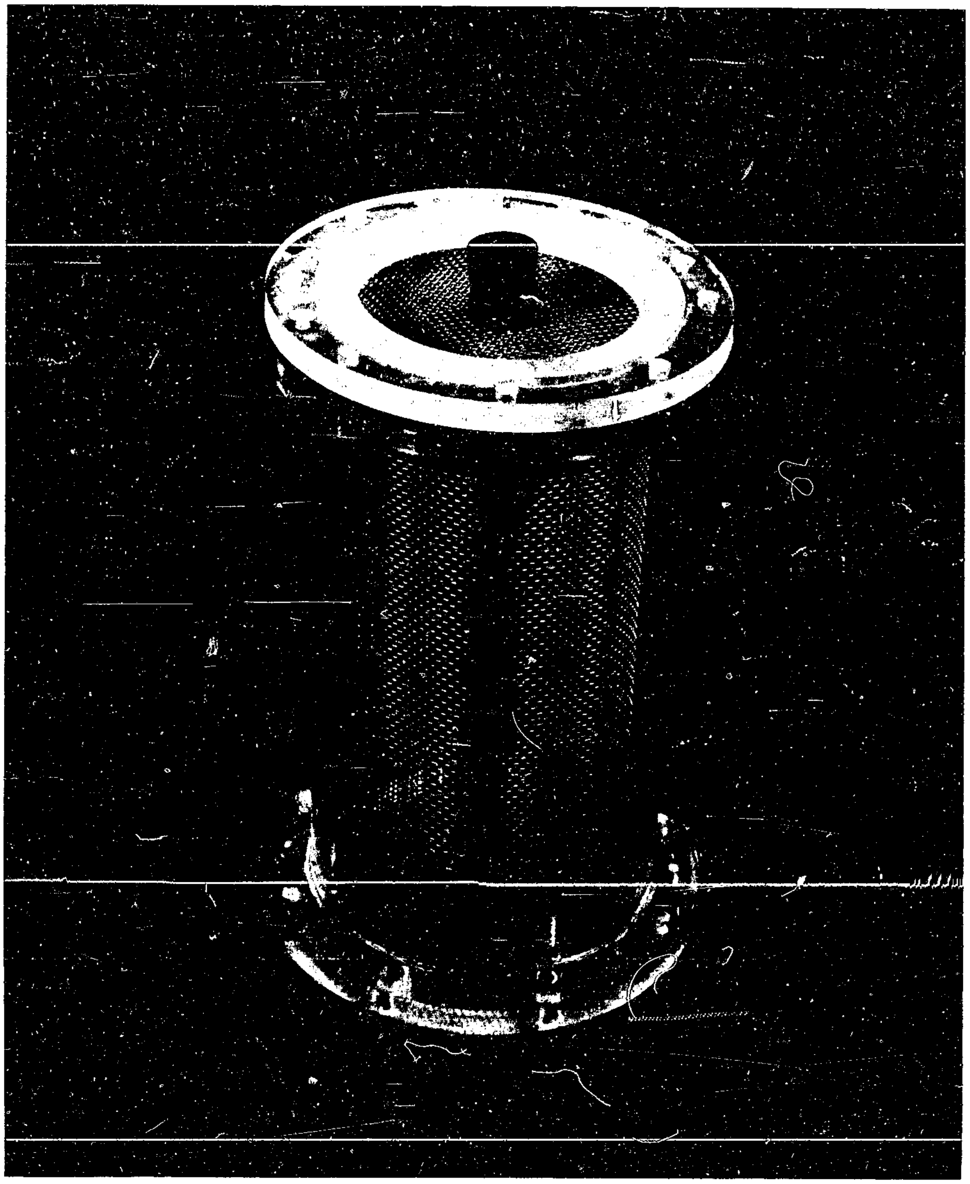


Figure 20 Inlet View, Canister A, Assembled

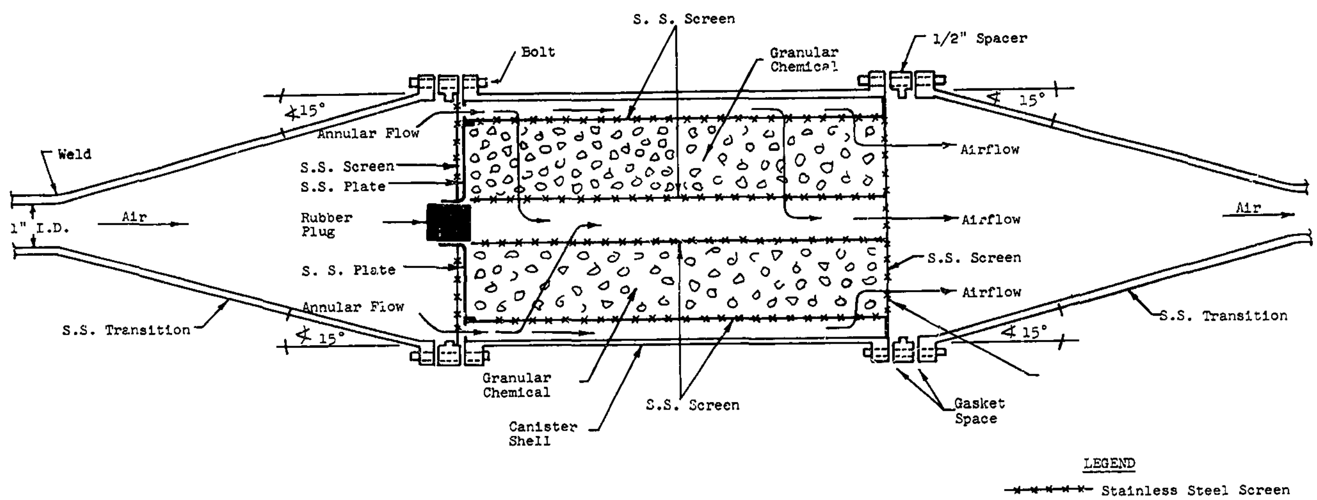


Figure 21 Sectional View of Canister "A" with Transitional Ducts

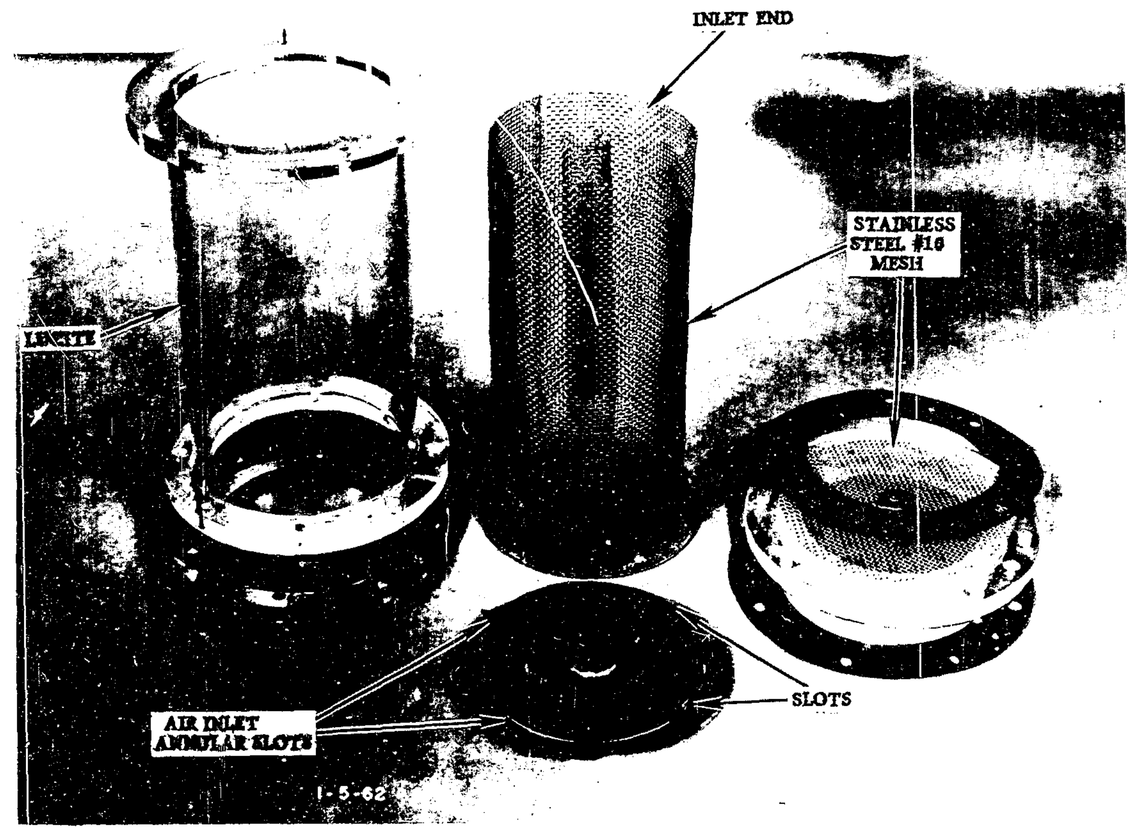


Figure 22 Exploded View, Canister A

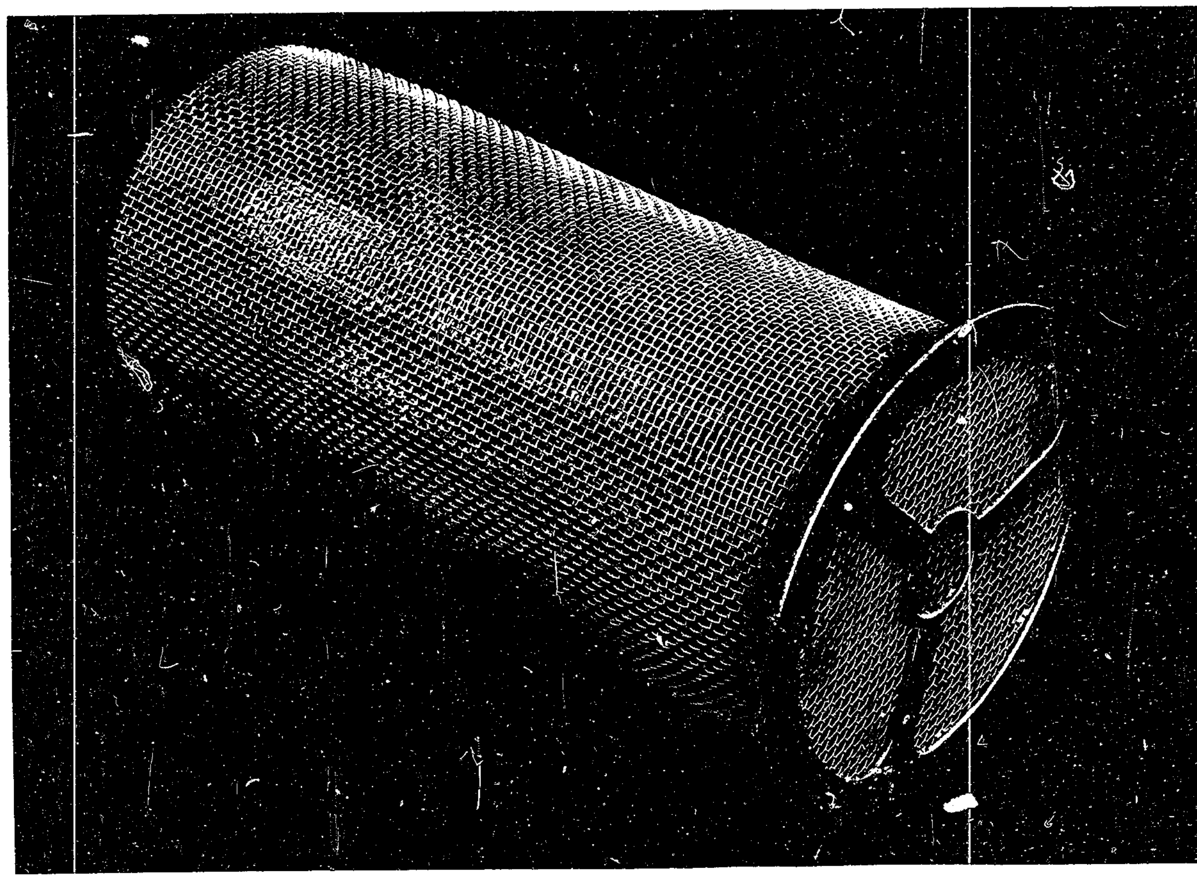


Figure 23 Outlet View, Canister A Annular Screen

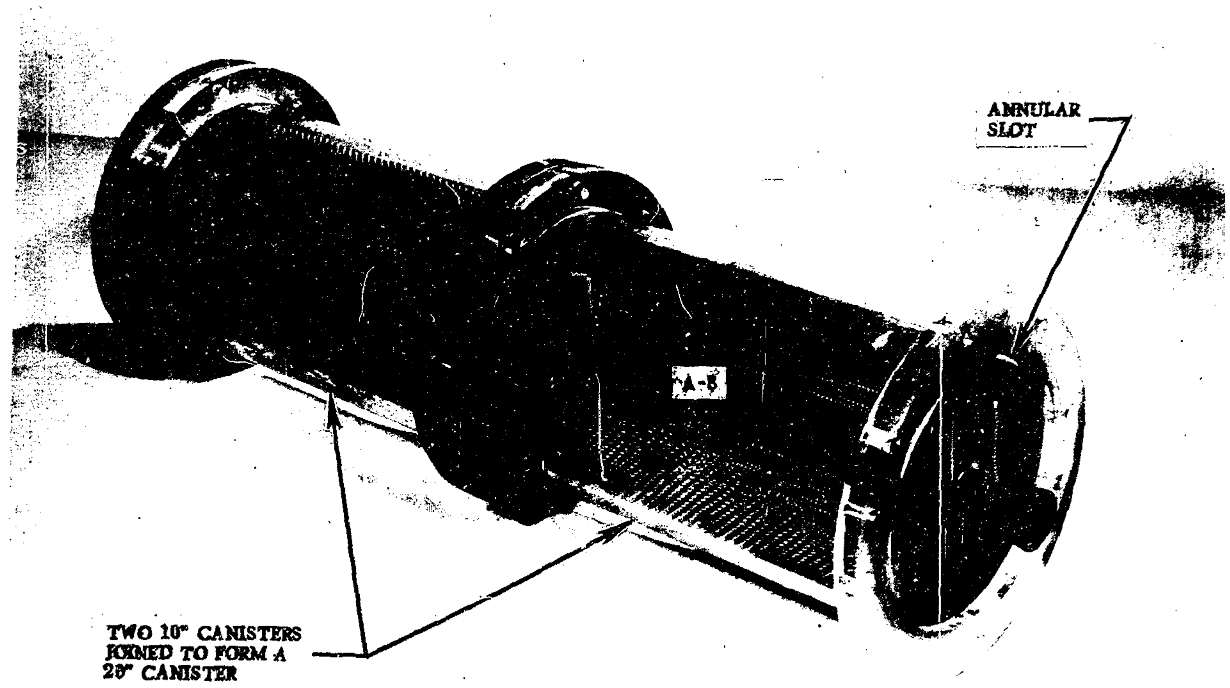


Figure 24 Inlet View, Canister A-8, Partial Assembly

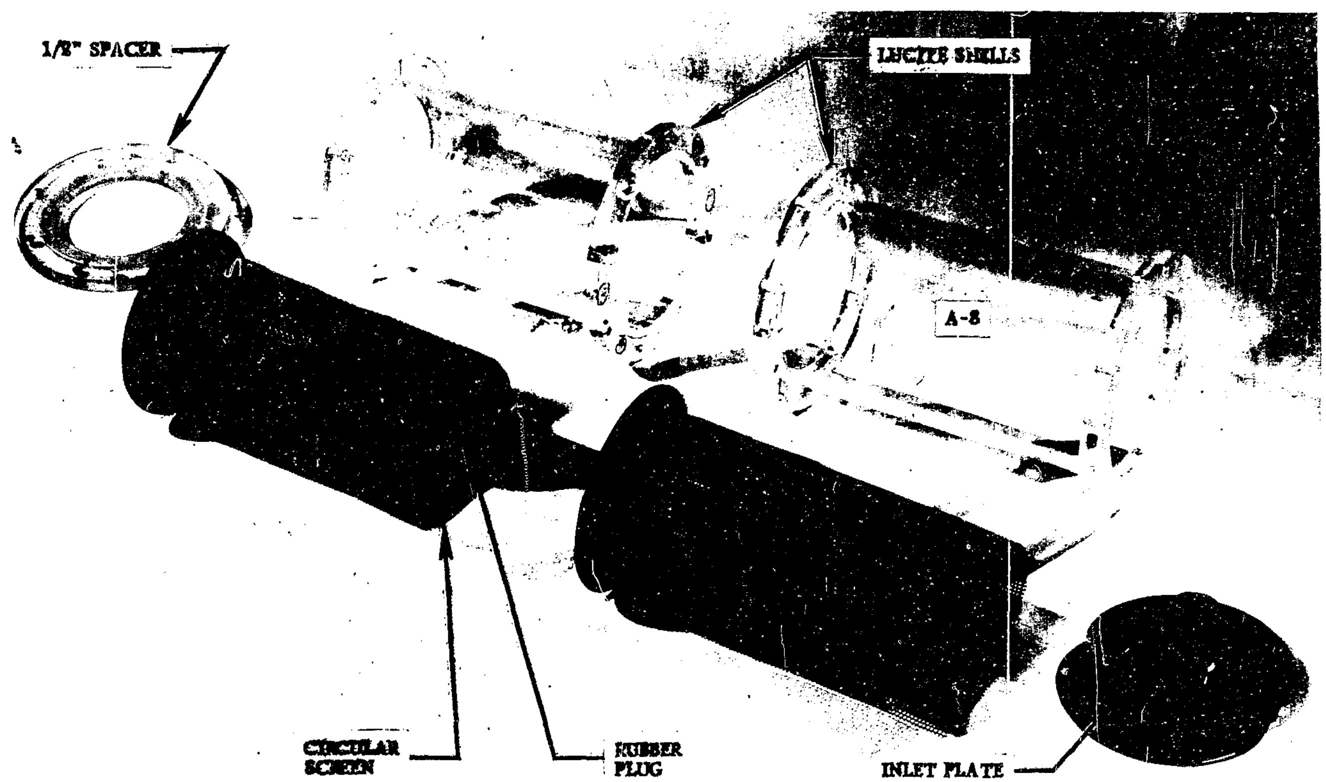


Figure 25 Canister A-8, Exploded View

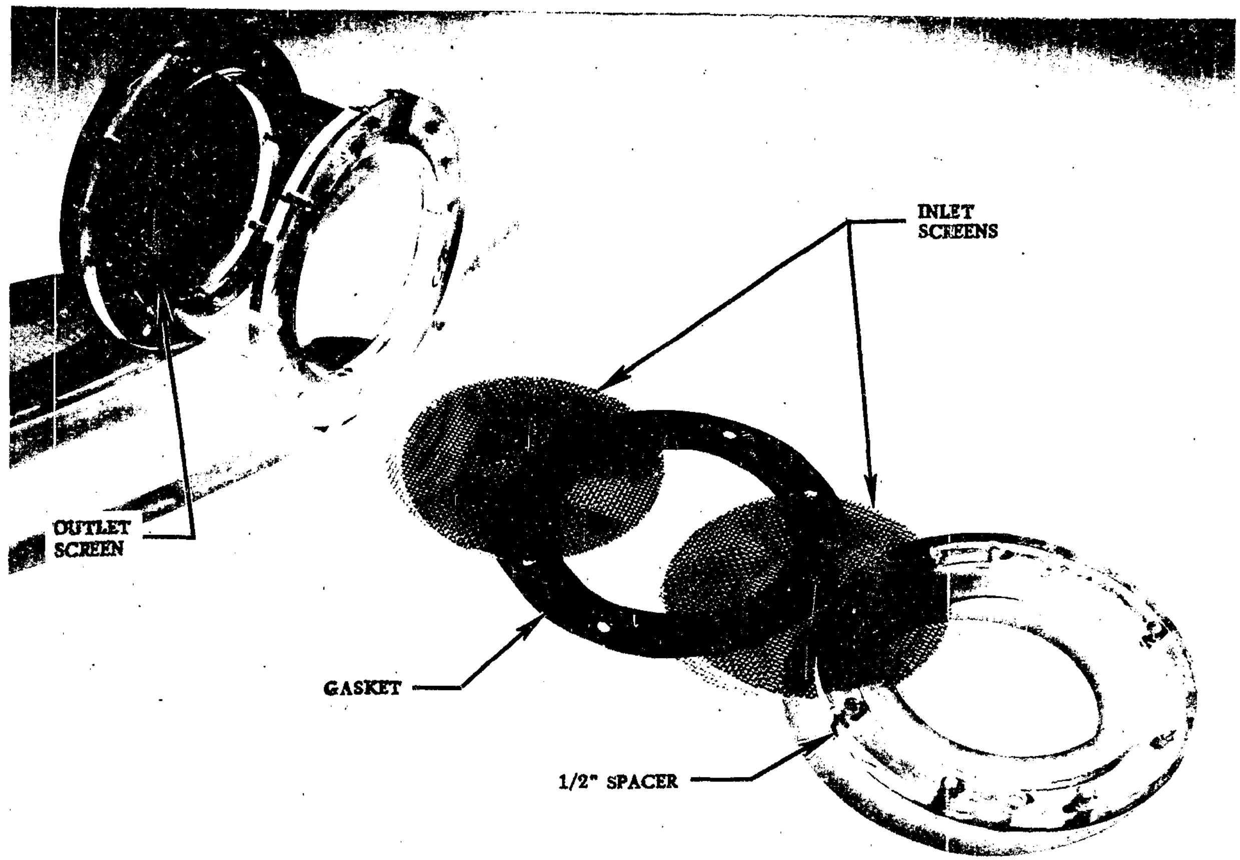


Figure 26   5" Canister, C-2 (and E), Exploded View

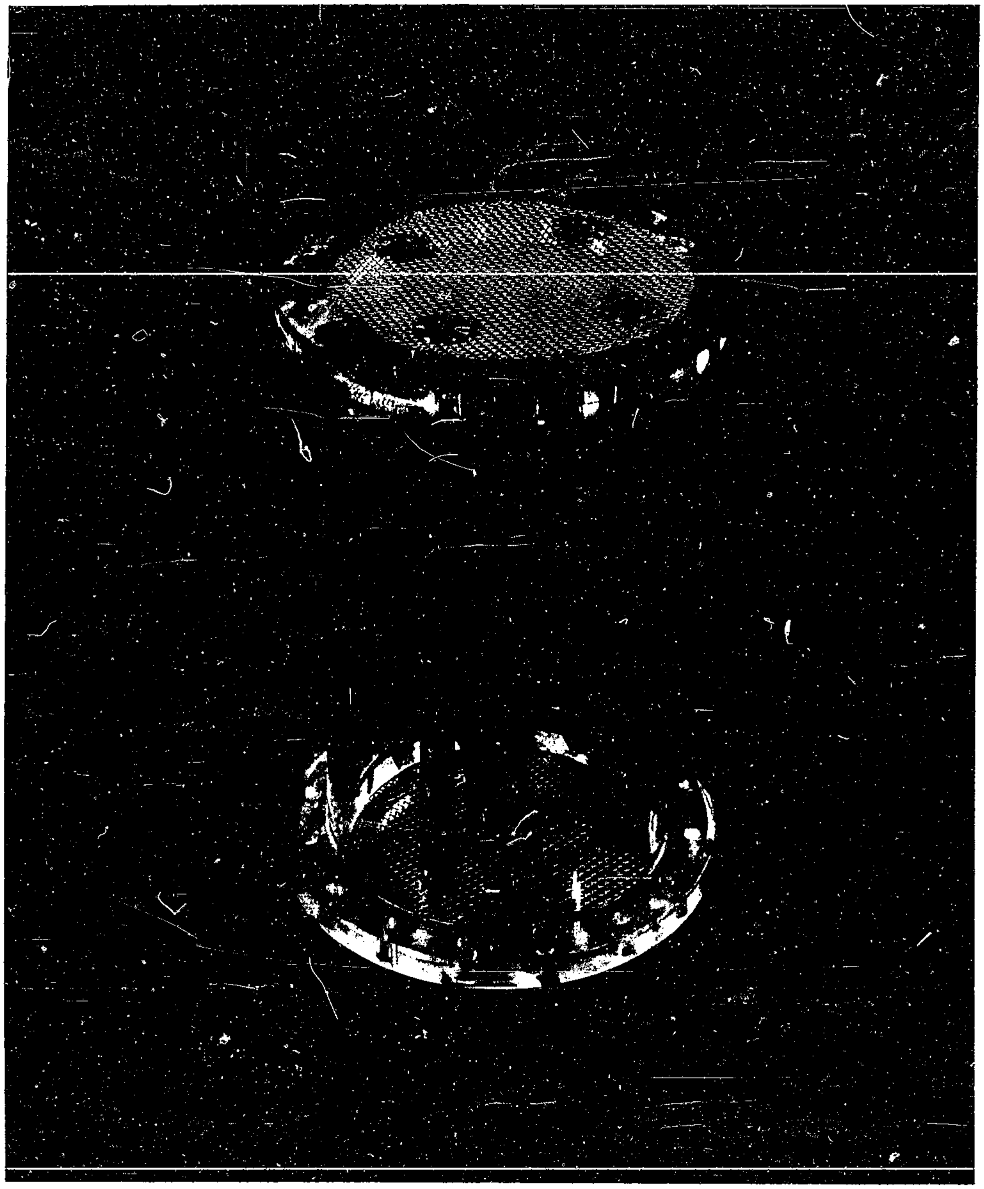


Figure 27 Inlet View, Canister D, Partial Assembly

Section VIII

TEST PROCEDURES

PRE-TEST PROCEDURES

The oxygen analyzer and carbon dioxide analyzer were calibrated against standard gas prior to test runs. Calibration time for standardizing the analyzers was approximately one hour. The battery operated Hygrophil "gun" required re-calibration before each reading. Pre-conditioning the system was accomplished by turning on the tap water to the cold water jacket (to prevent heat overload in the system and remove heat created by the blowers), adjusting the refrigeration unit to condition the air passing through the heat exchanger (ethylene glycol solution was used as the cooling agent in the refrigeration system), adjusting the heater to re-heat the air to the required temperature, opening the by-pass line for monitoring the air with the Hygrophil "gun", and adjusting the carbon dioxide flow from the pressurized bottle as required. Three hours were allowed for the pre-conditioning period before the test canisters were valved "on-stream" in the system.

TEST RUN

Placing the canisters in operation, i.e., "on-stream", consisted of opening the gate valves at the inlet duct to each canister, monitoring the orifice meter manometer board, adjusting the differential pressures across the orifice to obtain the desired flow rates, and re-adjusting the carbon dioxide flow from the bottle to the desired concentration. Maintaining constant inlet conditions required periodic checking of the refrigeration temperature, re-adjusting the gate valves in the ducts to the canisters as the differential pressure increased across the canisters, and maintaining the desired carbon dioxide concentration in the system.

DATA RECORDING CYCLE

Twenty-five minutes were required for each recording cycle. The following steps were incorporated in obtaining data for evaluation of the atmospheric composition control systems;

1. Recording inlet conditions of temperature, pressure, relative humidity, and the analysis of oxygen and carbon dioxide concentrations.

2. Recording parameters for canisters number 1 and 2: static and differential pressures at each orifice meter; static pressure and dry-bulb temperature at the inlet to each canister; pressure differential across each canister; dry bulb-wet bulb temperatures at the outlet of each canister; analyses of the oxygen production and carbon dioxide adsorption of each canister.

3. Recording cycle for canisters number 3 and 4 required the same procedure listed above with the addition of recording the dry bulb-wet bulb temperatures in the by-pass (bleed)line.

4. The frequency of the data recording cycles depended on the absolute humidity at each canister inlet.

A high absolute humidity required a data recording cycle each half hour, whereas a low absolute humidity required a cycle only once each hour. These cycles were continued as long as oxygen was generated, or carbon dioxide was adsorbed in the canisters.

TEST CONDITIONS

<u>Series P-1, P-2, P-3, and P-4</u>

Initial test conditions of the first four test series, P-1, P-2, P-3, and P-4, were identical in the following respects:

1. The size of the test canisters (not including the MSA control standard) was 5" x 10".

2. The face velocity to the test canisters was about 0.55 ft/sec. (It should be noted that the face velocity <u>inside</u> any canister with the annular screen device (series P-1 through P-10) is always much lower than the face velocity <u>to</u> the canister (i.e., to the slotted metal plate across the annular screen). This is because the annular screen area presented to the airflow is about 7 times greater in the 10" long canister, and about 14 times greater in the 20" long canister, than in canisters having axial flow only).

3. The (canister) inlet temperatures were about 70-80°F, except series P-3 where the temperatures were about 95-100°F.

4. The absolute humidity of the inlet air was in the range of about 45 to 75 grains H_2O/pound of dry air.

The CO_2 concentration to each canister inlet was about 1.0% for series P-1, P-2, and P-3, and about 0.5% for series P-4.

The main variable under investigation in series P-1, P-2, P-3 and P-4, was the canister bed packing configuration. Canister position #1 had the A configuration, #2 had the B configuration, and #3 had the C configuration. (Table 3).

Series P-5

Initial test conditions for the canisters in series P-5, were identical in the following respects:

1. The size of the test canisters (not including the MSA control standard) was 5" x 10".

2. The face velocity to the test canisters was about 0.55 ft/sec.

3. The (canister) inlet temperatures were about 80°F.

4. The absolute humidity of the inlet air was 60 to 80 grains H_2O/pound of dry air.

5. The CO_2 concentration to each canister inlet was about 0.5%.

The main variable under investigation in series P-5 was the bed packing configuration. Canister position #1 had the A-2 configuration, #2 had the A-3 configuration, and #3 had the D configuration (Table 3).

Series P-6

Initial test conditions for the canisters in series P-6, were identical in the following respects:

1. The size of the test canisters (not including the MSA control standard) was 5" x 10".

2. The face velocity to the test canisters was about 0.33 ft/sec.

3. The (canister) inlet temperatures were about 71-76°F.

4. The absolute humidity of the inlet air was about 12 to 28 grains H_2O/pound of dry air.

5. The CO_2 concentration to each canister inlet was about 0.2%.

The main variable under investigation in series P-6 was the bed packing configuration as follows:

#1 , A-2

#2 , A-4

#3 , A-5

<u>Series P-7</u>

Initial test conditions for the canisters in series P-7, were identical in the following respects:

1. The size of the test canisters (not including the MSA control standard) was 5" x 10".

2. The face velocity to the test canisters was about 0.33 ft/sec.

3. The (canister) inlet temperatures were about 73-79°F.

4. The absolute humidity of the inlet air was about 90 to 108 grains H_2O/pound of dry air.

5. The CO_2 concentration to each canister inlet was about 0.2%.

The main variable under investigation in series P-7 was the bed packing configuration as follows:

#1 , A

#2 , A-6

#3 , A-7

Series P-8

Initial test conditions for the canisters in series P-8, were identical in the following respects:

1. The size of the test canisters (not including the MSA control standard) was 5" x 10".

2. The face velocity to the test canisters was about 0.33 ft/sec.

3. The (canister) inlet temperatures were about 70-80°F.

4. The absolute humidity of the inlet air was about 10 to 20 grains H_2O/pound of dry air. (Near the end of this test the humidity was allowed to rise to about 74 grains H_2O/pound of dry air).

5. The CO_2 concentration to each canister inlet was about 0.5%.

The main variable under investigation in series P-8 was the bed packing configuration as follows:

#1 , A

#2 , A-6

#3 , A-7

Series P-9

Initial test conditions for the canisters in series P-9 were identical in the following respects:

1. The size of the test canisters (not including the MSA control standard) was 5" x 10".

2. The face velocity to the test canisters was about 0.55 ft/sec.

3. The (canister) inlet temperatures were about 72-80°F.

4. The absolute humidity of the inlet air was about 55 to 88 grains H_2O/pound of dry air.

5. The CO_2 concentration to each canister inlet was about 0.2%.

The main variable under investigation in series P-9 was the bed packing configuration as follows:

#1 , A

#2 , A-6

#3 , A-7

Series P-10

Initial conditions for the canisters in the last, and final, series P-10 were identical in the following respects:

1. The face velocity to the test canisters was about 0.33 ft/sec.

2. The (canister) inlet temperatures were about 70-80°F.

3. The absolute humidity of the inlet air was about 60 to 87 grains H_2O/pound of dry air.

4. The CO_2 concentration to each canister inlet was about 0.2%.

The two main variables under investigation in series P-10 were the canister size and bed packing configuration as follows:

#1 ,	E, and C-2	(5" x 5")
#2 ,	A-8	(5" x 20")
#3 ,	F	(5" x 20")

Section IX

DISCUSSION

THE ROLES OF CARBON DIOXIDE, WATER AND CATALYST

The partial pressure of CO_2 plays the dominant role in the reactions of the KO_2 bed. Its dominance is even greater in establishing the CO_2 adsorption rate of the KO_2 bed than in establishing the rate of oxygen evolution. (Figures 155 and 156, and 155 and 160). The oxygen evolution rate may be adequate (for a time) even with a low CO_2 partial pressure provided the absolute humidity is sufficiently high (Figure 163). In such cases, however, the CO_2 adsorption rate is inadequate (Figure 164). Since it may be desirable that a sealed cabin provide a low partial pressure of CO_2 for respiration, the insufficiency of the KO_2 to chemically match the man's R.Q. at a low % CO_2, must be in part corrected by an additional CO_2 adsorber in a dual canister system. Canister A-8, while remaining unplugged the entire run of 1765 minutes (29 hours and 25 minutes), would not maintain the support level for one man after 375 minutes (6 hours and 15 minutes). The "A" canisters in P-2 and P-3 (Tables 26 and 27) showed a more than sufficient O_2 generation rate up to 435 minutes (7 hours and 15 minutes), both of which experienced a high absolute humidity and a high CO_2 partial pressure. The PCO_2 in canister A-8 was very low, and probably accounts for this difference. No long duration run was performed with an A-8 configuration using both high absolute humidity and high PCO_2. It would have been interesting to see how long the canister would have sustained one man under such conditions. The test run of canister A-8 indicates that a problem still remains in using KO_2 to support a man for a long period of time. The effect of the catalyst on the O_2 evolution rate is shown in Table 30, P-6, A-2, A-4, and A-5. In the absence of the catalyst, the O_2 evolution rate drops sharply. Therefore, it is possible that a catalyst (other than that used in this test program), or different operating conditions (such as bed temperature, or total pressure)than those used in these tests may be selected which will allow the man's support level to be reached and maintained by KO_2 over a very long period of time. In the rat test, however, the KO_2 did maintain the physiological support level of the animals for 25 days, which indicates there may be difficulty in obtaining the same R.Q. responses in an open duct system as those experienced in a closed ecological system. Chemical R.Q. determinations apparently are best made in a physiolcgical closed-loop respiratory system.

It is believed that the water and CO_2 reacting with the KO_2 forms a K_2CO_3 coating around the KO_2 granule. At a low partial pressure, the CO_2 may not diffuse well through this coating, whereas with a high partial pressure the CO_2 can, and thereby the evolution rate of oxygen will be maintained as required for physiological support. Some white-coated (K_2CO_3) KO_2 granules from test run A-8 were broken open and unused yellow KO_2 was observed. The more effectively the support level was maintained (in other tests) the more completely white (K_2CO_3) were the KO_2 granules inside. Figure 28 is a diagramatic representation of this theoretical physico-chemical process of a KO_2 granule with H_2O and CO_2, as appears to be indicated by the results of these open duct canister tests. In the first two steps of the diagram, (Δ_1, Δ_2), H_2O initiates the process by first hydrating the KO_2 (evidenced by a color change from yellow to orange), and then with more H_2O forming an outside layer of white KOH (from this hydrate layer). At the same time, more yellow KO_2 becomes hydrated in a layer beneath the newly formed white KOH. In step 3, (Δ_3), the outer layer of KOH becomes K_2CO_3 under the influence of CO_2, and the layer beneath changes from hydrate to KOH, etc. In step 4, (Δ_4), the KOH layer has "moved" beneath two layers of carbonate by virtue of further action of H_2O upon orange hydrate ($KO_2 \cdot H_2O$) at that depth. The last step, n, represents the ideal end-point if 100% conversion from KO_2 to K_2CO_3 has occurred, and $\sum_{i=5}^{n} \Delta_i$ represents the summation of all the finite incremental changes between steps 4 and n. Under low PCO_2, the KOH layer, as it "moves" deeper in the granule, does not change quickly enough to K_2CO_3, and since KOH is very hygroscopic, water is not available for further hydration and reaction with the KO_2, and consequently the rate of O_2 generation falls below the man-support level. Identification of the crystalline compounds at the different layers, and proof of this theory, might be accomplished by X-ray diffraction of micro-slices through the granules, or by the technique of inorganic micro-qualitative analysis.

THE ROLE OF THE ANNULAR SCREEN

The effectiveness of exposing a large area of the chemical bed to a very low velocity flow airstream (as accomplished by the annular screen in configuration "A") in order to indefinitely prevent plugging of the canister is very well demonstrated in Figure 41, and Table 14. The configurations with the annular screen consistantly showed

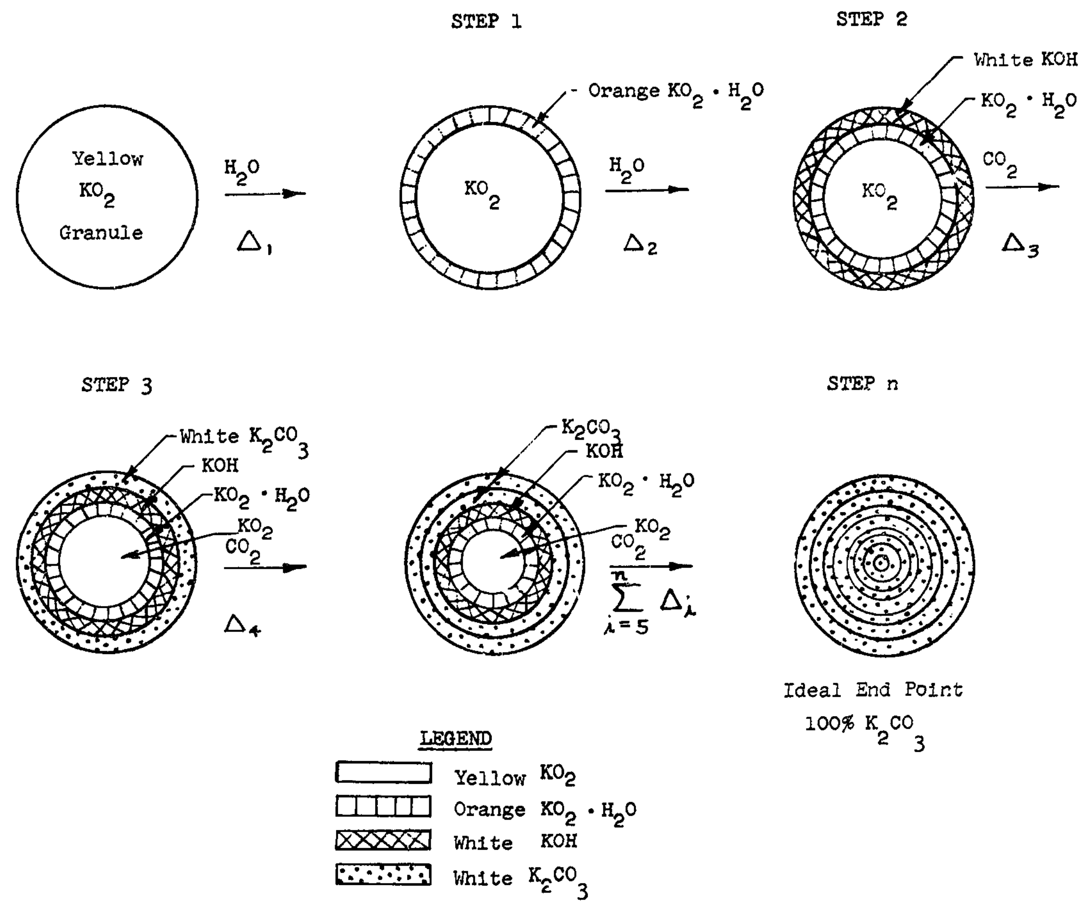


Figure 28 Theoretical Physico-Chemical Process of KO_2 with H_2O and CO_2

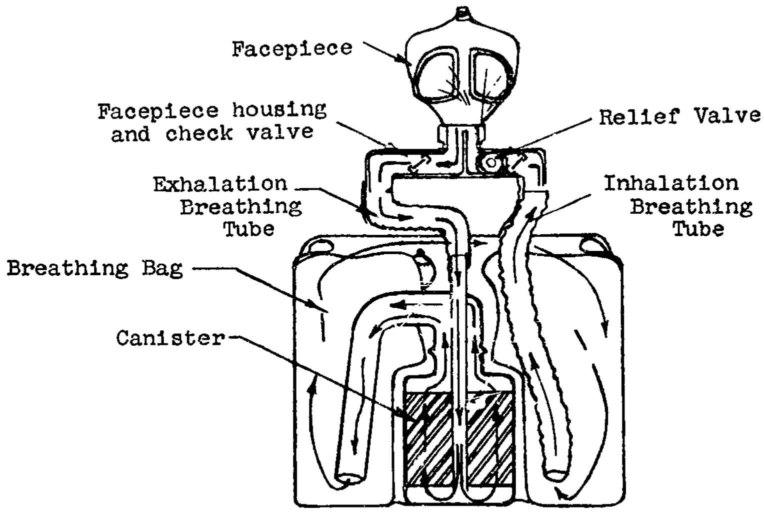
the minimum pressure drop across the canister both at the beginning and at the end of every test run. There was never any important increase in ΔP whenever the annular screen was used, i.e., never more than 0.5" H_2O increase per linear foot, and usually much less, regardless of the absolute humidity. The increase in resistance to the gas flow is a function of how well the granular state of the chemical is maintained. Water vapor (present in a physiological respiratory circuit) passing through a granular hygroscopic chemical, either directly by physical adsorption or indirectly through chemical adsorptive processes, tends in time to turn the granular chemical either into a soggy mass (Figure 40) which greatly restricts the gas flow, or into a fused solid salt plug (Figures 39 and 41) which completely blocks off all air passage through the canister. This has been the biggest drawback to the use of solid granular hygroscopic chemicals in any chemical process wherein a liquid vapor (such as water vapor) is present in the gas stream. The double canister (Figure 24) is an example of how the modular feature of the annular screen can be exploited. Two 10" long "A" canisters were joined in tandem, in which case the inlet plate was not used in the second 10" canister, but was replaced by a circular screen with a rubber plug to force annular flow in the second shell (Figure 25).

ADVANTAGE OF THE ANNULAR SCREEN DEVICE OVER THE CONTROL CANISTER

The control used in all tests was the standard Mine Safety Appliances (MSA) Company "Chemox" canister. This canister is used in the "Chemox Oxygen Breathing Apparatus" (Figure 29) which is a self-contained breathing circuit operating independently of the outside air. The replaceable "Chemox" canister, containing KO_2 with a catalyst, generates (upon contact with moisture in the exhaled breath) a supply of oxygen for breathing requirements for a short period of time, (i.e. about 45 minutes when used in the "Chemox Apparatus"). The evolved oxygen flows upward through the canister and into the breathing bag reservoir where it is cooled, and then passes through the inhalation tube to the wearer's facepiece. The evolvement of the oxygen automatically continues in accordance with breathing rates. An automatic timing device rings a bell at the end of a preset time (45 minutes) to indicate that the wearer should return to fresh air.

In the "Chemox" canister, the air can flow only axially through the packed chemical bed. The consequence of a small cross-sectional face area presented to the air path is the deterioration of the granular nature of the chemical bed, with a resultant increase in resistance to the air-flow through a soggy or fused chemical bed. The NAA annular screen device

"CHEMOX" APPARATUS ASSEMBLY



"CHEMOX" CANISTER

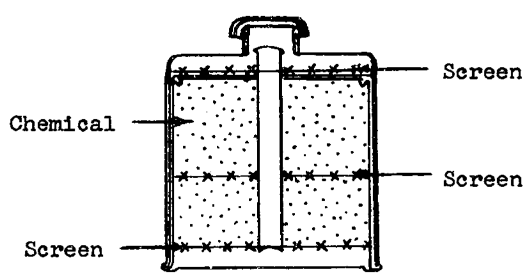


Figure 29 Chemox Oxygen Breathing Apparatus

maintains the chemical bed in the granular condition regardless of the length of time it is operated, even under conditions of high absolute humidity, or low partial pressure of carbon dioxide, in the air stream. The NAA annular screen device should prove very useful in any closed-circuit respiratory system using KO_2 or lithium oxides in the canister. This canister device should also be very useful in any chemical process where a gaseous stream is passed through, or over, a solid granular chemical bed. This may be in a chemical process having nothing at all to do with atmospheric composition control.

TEMPERATURE EFFECTS IN GENERAL

It was expected that the inlet temperature would affect the performance of a KO_2 canister in an atmospheric composition control system. In test series P-3 (Table 7) the inlet temperature was raised to about 95-100°F. The favorable effect of this on the O_2 generation of configurations A, B, and C is seen by comparing Figure 149 with Figure 145. At 200 minutes, for example, the average O_2 generation rate is increased about 67%. If configuration A only is compared at 200 minutes (in Figures 145 and 149), the O_2 generation rate is seen to increase about 68%. The annular screen (in configuration A) shows an even greater superiority over C and MSA at the higher temperature in P-3 than at the lower (normal) temperature in P-1. The O_2 generation rate of B is better than either C or MSA at the high temperature, presumably because the water-absorbing capacity of the activated alumina (in B) is negated at the higher temperature.

The effects of increasing temperature on the CO_2 adsorption rate characteristic is seen by comparing Figures 146 and 150. At 200 minutes, configurations A and C appear not to be effected by the increase in temperature in their CO_2 adsorption rates, although the increased temperature did increase their O_2 generation rates. Configuration B has increased its CO_2 adsorption rate about 41% with the increase in temperature, presumably due to negating the influence of the alumina, making more free water available for reaction. The MSA configuration has decreased its CO_2 adsorption rate by about 35% at 200 minutes. This follows along with the slight decrease in O_2 generation rate (of the MSA Configuration) at the higher temperature. Referring back to page 42 we see that B and C have less KO_2 in their configurations than does MSA. A, however, has more than MSA. This order holds true for the O_2 generation rates in Figure 145, but (unaccountably) in Figure 149, this order does not hold true for O_2 generation rates at the higher temperature.

As regards CO_2 adsorption at either the lower (Figure 146) or the higher (Figure 150) temperature it is seen that although C is of a less weight (KO_2) than A or MSA, it has the highest CO_2 adsorption rate, presumably due to the affinity of the LiOH for CO_2. Configuration B, although containing a lesser weight of KO_2 than MSA, shows a higher (Figure 150) CO_2 adsorption rate than MSA (at the high temperature). This may be due to additional water being freed from the alumina by the increasing temperature, and becoming available for reaction with KO_2.

The effects of temperature could not be pursued more fully during this test program, but the results of series P-3 clearly show that in any of the other test series where the O_2 generation rates failed to reach the man support level, an increase in the inlet temperature (or KO_2 bed temperature) would have increased the O_2 generation to the support level required, provided, of course, that the other conditions were satisfactory. These other conditions are parameters such as packing configuration, absolute humidity, partial pressure of CO_2, airflow rate, face velocity, etc. It is interesting to note (on page 67) the effect of a higher bed temperature on the chemical utilization (O_2 generation) index. In series P-2, this index for canister B is $\sim$112%, while in P-1 the index for B is only $\sim$ 40%. The major operating parameter difference between the two was a higher bed temperature for B in P-2 than in P-1. Also, in series P-2, the index for canister C is $\sim$ 117%, while in P-1 the index for C is only $\sim$ 53.5%. Here again, the only operating parameter difference was a higher bed temperature (evidenced by a higher ΔT) in P-2 than in P-1.

The effects of absolute humidity, PCO_2, and temperature on O_2 generation rates, are graphically shown on pages 68, 69, and 70. The effects of absolute humidity, PCO_2, and temperature on CO_2 adsorption rates, are graphically shown on pages 71, 72 , and 73.

FLOWRATE EFFECTS IN GENERAL

Some comparisons may be made concerning the effect of changing velocities in identical canisters. Comparing the canisters in series P-7 and P-9 (both of which series have similar absolute humidity, % CO_2, and temperature conditions) by inspecting Tables 31 and 33, we note that in the first fifteen minutes of operation, canister configuration A experienced a 150% increase in CO_2 adsorption at the increased airflow rate (P-9), and A-6 experienced about 67% increase in CO_2 adsorption. Similar increases are seen for A-7 and the MSA canister. The O_2 generation rates are not increased as consistently in P-9 (higher velocity) compared to P-7 (lower velocity), but they do show some increase (about 20-25%) in the A and A-7 configurations. Face velocity to the canister will be a less important factor in a closed-circuit respiratory system than in an open duct system. The closed-circuit offers repeated passes of the same atmosphere through the canister, whereas the open duct system used in this test program is a "one-shot" process.

RELATIVE CALCULATED CHEMICAL UTILIZATION INDEX

Table 4 shows the relative calculated chemical utilization index (%) of each canister configuration (for the best set of operating parameters at which it was tested), based on the weight of KO_2 in the canister. Because of economic (and time) considerations, emphasis was placed on testing in such a manner as to most rapidly develop a near-optimum canister design, and to discover as quickly as possible the broad areas of near-optimum operating parameters. Because of these facts it would be difficult to say that any particular canister configuration could not have had a higher relative index number, given more favorable operating conditions. Table 4 must be interpreted with an eye to the "varying operating parameters", which are not shown on the table. Time is one example of a variable operating parameter which must be considered when interpreting Table 4. The "best" index was determined irrespective of time. The "best" indexes for A-8 and MSA, for example, were determined at 2000 minutes (extrapolated past 1765 minutes) and 1120 minutes respectively. Time for other "best" indexes varied from 317 to 575 minutes. Another set of utilization index numbers would be obtained if, for example, all canisters were evaluated for a given common total operating time. The chemical utilization index numbers are based on total operating time (with each canister operating under its own particular conditions), which is not always the same as total life-support time for a man. The cross-over time-point can be seen by comparing the "O_2 consumed" and "O_2 generated" columns in Tables 25 through 34. Provided the other operating parameters are satisfactory, an increase in either the temperature, the airflow rate, or the CO_2 concentration, or a decrease in the superficial velocity, may be all that is required to increase the O_2 generation rate of those canisters whose rates are marginal, to the life-support level required by a man. All such variables should be considered when interpreting the relative index values of Table 4. The effects of some of these variables are graphically shown on pages 68, 69, 70, 71, 72, and 73.

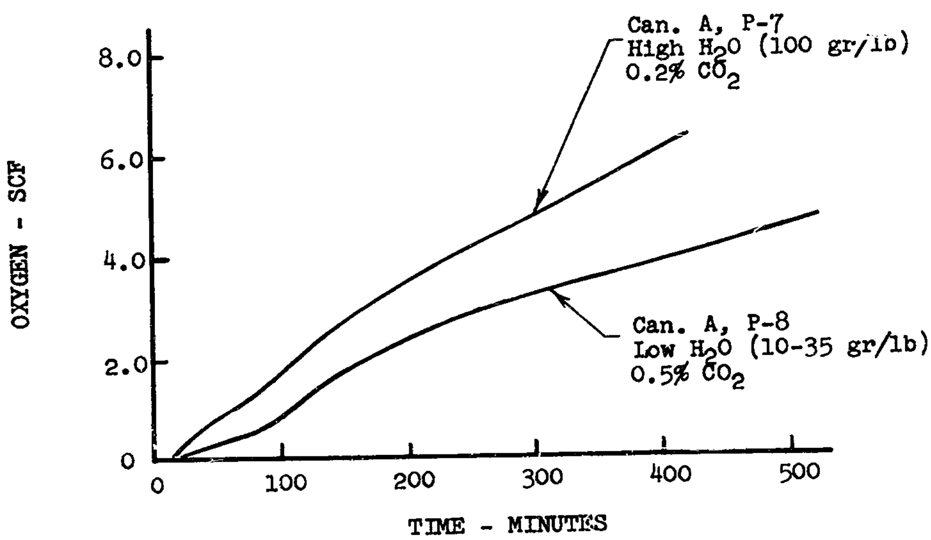
Table 4 Relative Calculated Chemical Utilization Index

CANISTER	CALCULATED WEIGHT OF KO_2 IN CANISTER, lbs KO_2	THEORETICAL AVAILABLE O_2 (33.7%), lbs O_2	THEORETICAL AVAILABLE O_2 (at 1 atmos. and 70°F, 0.0891lbs/1.077 ft3), SCF O_2	BEST CALCULATED UTILIZATION INDEX, where, $\frac{\text{Actual SCF } O_2}{\text{Theoretical SCF } O_2}$ = %	TOTAL TIME OF CANISTER OPERATION, MINUTES
A-3	1.05	0.354	4.28	$\frac{2.38}{4.28}$ = 55%	317 (P-5)
B	1.47	0.495	5.98	$\frac{6.73}{5.98}$ = 112% *	435 (P-2)
C	1.47	0.495	5.98	$\frac{7.00}{5.98}$ = 117% *	440 (P-2)
C-2	1.47	0.495	5.98	$\frac{4.76}{5.98}$ = 79.7%	365 (P-10)
MSA	2.00	0.674	8.15	$\frac{5.77}{8.15}$ = 71%	1120 (P-10)
D	2.11	0.711	8.60	$\frac{6.45}{8.60}$ = 75%	322 (P-5)
A-4	2.11	0.711	8.60	$\frac{0.99}{8.60}$ = 11.5%	446 (P-6)
A-5	2.11	0.711	8.60	$\frac{1.91}{8.60}$ = 22.2%	456 (P-6)
A-6	2.11	0.711	8.60	$\frac{5.33}{8.60}$ = 62%	565 (P-9)
A-7	2.11	0.711	8.60	$\frac{5.92}{8.60}$ = 69%	575 (P-9)
E	2.20	0.741	8.96	$\frac{4.45}{8.96}$ = 49.6%	375 (then plugged) (P-10)
A	3.16	1.065	12.90	$\frac{9.03}{12.90}$ = 70%	435 (P-3)
A-2	3.16	1.065	12.90	$\frac{5.79}{12.90}$ = 45%	317 (P-5)
A-8	6.32	2.129	25.76	$\frac{18.50}{25.76}$ = 72%	Extrapolated to 2000 (P-10)
F	8.80	2.965	35.80	$\frac{6.19}{35.80}$ = 17%	380 (then plugged) (P-10)

* NOTE: An index greater than 100% indicates that the measured weight of KO_2 in these particular canisters was probably greater than the calculated weight.

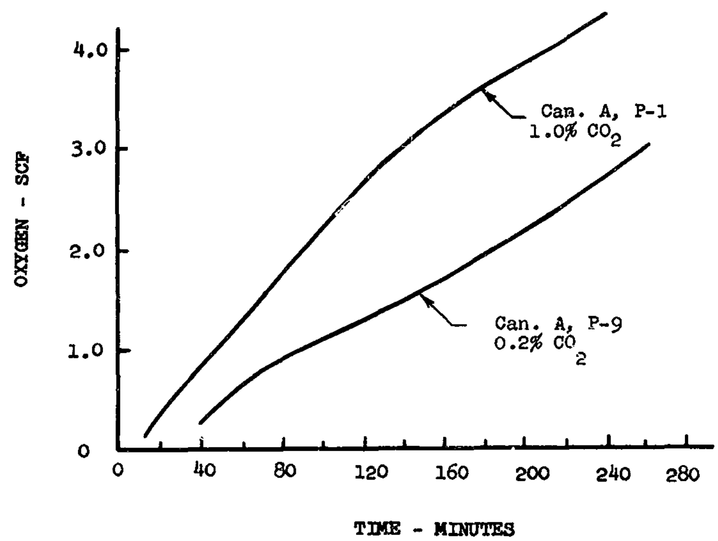
ABSOLUTE HUMIDITY, PCO_2, AND TEMPERATURE EFFECTS ON O_2 GENERATION RATES

Some interesting effects on oxygen generation rates are seen in the following tables and figures. Normal rates are seen in Table 18, while the rate depressing effect of molecular sieve is seen in Table 19 (A-3), Table 20(A-4), and Table 21 (A-6). The rate depressing effect of low absolute humidity is seen in Table 22 (P-8) as compared to Table 20 (A-2, A-4, and A-5). The plugging of configurations E and F are clearly shown in Figures 130 and 136. The man-rate support level graphs (Figures 145 thru 164) are very clear comparative representations of all the factors at various levels. We can compare O_2 generation curves from the man-rate support level graphs for the effect of absolute humidity on a particular canister configuration as follows;



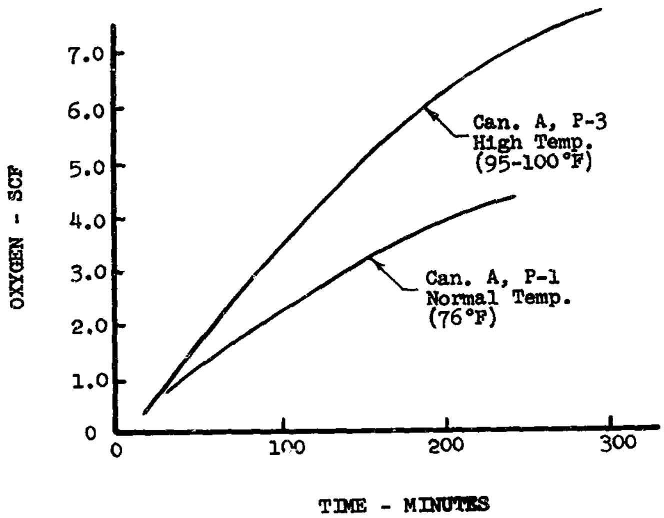
Although the PCO_2 in P-7 is seen to be lower than in P-8, the higher absolute humidity in P-7 was responsible for increasing the O_2 generation for canister A, P-7 over that of A, P-8. Canisters A, P-7, and A, P-8 operated under similar conditions of temperature and flowrate. The absolute humidity for the P-7 series was about 100 grains/lb of dry air, and about 10-35 grains/lb of dry air for the P-8 series. At 420 minutes the total O_2 generation for the A Canister in P-7 series was ~ 31% greater than that of the A canister in P-8 series.

The graph below compares the O_2 generation curves from the man-rate support level graphs for the effect of PCO_2 on a particular canister configuration.



Canisters A, P-1, and A, P-9 operated under similar conditions of absolute humidity, temperature, and flowrate. The PCO_2 in the P-1 series was ~ 1.0% and ~ 0.2% in the P-9 series. At 210 minutes the total O_2 generation for the A canister in the P-1 series (1.0% CO_2) was ~ 66% greater than that of the A canister in the P-9 series (0.2% CO_2).

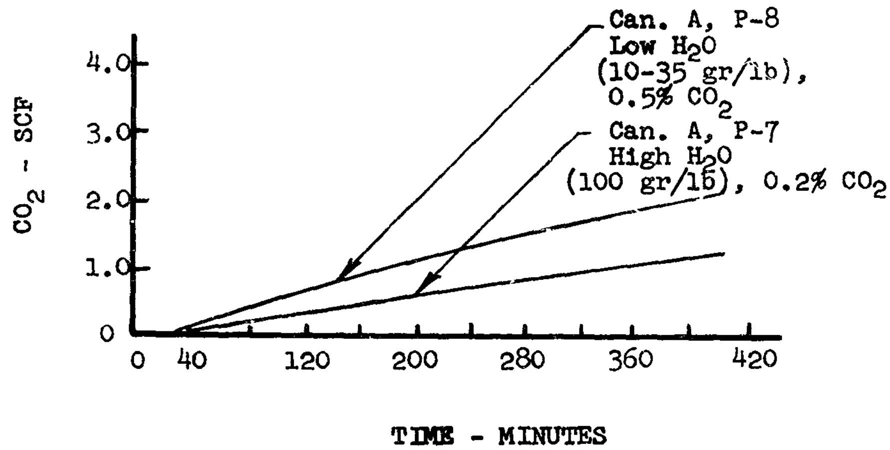
The graph below compares the O_2 generation curves from the man-rate support level graphs for the effect of temperature on a particular canister configuration.



Canisters A, P-3 and A, P-1 operated under similar conditions of absolute humidity, PCO_2, and flowrate. The temperature was ~95 - 100°F in the P-3 series, and ~76°F in the P-1 series. At 250 minutes the total O_2 generation for the A canister in the P-3 series was ~ 63.5% greater than that of the A canister in the P-1 series.

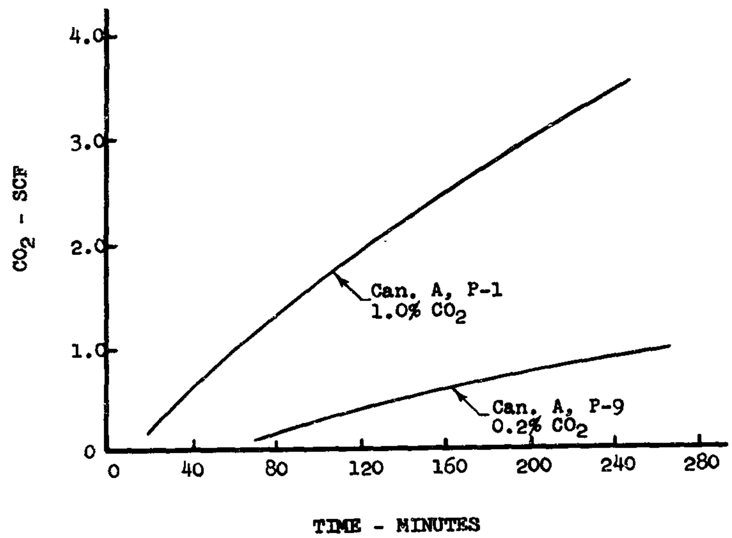
ABSOLUTE HUMIDITY, PCO_2, AND TEMPERATURE EFFECTS ON CO_2 ADSORPTION RATES

We can compare the CO_2 adsorption curves of the same canisters whose man-rate support level graphs were useful for comparing various effects on the O_2 generation rates. The graph below compares the CO_2 adsorption curves from the man-rate support level graphs for the effect of both absolute humidity and PCO_2 on a particular canister configuration.



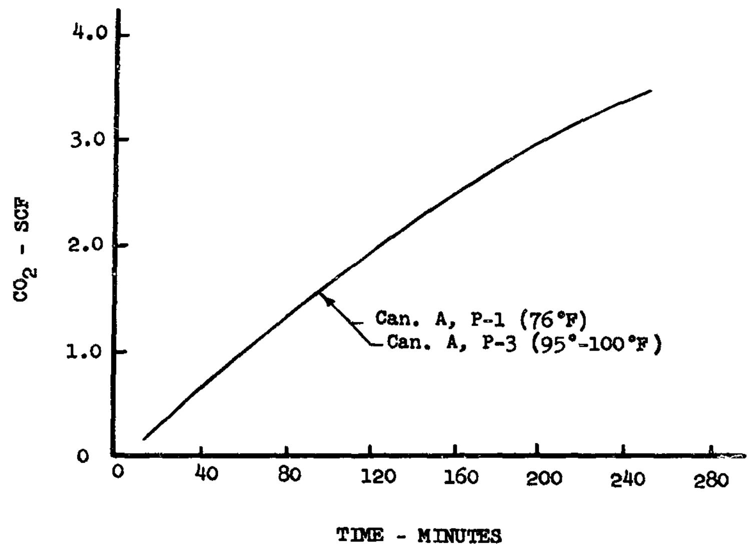
Canisters A, P-7, and A, P-8 operated under similar conditions of temperature and flowrate. The absolute humidity for the P-7 series was about 100 grains/lb of dry air, and only about 10-35 grains/lb of dry air for the P-8 series. At 420 minutes, however, the total CO_2 adsorption for the A canister in the P-8 series was ~ 73% greater than that of the A canister in the P-7 series. Since the absolute humidity was much lower in P-8 than in P-7, this difference is clearly due to the greater PCO_2 (0.5%) in P-8 than in P-7 (0.2%), and shows the dominance of PCO_2 as a controlling variable in CO_2 adsorption (of the A canister) over that of absolute humidity.

The graph below compares the CO_2 adsorption curves from the man-rate support level graphs for the effect of PCO_2 on a particular canister configuration.



Canister A, P-1 and A, P-9 operated under similar conditions of absolute humidity, temperature, and flowrate. The PCO_2 in the P-1 series was ~ 1.0% and ~ 0.2% in the P-9 series. At 210 minutes the total CO_2 adsorption for the A canister in the P-1 series (1.0% CO_2) was ~ 447% (4-1/2 times) greater than that of the A canister in the P-9 series (0.2%) CO_2, showing the very large effect of PCO_2 on CO_2 adsorption rates, and the similarity to the five fold increase in PCO_2.

The graph below compares the CO_2 adsorption curves from the man-rate support level graphs for the effect of temperature on a particular canister configuration.



It is immediately seen that the two CO_2 adsorption curves above coincide in this case. Canisters A, P-1 and A, P-3 operated under similar conditions of absolute humidity, PCO_2, and flowrate. Even though the temperature in the P-3 series was ~ 95-100°F, and ~ 76°F in the P-1 series, the CO_2 adsorption rate (for the A canister) was not affected by the increased temperature.

THE DUAL CANISTER SYSTEM

The author feels strongly that the dual-canister system will prove superior to a single canister containing one solid chemical (or even a mixture of two solid chemicals) for the purpose of O_2 generation and CO_2 adsorption. The best way to match man's R.Q. with a solid chemical system is to control the airflow through each one of two canisters (in the dual-canister system) by oxygen and carbon dioxide sensors which will modulate the airflows to each canister upon demand signals.

ADVANTAGES OF LITHIUM OXIDES OVER KO_2

Lithium peroxide, Li_2O_2, appears to offer some promise as an alternate to KO_2 for solid chemical atmosphere composition control. Li_2O_2 has a slight theoretical weight advantage ($\sim$ 34.6% available O_2) over KO_2 ($\sim$ 33.7% available O_2). Of more importance than the slight weight advantage is the advantage of Li_2O_2 in providing a less hygroscopic intermediate product (LiOH instead of KOH) which is less subject to liquid slugging. No published data is currently available on the performance of this promising material for use in an atmospheric composition control system, although lithium peroxide of 90 to 95 percent purity and good stability is available from three known sources. (Reference 3).

If lithium superoxide, LiO_2, can be synthesized and isolated in a stable form at normal room temperature (Reference 3), it would have a greater theoretical weight advantage ($\sim$ 61.7% available O_2) over KO_2 ($\sim$ 33.7% available O_2).

Use of a stable form of sodium superoxide, NaO_2, ($\sim$ 37% available O_2), might also prove advantageous weightwise, especially with the NAA annular screen device used to prevent plugging of the canister.

DISPROVING A THEORETICAL EQUATION FOR MATCHING MAN'S R.Q.

During the test program, it was observed that the necessary rate of reaction in the KO_2 canisters required a considerably higher absolute humidity (grains H_2O per pound dry air) than had been calculated on the basis of the much-publicized theoretical equation for KO_2 purporting to match man's R.Q. (used in Appendix A). This lead to the conclusion that the theoretical equation does not occur. The theoretical reaction is written as follows:

$$2\ KO_2 + 1.23\ CO_2 + 0.23\ H_2O = 0.77\ K_2CO_3 + 0.46\ KHCO_3 + 1.5\ O_2$$

The matching of man's R.Q., assuming it does occur in this equation, is calculated as follows:

$$\frac{1.23 \text{ pound-mol } CO_2}{1.5 \text{ pound-mol } O_2} = \frac{1.23 \times 44}{1.5 \times 32} = \frac{54.12 \text{ lbs } CO_2}{48 \text{ lbs } O_2}$$

$$\frac{0.123 \text{ lb } CO_2}{1 \text{ ft}^3} = \frac{54.12 \text{ lbs } CO_2}{X \text{ ft}^3}, \quad X = 440 \text{ ft}^3 \; CO_2$$

$$\frac{0.089 \text{ lb } O_2}{1 \text{ ft}^3} = \frac{48 \text{ lbs } O_2}{X \text{ ft}^3}, \quad X = 540 \text{ ft}^3 \; O_2$$

$$R.\,Q. = \frac{\text{Vol } CO_2}{\text{Vol } O_2} = \frac{440 \text{ ft}^3}{540 \text{ ft}^3} = 0.82$$

The calculation of the theoretical weight of H_2O for a pound of dry air (absolute humidity) required for this reaction to occur stoichiometrically is as follows:

Assuming 2.25 lb. CO_2 is produced per man-day, then the equation is simplified to the proportion,

$$\frac{1.23 \text{ pound-mol } CO_2}{2.25 \text{ lb } CO_2} = \frac{0.23 \text{ pound-mol } H_2O}{X \text{ lb } H_2O}$$

or

$$\frac{1.23 \times (44)}{2.25} = \frac{0.23 \times (18)}{X}$$

$$X = 0.173 \; \frac{\text{lbs. } H_2O}{\text{man-day}}$$

and

$$\frac{0.173}{(24)(60)} = 0.00012 \; \frac{\text{lb } H_2O}{\text{man-min.}} \times 7000 = 0.84 \; \frac{\text{grains } H_2O}{\text{man-min.}}$$

Assuming an airflow of 12.5 $\frac{\text{lbs}}{\text{man-hour}}$, an inlet air temperature of 70°F (530°R), a gas pressure of 1 atmosphere, and the weight of one pound-mol of air to be 29 pounds, the inlet absolute humidity required per minute (on a one man basis) to satisfy the theoretical equation is then calculated as follows:

$$pV = \frac{W}{M} RT$$

$$V = \frac{W}{M} \times R \times \frac{T}{p}$$

$$V = \frac{1.25 \frac{lbs}{hr}}{29 \text{ lbs}} \times \frac{10.7 \frac{lb\text{-}ft^3}{in^2 \, {}^\circ R}}{1} \times \frac{530 \; {}^\circ R}{14.7 \frac{lbs}{in^2}}$$

$$V = \frac{12.5 \times 10.7 \times 530}{29 \times 1 \times 14.7} = 166.5 \frac{ft^3}{hr}$$

$$V = \frac{166.5 \frac{ft^3}{hr}}{60 \frac{min}{hr}} = 2.78 \frac{ft^3}{min}$$

$$\text{Absolute Humidity} = \frac{0.84 \frac{grains}{min}}{2.78 \frac{ft^3}{min}} = 0.302 \frac{\text{grains } H_2O}{ft^3 \text{ air}}$$

$$\text{or Absolute Humidity} = \frac{0.84 \frac{grains}{min}}{12.5 \frac{lbs}{hr}} \times 60 \frac{min}{hr} = 4.04 \frac{\text{grains } H_2O}{\text{lb air}}$$

Since no apparent chemical reaction occurred during the tests at an absolute humidity as low as 8 grains H_2O per pound of dry air, this was understood (by empirical induction) to mean that the attempt to prove the theoretical equation correct had failed, and therefore the equation was not true. This was further substantiated by the fact that the use of KO_2 (without a separate canister of CO_2 adsorbent) could not provide for matching the respiratory quotient of man.

Section X

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APPENDIX A

A CANISTER DESIGN METHOD

The following method was used to determine the basic KO_2 canister sizes for the atmospheric composition control system test:

1. Assume the following:

   CO_2 production/man-day = 2.26 lbs. CO_2

   O_2 consumption/man-day = 2.0 lbs. O_2

2. Assume that both the absolute and relative humidities (through dew point and temperature control respectively), temperature and % CO_2 input to the test canisters can be controlled to match the overall chemical reaction with man's R.Q. (0.82) as follows:

$$2\ KO_2 + 1.23\ CO_2 + 0.23\ H_2O =$$
$$0.77\ K_2CO_3 + 0.46\ KHCO_3 + 1.5\ O_2$$

3. Simplify this equation to its essentials for the canister design, and calculate the stoichiometric weights, as follows:

$$\underset{2\ KO_2}{71\text{ gm}} + \underset{1.23\ CO_2}{44\text{ gm}} = \underset{1.5\ O_2}{32\text{ gm}}$$

$$(2)(71) \times 2.2 \times 10^{-3} = 0.312 \text{ lb. } KO_2$$

$$(1.23)(44) \times 2.2\ 10^{-3} = 0.119 \text{ lb. } CO_2$$

$$(1.5)(32) \times 2.2 \times 10^{-3} = 0.105 \text{ lb. } O_2$$

and determine that this matches man's R.Q.;

$$R.Q. = \frac{CO_2 ft^3}{O_2\ ft^3} = \frac{0.119/0.123}{0.105/0.089} = \frac{0.97\ ft^3}{1.18\ ft^3} = 0.82$$

4. Determine the KO_2 required to absorb 1.0 lb. CO_2 at 100% and 80% efficiencies;

$$\frac{0.312 \text{ lb. } KO_2}{0.119 \text{ lb. } CO_2} = \frac{X \text{lb } KO_2}{1.0 \text{ lb } CO_2}$$

$X = 2.6$ lb. KO_2/1.0 lb. CO_2, 100% efficiency

$X = \frac{2.6}{0.8} = 3.2$ lb. KO_2/1.0 lb. CO_2, 80% efficiency

5. Determine the KO_2 required to produce 1.0 lb. O_2 at 100% and 80% efficiencies;

$$\frac{0.312 \text{ lb. } KO_2}{0.105 \text{ lb. } O_2} = \frac{X \text{ lb } KO_2}{1.0 \text{ lb.} O_2}$$

$X = 2.9$ lb. KO_2/1.0 lb. O_2, 100% efficiency

$X = \frac{2.9}{0.8} = 3.6$ lb. KO_2/1.0 lb. O_2, 80% efficiency

6. Assume the CO_2 production per man per 5 hours is;

$$\frac{2.3 \text{ lbs. } \times 5}{24 \text{ hrs.}} = 0.5 \text{ lb. } CO_2$$

and the O_2 consumption per man per 5 hours is;

$$\frac{2.0 \text{ lbs. } \times 5}{24 \text{ hrs.}} = 0.42 \text{ lb. } O_2$$

7. Determine the weight of KO_2 required for CO_2 absorption and O_2 production per man per 5 hours (at 80% efficiencies);

$$\frac{1 \text{ lb. } CO_2}{3.2 \text{ lb. } KO_2} = \frac{0.5 \text{ lb. } CO_2}{X \text{ lb. } KO_2}$$

$X = 1.6$ lb. KO_2 per man per 5 hours

and $$\frac{1 \text{ lb. } O_2}{3.6 \text{ lb. } KO_2} = \frac{0.42 \text{ lb. } O_2}{X \text{ lb. } KO_2}$$

$X = 1.5$ lb. KO_2 per man per 5 hours

Take the weight of KO_2 required as being the greater of these two values, or 1.6 lb., since a greater weight of CO_2 is produced by man than is O_2 consumed.

8. Since a requirement of the test program is that the preliminary test canisters operate at near steady-state conditions during at least one hour of the 5 hour test, and also considering that the weight of the KO_2 in some canister packing configurations may account for only 70% of the total packing weight, we should calculate a canister volume good for double the hours of the actual test, and for a maximum of 30% inert packing weight, as follows:

$$1.6 \times 2 \times 1.3 = 4.16 \text{ lbs. } KO_2$$

$$40 \text{ lbs/ft}^3 = \text{density of 2 to 4 mesh } KO_2$$

therefore, $$\frac{40 \text{ lbs.}}{1 \text{ ft}^3} = \frac{4.16 \text{ lbs. } KO_2}{X \text{ ft}^3}$$

$$X = \text{canister volume required} = \frac{4.16}{40} = 0.10 \text{ ft}^3$$

9. If we assume a satisfactory residence time of the gases in the canister to be 1 second, and a face velocity of 1 ft/sec, we need only solve for the cross-sectional area of a 12 inch long cylindrical canister as follows;

$$\pi r^2 = \frac{\text{volume}}{\text{length}}$$

$$r^2 = \frac{\frac{0.10 \text{ ft}^3}{1 \text{ ft}}}{3.1416}$$

$$r = \sqrt{0.0318}$$

$$r = 0.178 \text{ ft} \times 12 = 2.136 \text{ inches}$$

Inside diameter of required cylinder =

$D = 4.3$ inches and D^2 of cylinder $= 18.5$ inches^2.

The volume of a 12 inch long cylinder is then;

$$\text{Volume} = \frac{(18.5)(12)}{4} = 174 \text{ inches}^3$$

or

$$\text{Volume} = 174 \text{ inches}^3 \times 5.78 \times 10^{-4}$$
$$= 0.10 \text{ ft}^3$$

The weight of 100% KO_2 that would fill up this size cylinder is;

$$W = (0.10 \text{ ft}^3)(40 \text{ lbs/ft}^3) = 4 \text{ lbs}$$

and this corresponds closely to the weight of the KO_2 in step 8 which will make allowance for up to 30% inert material in the canister packing contents, and provide for about 10 hours of operation before exhaustion of the chemical.

10. The volume of gas which would flow through a canister of this size at a face velocity of 1 ft/sec is 6 CFM.

11. The engineering laboratory had on hand three plexiglass canisters (from the test in Reference 1) with dimensions of 5" (I.D.) x 10" long and it was decided to use these cylinders, and fabricate the others needed with the same inside diameter. The volume of these basic canisters is 196.35 inches^3 or 0.11 ft^3. With the same density of KO_2 as in step 8, this canister could hold 4.4 lbs. of 100% KO_2, or allowing for up to 30% inert material, the canister will provide about 9.6 man-hours of operation before exhaustion of the chemical. The volume of gas which would flow through a canister of this size at a face velocity of 1 ft/sec is 8.16 CFM, 5.5 CFM at 0.67 ft/sec, and 2.7 CFM at 0.33 ft/sec.

12. Two other sized canisters were needed for the test program where the face area/length ratio is varied. The experimental test plan indicated that with a constant face area, the length of these other two canisters should be respectively one-half and twice the length of the basic canister (in step 11). The three canister face area/length dimensions are therefore 5" x 5", 5" x 10", and 5" x 20".

13. The dimensions and packing configuration of the extended-duration test canister depended on data gathered during the preliminary tests.

14. If we assume the volume of air flowing through the canister to be 5.5 CFM (step 11), we can check the feasibility of 1.0 inch ducts (0.0054 ft^2) to and from the transition pieces at each end of the canister, as follows;

$$\frac{5.5\ \text{CFM}}{0.0054\ \text{ft}^2} = 1018.5\ \text{FPM} = 16.9\ \text{FPS}$$

This duct velocity corresponds to recommended duct velocities for taking wet-bulb temperatures.

15. The transition pieces at each end of the canisters were designed with a half-angle of 15° to assure uniform superficial flow over the inlet face of each canister. Number 10 mesh stainless steel screens at each canister face served further as airflow straighteners and diffusers.

Appendix B

TEST DATA

PICTORIAL REPRESENTATION

The test data is presented here in five distinct groups of tables and graphs (described on pages 89-91) accompanied by a series of photographs which serve in some measure to illustrate the degree of fusion of the solid chemical granules in each canister after each test. Inasmuch as the photography is not in color, the identification of the materials, and their appearance in the black and white photos is given as follows:

In canister A, the reacted (used) KO_2 granules appear as white K_2CO_3, as expected. However, in the E and F canisters, (Figures 39, 41) the unused KO_2 appears white in the photo whereas its actual color was yellow. Also easily seen (especially in canisters E and F) are the grey unreacted granules of KO_2 impregnated with the catalyst which is close to their actual "color". It is noticeable (especially in canister A-8, and the reacted portion of F), that the grey granules turn black when reacted, which is true to the actual "color". In canister C-2 the small white granules of LiOH are easily distinguished from the larger white reacted KO_2 (K_2CO_3) granules, and of course the black granules are reacted KO_2 (K_2CO_3) impregnated with the catalyst. The small white granules of LiOH are easily apparent in the C, D, A-5, and A-7 canisters. The black lava rock appears as black granules in canisters B, C and A-3, and of course are difficult to distinguish from the reacted KO_2 (K_2CO_3) granules impregnated with the catalyst.

The activated alumina in canister B appears in its true "color" as very small grey round pellets.

The small grey rod-shaped pieces of molecular sieve in canister A-3, A-4, and A-6, are very difficult to identify. The photographs, if carefully observed, show the varying degree of fusion, and/or bonding, of the chemical granules in each canister. It is apparent that the least fusion occurred in the various A canisters. Canister C and D, both of which contained LiOH, show a greater fusion than A.

Canister B, containing activated alumina also shows greater fusion than the various A canisters. The photograph of canister E clearly shows the solid plug formation (about 1-1/2" thick) which caused complete airflow stoppage of the canister after 425 minutes. Canister F shows this same plug, with the same results. The photo of canister C-2, even though it contained LiOH, illustrates how the entire contents were turned into a soggy mass which offered greatly increased impedance to the flow of air through the canister. In the last photo, the white reacted KO_2 (K_2CO_3) granules, and the black reacted granules of KO_2 (K_2CO_3) with catalyst, are seen throughout the entire A-8 canister, which contrasts strongly with the F canister with its 2" plug formation at the inlet end, and its 18" long unused bed of KO_2 + catalyst.

PARTIALLY REDUCED DATA

Tables 5 through 14 are the partially reduced data from the test instrumentation measurements. These are self-explanatory with some exceptions. In the test series P-1 through P-5, the grains/lb H_2O columns for outlet air are not filled. This is because the data obtained from the wet bulb thermocouples was not considered correct when it was discovered that the wicking material around the thermocouple junctions did not remain properly wetted by capillary action from the wick-wetting water jars. (Figure 17). The readings from these particular thermocouples were ignored after ducts were installed for taking wet bulb readings with the Hygrophil "gun". (Figures 13 and 14). Also, after the P-5 test series, the exhaust manifold was removed (Figure 13) which lowered the pressure upstream of the canisters (P_n columns). This allowed a more nearly constant flow-rate through the canisters as well as providing for a greater capacity from the blowers.

IBM REDUCED DATA

Tables 15 through 24 consist of the data reduced by the IBM 7090 computer from the first group of tables. These tables are self-explanatory. Standard conditions in these tables are 70°F and 1 atmosphere pressure.

SC-4020 GRAPHS

The curves in Figures 42 through 144 were drawn by the Stromberg-Carlson SC-4020 computer from the IBM 7090 reduced data. The graphs are self-explanatory with the possible exception of Figures 108, 114, and 117. The portion of the curves below the abscissa in these figures represent negative values, or desorption of water from the KO_2 bed due to the low inlet absolute humidities. The horizontal lines below the abscissa represent the limit of the computer scale, or a truncation of the curves. The requirements for O_2 consumption per man are ~ 0.0168 SCFM, and the man-rate of CO_2 production is ~ 0.0138 SCFM, where 70°F and atmosphere pressure are taken as standard conditions. (R.Q. = 0.82).

The heavy black horizontal line across each graph of O_2 produced and CO_2 adsorbed represents the rate of O_2 consumption and CO_2 production, respectively, of one man. Of course, in a sealed cabin with the dual-canister system described on pages 16, 73 these rates would be adjusted by demand controls, and, provided the absolute humidity and partial pressure of the CO_2 in the cabin air are both sufficient to assure a good rate of O_2 evolution (Figure 42), the curves would approach, and tend to parallel, the man-rate line.

On some graphs, the man-rate line for CO_2 appears above the grid. In these cases, the line is actually beyond the computer scale limit, but has been inserted as a reminder that the true location is somewhere above the grid. These cases in particular occurred when low absolute inlet humidites and low PCO_2 were used, or when molecular sieve was used. The % inlet CO_2 is repeated on each graph of O_2 generation and CO_2 adsorption for convenient reference because of the importance of the CO_2 partial pressure in the evolution and adsorption rates of oxygen and carbon dioxide respectively. The inlet absolute humidity range is also indicated on the graphs. Because of the relatively wide range of inlet absolute humidities, reference to the exact values of absolute humidities can be made from the appropriate partially reduced data sheet. The same may be done in regard to the H_2O adsorption graphs. It is seen from the curves that the H_2O adsorption is, in general, proportional to the inlet absolute humidity. Also, the reader will notice that a low (0.2%) CO_2 partial pressure, or a moderate (0.5%) CO_2 partial pressure, is not the sole influence for a low generation-adsorption rate inasmuch as a low absolute inlet humidity may have the same effect on the curve. For example, Figures 94, 95, and Figures 106, 107 show low generation-adsorption rates, but for different reasons. Figures 106, 107 represent a moderate CO_2 partial pressure with a low absolute humidity. (Table 12).

INTEGRATED DATA

Cumulative Data

Tables 25 through 34 are cumulative and comparative, and were compiled (partly) by geometric integration of the areas under the SC-4020 curves. The columns show the parameters becoming (usually) larger by successive additions as functions of time. The oxygen generated and carbon dioxide absorbed columns together represent the chemical respiratory quotient. Their ratio is presented in the CUM. R.Q. column which does not show an increase in every case (such as when the cumulation rate of oxygen is greater than the cumulation rate of carbon dioxide). The oxygen consumed and carbon dioxide produced columns together represent the normal physiological respiratory quotient of man, which is taken as 0.82.

Man-Rate Support Level Graphs

The areas under the SC-4020 curves for O_2 generation and CO_2 adsorption were geometrically integrated, and the results were plotted in Figures 145 through 164 with the man-rate production, or adsorption, as a function of time. Curves, or portions of curves, above the man's support level (dashed line) indicate the ability to support the respiratory requirements of one man. This ability is mainly dependent on bed packing configuration, inlet CO_2 partial pressure, and inlet absolute humidity.

FURTHER ANALYSIS OF TEST DATA

All test data of any importance has been included in this report to encourage the individual reader towards further study and analysis of the figures, tables, and graphs, inasmuch as it was beyond the capabilities of the author to extract all possible information in the time allotted to do so.

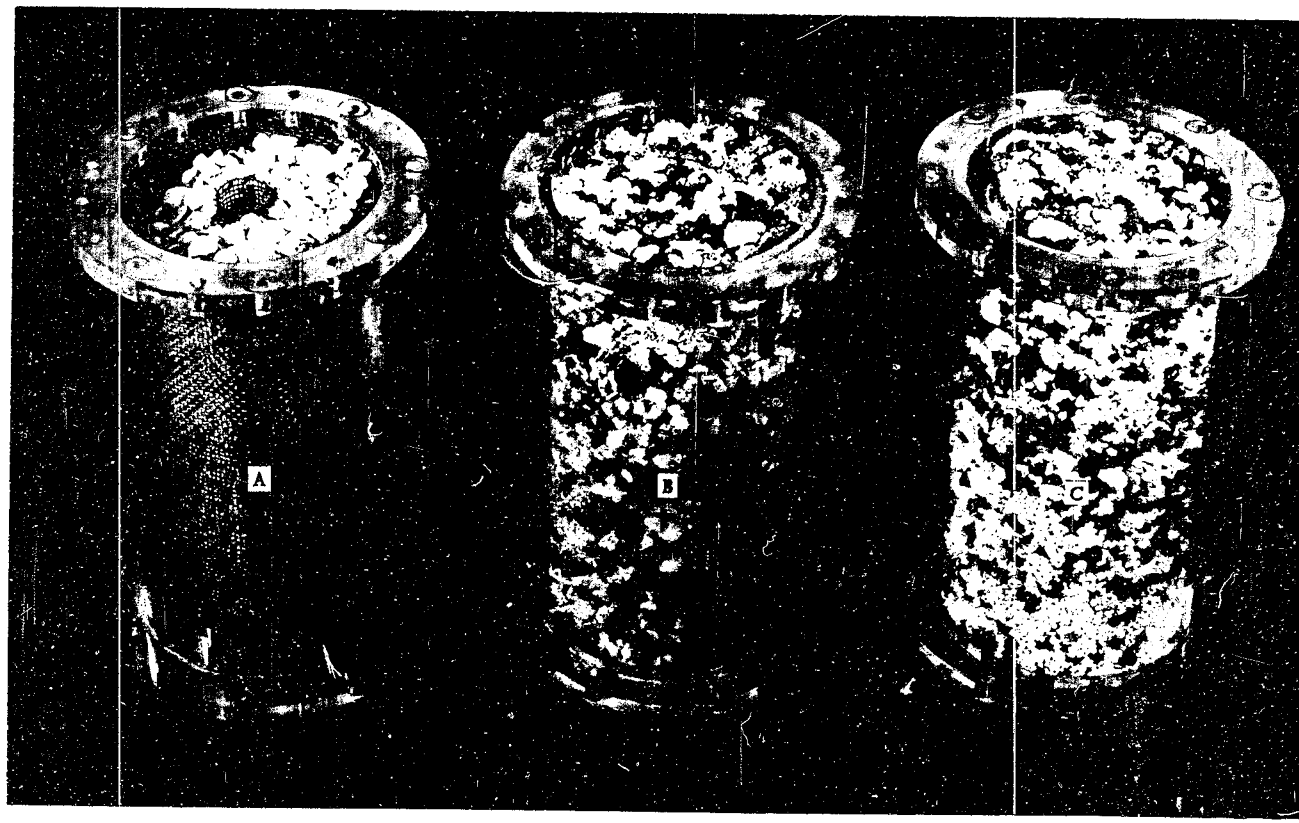

Figure 30 Test P-1, Inlet End, After 250 Minutes

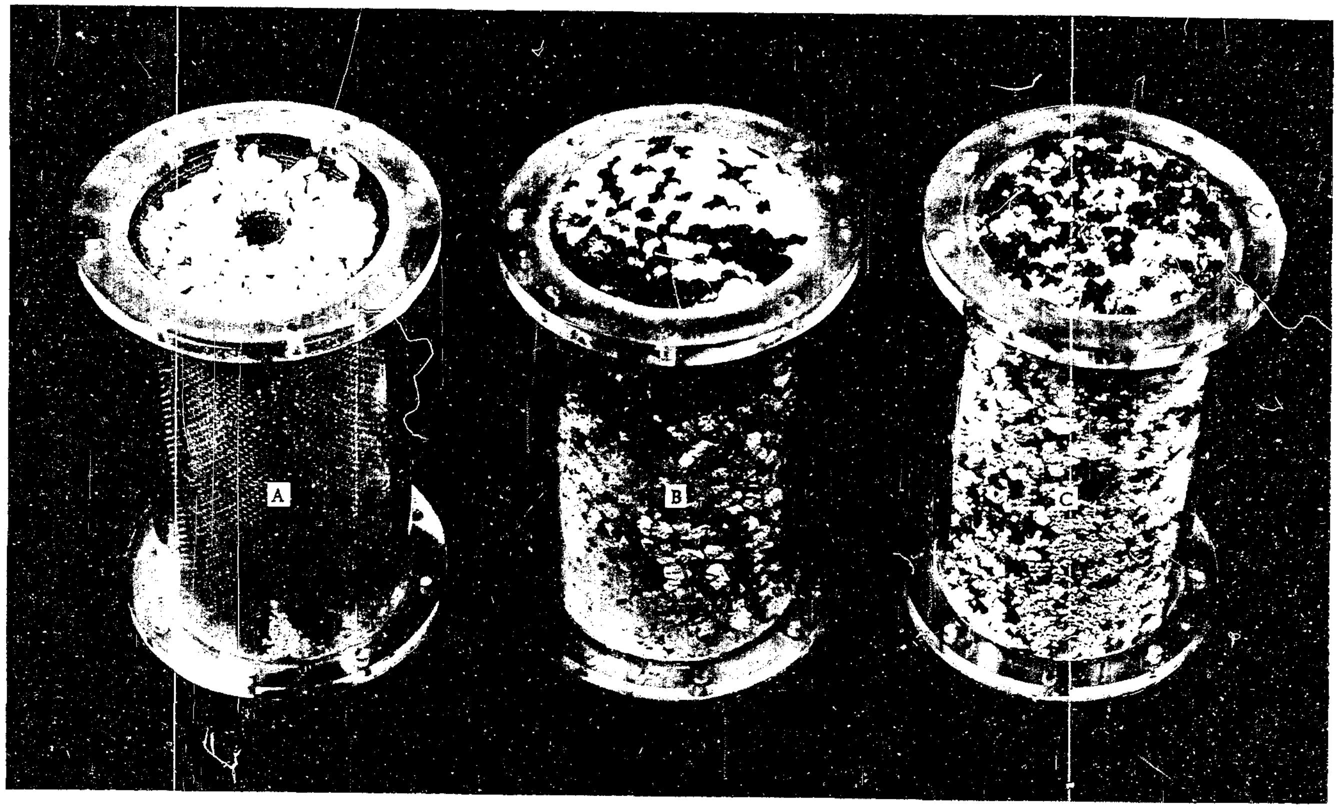

Figure 31 Test P-2, Inlet End, After 450 Minutes

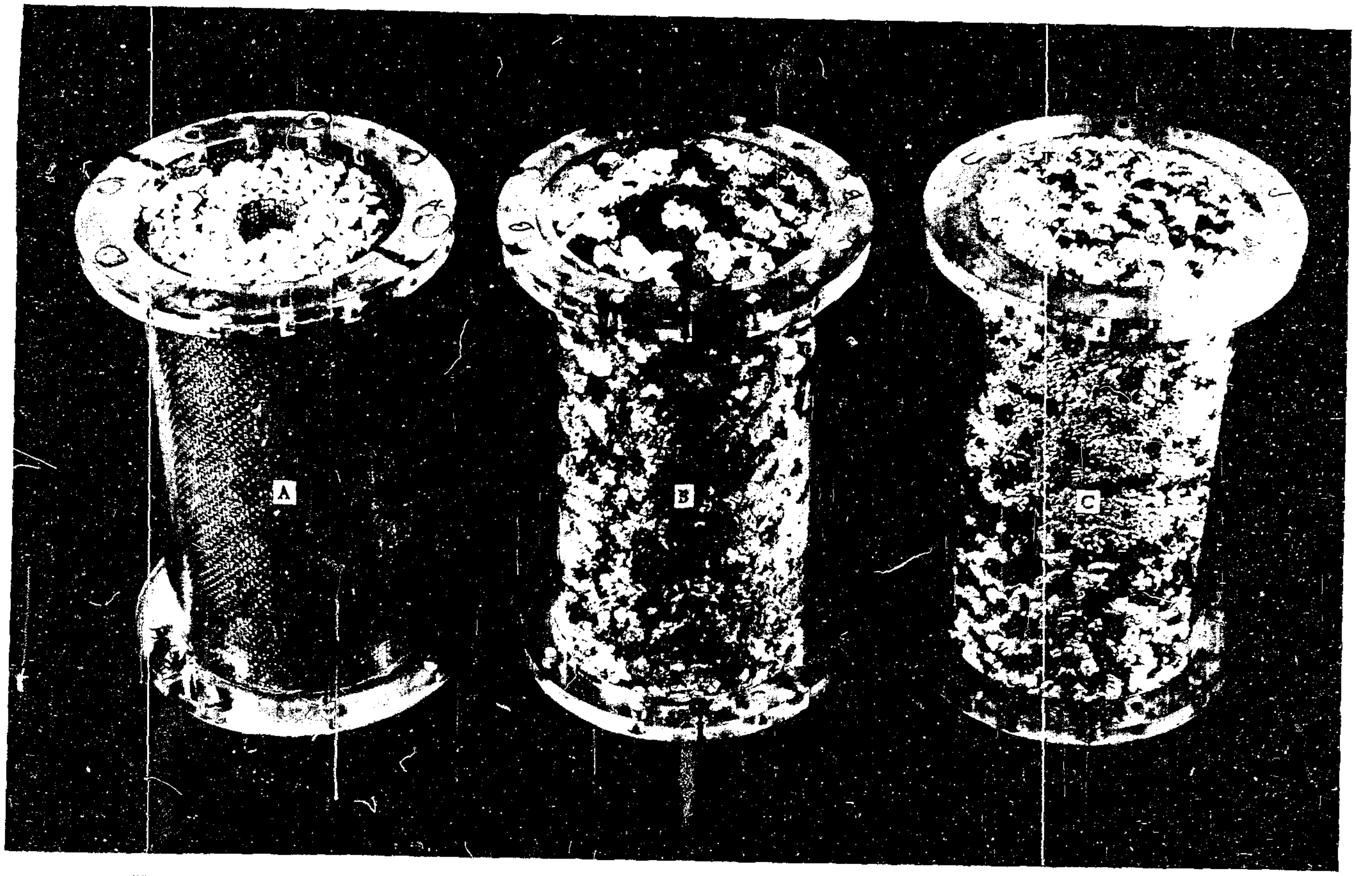

Figure 32 Test P-3, Inlet End, After 450 Minutes

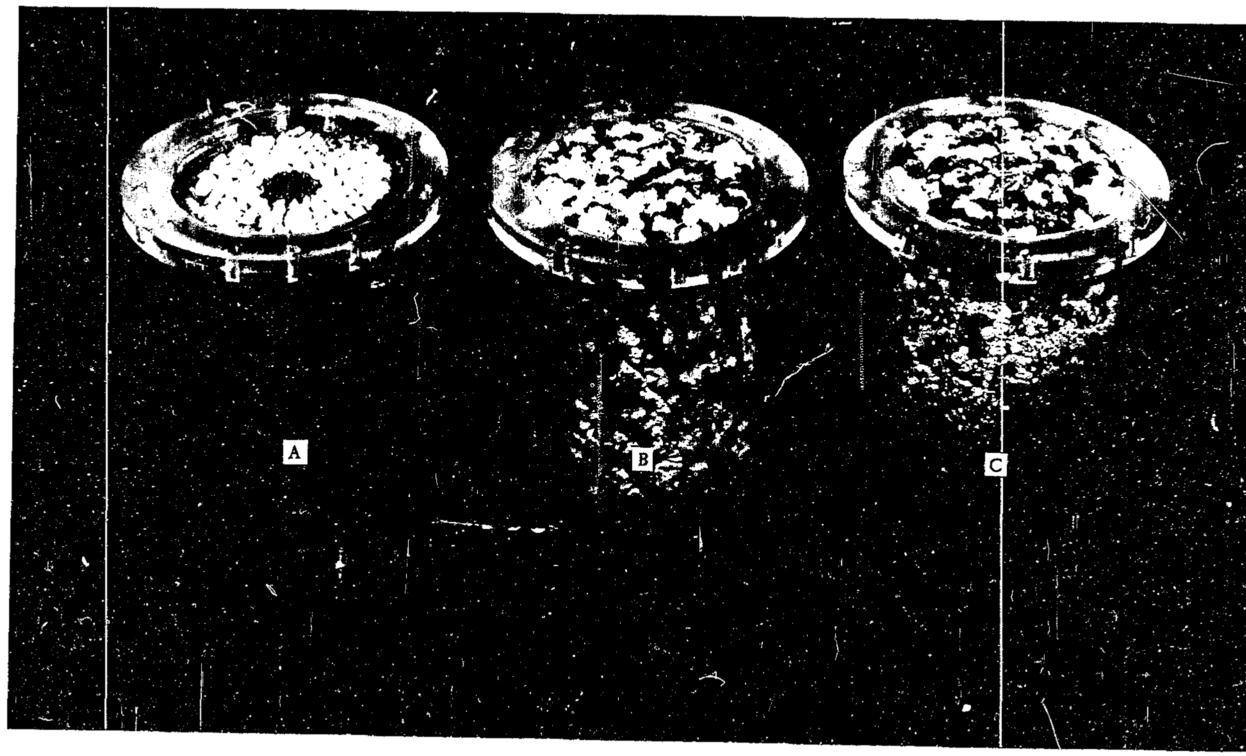

Figure 33 Test P-4, Inlet End, After 255 Minutes

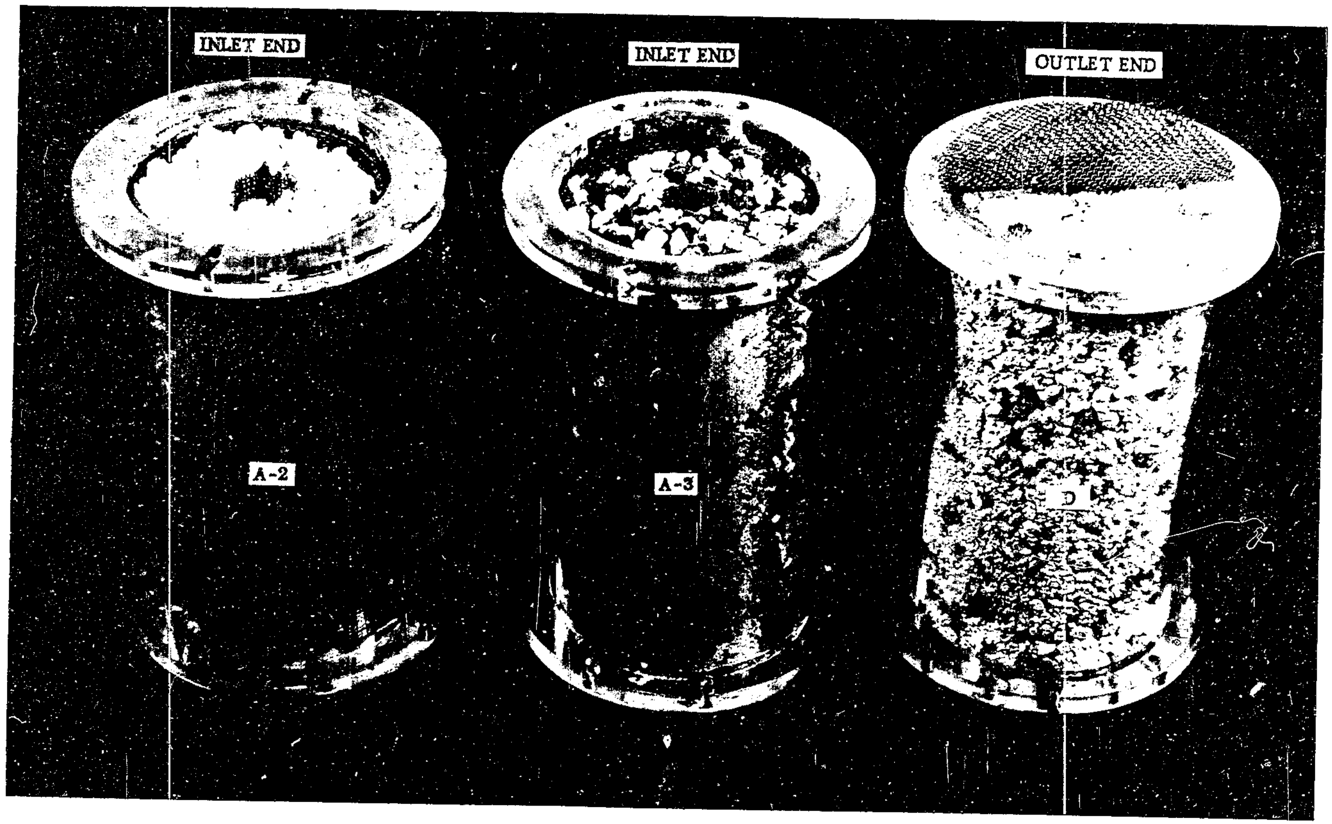

Figure 34 Test P-5, After 337 Minutes

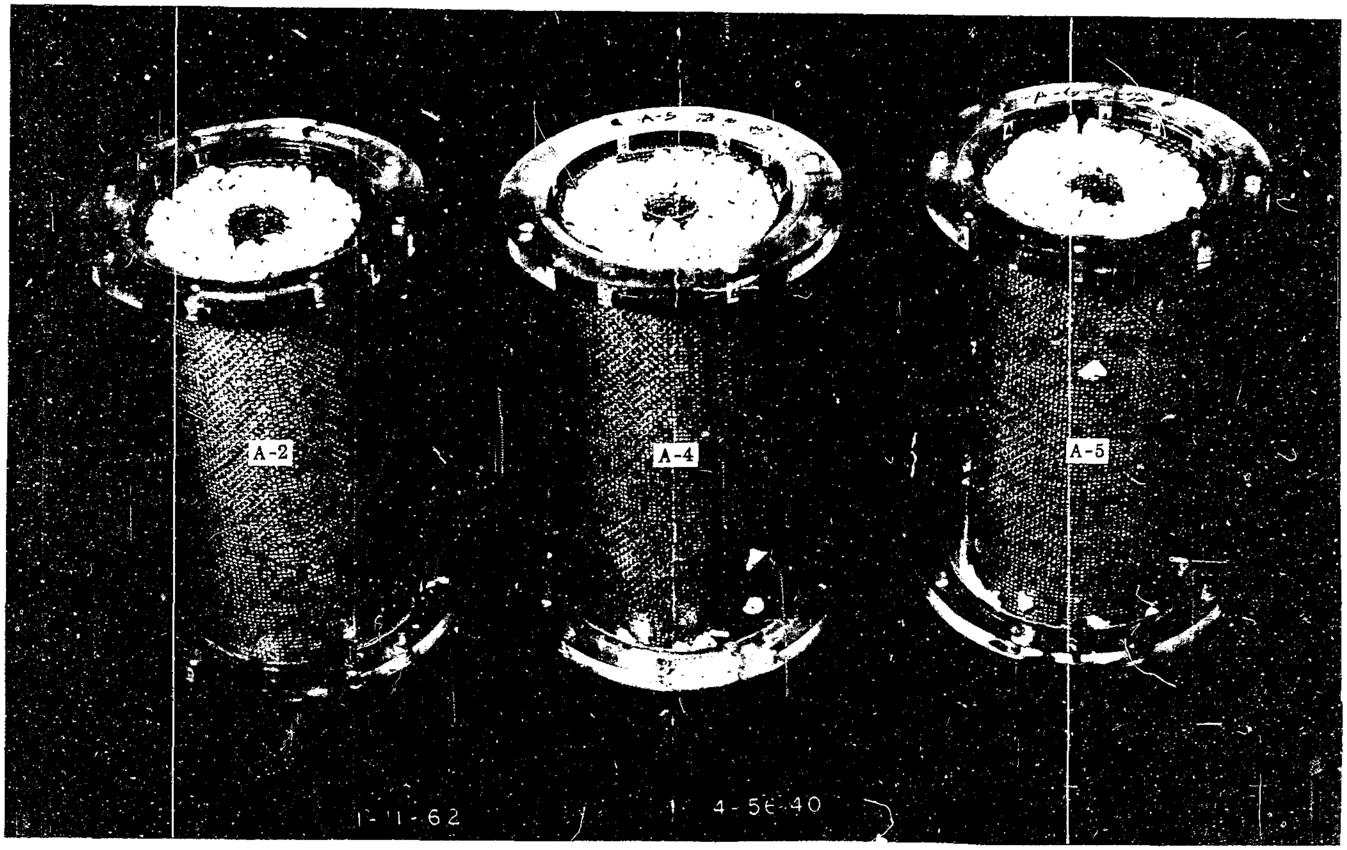

Figure 35 Test P-6, Inlet End, After 461 Minutes

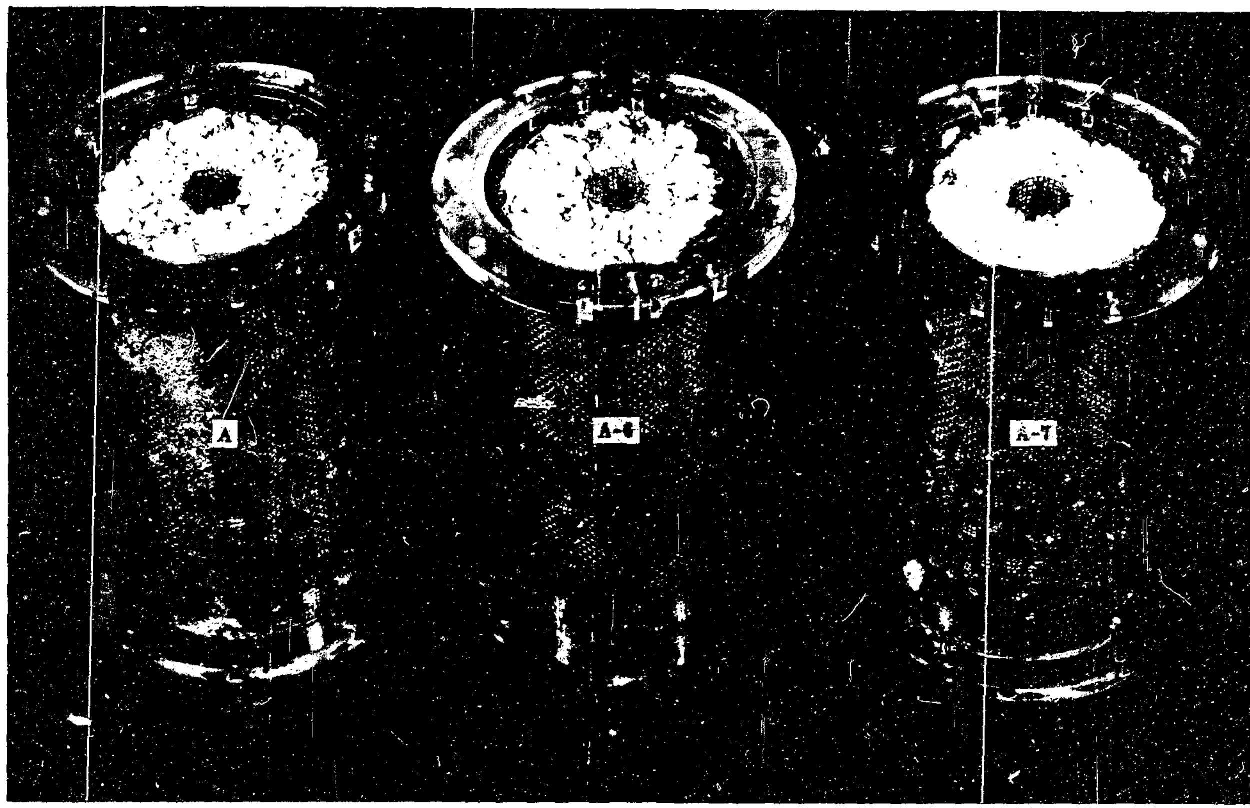

Figure 36 Test P-7, Inlet End, After 435 Minutes

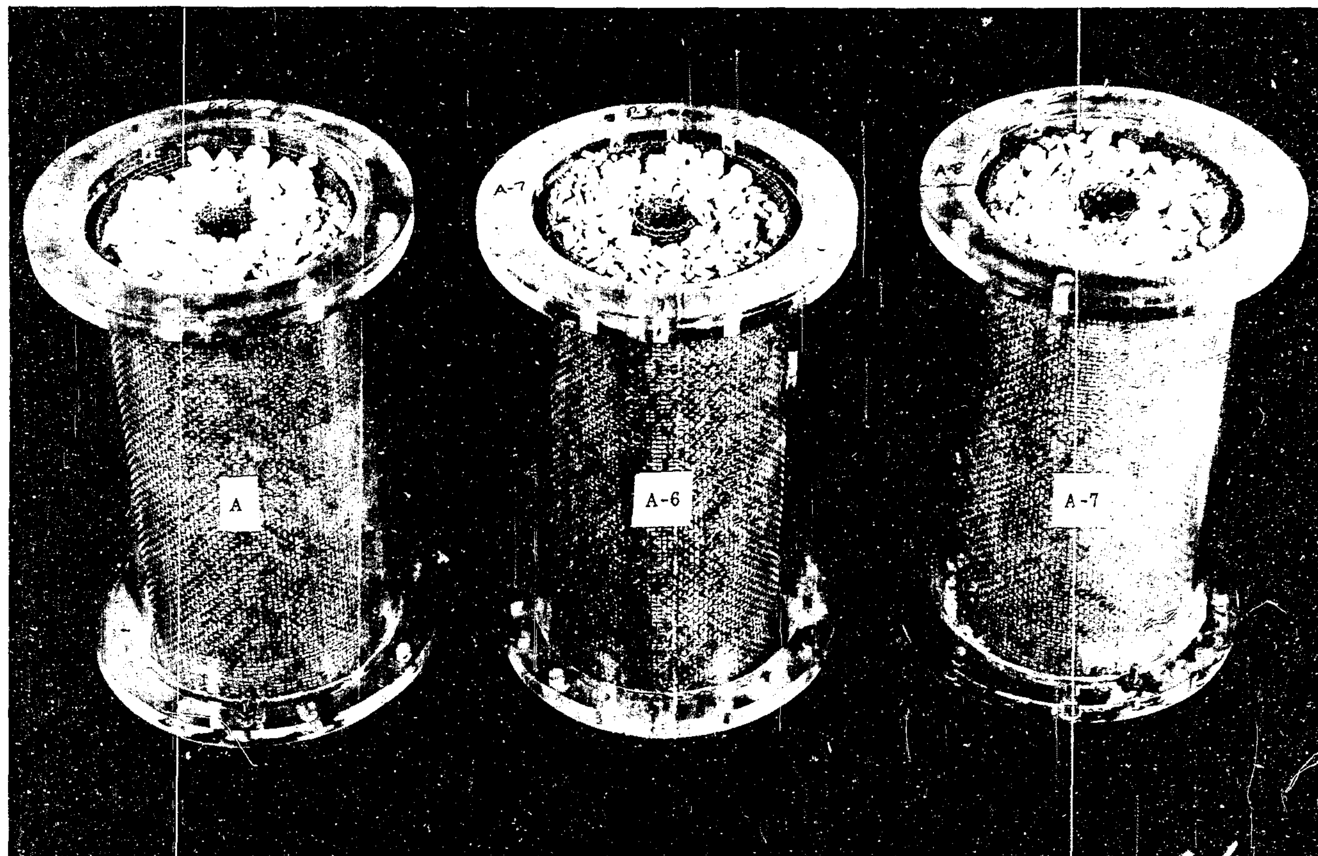

Figure 37 Test P-8, Inlet End, After 728 Minutes

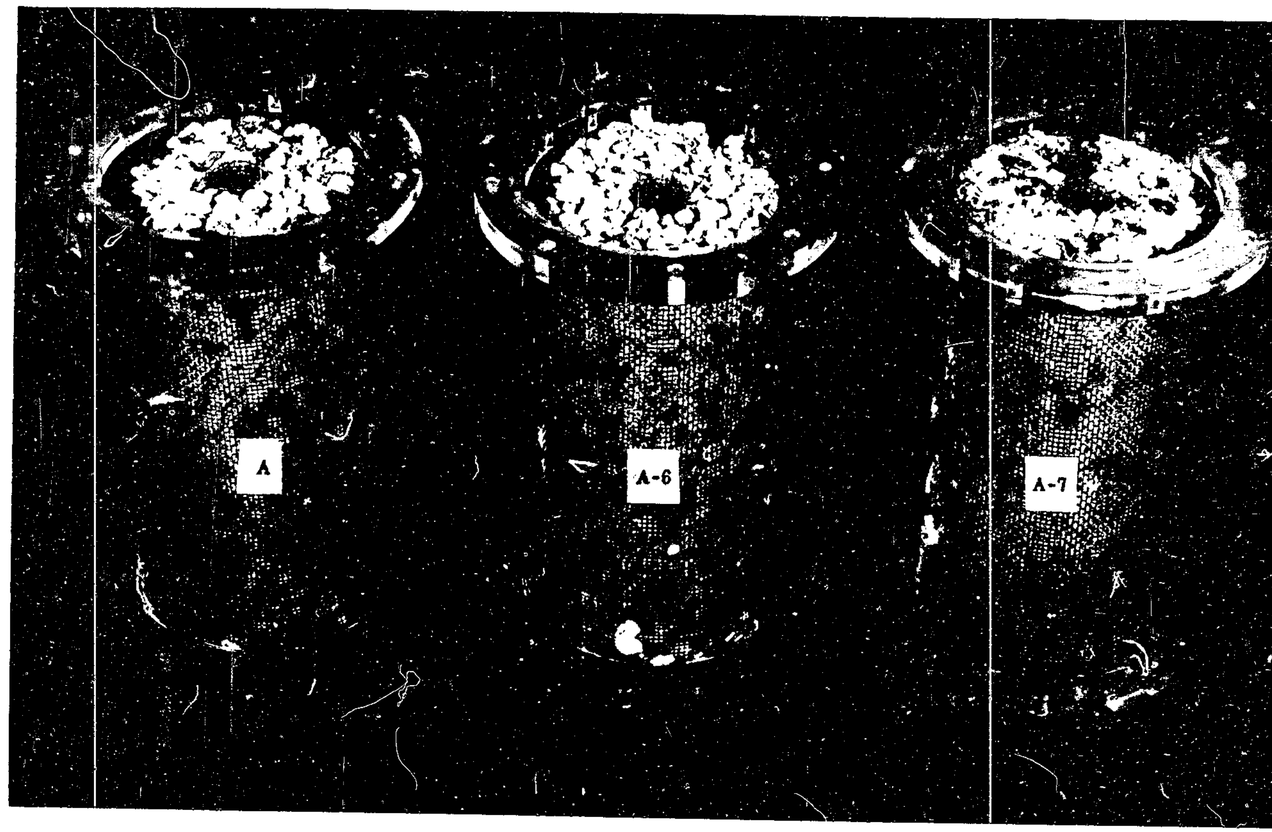

Figure 38 Test P-9, Inlet End, After 650 Minutes

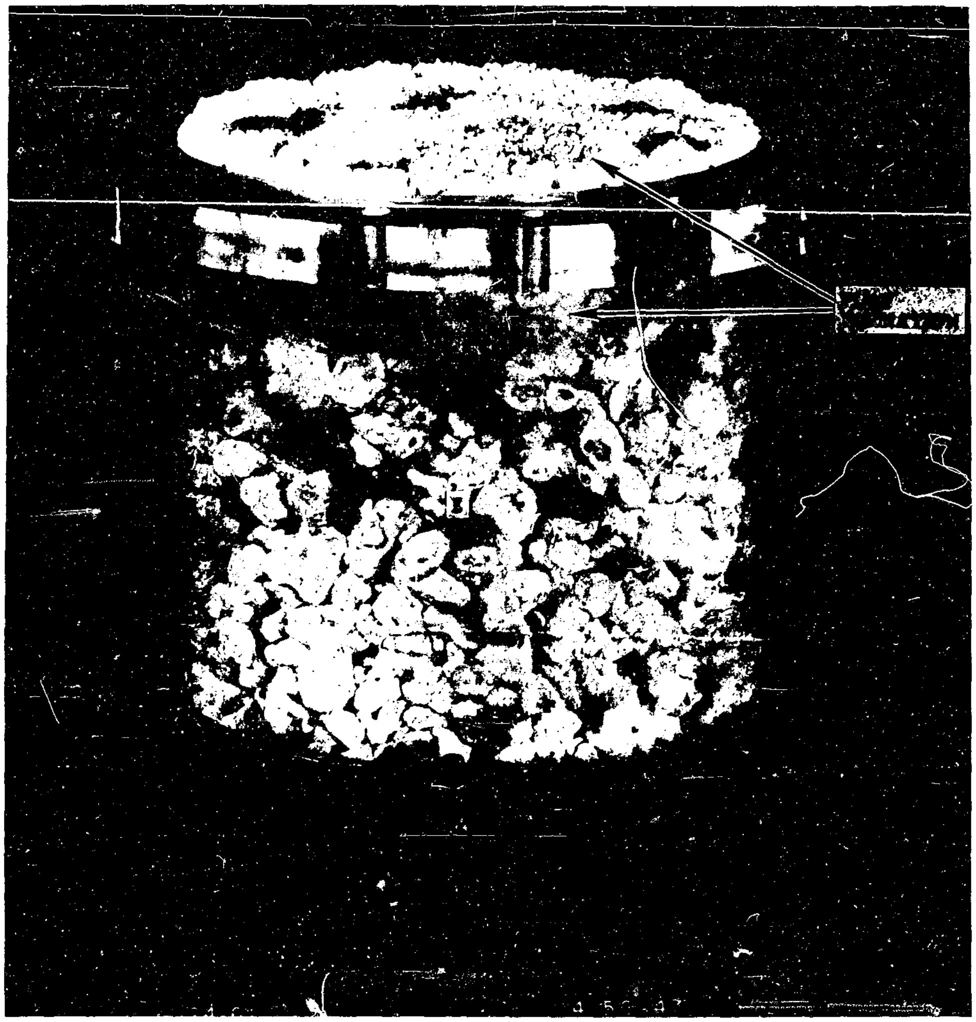

Figure 39 Test P-10, Inlet End, Canister E, After 425 Minutes

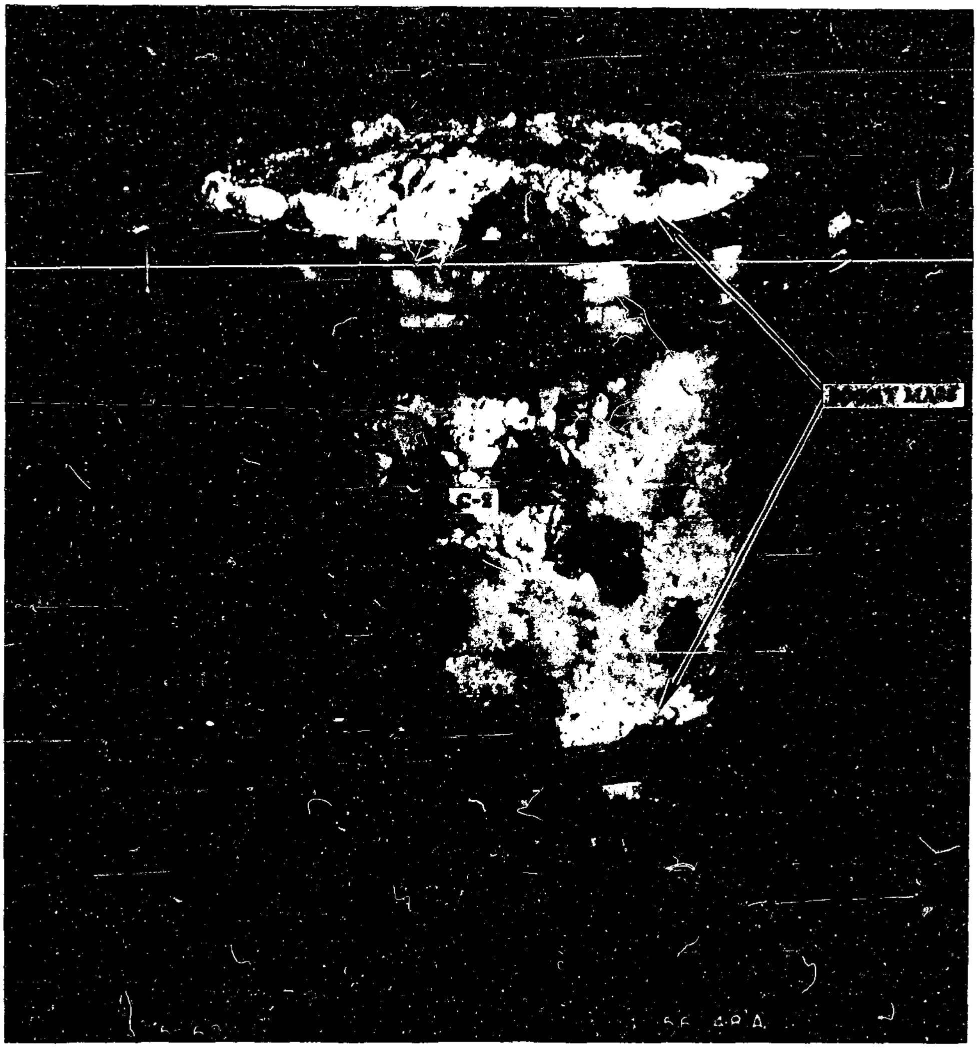

Figure 40 Test P-10, Inlet End, Canister C-2, After 680 Minutes

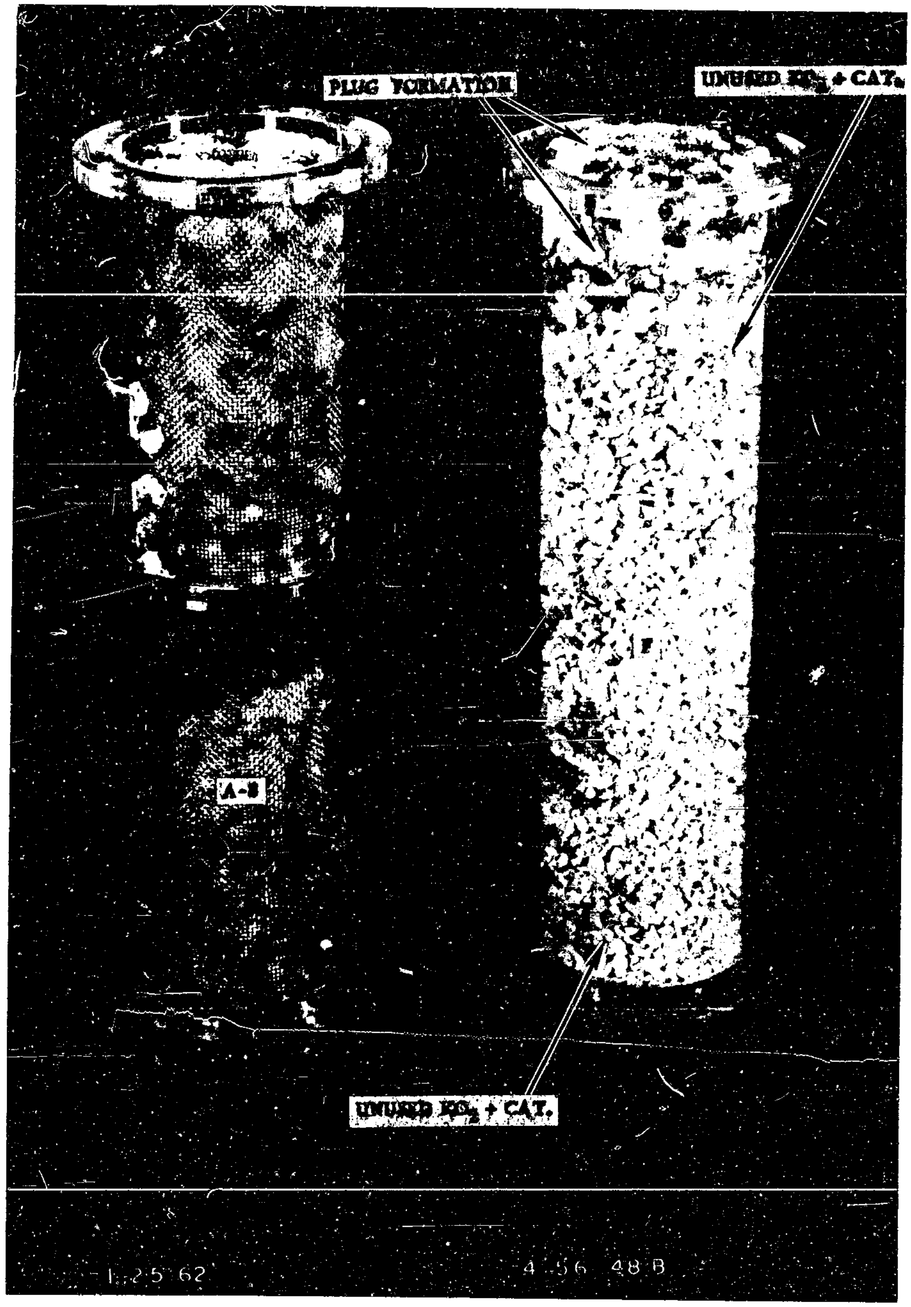

Figure 41 Test P-10, Inlet End, Canisters A-8 After 1765 Minutes, and F After 425 Minutes

Table 5 Partially Reduced Data, P-1

Test P - 1 Date: 12 - 18 - 61

TIME	INLET AIR			CANISTER A — KO_2 + Cat. + Annular Screen									CANISTER B — 1/3 KO_2 + Cat. + 1/3 Lava Rock + 1/3 Activated Alumina								
									OUTLET AIR									OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0		1.05	21.12																		
15	53.1	0.73	21.00	8.00	0.30	76	29	4.42		0.38	21.54	0.65	7.70	0.25	76	19	4.56		0.55	21.54	0.33
45	47.1	1.01	20.85	8.05	0.30	76	47	4.48		0.55	21.39	0.85	7.80	0.25	77	24	4.67		0.75	22.12	0.96
90	61.8	1.01	20.85	8.05	0.30	76	49	4.42		0.70	21.30	0.69	7.80	0.30	77	26	4.77		0.83	21.06	0.86
125	68.5	1.01	20.79	8.05	0.33	76	46	4.47		0.69	21.27	0.67	7.80	0.30	76	26	4.67		0.85	21.00	0.76
150	61.4	0.99	20.85	8.05	0.30	76	43	4.47		0.72	21.21	0.75	7.85	0.30	76	24	4.56		0.80	21.00	1.27
180	61.4	0.97	20.85	8.05	0.30	76	40	4.52		0.70	21.15	0.90	7.85	0.30	77	23	4.56		0.83	20.94	1.56
215	60.5	0.97	20.82	8.10	0.32	77	35	4.63		0.73	20.97	1.60	7.90	0.30	77	22	4.56		0.86	20.94	1.75
245	68.1	0.97	20.76	8.15	0.32	77	34	4.66		0.75	21.12	0.61	7.90	0.32	77	21	4.56		0.86	20.91	0.73
250				Shut Down.																	

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 5 (cont.) Partially Reduced Data, P-1

Test P-1 Date: 12-18-61

TIME	INLET AIR			CANISTER C: 1/3 KO_2 + Cat. + Lava Rock + 1/3 LiOH					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0		1.05	21.12																		
5	53.1	0.73	21.00	7.45	0.30	76	19	4.75		0.27	21.57	0.81	7.40	1.10	78	65	4.15		0.21	21.93	0.56
40	47.1	1.01	20.85	7.55	0.35	76	46	4.75		0.49	21.36	1.02	7.60	1.10	78	69	4.15		0.52	21.54	0.71
80	48.3	0.97	20.85	7.65	0.40	77	47	4.76		0.55	21.21	1.17	7.60	1.10	78	59	4.15		0.64	21.36	0.65
115	68.5	1.05	20.79	7.60	0.45	77	42	4.76		0.58	21.06	1.74	7.60	1.15	78	44	4.15		0.70	21.18	0.90
145	61.4	0.99	20.87	7.60	0.45	77	42	4.76		0.62	21.00	2.47	7.60	1.10	77	38	4.15		0.75	21.09	1.00
175	61.4	0.97	20.85	7.60	0.45	77	33	4.76		0.65	20.94	3.56	7.60	1.15	78	34	4.15		0.80	21.00	1.13
205	60.5	0.97	20.82	7.60	0.45	77	27	4.76		0.70	20.91	3.00	7.60	1.15	78	27	4.15		0.85	20.94	1.00
235	68.1	0.97	20.76	7.70	0.50	77	24	4.76		0.73	20.88	2.00	7.70	1.20	78	25	4.15		0.86	20.94	0.61
250				SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 6 Partially Reduced Data, P-2

Test P-2 Date: 12-21-61

TIME	INLET AIR			CANISTER A — KO_2 + Cat. + Annular Screen					OUTLET AIR				CANISTER B — 1/3 KO_2 + Cat. + 1/3 Lava Rock + 1/3 Act. Alumina					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{14} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	60	0.97	20.52																		
5	66.5	0.85	20.55	8.65	0.80	76	30	4.22		0.43	21.42	0.48	8.60	0.75	74	27	4.15		0.21	21.93	0.46
45	69.3	0.99	20.52	9.10	0.80	69	65	4.10		0.49	21.27	0.67	9.10	0.85	69	107	3.75		0.55	21.42	0.49
75	69.0	0.95	20.58	8.95	0.80	69	62	4.22		0.69	21.12	0.48	9.00	0.95	70	69	3.86		0.61	21.24	0.52
105	73.0	0.99	20.49	8.95	0.82	72	57	4.23		0.73	21.12	0.41	9.00	1.10	71	80	3.81		0.69	21.09	0.50
133	67.7	0.97	20.58	8.92	0.85	71	52	4.36		0.76	20.97	0.67	9.15	1.30	71	71	3.75		0.75	20.91	0.67
165	70.8	0.99	20.46	8.75	0.88	70	47	4.64		0.76	20.94	0.48	9.15	1.35	69	62	3.48		0.78	20.88	0.58
195	66.0	0.99	20.46	8.75	0.95	68	44	4.50		0.80	20.88	0.45	9.15	1.65	69	55	3.30		0.80	20.88	0.53
225	66.1	0.99	20.46	8.75	0.90	69	40	4.88		0.85	20.76	0.47	9.25	1.80	70	49	2.01		0.83	20.79	0.49
255	68.1	0.99	20.49	8.65	1.02	69	37	4.90		0.86	20.73	0.54	9.25	1.85	70	46	3.18		0.86	20.73	0.54
285	65.5	0.99	20.46	8.70	1.07	69	34	6.07		0.86	20.73	0.48	9.30	1.95	70	44	3.18		0.86	20.67	0.62
315	70.3	0.99	20.46	8.65	1.15	69	33	6.07		0.88	20.70	0.46	9.35	2.02	70	41	3.04		0.88	20.70	0.46
345	66.2	0.99	20.46	8.75	1.15	69	30	6.07		0.88	20.70	0.46	9.35	2.08	70	37	3.12		0.88	20.64	0.61
385	68.8	0.99	20.49	8.75	1.15	68	29	6.07		0.88	20.70	0.52	9.35	2.10	70	34	3.18		0.88	20.64	0.73
405	66.8	0.99	20.49	8.73	1.20	68	26	6.07		0.88	20.64	0.73	9.24	2.03	70	32	3.1C		0.88	20.61	0.92
435	69.9	0.99	20.49	8.72	1.21	68	26	6.07		0.90	20.64	0.60	9.30	2.06	70	30	3.18		0.90	20.61	0.75
450				SHUT DOWN																	

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 6 (cont.) Partially Reduced Data, P-2

Test P-2 **Date:** 12-21-61

Canister C: 1/3 KO_2 + Cat. + Lava Rock + 1/3 LiOH

TIME Min.	INLET AIR H_2O Gr/Lb.	INLET AIR CO_2 %	INLET AIR O_2 %	CANISTER C P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	OUTLET AIR H_2O Gr/Lb	OUTLET AIR CO_2 %	OUTLET AIR O_2 %	R.Q.
0	60	0.97	20.52									
12	66.5	0.85	20.55	8.50	0.75	75	62	5.17		0.05	21.84	0.62
51	69.3	0.99	20.52	8.70	0.85	69	112	4.86		0.44	21.24	0.76
80	69.0	0.95	20.58	8.60	1.00	70	80	4.69		0.55	21.06	0.83
115	73.0	0.99	20.49	8.60	1.10	72	66	4.65		0.66	20.82	1.00
140	67.7	0.97	20.58	8.70	1.20	71	55	4.47		0.69	20.76	1.55
170	70.8	0.99	20.46	8.60	1.23	69	48	4.46		0.73	20.73	0.96
200	66.0	0.99	20.46	8.60	1.35	69	44	4.86		0.78	20.73	0.78
230	66.1	0.99	20.46	8.60	1.43	69	40	4.86		0.80	20.70	0.79
262	68.1	0.99	20.49	8.60	1.50	69	37	4.45		0.81	20.70	0.86
290	65.5	0.99	20.46	8.68	1.58	69	34	4.45		0.85	20.61	0.93
320	70.3	0.99	20.46	8.70	1.70	69	31	4.46		0.86	20.61	0.87
350	66.2	0.99	20.46	8.80	1.80	69	28	4.46		0.88	20.61	0.73
377	68.8	0.99	20.49	8.75	1.80	69	25	4.33		0.90	20.61	0.75
408	66.8	0.99	20.49	8.58	1.82	69	23	4.50		0.92	20.58	0.78
440	69.9	0.99	20.49	8.70	1.80	70	22	4.51		0.92	20.58	0.78
[illegible]				SHUT	DOWN							

TIME Min.	CANISTER MSA P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	OUTLET AIR H_2O Gr/Lb	OUTLET AIR CO_2 %	OUTLET AIR O_2 %	R.Q.
0									
12	8.20	1.32	75	105	3.84		0.38	21.51	0.49
51	8.75	1.30	72	80	3.88		0.62	21.24	0.51
80	8.05	1.30	72	61	3.96		0.72	21.00	0.55
115	7.90	1.30	75	47	3.98		0.83	20.73	0.67
140	8.00	1.35	73	45	4.06		0.83	20.67	1.78
170	7.85	1.40	71	31	4.11		0.85	20.70	0.58
200	7.85	1.45	71	27	3.84		0.85	20.64	0.78
230	7.80	1.50	71	23	3.84		0.90	20.64	0.50
262	7.80	1.55	71	22	3.84		0.92	20.64	0.47
290	7.85	1.55	71	21	3.84		0.92	20.61	0.47
320	7.90	1.70	71	20	3.84		0.93	20.61	0.40
350	7.92	1.75	71	17	3.84		0.93	20.61	0.40
377	7.90	1.85	71	16	3.84		0.95	20.58	0.45
408	8.05	1.90	71	15	4.11		0.95	20.58	0.45
440	8.05	1.95	71	15	3.84		0.95	20.58	0.45
[illegible]									

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 7 Partially Reduced Data, P-3

Test P-3 **Date:** 12-20-61

TIME	INLET AIR			CANISTER A: KO_2 + Cat. + Annular Screen					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	65.8	1.01	20.61									
15	63.6	0.90	20.64	8.75	0.27	81	65	5.26		0.54	21.36	0.50
55	54.8	0.95	20.64	8.75	0.27	92	66	5.31		0.64	21.33	0.45
75	56.2	0.97	20.64	8.60	0.30	94	62	5.31		0.67	21.27	0.48
107	61.1	0.97	20.64	8.60	0.30	95	60	5.31		0.72	21.27	0.40
135	59.2	1.01	20.59	8.50	0.30	98	52	5.40		0.77	21.15	0.43
165	75.9	1.01	20.59	8.40	0.30	97	45	5.44		0.77	21.06	0.51
195	58.1	1.01	20.61	8.35	0.30	100	37	5.47		0.80	21.03	0.50
225	57.8	1.01	20.61	8.30	0.30	100	34	5.50		0.81	20.97	0.56
255	58.4	1.01	20.61	8.20	0.29	100	30	5.49		0.81	20.88	0.74
280	56.7	1.00	20.64	8.15	0.30	100	26	5.50		0.85	20.88	0.63
315	56.5	1.01	20.61	8.17	0.29	99	23	5.52		0.85	20.85	0.67
345	60.0	1.01	20.61	8.15	0.30	97	22	5.57		0.88	20.76	0.87
375	58.1	1.01	20.49	8.07	0.29	99	17	5.48		0.88	20.70	0.62
405	55.7	1.01	20.49	8.08	0.30	99	15	5.48		0.92	20.61	0.75
435	55.7	1.01	20.49	8.07	0.29	99	14	5.49		0.92	20.58	1.00
450	27.6*	1.01	20.52	SHUT	DOWN							
	*	BOILER	DRY									

TIME	CANISTER B: 1/3 KO_2 + Cat. + 1/3 Lava Rock + 1/3 Act. Alumina					OUTLET AIR			
Min.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0									
15	9.25	1.05	82	85	3.72		0.35	21.78	0.48
55	9.20	1.07	92	87	3.75		0.55	21.39	0.53
75	9.20	1.10	94	69	3.76		0.63	21.36	0.47
107	9.20	1.10	95	62	3.77		0.67	21.27	0.48
135	9.10	1.15	98	52	3.77		0.74	21.16	0.47
165	9.00	1.20	96	46	3.77		0.77	21.00	0.59
195	9.00	1.20	98	39	3.77		0.82	20.94	0.58
225	9.00	1.20	99	32	3.72		0.86	20.85	0.62
255	8.93	1.23	99	28	3.60		0.85	20.85	0.67
280	8.90	1.30	99	25	3.60		0.87	20.76	1.08
315	8.93	1.30	98	21	3.56		0.88	20.79	0.72
345	8.95	1.33	96	21	3.56		0.90	20.76	0.73
375	8.92	1.39	96	18	3.56		0.90	20.67	0.61
405	8.95	1.40	98	15	3.56		0.93	20.61	0.67
435	8.96	1.42	98	14	3.56		0.93	20.61	0.67
450									

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 7 (cont.) Partially Reduced Data, P-3

Test P-3 Date: 12-20-61

TIME	INLET AIR			CANISTER C 1/3 KO_2 + Cat. + 1/3 Lava Rock + 1/3 LiOH					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	65.8	1.01	20.61																		
30	63.6	0.90	20.64	8.45	0.60	86	103	4.66		0.09	21.69	0.77	8.25	1.25	85	79	4.01		0.52	21.51	0.44
65	54.8	0.95	20.64	8.50	0.77	92	77	4.62		0.34	21.24	0.76	8.20	1.20	92	66	4.12		0.60	21.30	0.53
83	56.2	0.97	20.64	8.45	0.80	94	59	4.63		0.52	21.03	1.15	8.15	1.20	93	50	4.09		0.72	21.14	0.49
110	61.1	0.97	20.64	8.40	0.82	97	44	4.65		0.61	20.91	1.33	8.10	1.22	95	41	4.09		0.78	21.03	0.49
140	59.2	1.01	20.59	8.35	0.85	97	33	4.65		0.67	20.82	1.48	8.00	1.20	96	31	4.06		0.83	20.88	0.62
170	75.9	1.01	20.59	8.25	0.85	97	29	4.65		0.73	20.79	1.40	7.85	1.20	96	25	4.02		0.86	20.82	0.65
200	58.1	1.01	20.61	8.20	0.85	100	21	4.64		0.76	20.79	1.39	7.85	1.25	97	20	4.06		0.88	20.79	0.72
230	57.8	1.01	20.61	8.15	0.85	99	18	4.64		0.83	20.73	1.50	7.80	1.25	97	16	4.09		0.90	20.73	0.92
260	58.4	1.01	20.61	8.10	0.87	100	14	4.64		0.83	20.76	1.20	7.81	1.27	98	13	4.15		0.90	20.73	0.92
290	56.7	1.01	20.64	8.10	0.90	100	11	4.64		0.83	20.70	3.00	7.80	1.30	98	12	4.11		0.90	20.73	1.22
320	56.5	1.01	20.61	8.10	0.89	98	10	4.63		0.86	20.73	1.25	7.81	1.29	97	10	4.11		0.88	20.73	1.08
350	60.0	1.01	20.61	8.10	0.90	97	10	4.67		0.87	20.70	1.55	7.80	1.32	96	9	4.09		0.88	20.73	1.08
385	58.1	1.01	20.49	8.10	0.94	98	7	4.67		0.86	20.61	1.25	7.76	1.35	97	7	4.13		0.92	20.58	1.00
410	55.7	1.01	20.49	8.07	0.95	99	5	4.71		0.90	20.58	1.22	7.78	1.40	97	6	4.11		0.94	20.58	0.78
440	55.7	1.01	20.49	8.05	0.94	99	3	4.71		0.90	20.58	1.22	7.78	1.37	97	5	4.13		0.95	20.55	1.00
450	27.6*	1.01	20.52	SHUT	DOWN																
		*BOILER	DRY																		

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 8 Partially Reduced Data, P-4

Test P-4 **Date:** 12-19-61

TIME	INLET AIR			CANISTER A — KO_2 + Cat. + Annular Screen					OUTLET AIR				CANISTER B — 1/3 KO_2 + Cat. + Lava Rock + 1/3 Act. Alumina					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	91.4	0.52	20.88																		
20	91.4	0.51	20.88	8.50	0.30	75	32	4.64		0.21	21.36	0.63	8.40	0.40	76	31	4.39		0.17	21.42	0.63
65	61.6	0.51	20.91	8.50	0.36	76	47	4.64		0.30	21.36	0.47	8.47	0.46	77	46	4.32		0.24	21.42	0.53
95	62.0	0.52	20.91	8.45	0.35	76	45	4.89		0.34	21.34	0.42	8.50	0.55	76	46	4.32		0.28	21.36	0.53
140	62.2	0.51	20.91	8.50	0.40	76	39	4.89		0.33	21.30	0.46	8.55	0.65	76	42	4.19		0.32	21.27	0.53
180	63.6	0.51	20.95	8.40	0.40	76	36	4.99		0.33	21.27	0.56	8.60	0.80	76	40	4.19		0.32	21.24	0.66
218	61.6	0.51	20.95	8.40	0.42	76	33	5.21		0.35	21.24	0.55	8.62	0.85	76	36	4.19		0.33	21.18	0.78
242	61.2	0.51	20.95	8.40	0.40	76	31	5.32		0.37	21.21	0.54	8.60	0.90	76	34	4.19		0.36	21.18	0.65
255	61.2	0.51	20.95	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 8 (cont.) Partially Reduced Data, P-4

Test P-4 **Date:** 12-19-61

TIME	INLET AIR			CANISTER C: 1/3 KO_2 + Cat. + Lava Rock + 1/3 LiOH					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	91.4	0.52	20.88																		
5	91.4	0.51	20.88	7.90	0.70	77	18	4.74		0	21.99	0.46	7.90	1.20	79	44	4.41		0.01	21.00	4.18
50	61.6	0.51	20.91	8.40	0.81	76	75	4.64		0.07	21.51	0.73	7.60	1.37	78	50	4.15		0.24	21.42	0.53
90	62.0	0.52	20.91	8.36	0.94	76	69	4.64		0.11	21.45	0.76	8.09	1.36	77	43	4.12		0.34	21.30	0.46
135	62.2	0.51	20.91	8.14	1.10	75	56	4.64		0.15	21.30	0.92	8.20	1.50	77	35	4.03		0.38	21.21	0.43
175	63.6	0.51	20.95	8.55	1.21	76	49	4.53		0.19	21.24	1.10	8.30	1.55	77	30	4.06		0.39	21.18	0.52
213	61.6	0.51	20.95	8.62	1.30	76	44	4.53		0.21	21.18	1.30	8.40	1.85	77	26	3.88		0.41	21.12	0.59
237	61.2	0.51	20.95	8.55	1.37	76	41	4.53		0.24	21.15	1.35	8.50	2.00	79	25	3.81		0.43	21.12	0.47
255	61.2	0.51	20.95	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 9 Partially Reduced Data, P-5

Test P-5 **Date:** 12-29-61

TIME	INLET AIR			CANISTER A-2 KO$_2$ (no Cat.) + Annular Screen					OUTLET AIR				CANISTER A-3 KO$_2$ + Cat. + Lava Rock + M.S. + Ann. Screen					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	79.9	0.51	20.76																		
17	79.9	0.54	20.73	8.35	0.40	79	38	4.58		0.20	21.45	0.47	8.25	0.42	79	28	4.37		0.34	21.03	0.67
47	76.6	0.51	20.79	8.45	0.40	80	50	4.49		0.29	21.42	0.35	8.30	0.42	80	39	4.37		0.38	21.03	0.54
68	70.0	0.51	20.79	8.35	0.40	78	56	4.58		0.33	21.27	0.37	8.30	0.42	79	36	4.37		0.38	21.03	0.54
102	80.6	0.51	20.67	8.30	0.42	78	54	4.58		0.33	21.21	0.33	8.35	0.42	79	33	4.37		0.39	20.94	0.44
132	70.6	0.51	20.70	8.45	0.42	80	51	4.49		0.34	21.12	0.40	8.30	0.45	80	30	4.37		0.41	20.91	0.48
167	61.4	0.51	20.67	8.35	0.40	79	39	4.58		0.35	21.03	0.44	8.25	0.45	79	23	4.49		0.42	20.85	0.50
207	61.3	0.51	20.67	8.30	0.42	79	34	4.58		0.38	20.91	0.54	8.20	0.45	79	22	4.49		0.42	20.73	1.50
227	69.4	0.49	20.61	8.35	0.42	78	33	4.67		0.38	20.88	0.41	8.25	0.47	79	20	4.49		0.42	20.67	1.17
252	70.1	0.49	20.58	8.35	0.42	78	33	4.69		0.39	20.82	0.42	8.25	0.47	79	20	4.49		0.42	20.67	0.78
287	71.7	0.49	20.52	8.35	0.42	78	30	4.69		0.39	20.79	0.37	8.25	0.47	78	19	4.64		0.42	20.61	0.78
317	72.0	0.51	20.49	8.30	0.42	78	30	4.69		0.41	20.67	0.56	8.20	0.47	79	16	4.64		0.44	20.58	0.78
337	62.6	0.51	20.49	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 9 (cont.) Partially Reduced Data, P-5

Test P-5 Date: 12-29-61

TIME	INLET AIR			CANISTER D 2/3 KO_2 + Cat. + 1/3 LiOH + Brass Probes									CANISTER MSA								
									OUTLET AIR									OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	79.9	0.51	20.76																		
22	79.9	0.54	20.73	7.85	0.45	79	75	4.66		0.08	21.87	0.40	7.85	1.35	80	86	3.65		0.17	21.54	0.46
52	76.6	0.51	20.79	7.90	0.48	80	86	4.61		0.11	21.54	0.53	7.90	1.35	80	67	3.65		0.23	21.42	0.44
73	70.0	0.51	20.79	7.85	0.52	80	73	4.58		0.13	21.39	0.63	7.85	1.35	80	54	3.55		0.30	21.27	0.44
107	80.6	0.51	20.67	7.90	0.55	79	65	4.62		0.19	21.24	0.56	7.85	1.35	80	45	3.65		0.34	21.09	0.40
137	70.6	0.51	20.70	7.95	0.60	80	60	4.62		0.24	21.06	0.75	8.00	1.45	80	41	3.65		0.38	20.94	0.54
172	61.4	0.51	20.67	7.90	0.60	79	44	4.66		0.27	21.00	0.71	7.90	1.50	80	27	3.65		0.39	20.91	0.50
209	61.3	0.51	20.67	7.85	0.62	79	41	4.66		0.27	20.88	1.14	7.95	1.55	80	25	3.61		0.39	20.76	1.33
232	69.4	0.49	20.61	7.90	0.65	79	39	4.66		0.27	20.85	0.92	7.90	1.68	80	25	3.61		0.39	20.76	0.67
257	70.1	0.49	20.58	7.90	0.68	78	37	4.66		0.30	20.79	0.90	8.15	1.80	80	24	3.61		0.41	20.73	0.53
292	71.7	0.49	20.52	8.00	0.70	78	34	4.70		0.30	20.73	0.90	8.35	2.05	79	23	3.44		0.41	20.67	0.53
322	72.0	0.51	20.49	8.10	0.75	79	30	4.66		0.33	20.67	1.56	8.75	2.35	80	19	3.49		0.42	20.61	0.75
337	62.6	0.51	20.49	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 10 Partially Reduced Data, P-6

Test P-6 Date: 1-10-62

TIME	INLET AIR			CANISTER A-2 KO$_2$ (no catalyst) + Ann. Screen					OUTLET AIR				CANISTER A-4 2/3 KO$_2$ (no catalyst) + 1/3 M.S. + Ann. Screen					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	18.1	0.19	21.03																		
14	18.1	0.20	21.00	0.20	0.10	73		2.78	15.3	0.10	21.12	.834	0.20	0.20	73		2.72	7.7	0.11	21.03	3.00
56	17.7	0.20	21.00	0.20	0.10	71	19.5	2.78	17.0	0.12	21.18	.446	0.20	0.20	71.5	13.5	2.72	7.7	0.13	21.06	1.17
86	18.4	0.20	21.00	0.20	0.10	71.5	17.5	2.78	12.9	0.13	21.18	.390	0.20	0.20	72	12	2.72	5.5	0.16	21.03	1.33
116	13.3	0.20	21.00	0.20	0.10	72		2.78	12.9	0.13	21.15	.461	0.20	0.20	72		2.72	7.1	0.16	21.06	0.67
146	17.1	0.20	21.00	0.20	0.10	72.5	16	2.78	14.5	0.12	21.15	.535	0.20	0.20	73	10	2.72	8.7	0.16	21.06	0.67
206	13.3	0.20	21.00	0.20	0.10	73	15	2.78	10.6	0.12	21.18	.448	0.20	0.20	73.5	8.5	2.72	7.1	0.17	21.06	0.50
266	15.5	0.20	21.00	0.20	0.10	73	14	2.78	12.2	0.11	21.15	.603	0.20	0.20	74	8	2.72	8.7	0.15	21.03	1.67
326	28.0	0.20	21.00	0.20	0.10	73	18.5	2.78	17.9	0.08	21.27	.447	0.20	0.20	74	13	2.72	17.7	0.13	21.15	0.47
386	22.4	0.20	21.00	0.20	0.10	73.5	18.5	2.78	18.5	0.11	21.21	.432	0.20	0.20	74	16	2.72	17.0	0.12	21.18	0.45
446	11.8	0.20	21.00	0.20	0.10	74		2.78		0.11	21.12	.759	0.20	0.20	74.5	11	2.72		0.15	21.06	0.83
461	11.8	0.20	21.00	SHUT	DOWN																

P_n = Static pressure just upstream of canister
T_n = Temperature just upstream of canister
ΔP_n = Pressure drop across canister
ΔT_n = Temperature rise across canister

Table 10 (cont.) Partially Reduced Data, P-6

Test P-6 **Date:** 1-10-62

TIME	INLET AIR			CANISTER A-5 2/3 KO_2 (no catalyst) + 1/3 LiOH + Ann. Screen					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{16} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	18.1	0.19	21.03																		
19	18.1	0.20	21.00	0.35	0.25	71		2.74	13.7	0.05	21.15	1.00	0.75	0.70	77		1.93	12.9	0.03	21.27	0.63
61	17.7	0.20	21.00	0.35	0.25	72	21.5	2.74	15.4	0.08	21.18	0.67	0.75	0.75	76.5	24	1.93	16.4	0.06	21.27	0.52
91	18.4	0.20	21.00	0.36	0.25	72	21	2.74	12.9	0.11	21.18	0.50	0.75	0.75	76	21	1.93	15.4	0.06	21.24	0.58
121	13.3	0.20	21.00	0.36	0.25	72.5		2.74	12.9	0.11	21.15	0.60	0.75	0.75	76.5		1.93	12.9	0.08	21.21	0.57
156	17.1	0.20	21.00	0.35	0.25	73	19	2.74	14.5	0.11	21.15	0.60	0.77	0.75	77	16	1.93	14.5	0.09	21.18	0.61
216	13.3	0.20	21.00	0.35	0.28	73.5	17	2.74	14.5	0.11	21.12	0.75	0.78	0.73	77.5	13	1.93	12.2	0.09	21.18	0.61
276	15.5	0.20	21.00	0.38	0.28	74	16.5	2.74	12.2	0.09	21.12	0.92	0.77	0.73	77.5	11	1.93	9.9	0.09	21.18	0.61
336	28.0	0.20	21.00	0.38	0.28	74	18.5	2.74	21.1	0.08	21.18	0.67	0.80	0.75	78	22.5	1.93	18.5	0.03	21.33	0.52
396	22.4	0.20	21.00	0.40	0.28	74.5	19	2.74	19.5	0.09	21.18	0.61	0.82	0.75	78	21	1.93	18.5	0.06	21.30	0.47
456	11.8	0.20	21.00	0.38	0.28	75.0	16	2.74	10.6	0.12	21.12	0.67	0.78	0.75	77.5	11	1.93	8.3	0.12	21.12	0.67
461	11.8	0.20	21.00	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 11 Partially Reduced Data, P-7

Test P-7 Date: 1-19-62

TIME	INLET AIR			CANISTER A — KO_2 + Cat. + Ann. Screen					OUTLET AIR				CANISTER A-6 — 2/3 KO_2 + Cat. + 1/3 M.S. + Ann. Screen					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0		0.34	20.79																		
15	80.4	0.20	20.85	0.22	0.15	74	24.5	2.77	42.9	0.09	21.24	0.28	0.20	0.12	73.5	21.5	2.69	34.8	0.08	21.27	0.29
45	93.4	0.20	20.85	0.22	0.15	74	48.5	2.79	51.5	0.08	21.39	0.22	0.20	0.12	75	38	2.71	49.2	0.08	21.27	0.17
75	96.7	0.18	20.88	0.25	0.15	75	45.5	2.81	54.7	0.09	21.39	0.22	0.20	0.12	76	40.5	2.71	52.3	0.11	21.30	0.21
120	99.1	0.20	20.85	0.25	0.15	75.5	44.0	2.81	59.0	0.08	21.36	0.24	0.20	0.12	76.5	41.5	2.71	62.2	0.08	21.27	0.29
150	99.1	0.18	20.88	0.26	0.14	76	42.0	2.81	60.6	0.09	21.36	0.23	0.20	0.12	76.5	39.0	2.71	63.8	0.09	21.27	0.23
180	99.1	0.20	20.85	0.26	0.15	76.5	41.5	2.81	63.8	0.09	21.36	0.22	0.20	0.12	77	37.5	2.71	65.4	0.09	21.27	0.26
240	99.1	0.20	20.85	0.26	0.15	76.5	38.5	2.81	67.0	0.09	21.24	0.28	0.20	0.12	77	37.0	2.71	67.0	0.09	21.21	0.31
300	78.8	0.20	20.85	0.26	0.15	76	37.0	2.81	61.9	0.09	21.18	0.33	0.20	0.12	76	35.5	2.71	54.7	0.09	21.15	0.37
360	108.1	0.20	20.82	0.26	0.15	74.5	36.0	2.88	67.6	0.12	21.18	0.22	0.20	0.12	75	31.0	2.81	69.2	0.12	21.15	0.24
420	108.1	0.20	20.82	0.26	0.15	75.5	37.5	2.81	73.4	0.12	21.18	0.22	0.20	0.12	76	35.0	2.82	73.4	0.11	21.15	0.30
435	108.1	0.20	20.82	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 11 (cont.) Partially Reduced Data, P-7

Test P-7 Date: 1-19-62

TIME	INLET AIR			CANISTER A-7 2/3 KO_2 + Cat. + 1/3 LiOH + Ann. Screen					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0		0.34	20.79																		
20	80.4	0.20	20.85	0.20	0.14	73.5	20.5	2.71	50.9	0.07	21.45	0.22	0.53	0.46	76.5	34.0	2.13	29.2	0.05	21.48	0.24
50	93.4	0.20	20.85	0.23	0.14	75.5	31.5	2.73	60.4	0.08	21.33	0.25	0.55	0.46	77.5	54.0	2.13	39.2	0.05	21.57	0.22
80	96.7	0.18	20.88	0.23	0.14	76.5	35.0	2.74	65.0	0.11	21.30	0.17	0.55	0.46	78.0	54.0	2.13	46.7	0.04	21.57	0.20
125	99.1	0.20	20.85	0.23	0.14	77	35.5	2.82	67.5	0.09	21.27	0.26	0.56	0.50	78.5	50.5	2.16	53.9	0.04	21.48	0.25
155	99.1	0.18	20.88	0.23	0.14	76.5	35.0	2.82	69.2	0.09	21.27	0.23	0.59	0.51	78.5	46.5	2.16	57.0	0.05	21.42	0.24
185	99.1	0.20	20.85	0.23	0.14	77	33.0	2.82	70.8	0.09	21.24	0.28	0.61	0.52	79	41.0	2.14	63.4	0.07	21.36	0.25
245	99.1	0.20	20.85	0.25	0.14	77	31.5	2.74	72.4	0.11	21.18	0.27	0.75	0.68	79.5	33.5	2.13	68.3	0.07	21.24	0.32
305	78.8	0.20	20.85	0.25	0.16	76	30.5	2.88	57.2	0.09	21.09	0.46	0.75	0.70	79	27.0	1.88	64.3	0.08	21.12	0.44
365	108.1	0.20	20.82	0.25	0.15	76	28.5	2.88	71.5	0.12	21.12	0.27	0.95	0.90	78.5	23.0	1.66	77.2	0.09	21.12	0.37
425	108.1	0.20	20.82	0.25	0.15	76.5	29.5	2.88	75.6	0.11	21.09	0.33	1.75	1.70	78.5	20.0	2.05	77.2	0.11	21.09	0.33

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 12 Partially Reduced Data, P-8

Test P-8 Date: 1-11-62

TIME	INLET AIR			CANISTER A KO$_2$ + Cat. + Ann. Screen					OUTLET AIR				CANISTER A-6 2/3 KO$_2$ + Cat. + 1/3 M. S. + Annular Screen					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	10.8	0.49	20.67																		
13	10.8	0.51	20.70	0.23	0.13	73.5	22	2.93	8.1	0.37	20.88	0.78	0.22	0.20	73.5	14.5	2.76	7.7	0.39	20.76	2.00
43	15.5	0.51	20.70	0.23	0.13	72.5	27	2.73	20.5	0.34	20.97	0.63	0.20	0.20	72.5	15.0	2.76	9.9	0.45	20.76	1.00
73	19.3	0.51	20.70	0.23	0.13	73	32	2.73	21.3	0.31	21.09	0.51	0.20	0.20	73.5	14.0	2.76	9.9	0.45	20.79	0.67
103	19.3	0.50	20.70	0.23	0.13	74	35	2.73	22.4	0.28	21.18	0.48	0.20	0.20	74	15	2.76	12.2	0.45	20.85	0.40
148	35.2	0.51	20.70	0.23	0.13	73.5	39.5	2.57	25.5	0.24	21.27	0.47	0.20	0.20	74	22.5	2.76	16.4	0.38	20.97	0.48
183	35.2	0.51	20.70	0.23	0.13	73	39.5	2.57	27.0	0.27	21.15	0.53	0.20	0.20	74	30	2.76	21.3	0.34	21.00	0.57
208	35.3	0.51	20.70	0.23	0.13	73.5	35.5	2.57	27.0	0.27	21.12	0.57	0.20	0.20	74	31	2.76	21.3	0.37	21.00	0.47
238	32.1	0.51	20.70	0.23	0.13	73.5	34.0	2.57	27.0	0.30	21.12	0.50	0.20	0.20	74	33	2.76	23.2	0.32	21.06	0.53
268	26.4	0.51	20.70	0.23	0.13	73.5	32.5	2.57	24.0	0.34	21.06	0.47	0.20	0.20	74	34.5	2.76	18.[illegible]	0.37	20.97	0.52
298	20.0	0.51	20.70	0.23	0.13	73.5	28.5	2.57	16.9	0.34	20.97	0.63	0.20	0.20	74	27	2.76	13.2	0.38	20.97	0.47
328	21.6	0.51	20.70	0.23	0.13	73.5	25.5	2.57	17.4	0.35	20.94	0.67	0.20	0.20	74	19.5	2.76	12.9	0.4[illegible]	20.85	0.67
358	19.3	0.51	20.70	0.23	0.13	74	23.0	2.57	14.8	0.38	20.91	0.62	0.20	0.20	74	16.5	2.76	12.2	0.41	20.91	0.48
388	13.9	0.51	20.70	0.23	0.13	74	20.5	2.57	13.8	0.39	20.88	0.67	0.20	0.20	74	14.5	2.76	9.9	0.42	20.82	0.75
408	13.9	0.51	20.70	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 12 (cont.) Partially Reduced Data, P-8

Test P-8 (cont.) Date: 1-12-62

TIME	INLET AIR			CANISTER A KO_2 + Cat. + Ann. Screen					OUTLET AIR				CANISTER A-6 2/3 KO_2 + Cat. + 1/3 M.S. + Ann. Screen					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
408	23.2	0.51	20.73																		
423	23.2	0.51	20.67	0.23	0.13	70.5	18	2.89	17.7	0.38	21.00	0.39	0.20	0.20	70	14	2.87	10.8	0.42	20.82	0.60
468	21.6	0.51	20.67	0.25	0.15	69.5	22	2.89	17.0	0.34	20.85	0.94	0.25	0.20	70	16	2.87	9.9	0.39	20.79	1.00
533	29.6	0.51	20.64	0.23	0.13	71.5	23.5	2.89	29.2	0.35	20.88	0.67	0.22	0.20	72	21.5	2.87	27.9	0.37	21.00	0.39
593	68.8	0.51	20.64	0.23	0.13	72	35	2.89	51.5	0.30	21.15	0.41	0.22	0.20	72.5	40.5	2.87	48.7	0.28	21.15	0.45
653	73.6	0.51	20.64	0.23	0.15	73	36	2.89	50.3	0.31	20.97	0.61	0.25	0.20	73.5	43	2.87	50.8	0.28	21.00	0.64
713	73.9	0.51	20.64	0.23	0.15	74	32.5	2.89	58.8	0.33	20.94	0.69	0.23	0.20	74.5	39	2.87	55.6	0.33	20.94	0.60
728	SHUT	DOWN																			

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 12 (cont.) Partially Reduced Data, P-8

Test P-8 Date: 1-11-62

TIME	INLET AIR			CANISTER A-7 2/3 KO_2 + Cat. + 1/3 LiOH + Ann. Screen					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	10.8	0.49	20.67																		
23	10.8	0.51	20.70	0.20	0.10	73	24	2.74	19.4	0.30	21.24	0.39	0.63	0.55	78	34	2.14	15.3	0.31	21.06	0.56
53	15.5	0.51	20.70	0.20	0.10	73.5	30	2.74	24.4	0.28	21.00	0.77	0.63	0.55	77	26	2.14	13.2	0.21	21.12	0.72
83	19.3	0.51	20.70	0.20	0.10	74	30	2.74	22.9	0.32	21.00	0.63	0.65	0.55	78	30.5	2.14	15.3	0.21	21.18	0.63
113	19.3	0.50	20.70	0.20	0.10	74.5	29.5	2.74	25.7	0.34	21.00	0.57	0.68	0.63	78.5	41.5	2.14	28.6	0.12	21.45	0.52
153	35.2	0.51	20.70	0.20	0.11	74	31	2.86	28.7	0.30	21.03	0.64	0.70	0.63	78	45	2.14	27.1	0.16	21.30	0.58
186	35.2	0.51	20.70	0.20	0.11	74	30.5	2.86	33.4	0.32	21.00	0.64	0.70	0.64	78	39.5	2.14	28.6	0.24	21.21	0.53
213	35.3	0.51	20.70	0.20	0.11	74	28.5	2.86	32.0	0.32	21.00	0.64	0.70	0.64	77.5	32.5	2.14	27.1	0.23	21.18	0.58
243	32.1	0.51	20.70	0.20	0.11	74	28	2.86	32.0	0.31	21.00	0.67	0.70	0.64	77.5	32.5	2.14	27.1	0.27	21.09	0.62
273	26.4	0.51	20.70	0.20	0.11	74	26.5	2.86	27.3	0.35	20.94	0.67	0.70	0.64	78	26.5	2.14	21.3	0.35	20.94	0.67
303	20.0	0.51	20.70	0.20	0.11	74	23	2.86	21.6	0.37	20.97	0.52	0.70	0.64	77.5	17.5	2.14	15.4	0.39	20.88	0.67
333	21.6	0.51	20.70	0.20	0.11	74	21	2.86	20.5	0.38	20.85	0.87	0.70	0.64	78	13.5	2.14	14.5	0.41	20.85	0.80
363	19.3	0.51	20.70	0.20	0.11	74	20	2.86	17.9	0.39	20.85	0.80	0.70	0.64	77.5	13.0	2.14	12.2	0.41	20.82	0.83
393	13.9	0.51	20.70	0.20	0.11	74	18.5	2.86	17.0	0.41	20.82	0.83	0.70	0.64	77.5	11.0	2.14	9.9	0.41	20.82	0.83
408	13.9	0.51	20.70	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 12 (cont.) Partially Reduced Data, P-8

Test P-8 (cont.) **Date:** 1-12-62

TIME	INLET AIR			CANISTER A-7: 2/3 KO_2 + Cat. + 1/3 LiOH + Ann. Screen					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
408	23.2	0.51	20.73																		
433	23.2	0.51	20.67	0.15	0.11	69	16.5	2.75	18.4	0.41	20.91	0.42	0.66	0.58	74.5	19.0	2.15	16.1	0.39	20.82	0.80
473	21.6	0.51	20.67	0.15	0.11	71	20.0	2.75	21.7	0.37	20.79	1.17	0.66	0.58	75	16.5	2.15	16.1	0.38	20.79	1.08
543	29.6	0.51	20.64	0.15	0.11	71	21.5	2.75	33.9	0.35	20.82	0.89	0.66	0.58	76	20.5	2.15	23.7	0.33	20.88	0.75
598	58.8	0.51	20.64	0.15	0.11	73	30.0	2.75	59.5	0.31	21.00	0.56	0.66	0.62	77.5	37.5	2.15	48.7	0.26	21.00	0.69
658	73.6	0.51	20.64	0.15	0.11	74	31.5	2.75	58.3	0.32	20.94	0.63	0.66	0.60	78	29.0	2.15	53.1	0.30	20.94	0.70
718	73.9	0.51	20.64	0.15	0.11	75	29.5	2.75	65.2	0.34	20.88	0.71	0.66	0.60	79	20.5	2.15	59.4	0.37	20.79	0.93
728				SHUT	DOWN																

P_n = Static pressure just upstream of canister
T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister
ΔT_n = Temperature rise across canister

Table 13 Partially Reduced Data, P-9

Test P-9 Date: 1-16-62

TIME	INLET AIR			CANISTER A — KO_2 + Cat. + Ann. Screen					OUTLET AIR				CANISTER A-6 — 2/3 KO_2 + Cat. + 1/3 M.S. + Ann. Screen					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	75.3	0.23	20.85																		
15	75.3	0.23	20.85	0.55	0.33	72	24.5	4.60	46.1	0.09	21.12	0.52	0.60	0.33	72	41	4.65	38.4	0.08	21.09	0.62
45	57.3	0.20	20.88	0.55	0.35	74	29.5	4.60	48.0	0.16	21.12	0.17	0.50	0.33	74.5	38	4.62	26.5	0.12	21.15	0.30
75	55.4	0.20	20.88	0.60	0.35	76	31	4.60	51.5	0.13	21.15	0.26	0.50	0.33	76	38.5	4.66	34.0	0.12	21.18	0.27
115	57.0	0.20	20.88	0.60	0.35	76.5	30.5	4.60	49.9	0.13	21.15	0.26	0.50	0.33	77	35.5	4.66	35.6	0.09	21.15	0.41
145	57.3	0.20	20.88	0.60	0.35	76	28.5	4.60	51.5	0.13	21.15	0.26	0.50	0.33	76.5	33.5	4.66	43.9	0.11	21.15	0.33
175	52.1	0.20	20.88	0.60	0.35	76.5	29.5	4.60	51.5	0.13	21.12	0.29	0.50	0.33	77	31	4.64	45.5	0.11	21.12	0.37
205	82.6	0.20	20.88	0.60	0.35	76.5	28.5	4.60	62.0	0.16	21.15	0.15	0.50	0.33	77	28.5	4.64	60.2	0.16	21.15	0.15
240	87.9	0.20	20.88	0.60	0.35	78	29	4.61	71.5	0.13	21.15	0.26	0.50	0.33	78.5	30.5	4.65	65.9	0.14	21.15	0.22
265	54.1	0.20	20.88	0.60	0.35	77.5	24	4.78	51.2	0.13	21.06	0.39	0.50	0.33	77.5	22.5	4.85	46.4	0.17	21.06	0.17
310	77.1	0.21	20.88	0.60	0.35	76.5	23.5	4.66	57.9	0.16	21.06	0.22	0.50	0.33	77	23	4.76	56.7	0.16	21.09	0.19
335		0.21	20.88	SHUT	DOWN																
355	54.1	0.20	20.88	0.55	0.38	81.5	9.5	4.62	46.2	0.17	20.97	0.33	0.48	0.33	81	12.5	4.63	42.9	0.16	21.06	0.22
385	67.0	0.24	20.82	0.58	0.38	72	18.5	4.61	59.0	0.17	20.97	0.78	0.50	0.35	72.5	18.5	4.64	54.2	0.17	20.94	0.50
445	73.6	0.20	20.85	0.57	0.38	73	18.5	4.61	62.4	0.16	20.97	0.33	0.50	0.35	73.5	17.5	4.59	59.1	0.16	20.94	0.44
505	77.1	0.20	20.85	0.57	0.38	73	20	4.61	65.8	0.14	21.00	0.40	0.52	0.35	73.5	18.5	4.64	62.7	0.14	21.00	0.40
565	82.5	0.20	20.85	0.57	0.38	74	22	4.65	67.9		21.00		0.52	0.36	74.5	21.5	4.69	66.8		21.00	
625	77.1	0.20	20.85	0.57	0.38	73	19.5	4.65	65.9		21.00		0.52	0.38	73.5	18.5	4.64	62.7		21.00	
650		0.20	20.85	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 13 (cont.) Partially Reduced Data, P-9

Test P-9 **Date:** 1-16-62

TIME	INLET AIR			CANISTER A-7, 2/3 KO_2 + Cat. + 1/3 LiOH + Ann. Screen					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	75.3	0.23	20.85																		
20	75.3	0.23	20.85	0.41	0.25	72	27.5	4.59	47.8	0.06	21.33	0.35	1.17	0.92	76.5	54	3.59	32.4	0.03	21.24	0.51
55	57.3	0.20	20.88	0.43	0.25	75.5	31	4.59	50.3	0.09	21.18	0.37	1.17	0.95	78	39	3.60	45.5	0.09	21.21	0.33
80	65.4	0.20	20.88	0.43	0.25	76.5	32	4.64	43.5	0.12	21.21	0.24	1.22	1.00	79	35.5	3.60	41.9	0.11	21.21	0.27
115	67.0	0.20	20.88	0.43	0.25	77	30.5	4.64	45.1	0.07	21.18	0.43	1.30	1.10	79.5	30.5	3.61	46.7	0.07	21.18	0.43
150	57.3	0.20	20.88	0.43	0.25	77	29	4.64	51.5	0.09	21.15	0.41	1.40	1.20	79.5	28	3.50	49.9	0.09	21.15	0.41
180	62.1	0.20	20.88	0.43	0.25	77	30	4.64	55.6	0.11	21.12	0.37	1.55	1.40	79	27	3.31	53.1	0.11	21.12	0.37
210	82.6	0.20	20.88	0.43	0.25	77	30	4.64	66.7	0.11	21.15	0.33	1.65	1.50	79.5	26	3.17	63.6	0.09	21.18	0.37
240	87.9	0.20	20.88	0.43	0.25	78.5	31.5	4.64	70.8	0.09	21.09	0.52	1.98	1.80	80	29	2.90	73.1	0.11	21.09	0.43
270	54.1	0.20	20.88	0.45	0.26	77	27	4.83	49.9	0.12	21.06	0.44	2.35	2.20	80.5	19	2.83	51.0	0.16	21.06	0.22
315	77.1	0.21	20.88	0.45	0.27	77.5	26	4.83	62.0	0.13	21.06	0.39	3.60	2.42	80	19	2.69	59.7	0.14	21.12	0.25
335		0.21	20.88	SHUT	DOWN																
360	54.1	0.20	20.88	0.42	0.28	80	14	4.60	43.0	0.14	21.12	0.25	5.35	5.10	82.5	6.5	3.59	47.8	0.19	20.91	0.33
395	67.0	0.24	20.82	0.46	0.28	72.5	24	4.56	55.9	0.16	20.97	0.53	5.75	5.57	77	8.5	3.53	58.9	0.19	20.91	0.56
455	73.6	0.20	20.85	0.46	0.30	73.5	22.5	4.69	61.1	0.13	20.94	0.78	7.90	7.75	77	12	3.07	62.2	0.13	20.97	0.58
515	77.1	0.20	20.85	0.48	0.30	75	21.0	4.69	61.1	0.13	21.03	0.39	9.70	9.65	79	10.5	2.07	72.3	0.13	21.03	0.39
575	82.5	0.20	20.85	0.46	0.28	74.5	23.5	4.57	75.5		20.97		SHUT	DOWN	AT 530	MIN.					
625	77.1	0.20	20.85	0.46	0.28	74	19.5	4.57	69.5		20.97										
650	77.1	0.20	20.85	SHUT	DOWN																

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 14 Partially Reduced Data, P-10

Test P-10 Date: 1-23-62

TIME	INLET AIR			CANISTER E, KO_2 + Cat., in 5" Canister (no screen)					OUTLET AIR				CANISTER A-8, KO_2 + Cat., in 20" Canister + Ann. Screen					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{12} In.H_2O	ΔP_{13} In.H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0		0.23	20.82																		
15	87.3	0.19	20.85	0.30	0.12	74	58	2.92	28.1	0.03	21.54	0.23	0.26	0.18	74	20.5	2.80	24.4	0.03	21.51	0.24
45	72.0	0.20	20.88	0.30	0.17	72.5	66.5	2.88	23.0	0.01	21.51	0.30	0.26	0.18	73	45	2.86	30.5	0.03	21.54	0.30
75	75.5	0.20	20.88	0.35	0.24	73	67.0	2.88	23.0	0.01	21.48	0.32	0.26	0.18	73.5	51.5	2.86	31.2	0.04	21.54	0.29
135	77.1	0.23	20.82	0.78	0.68	73.5	59.5	2.79	37.2	0.01	21.39	0.39	0.26	0.18	73.5	53	2.86	31.8	0.04	21.48	0.29
195	63.7	0.20	20.85	3.25	3.20	72.5	51.5	2.74	39.2	0.01	21.30	0.42	0.26	0.18	73	49	2.78	36.5	0.03	21.45	0.28
215				5.05	5.00	flow wide	valve open						0.26	0.18							
255	75.3	0.20	20.85	6.10	6.10	74.5	45.0	1.62	43.9	0.01	21.45	0.32	0.26	0.18	73	48.5	2.78	38.1	0.03	21.45	0.28
315	70.2	0.21	20.85	6.95	6.95	76.5	44.0	0.93	53.1	0.03	21.45	0.30	0.26	0.18	73	46.5	2.78	45.1	0.05	21.45	0.27
375	72.0	0.21	20.85	7.75	7.75	78	39.0	0.0	38.2	0.03	21.45	0.30	0.26	0.18	73	46.5	2.78	39.2	0.05	21.42	0.28
435	80.4	0.21	20.85	SHUT	DOWN	AT 425	MIN.						0.26	0.18	73	44	2.78	34.0	0.07	21.39	0.26
495	65.3	0.23	20.82										0.26	0.18	72	44	2.78	38.7	0.07	21.30	0.33
555	66.9	0.21	20.82										0.26	0.18	72	39	2.78	40.3	0.07	21.30	0.29
615	71.8	0.20	20.85										0.26	0.18	72	37	2.78	43.5	0.07	21.30	0.29
675	68.5	0.20	20.88										0.26	0.18	70	38	2.75	45.1	0.07	21.30	0.31
735	54.3	0.20	20.85										0.26	0.18	68	36	2.75	35.0	0.07	21.21	0.28
795	73.4	0.20	20.85										0.26	0.18	70	35	2.75	43.2	0.07	21.21	0.28
855	75.0	0.19	20.82										0.28	0.20	70	35.5	2.75	43.9	0.07	21.18	0.33

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 14 (cont.) Partially Reduced Data, P-10

Test P-10 **Date:** 1-23-62

TIME	INLET AIR			CANISTER F, KO_2 + Cat., in 20" Canister (no screen)					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{14} In.H_2O	ΔP_{15} In.H_2O	T_7 °F	ΔT_3 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In.H_2O	ΔP_{17} In.H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0		0.23	20.82																		
20	87.3	0.19	20.85	0.38	0.27	73	11.5	2.84	1.9	0.0	21.63	0.24	0.50	0.43	76.5	39.5	2.21	35.1	0.03	21.51	0.24
50	72.0	0.20	20.88	0.43	0.36	73.5	60.0	2.79	9.7	0.0	21.69	0.25	0.53	0.45	76	47.0	2.15	38.7	0.04	21.48	0.27
80	75.5	0.20	20.88	0.50	0.41	74	65.5	2.76	5.7	0.0	21.66	0.26	0.55	0.45	76.5	45.5	2.16	38.7	0.04	21.48	0.27
140	77.1	0.23	20.82	0.98	0.83	74	59.5	2.68	2.6	0.0	21.66	0.27	0.60	0.48	77	37.5	2.21	48.7	0.06	21.39	0.30
200	63.7	0.20	20.85	3.25	3.00	73	60.5	2.75	7.7	0.0	21.66	0.25	0.65	0.53	76	30.5	2.15	54.7	0.07	21.21	0.36
220				4.70	4.45	flow wide	valve open						0.68	0.57							
260	75.3	0.20	20.85	6.20	5.97	75.5	47.5	1.30	13.0	0.0	21.78	0.22	0.72	0.60	76	25.5	2.15	57.9	0.09	21.21	0.31
320	70.2	0.21	20.85	7.15	6.85	77	38	0.91	35.0	0.0	21.75	0.23	0.83	0.72	76	22.0	2.15	62.7	0.11	21.18	0.30
380	72.0	0.21	20.85	7.45	7.10	78.5	30.5	0.0	9.1	0.0	21.75	0.23	1.03	0.90	76	19.0	2.15	71.1	0.11	21.09	0.42
435	80.4	0.21	20.85	SHUT	DOWN	AT	425 MIN.						1.12	1.00	75.5	17.0	2.15	72.7	0.14	21.06	0.33
495	65.3	0.23	20.82										1.30	1.15	75.5	15.0	2.14	60.6	0.14	21.03	0.43
560	66.9	0.21	20.82										1.80	1.64	75.5	11.5	2.12	63.8	0.13	21.03	0.38
620	71.8	0.20	20.85										1.82	1.78	74	11.5	2.12	60.5	0.13	21.03	0.39
680	68.5	0.20	20.88										2.84	2.60	74	9.5	2.13	63.7	0.13	20.97	0.78
740	54.3	0.20	20.85										3.40	3.25	72.5	7.5	2.13	52.7	0.13	20.97	0.58
800	73.4	0.20	20.85										3.90	3.74	73.5	5.5	2.13	63.7	0.13	20.94	0.58
860	75.0	0.19	20.82										4.32	4.20	73	5.0	2.13	64.3	0.14	20.94	0.56

P_n = Static pressure just upstream of canister
T_n = Temperature just upstream of canister
ΔP_n = Pressure drop across canister
ΔT_n = Temperature rise across canister

Table 14 (cont.) Partially Reduced Data, P-10

Test P-10 (cont.) Date: 1-23,24-62

TIME	INLET AIR			CANISTER A-8 KO_2 + Cat., in 20" Canister + Ann. Screen					OUTLET AIR				CANISTER MSA					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{12} In. H_2O	ΔP_{13} In. H_2O	T_4 °F	ΔT_2 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P_{16} In. H_2O	ΔP_{17} In. H_2O	T_{10} °F	ΔT_4 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
915	75.0	0.19	20.82	0.28	0.20	70	34	2.75	44.8	0.07	21.15	0.36	4.45	4.35	73.0	3.5	2.13	68.5	0.14	20.91	0.56
975	75.0	0.19	20.82	0.28	0.20	70	34	2.75	49.9	0.07	21.15	0.36	4.80	4.67	73.0	3.0	2.13	66.9	0.16	20.88	0.50
1035	76.7	0.19	20.82	0.28	0.20	69.5	33.5	2.75	46.4	0.07	21.12	0.40	5.20	5.12	72.5	3.5	2.12	68.5	0.16	20.88	0.50
1095	81.7	0.20	20.82	0.28	0.20	68	32	2.75	46.2	0.07	21.12	0.43	5.40	5.35	72.0	2.5	2.12	65.4	0.20	20.82	
1155	70.1	0.19	20.82	0.28	0.20	71	33	2.75	51.5	0.08	21.12	0.37		SHUT	DOWN	AT 1120	MIN.				
1215	70.1	0.19	20.79	0.28	0.20	70	30.5	2.75	53.1	0.08	21.06	0.40									
1275	68.5	0.20	20.76	0.30	0.20	71	28.5	2.79	49.6	0.09	21.03	0.45									
1335	71.8	0.20	20.79	0.32	0.20	71.5	27.5	2.79	54.7	0.09	21.06	0.40									
1395	70.3	0.20	20.82	0.32	0.20	72	26	2.79	51.2	0.09	21.00	0.61									
1455	71.8	0.20	20.79	0.32	0.20	71.5	25.5	2.79	57.9	0.09	21.00	0.52									
1515	70.3	0.20	20.76	0.32	0.20	72	24.5	2.79	57.9	0.11	20.97	0.43									
1575	73.4	0.20	20.76	0.32	0.20	71.5	22.5	2.79	54.3	0.11	20.94	0.50									
1635	73.4	0.20	20.73	0.32	0.20	71.5	22.5	2.79	55.9	0.11	20.94	0.53									
1695	73.4	0.20	20.76	0.34	0.22	71.5	21.5	2.79	62.7	0.11	20.94	0.50									
1755	75.0	0.20	20.76	0.34	0.22	72	20.5	2.79	62.7	0.11	20.94	0.50									
				SHUT	DOWN	AT 1765	MIN.														

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 14 (cont.) Partially Reduced Data, P-10

Test P-10 Date: 1-23,24-62

TIME	INLET AIR			CANISTER C-2 2/3 KO_2 + Cat. + 1/3 LiOH, in 5" Canister (no screen)					OUTLET AIR				CANISTER					OUTLET AIR			
Min.	H_2O Gr/Lb.	CO_2 %	O_2 %	P_{10} In.H_2O	ΔP_{11} In.H_2O	T_1 °F	ΔT_1 °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.	P In.H_2O	ΔP In.H_2O	T °F	ΔT °F	FLOW cfm	H_2O Gr/Lb	CO_2 %	O_2 %	R.Q.
0	66.9	0.21	20.82																		
5	66.9	0.21	20.82	0.34	0.22	76	18.5	2.76	45.1	0.01	22.05	0.16									
65	71.8	0.20	20.85	0.36	0.25	70	54.0	2.74	32.4	0.03	21.42	0.30									
125	68.5	0.20	20.83	0.42	0.44	70	51.0	2.72	32.4	0.03	21.33	0.38									
185	54.3	0.20	20.85	0.80	0.65	68	45.5	2.72	32.9	0.04	21.21	0.45									
245	73.4	0.20	20.85	1.40	1.28	68.5	48.5	2.72	37.2	0.04	21.18	0.48									
305	75.0	0.19	20.82	2.80	2.72	70	46.5	2.72	40.3	0.04	21.15	0.46									
365	75.0	0.19	20.82	4.10	4.00	69	43.5	2.72	43.5	0.03	21.12	0.53									
425	75.0	0.19	20.82	4.10	4.05	69	43.0	2.72	42.7	0.03	21.06	0.67									
485	76.7	0.19	20.82	3.95	3.90	69	37.0	2.72	53.1	0.04	20.97	1.00									
545	81.7	0.20	20.82	4.20	4.05	68	25.5	2.72	52.4	0.09	20.88	1.83									
605	70.1	0.19	20.82	4.10	4.05	69.5	21.5	2.72	60.6	0.12	20.85	2.30									
665	70.1	0.19	20.79	3.95	3.85	69.0	17.0	2.72	60.5	0.13	20.84	1.20									
680				SHUT	DOWN	AT 680 MIN.															

P_n = Static pressure just upstream of canister

T_n = Temperature just upstream of canister

ΔP_n = Pressure drop across canister

ΔT_n = Temperature rise across canister

Table 15 IBM Reduced Data, P-1

TEST P-1 — KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN — DATE 12-18-1961 12-18-1961

CANISTER A (KØ2 IN SCREEN — CANISTER B (1/3KØ2+1/3LAVA RØCK+1/3ACT.ALUMINA)

TIME (MINUTES)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
15.	0.02480	0.01607	0.	0.02556	0.00852	0.
45.	0.02480	0.02113	0.	0.01307	0.01259	0.
90.	0.02067	0.01424	0.	0.01038	0.00890	0.
125.	0.02229	0.01486	0.	0.01018	0.00776	0.
150.	0.01672	0.01254	0.	0.00710	0.00900	0.
180.	0.01409	0.01268	0.	0.00425	0.00662	0.
215.	0.00720	0.01153	0.	0.00567	0.00520	0.
245.	0.01740	0.01063	0.	0.00709	0.00520	0.

TEST P-1 — KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN — DATE 12-18-1961 12-18-1961

CANISTER C (1/3KØ2+1/3LAVA RØCK+1/3 LIØH) — CANISTER MSA (

TIME (MINUTES)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
5.	0.02809	0.02267	0.	0.03989	0.02231	0.
40.	0.02514	0.02563	0.	0.02961	0.02103	0.
80.	0.01776	0.02071	0.	0.02189	0.01416	0.
115.	0.01331	0.02318	0.	0.01674	0.01502	0.
145.	0.00740	0.01825	0.	0.01032	0.01032	0.
175.	0.00444	0.01578	0.	0.00644	0.00730	0.
205.	0.00444	0.01331	0.	0.00515	0.00515	0.
235.	0.00592	0.01184	0.	0.00773	0.00472	0.

Table 16 IBM Reduced Data, P-2

TEST P2 — KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN — DATE 12-21-1961 12-21-1961

TIME (MINUTES)	CANISTER A (KØ2 IN SCREEN) Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)	CANISTER B (1/3KØ2+1/3LAVARØCK+1/3ACT.AL) Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
5.	0.03847	0.01857	0.	0.06023	0.02793	0.
45.	0.03268	0.02179	0.	0.03587	0.01754	0.
75.	0.02421	0.01166	0.	0.02702	0.01392	0.
105.	0.02815	0.01162	0.	0.02420	0.01210	0.
133.	0.01800	0.00969	0.	0.01310	0.00874	0.
165.	0.02361	0.01131	0.	0.01332	0.00777	0.
195.	0.02011	0.00910	0.	0.01263	0.00666	0.
225.	0.01555	0.00726	0.	0.00704	0.00341	0.
255.	0.01249	0.00676	0.	0.00810	0.00439	0.
285.	0.01740	0.00838	0.	0.00709	0.00439	0.
315.	0.01547	0.00709	0.	0.00774	0.00355	0.
345.	0.01547	0.00709	0.	0.00596	0.00364	0.
385.	0.01356	0.00710	0.	0.00506	0.00371	0.
405.	0.00969	0.00710	0.	0.00402	0.00369	0.
435.	0.00969	0.00581	0.	0.00405	0.00304	0.

TEST P2 — KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN — DATE 12-21-1961 12-21-1961

TIME (MINUTES)	CANISTER C (1/3KØ2+1/3LAVARØCK+1/3LIØH) Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)	CANISTER MSA ( ) Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
12.	0.06999	0.04340	0.	0.03866	0.01893	0.
51.	0.03715	0.02838	0.	0.02950	0.01516	0.
80.	0.02385	0.01988	0.	0.01753	0.00960	0.
115.	0.01620	0.01620	0.	0.01001	0.00667	0.
140.	0.00851	0.01324	0.	0.00384	0.00598	0.
170.	0.01278	0.01231	0.	0.01041	0.00607	0.
200.	0.01393	0.01083	0.	0.00730	0.00568	0.
230.	0.01238	0.00980	0.	0.00730	0.00365	0.
262.	0.00992	0.00850	0.	0.00608	0.00284	0.
290.	0.00709	0.00661	0.	0.00608	0.00284	0.
320.	0.00710	0.00616	0.	0.00608	0.00243	0.
350.	0.00711	0.00521	0.	0.00608	0.00243	0.
377.	0.00552	0.00414	0.	0.00365	0.00162	0.
408.	0.00430	0.00334	0.	0.00391	0.00174	0.
440.	0.00430	0.00335	0.	0.00365	0.00162	0.

Table 17 IBM Reduced Data, P-3

TEST P3 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 12-20-1961 12-20-1961

TIME (MINUTES)	CANISTER A (KO2 IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER B (1/3KO2+1/3LAVAROCK+1/3 ACT.ALUMINA) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
15.	0.03882	0.01941	0.	0.04344	0.02096	0.
55.	0.03681	0.01654	0.	0.02829	0.01509	0.
75.	0.03348	0.01594	0.	0.02713	0.01281	0.
107.	0.03342	0.01326	0.	0.02376	0.01131	0.
135.	0.03004	0.01287	0.	0.02137	0.01012	0.
165.	0.02544	0.01299	0.	0.01543	0.00903	0.
195.	0.02273	0.01137	0.	0.01237	0.00712	0.
225.	0.01959	0.01088	0.	0.00886	0.00554	0.
255.	0.01[illegible]66	0.01086	0.	0.00858	0.00572	0.
280.	0.01305	0.00816	0.	0.00429	0.00464	0.
315.	0.01313	0.00875	0.	0.00637	0.00460	0.
345.	0.00831	0.00720	0.	0.00533	0.00391	0.
375.	0.01140	0.00706	0.	0.00639	0.00391	0.
405.	0.00651	0.00489	0.	0.00425	0.00283	0.
435.	0.00489	0.00489	0.	0.00425	0.00283	0.

TEST P3 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 12-20-1961 12-20-1961

TIME (MINUTES)	CANISTER C (1/3KO2+1/3LAVAROCK+1/3LIOH) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER MSA ( ) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
30.	0.04966	0.03831	0.	0.03546	0.01549	0.
65.	0.02783	0.02830	0.	0.02728	0.01447	0.
83.	0.01806	0.02084	0.	0.02089	0.01024	0.
110.	0.01249	0.01665	0.	0.01591	0.00775	0.
140.	0.01064	0.01573	0.	0.01172	0.00728	0.
170.	0.00925	0.01295	0.	0.00920	0.00600	0.
200.	0.00826	0.01147	0.	0.00726	0.00524	0.
230.	0.00552	0.00827	0.	0.00488	0.00447	0.
260.	0.00688	0.00826	0.	0.00494	0.00453	0.
290.	0.00275	0.00826	0.	0.00367	0.00448	0.
320.	0.00551	0.00689	0.	0.00490	0.00531	0.
350.	0.00418	0.00650	0.	0.00488	0.00529	0.
385.	0.00556	0.00695	0.	0.00369	0.00369	0.
410.	0.00420	0.00513	0.	0.00367	0.00286	0.
440.	0.00420	0.00513	0.	0.00246	0.00246	0.

Table 18 IBM Reduced Data, P-4

TEST P4 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 12-19-1961 12-19-1961

TIME (MINUTES)	CANISTER A (KO2 IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER B (KO2-LAVA ROCK-ACTIVATED ALUMINA) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
20.	0.02316	0.01447	0.	0.02459	0.01549	0.
65.	0.02167	0.01011	0.	0.02282	0.01208	0.
95.	0.02182	0.00913	0.	0.02017	0.01076	0.
140.	0.01979	0.00913	0.	0.01565	0.00826	0.
180.	0.01657	0.00932	0.	0.01261	0.00826	0.
218.	0.01568	0.00865	0.	0.01000	0.00783	0.
242.	0.01435	0.00773	0.	0.01000	0.00652	0.

TEST P4 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 12-19-1961 12-19-1961

TIME (MINUTES)	CANISTER C (KO2-LIOH-LAVA ROCK) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER MSA ( ) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
5.	0.05442	0.02500	0.	0.00545	0.02272	0.
50.	0.02888	0.02118	0.	0.02184	0.01156	0.
90.	0.02599	0.01973	0.	0.01663	0.00767	0.
135.	0.01876	0.01732	0.	0.01251	0.00542	0.
175.	0.01363	0.01504	0.	0.00967	0.00504	0.
213.	0.01081	0.01411	0.	0.00683	0.00402	0.
237.	0.00940	0.01269	0.	0.00668	0.00315	0.

Table 19 IBM Redueed Data, P-5

TEST P5 — KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN — DATE 12-29-1961 12-29-1961

	CANISTER A-2 (KØ2(NØ CATALYST)IN SCREEN)			CANISTER A-3 (KØ2-LAVA RØCK-MS X-13 IN SCREEN)		
TIME (MINUTES)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
17.	0.03402	0.01606	0.	0.01352	0.00901	0.
47.	0.02913	0.01017	0.	0.01080	0.00585	0.
68.	0.02272	0.00852	0.	0.01082	0.00586	0.
102.	0.02556	0.00852	0.	0.01217	0.00541	0.
132.	0.01942	0.00786	0.	0.00945	0.00450	0.
167.	0.01701	0.00756	0.	0.00834	0.00417	0.
207.	0.01134	0.00614	0.	0.00278	0.00417	0.
227.	0.01303	0.00531	0.	0.00278	0.00324	0.
252.	0.01163	0.00485	0.	0.00417	0.00324	0.
287.	0.01309	0.00485	0.	0.00431	0.00336	0.
317.	0.00872	0.00485	0.	0.00431	0.00335	0.

TEST P5 — KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN — DATE 12-29-1961 12-29-1961

	CANISTER D (2/3KØ2+1/3LIØH WITH PRØBES)			CANISTER MSA ( )		
TIME (MINUTES)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
22.	0.05474	0.02209	0.	0.03041	0.01389	0.
52.	0.03556	0.01897	0.	0.02365	0.01051	0.
73.	0.02826	0.01790	0.	0.01802	0.00788	0.
107.	0.02714	0.01523	0.	0.01577	0.00638	0.
137.	0.01711	0.01283	0.	0.00901	0.00488	0.
172.	0.01585	0.01152	0.	0.00901	0.00451	0.
209.	0.01008	0.01152	0.	0.00334	0.00446	0.
232.	0.01152	0.01056	0.	0.00557	0.00371	0.
257.	0.01010	0.00914	0.	0.00557	0.00297	0.
292.	0.01019	0.00922	0.	0.00532	0.00284	0.
322.	0.00865	0.00865	0.	0.00432	0.00324	0.

Table 19 IBM Reduced Data, P-5

TEST P5 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 12-29-1961 12-29-1961

TIME (MINUTES)	CANISTER A-2 (KO2(NO CATALYST)IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER A-3 (KO2-LAVA ROCK-MS X-13 IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
17.	0.03402	0.01606	0.	0.01352	0.00901	0.
47.	0.02913	0.01017	0.	0.01080	0.00585	0.
68.	0.02272	0.00852	0.	0.01082	0.00586	0.
102.	0.02556	0.00852	0.	0.01217	0.00541	0.
132.	0.01942	0.00786	0.	0.00945	0.00450	0.
167.	0.01701	0.00756	0.	0.00834	0.00417	0.
207.	0.01134	0.00614	0.	0.00278	0.00417	0.
227.	0.01303	0.00531	0.	0.00278	0.00324	0.
252.	0.01163	0.00485	0.	0.00417	0.00324	0.
287.	0.01309	0.00485	0.	0.00431	0.00336	0.
317.	0.00872	0.00485	0.	0.00431	0.00335	0.

TEST P5 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 12-29-1961 12-29-1961

TIME (MINUTES)	CANISTER D (2/3KO2+1/3LIOH WITH PROBES) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER MSA ( ) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
22.	0.05474	0.02209	0.	0.03041	0.01389	0.
52.	0.03556	0.01897	0.	0.02365	0.01051	0.
73.	0.02826	0.01790	0.	0.01802	0.00788	0.
107.	0.02714	0.01523	0.	0.01577	0.00638	0.
137.	0.01711	0.01283	0.	0.00901	0.00488	0.
172.	0.01585	0.01152	0.	0.00901	0.00451	0.
209.	0.01008	0.01152	0.	0.00334	0.00446	0.
232.	0.01152	0.01056	0.	0.00557	0.00371	0.
257.	0.01010	0.00914	0.	0.00557	0.00297	0.
292.	0.01019	0.00922	0.	0.00532	0.00284	0.
322.	0.00865	0.00865	0.	0.00432	0.00324	0.

Table 18 IBM Reduced Data, P-4

TEST P4

KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION DATE 12-19-1961 12-19-1961

TIME (MINUTES)	CANISTER A (KO2 IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER B (KO2-LAVA ROCK-ACTIVATED ALUMINA) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
20.	0.02316	0.01447	0.	0.02459	0.01549	0.
65.	0.02167	0.01011	0.	0.02282	0.01208	0.
95.	0.02182	0.00913	0.	0.02017	0.01076	0.
140.	0.01979	0.00913	0.	0.01565	0.00826	0.
180.	0.01657	0.00932	0.	0.01261	0.00826	0.
218.	0.01568	0.00865	0.	0.01000	0.00783	0.
242.	0.01435	0.00773	0.	0.01000	0.00652	0.

TEST P4

KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION DATE 12-19-1961 12-19-1961

TIME (MINUTES)	CANISTER C (KO2-LIGH-LAVA ROCK) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER MSA ( ) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
5.	0.05442	0.02500	0.	0.00545	0.02272	0.
50.	0.02888	0.02118	0.	0.02184	0.01156	0.
90.	0.02599	0.01973	0.	0.01663	0.00767	0.
135.	0.01876	0.01732	0.	0.01251	0.00542	0.
175.	0.01363	0.01504	0.	0.00967	0.00504	0.
213.	0.01081	0.01411	0.	0.00683	0.00402	0.
237.	0.00940	0.01269	0.	0.00668	0.00315	0.

Table 19 IBM Reduced Data, P-5

TEST P5 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 12-29-1961 12-29-1961

TIME (MINUTES)	CANISTER A-2 (KO2(NO CATALYST)IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER A-3 (KO2-LAVA ROCK-MS X-13 IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
17.	0.03402	0.01606	0.	0.01352	0.00901	0.
47.	0.02913	0.01017	0.	0.01080	0.00585	0.
68.	0.02272	0.00852	0.	0.01082	0.00586	0.
102.	0.02556	0.00852	0.	0.01217	0.00541	0.
132.	0.01942	0.00786	0.	0.00945	0.00450	0.
167.	0.01701	0.00756	0.	0.00834	0.00417	0.
207.	0.01134	0.00614	0.	0.00278	0.00417	0.
227.	0.01303	0.00531	0.	0.00278	0.00324	0.
252.	0.01163	0.00485	0.	0.00417	0.00324	0.
287.	0.01309	0.00485	0.	0.00431	0.00336	0.
317.	0.00872	0.00485	0.	0.00431	0.00335	0.

TEST P5 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 12-29-1961 12-29-1961

TIME (MINUTES)	CANISTER D (2/3KO2+1/3LIOH WITH PROBES) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER MSA ( ) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
22.	0.05474	0.02209	0.	0.03041	0.01389	0.
52.	0.03556	0.01897	0.	0.02365	0.01051	0.
73.	0.02826	0.01790	0.	0.01802	0.00788	0.
107.	0.02714	0.01523	0.	0.01577	0.00638	0.
137.	0.01711	0.01283	0.	0.00901	0.00488	0.
172.	0.01585	0.01152	0.	0.00901	0.00451	0.
209.	0.01008	0.01152	0.	0.00334	0.00446	0.
232.	0.01152	0.01056	0.	0.00557	0.00371	0.
257.	0.01010	0.00914	0.	0.00557	0.00297	0.
292.	0.01019	0.00922	0.	0.00532	0.00284	0.
322.	0.00865	0.00865	0.	0.00432	0.00324	0.

Table 20 IBM Reduced Data, P-6

TEST P-6

KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION DATE 1-10-1962 1-10-1962

CANISTER A-2 (KO2 (NO CATALYST) IN SCREEN — CANISTER A-4 (2/3 KO2(NO CAT.)+1/3 MSX13 IN SCRN)

TIME (MINUTES)	O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
14.	0.00342	0.00285	0.580	0.00084	0.00251	2.10727
56.	0.00515	0.00229	0.146	0.00168	0.00196	2.03152
86.	0.00515	0.00200	1.142	0.00084	0.00112	2.61870
116.	0.00429	0.00200	0.083	0.00168	0.00112	1.25860
146.	0.00428	0.00228	0.539	0.00167	0.00112	1.70203
206.	0.00513	0.00228	0.559	0.00167	0.00084	1.25486
266.	0.00428	0.00257	0.683	0.00084	0.00139	1.37517
326.	0.00770	0.00342	2.092	0.00418	0.00195	2.08297
386.	0.00598	0.00256	0.807	0.00501	0.00223	1.09204
446.	0.00342	0.00256	0.	0.00167	0.00139	0.

TEST P-6

KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION DATE 1-10-1962 1-10-1962

CANISTER A-5 (2/3 KO2(NO CAT)+1/3 LIOH IN SCREEN) — CANISTER MSA ( )

TIME (MINUTES)	O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
19.	0.00423	0.00423	0.901	0.00531	0.00334	0.74203
61.	0.00507	0.00338	0.470	0.00532	0.00276	0.18565
91.	0.00507	0.00254	1.125	0.00473	0.00276	0.42889
121.	0.00422	0.00253	0.082	0.00414	0.00236	0.05712
156.	0.00422	0.00253	0.531	0.00354	0.00216	0.37102
216.	0.00337	0.00253	-0.245	0.00354	0.00216	0.15684
276.	0.00337	0.00309	0.672	0.00354	0.00216	0.79846
336.	0.00505	0.00337	3.239	0.00648	0.00334	1.35304
396.	0.00505	0.00308	0.590	0.00589	0.00275	0.55546
456.	0.00336	0.00224	0.244	0.00236	0.00157	0.49904

Table 21 IBM Reduced Data, P-7

TEST P-7 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 1-19-1962 1-19-1962

TIME (MINUTES)	CANISTER A (KO2 IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER A-6 (2/3 KO2 + 1/3 M.S. X13 IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
15.	0.01117	0.00315	7.723	0.01169	0.00334	9.12746
45.	0.01557	0.00346	8.692	0.01174	0.00335	8.88920
75.	0.01479	0.00261	8.758	0.01172	0.00195	8.91289
120.	0.01477	0.00348	8.353	0.01171	0.00335	7.39911
150.	0.01389	0.00260	8.014	0.01087	0.00251	7.07828
180.	0.01474	0.00318	7.339	0.01170	0.00306	6.75246
240.	0.01128	0.00318	6.674	0.01003	0.00306	6.43187
300.	0.00955	0.00318	3.518	0.00837	0.00307	4.83785
360.	0.01071	0.00238	8.662	0.00957	0.00232	8.11198
420.	0.01043	0.00232	7.228	0.00958	0.00261	7.24844

TEST P-7 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 1-19-1962 1-19-1962

TIME (MINUTES)	CANISTER A-7 (2/3 KO2 + 1/3 LIOH IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER MSA ( ) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
20.	0.01682	0.00364	5.949	0.01382	0.00329	8.06926
50.	0.01351	0.00338	6.678	0.01576	0.00328	8.52881
80.	0.01184	0.00197	6.427	0.01509	0.00306	7.85920
125.	0.01217	0.00319	6.589	0.01396	0.00355	7.19682
155.	0.01131	0.00261	6.239	0.01197	0.00288	6.70323
185.	0.01130	0.00319	5.901	0.01119	0.00285	5.62743
245.	0.00929	0.00253	5.409	0.00851	0.00284	4.82702
305.	0.00712	0.00326	4.608	0.00520	0.00231	2.00796
365.	0.00890	0.00237	7.808	0.00511	0.00187	3.78107
425.	0.00800	0.00267	6.926	0.00569	0.00190	4.66939

Table 22 IBM Reduced Data, P-8

TEST P-8 — KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN — DATE 1-11-1962 1-12-1962

TIME (MINUTES)	CANISTER A (KØ2 IN SCREEN) Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)	CANISTER A-6 (2/3 KØ2 + 1/3 M.S. X13 IN SCREEN) Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
13.	0.00631	0.00420	0.589	0.00255	0.00339	0.63665
43.	0.00757	0.00477	-1.018	0.00170	0.00170	1.15223
73.	0.01092	0.00560	-0.407	0.00255	0.00170	1.93050
103.	0.01342	0.00615	-0.629	0.00424	0.00141	1.45695
148.	0.01501	0.00711	1.855	0.00763	0.00367	3.85784
183.	0.01186	0.00633	1.570	0.00848	0.00480	2.85234
208.	0.01106	0.00632	1.587	0.00848	0.00396	2.87286
238.	0.01106	0.00553	0.975	0.01017	0.00537	1.82632
268.	0.00948	0.00448	0.459	0.00763	0.00396	1.70320
298.	0.00711	0.00448	0.593	0.00763	0.00367	1.39539
328.	0.00632	0.00421	0.803	0.00424	0.00283	1.78528
358.	0.00553	0.00342	0.860	0.00593	0.00283	1.45695
388.	0.00474	0.00316	0.019	0.00339	0.00254	0.82082
423.	0.00971	0.00383	1.190	0.00439	0.00263	2.66617
468.	0.00531	0.00501	0.997	0.00351	0.00351	2.51566
533.	0.00705	0.00470	0.086	0.01049	0.00408	0.36413
593.	0.01497	0.00616	3.731	0.01485	0.00670	4.30051
653.	0.00967	0.00586	5.016	0.01046	0.00668	4.86911
713.	0.00877	0.00526	3.245	0.00870	0.00522	3.90056

Table 22 (cont.) IBM Reduced Data, P-8

TEST P-8 KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN DATE 1-11-1962 1-12-1962

CANISTER A-7 (2/3 KØ2 + 1/3 LIØH IN SCREEN) | CANISTER MSA ( )

TIME (MINUTES)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
23.	0.01518	0.00590	-1.755	0.00784	0.00435	-0.71065
53.	0.00842	0.00646	-1.815	0.00916	0.00654	0.36392
83.	0.00842	0.00533	-0.733	0.01045	0.00653	0.63169
113.	0.00841	0.00448	-1.302	0.01631	0.00827	-1.46705
153.	0.00966	0.00615	1.382	0.01306	0.00762	1.27917
186.	0.00878	0.00556	0.383	0.01110	0.00588	1.04228
213.	0.00878	0.00556	0.702	0.01046	0.00610	1.29639
243.	0.00878	0.00586	0.021	0.00850	0.00523	0.79048
273.	0.00703	0.00468	-0.191	0.00523	0.00348	0.80540
303.	0.00791	0.00410	-0.340	0.00392	0.00262	0.72725
333.	0.00439	0.00381	0.234	0.00327	0.00218	1.12125
363.	0.00439	0.00351	0.298	0.00262	0.00218	1.12249
393.	0.00351	0.00293	-0.659	0.00262	0.00218	0.63239
433.	0.00674	0.00281	0.991	0.00326	0.00261	1.13368
473.	0.00336	0.00392	-0.021	0.00261	0.00283	0.87755
543.	0.00503	0.00448	-0.884	0.00521	0.00390	0.93963
598.	0.01003	0.00557	1.905	0.00779	0.00541	3.19260
658.	0.00834	0.00528	3.128	0.00648	0.00454	3.25253
718.	0.00666	0.00472	1.776	0.00324	0.00302	2.29633

Table 23 IBM Reduced Data, P-9

TEST P-9 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 1-16-1962 1-16-1962

TIME (MINUTES)	CANISTER A (KO2 IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER A-6 (2/3 KO2 + 1/3 M.S. X13 IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
15.	0.01274	0.00661	10.025	0.01145	0.00716	12.80581
45.	0.01128	0.00329	3.181	0.01274	0.00519	10.56784
75.	0.01265	0.00328	4.736	0.01411	0.00376	10.74578
115.	0.01264	0.00328	5.820	0.01268	0.00517	10.72591
145.	0.01265	0.00328	1.976	0.01269	0.00423	4.58069
175.	0.01123	0.00328	3.608	0.01132	0.00424	5.69494
205.	0.01264	0.00187	7.011	0.01273	0.00189	7.68473
240.	0.01263	0.00327	5.579	0.01272	0.00283	7.54091
265.	0.00874	0.00340	1.024	0.00886	0.00148	2.75894
310.	0.00854	0.00237	6.620	0.01016	0.00242	7.17959
355.	0.00419	0.00140	2.676	0.00841	0.00187	3.80567
385.	0.00710	0.00331	2.752	0.00571	0.00333	4.42761
445.	0.00567	0.00189	3.846	0.00423	0.00188	4.95238
505.	0.00708	0.00283	3.881	0.00712	0.00285	4.97180
565.	0.00713	0.00808	5.048	0.00718	0.00958	5.46847

TEST P-9 — KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 1-16-1962 1-16-1962

TIME (MINUTES)	CANISTER A-7 (2/3 KO2 + 1/3 LIOH IN SCREEN) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)	CANISTER MSA ( ) O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
20.	0.02260	0.00800	9.420	0.01427	0.00732	11.39556
55.	0.01403	0.00515	2.382	0.01207	0.00402	3.13482
80.	0.01557	0.00378	7.519	0.01205	0.00329	6.23159
115.	0.01415	0.00613	7.513	0.01098	0.00476	5.39202
150.	0.01273	0.00519	1.990	0.00958	0.00390	1.90567
180.	0.01132	0.00424	2.230	0.00806	0.00302	2.19431
210.	0.01273	0.00424	5.455	0.00965	0.00354	4.43161
240.	0.00987	0.00517	5.849	0.00618	0.00265	3.15565
270.	0.00884	0.00393	1.500	0.00517	0.00115	0.64432
315.	0.00883	0.00392	5.388	0.00657	0.00192	3.44136
360.	0.01116	0.00279	3.754	0.00110	0.00037	1.65486
395.	0.00701	0.00374	3.773	0.00327	0.00182	2.11409
455.	0.00432	0.00336	4.362	0.00381	0.00222	2.58765
515.	0.00861	0.00335	5.569	0.00386	0.00150	0.73188
575.	0.00560	0.00327	2.376	0.00386	0.00150	1.55524

Table 24 IBM Reduced Data, P-10

TEST P-10 — KO_2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION — DATE 1-23-1962 1-24-1962

CANISTER A-8

(KO_2(CAT.) IN TWO SCREENS AT 10 IN.)

TIME (MINUTES)	O_2 GENERATED (SCFM)	CO_2 ABSORBED (SCFM)	H_2O ABSORBED (GR/MIN)
15.	0.01865	0.00452	13.094
45.	0.01909	0.00492	8.842
75.	0.01907	0.00462	9.428
135.	0.01907	0.00549	9.640
195.	0.01687	0.00478	5.633
255.	0.01687	0.00478	7.704
315.	0.01687	0.00450	5.198
375.	0.01602	0.00450	6.793
435.	0.01518	0.00394	9.609
495.	0.01352	0.00451	5.519
555.	0.01352	0.00394	5.519
615.	0.01267	0.00366	5.872
675.	0.01174	0.00364	4.821
735.	0.01018	0.00368	3.991
795.	0.01014	0.00366	6.222
855.	0.01014	0.00338	6.407
915.	0.00930	0.00338	6.222
975.	0.00930	0.00338	5.171
1035.	0.00846	0.00338	6.247
1095.	0.00848	0.00368	7.341
1155.	0.00843	0.00309	3.825
1215.	0.00761	0.00310	3.502
1275.	0.00770	0.00314	3.943
1335.	0.00770	0.00314	3.563
1395.	0.00513	0.00313	3.977
1455.	0.00599	0.00314	2.896
1515.	0.00598	0.00256	2.582
1575.	0.00513	0.00257	3.980
1635.	0.00599	0.00257	3.647
1695.	0.00513	0.00257	2.230
1755.	0.00513	0.00256	2.561

Table 24 (cont.) IBM Reduced Data, P-10

TEST P-10 KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION DATE 1-23-1962 1-23-1962

CANISTER E

(KO2 (CAT) IN 5 IN. CANISTER)

TIME (MINUTES)	O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
15.	0.02034	0.00472	12.852
45.	0.01837	0.00554	10.520
75.	0.01748	0.00553	11.263
135.	0.01609	0.00621	8.283
195.	0.01257	0.00531	5.004
255.	0.00994	0.00315	3.778
315.	0.00570	0.00171	1.177
375.	-0.	-0.	-0.

TEST P-10 KO2 ATMOSPHERIC COMPOSITION CONTROL EVALUATION DATE 1-23-1962 1-23-1962

CANISTER F

(KO2(CAT.) IN 20 IN. CANISTER)

TIME (MINUTES)	O2 GENERATED (SCFM)	CO2 ABSORBED (SCFM)	H2O ABSORBED (GR/MIN)
20.	0.02241	0.00546	18.067
50.	0.02284	0.00564	12.934
80.	0.02174	0.00557	14.323
140.	0.02276	0.00623	14.845
200.	0.02269	0.00560	11.472
260.	0.01234	0.00265	6.004
320.	0.00836	0.00195	2.368
380.	-0.	-0.	-0.

Table 24 (cont.) IBM Reduced Data, P-10

TEST P-10 KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN DATE 1-23-1962 1-24-1962

CANISTER C-2

(2/3KØ2+1/3LIØH IN 5 IN CANISTER)

TIME (MINUTES)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
5.	0.03414	0.00555	4.457
65.	0.01589	0.00474	8.088
125.	0.01245	0.00470	7.356
185.	0.01001	0.00445	4.377
245.	0.00918	0.00445	7.396
305.	0.00918	0.00417	7.071
365.	0.00839	0.00448	6.431
425.	0.00671	0.00448	6.594
485.	0.00419	0.00419	4.818
545.	0.00168	0.00308	5.993
605.	0.00084	0.00196	1.937
665.	0.00140	0.00168	1.960

TEST P-10 KØ2 ATMØSPHERIC CØMPØSITIØN CØNTRØL EVALUATIØN DATE 1-23-1962 1-24-1962

CANISTER MSA

( )

TIME (MINUTES)	Ø2 GENERATED (SCFM)	CØ2 ABSØRBED (SCFM)	H2Ø ABSØRBED (GR/MIN)
20.	0.01466	0.00355	8.536
50.	0.01298	0.00346	5.303
80.	0.01303	0.00347	5.881
140.	0.01265	0.00377	4.641
200.	0.00779	0.00281	1.433
260.	0.00779	0.00238	2.771
320.	0.00714	0.00216	1.194
380.	0.00520	0.00217	0.143
435.	0.00455	0.00152	1.227
495.	0.00453	0.00194	0.746
560.	0.00450	0.00171	0.487
620.	0.00387	0.00150	1.781
680.	0.00195	0.00151	0.760
740.	0.00263	0.00153	0.254
800.	0.00197	0.00153	1.537
860.	0.00263	0.00110	1.698
920.	0.00197	0.00110	1.031
980.	0.00132	0.00066	1.285
1040.	0.00131	0.00066	1.296
1100.	0.	0.	2.579

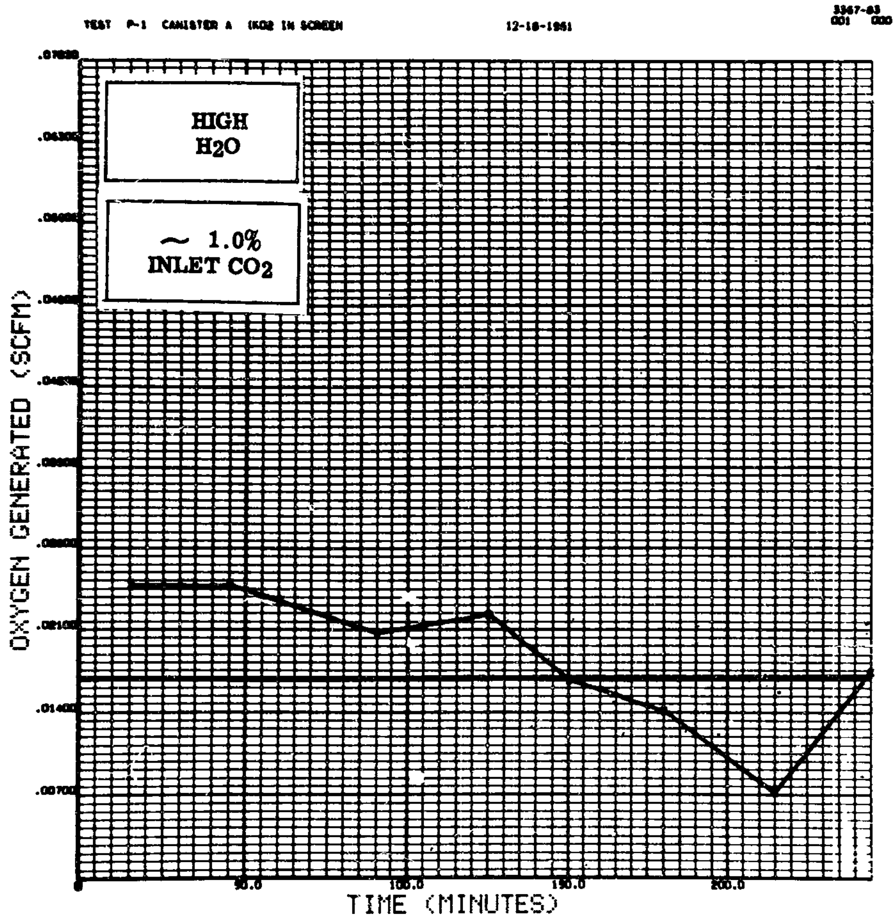

Figure 42 SC-4020 Curve, O_2, P-1, A

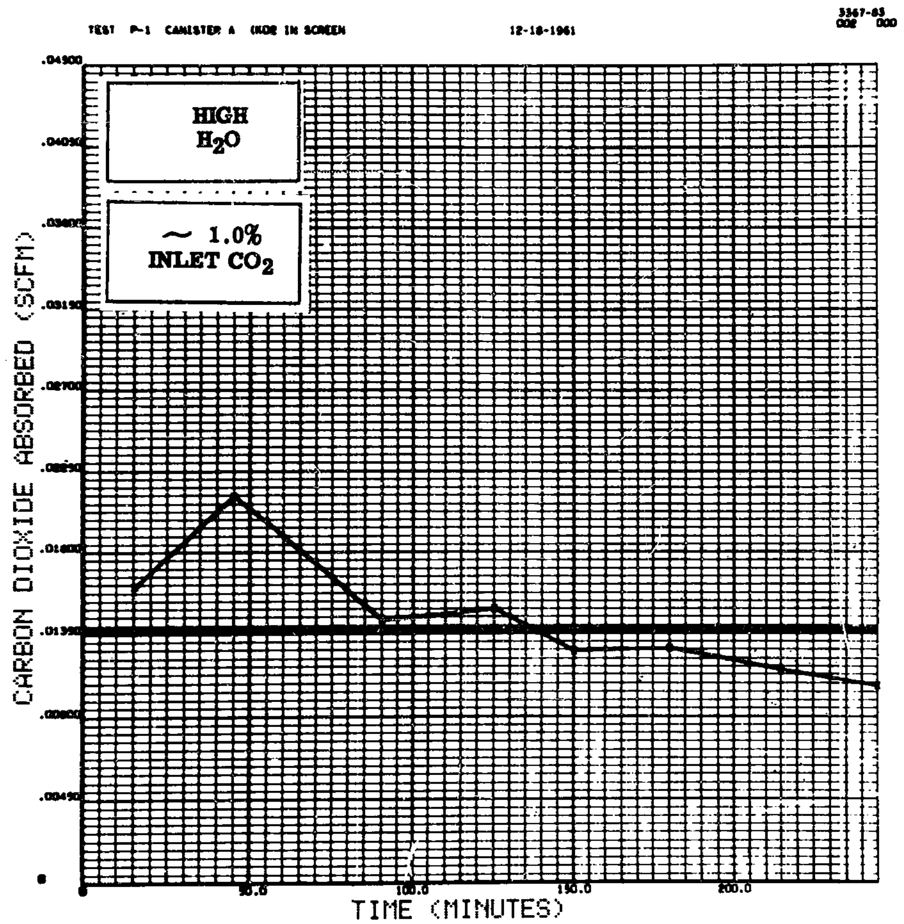

Figure 43 SC-4020 Curve, CO_2, P-1, A

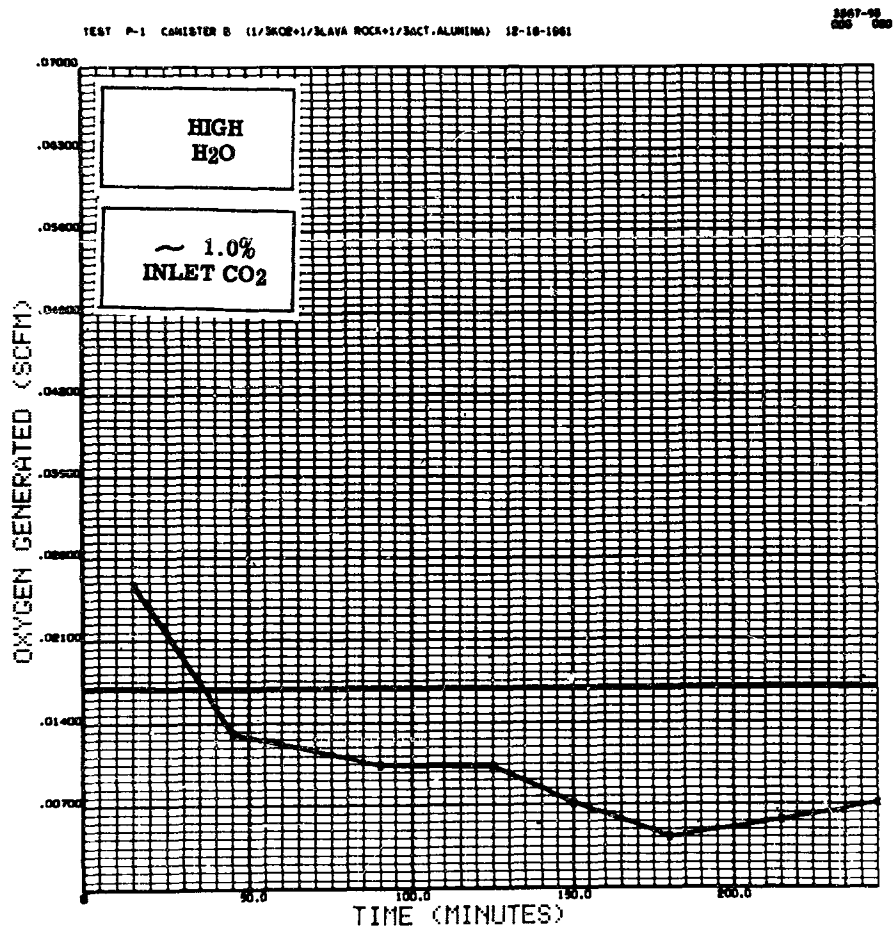

Figure 44 SC-4020 Curve, O_2, P-1, B

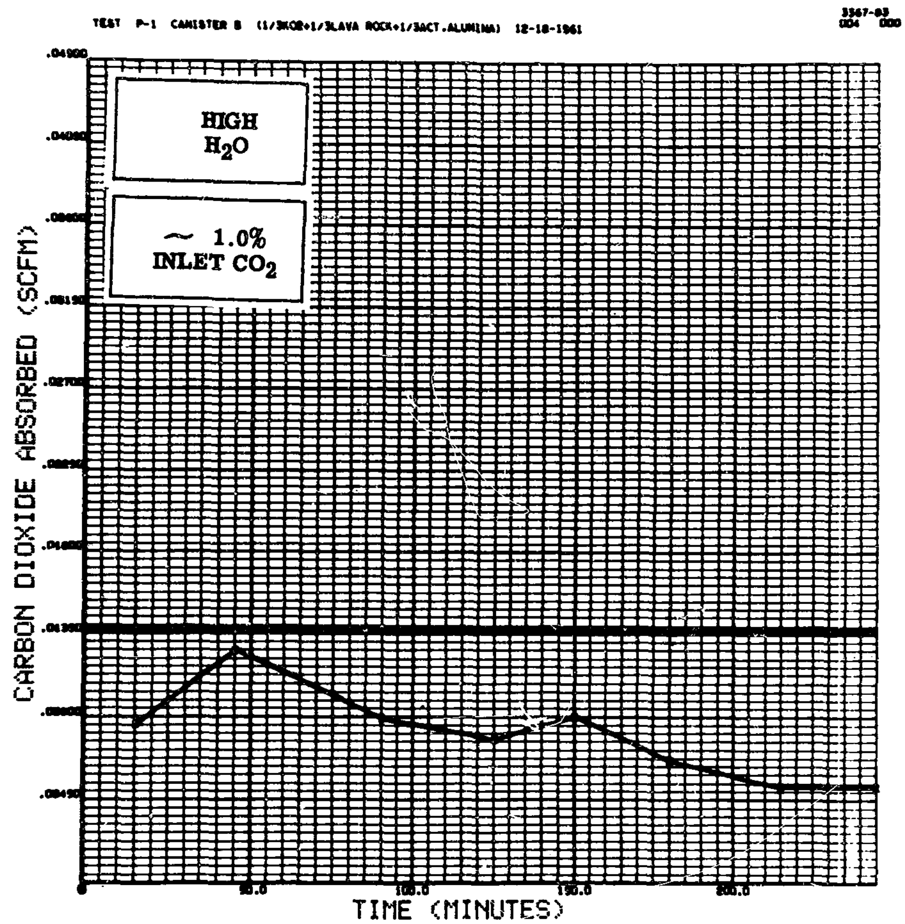

Figure 45 SC-4020 Curve, CO_2, P-1, B

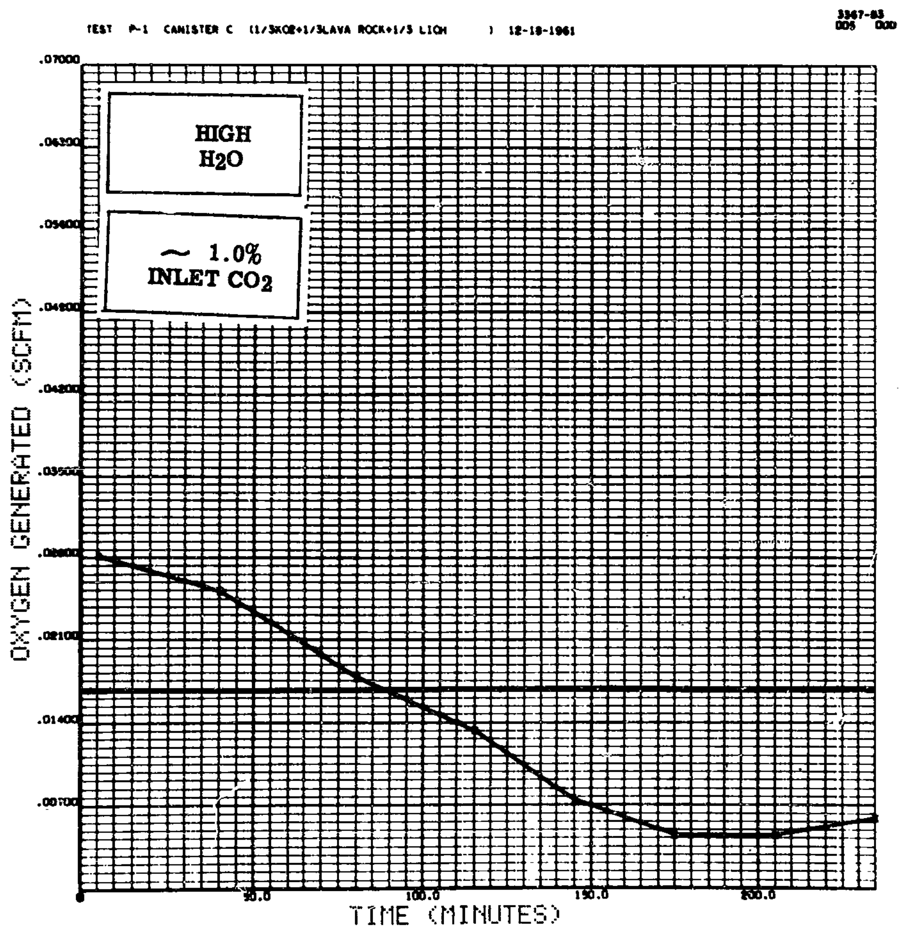

Figure 46 SC-4020 Curve, O_2, P-1, C

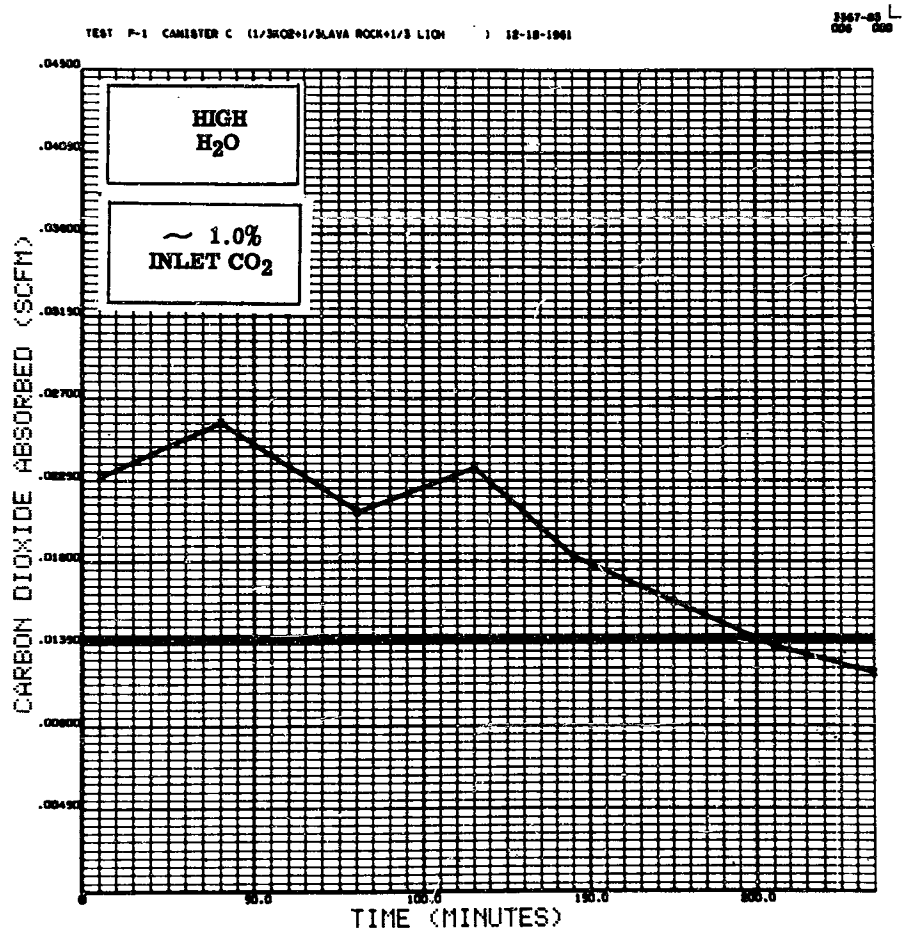

Figure 47 SC-4020 Curve, CO_2, P-1, C

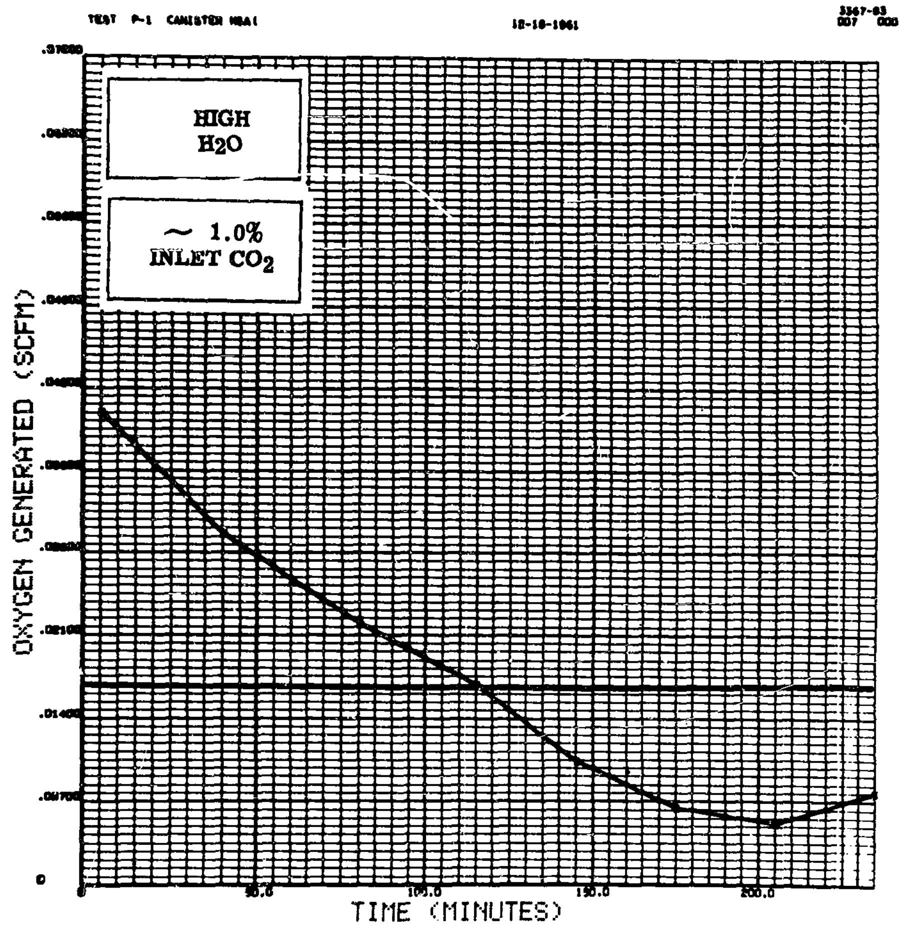

Figure 48 SC-4020 Curve, O_2, P-1, MSA

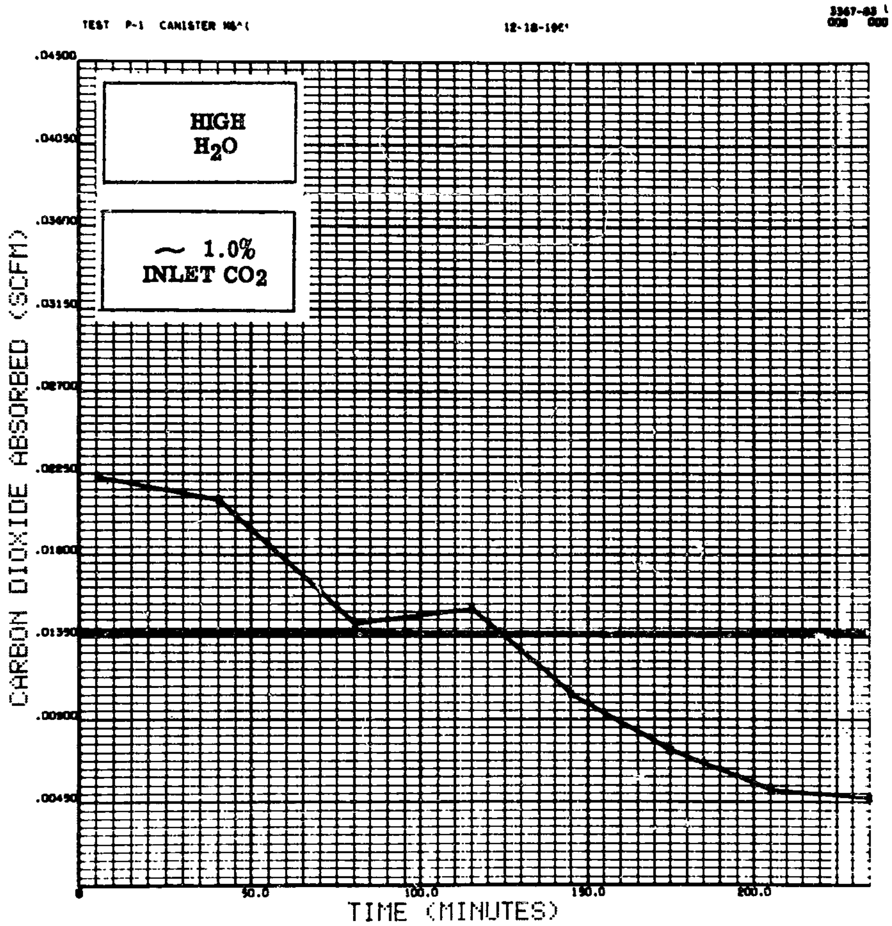

Figure 49 SC-4020 Curve, CO_2, P-1, MSA

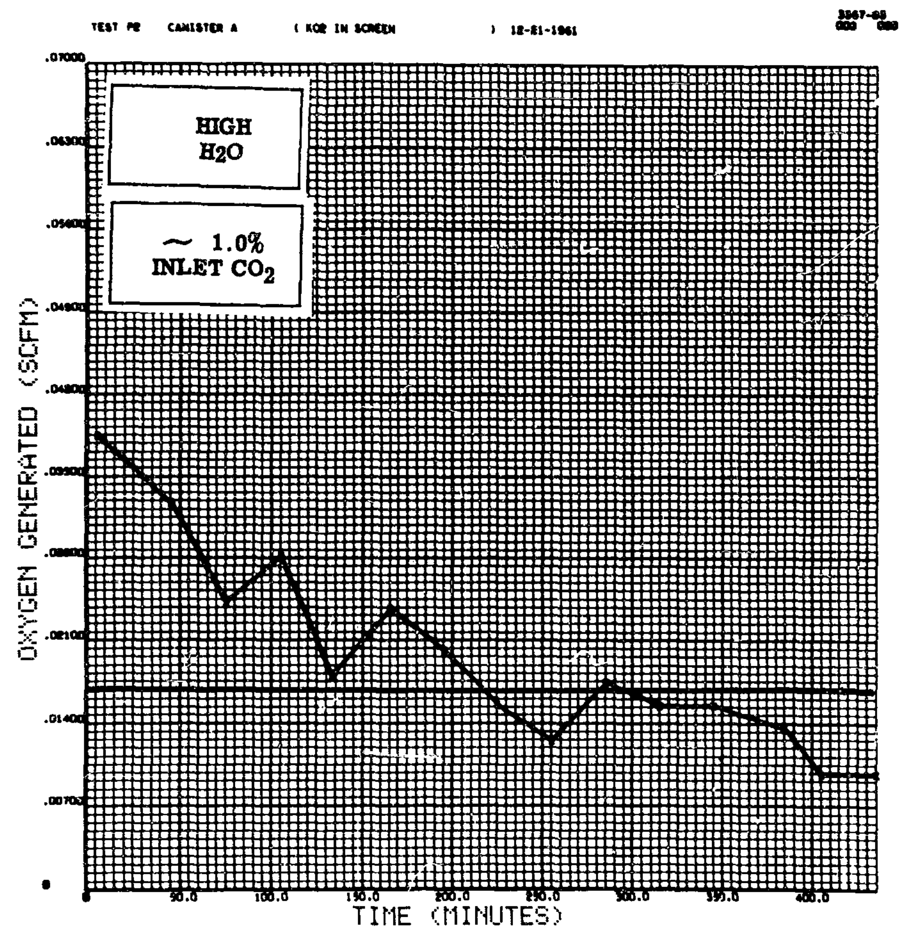

Figure 50 SC-4020 Curve, O_2, P-2, A

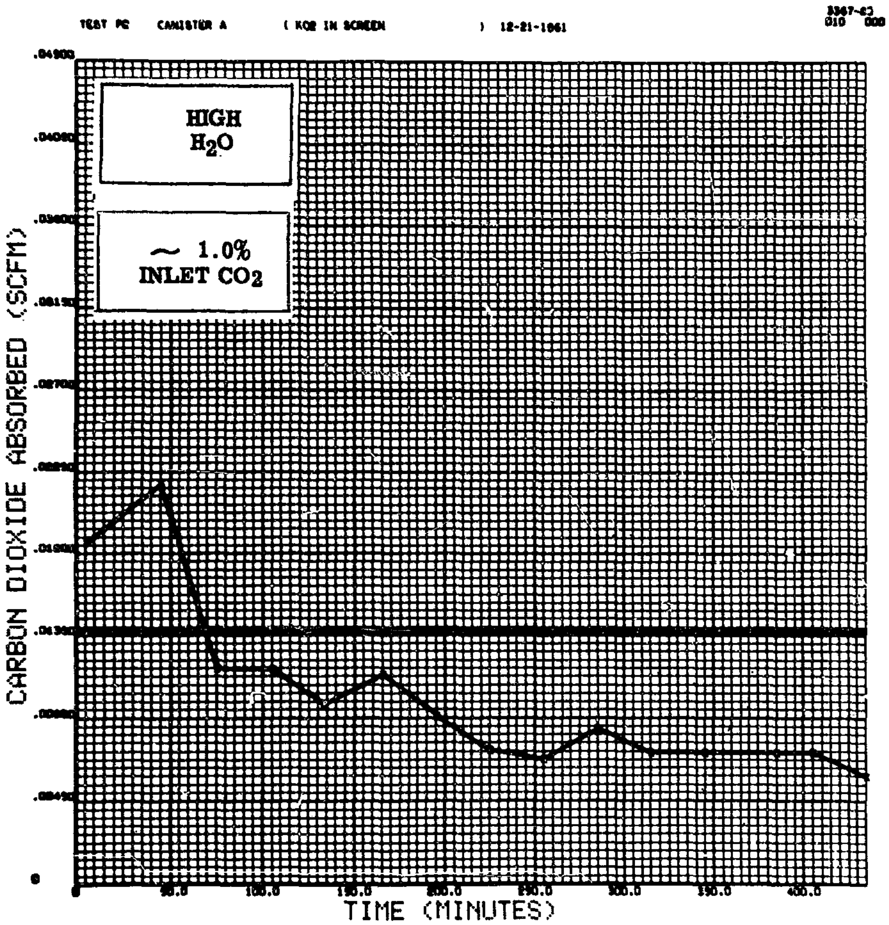

Figure 51 SC-4020 Curve, CO_2, P-2, A

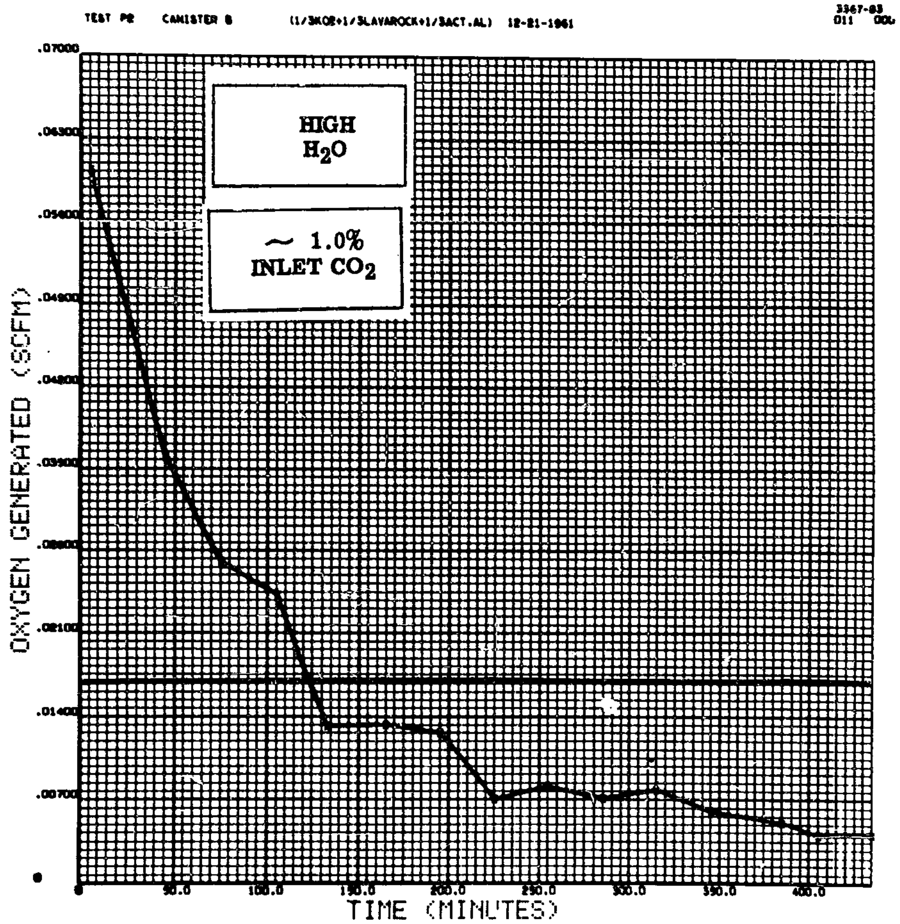

Figure 52 SC-4020 Curve, O_2, P-2, B

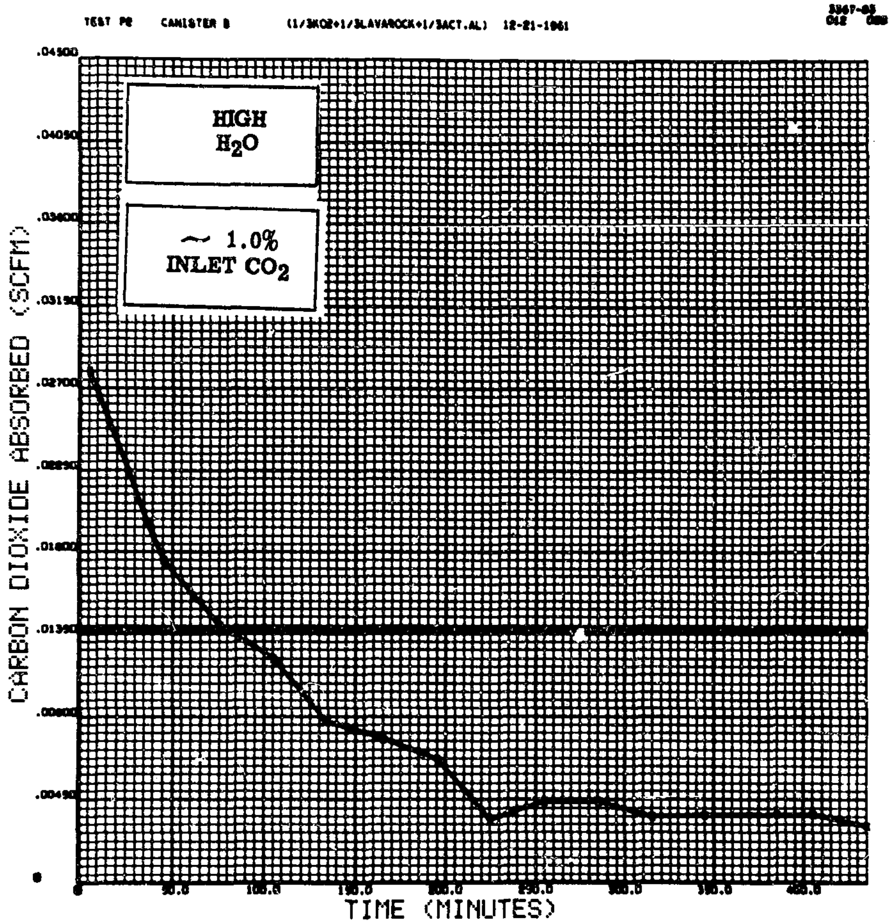

Figure 53 SC-4020 Curve, CO_2, P-2, B

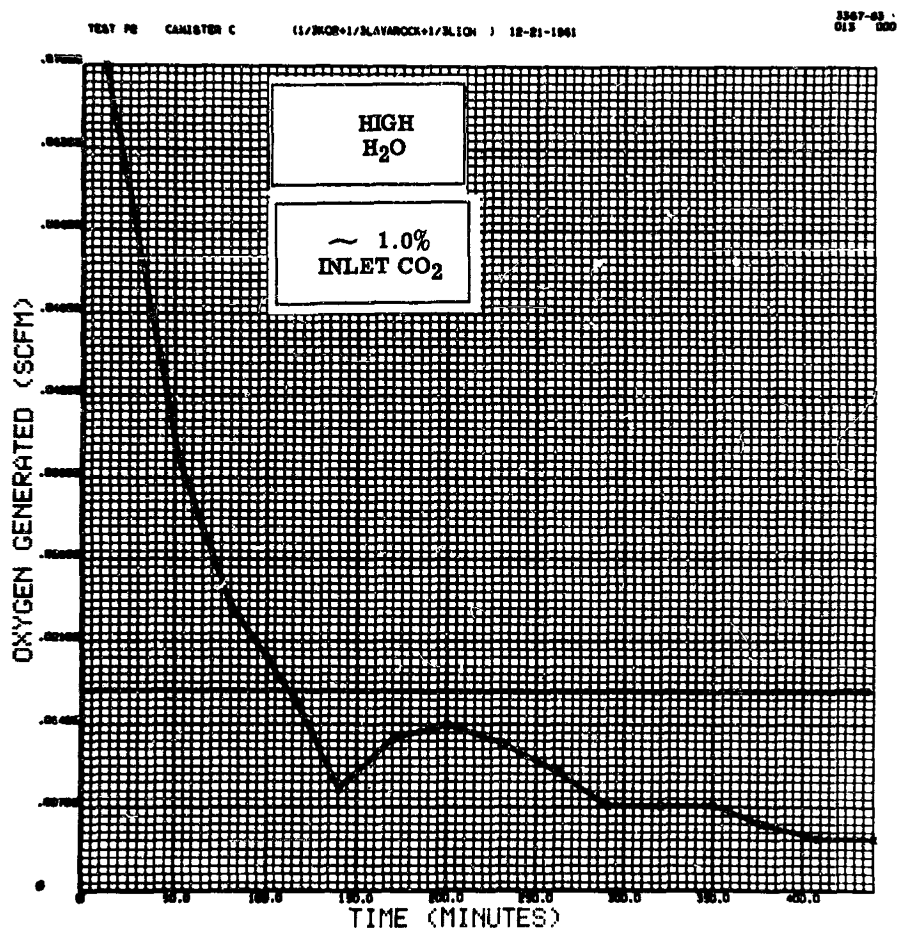

Figure 54 SC-4020 Curve, O_2, P-2, C

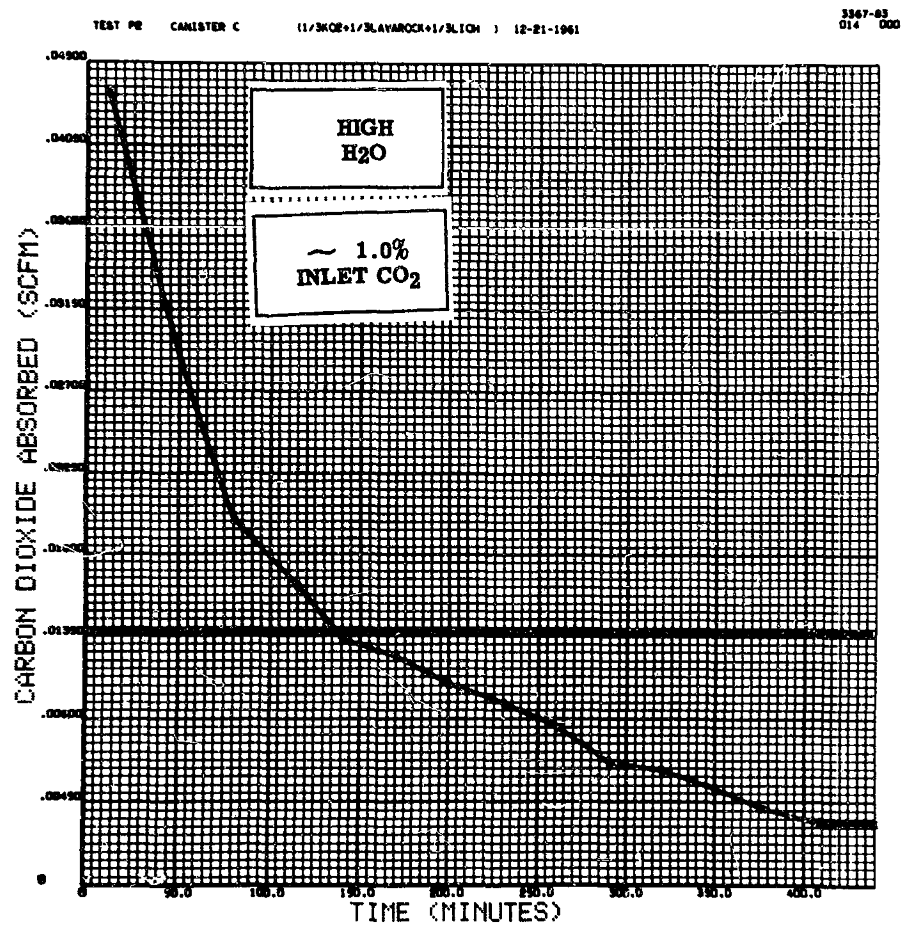

Figure 55 SC-4020 Curve, CO_2, P-2, C

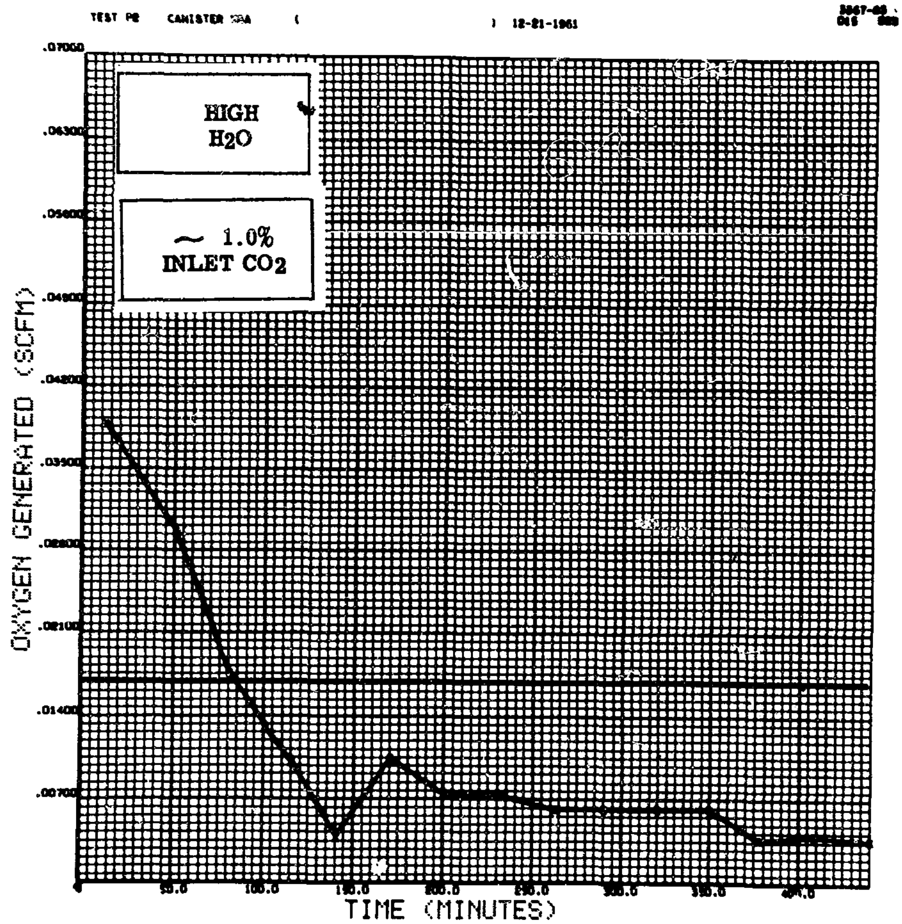

Figure 56 SC-4020 Curve, O_2, P-2, MSA

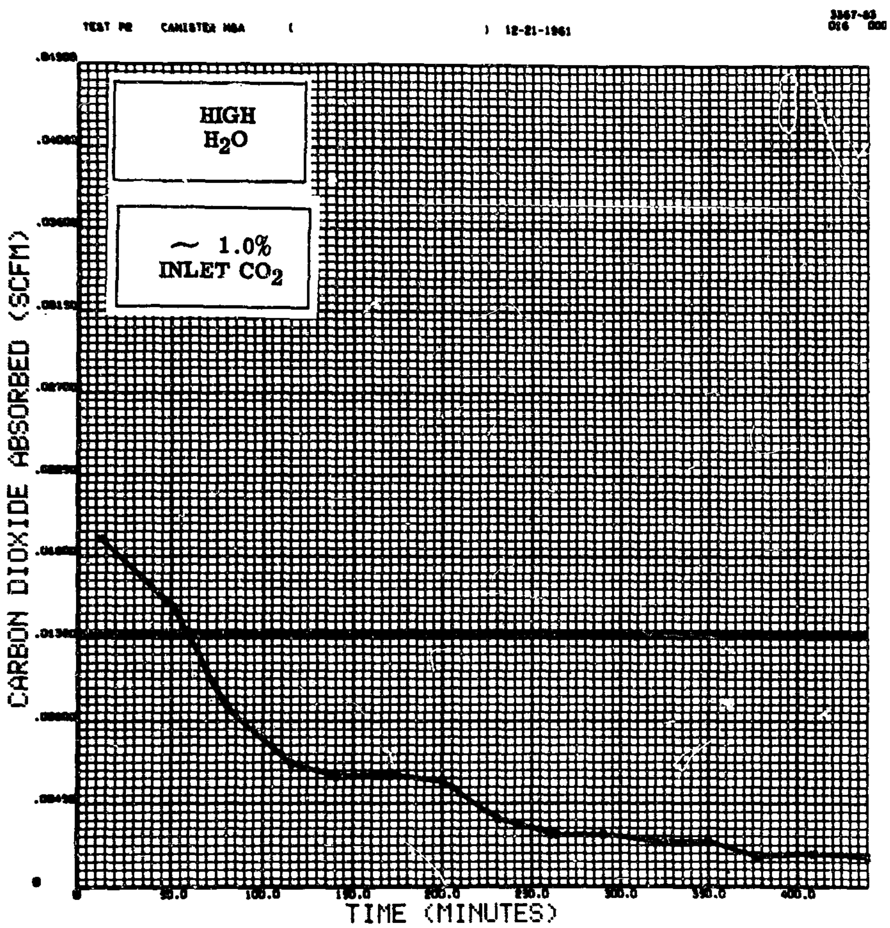

Figure 57 SC-4020 Curve, CO_2, P-2, MSA

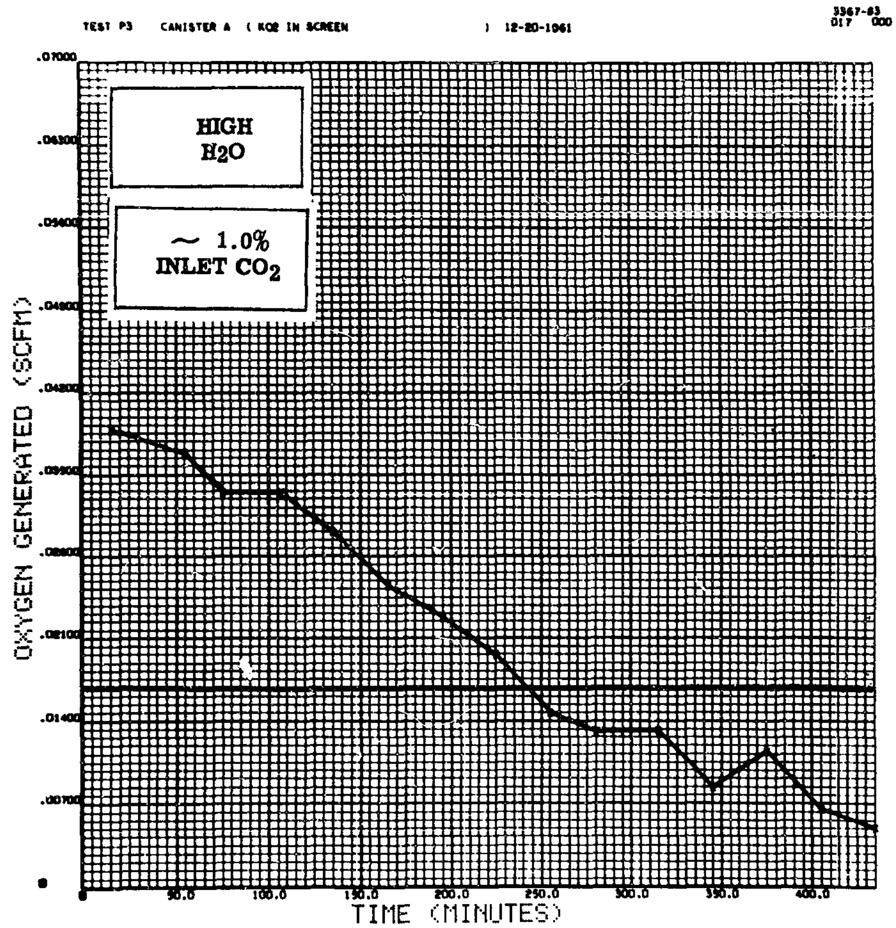

Figure 58 SC-4020 Curve, O_2, P-3, A

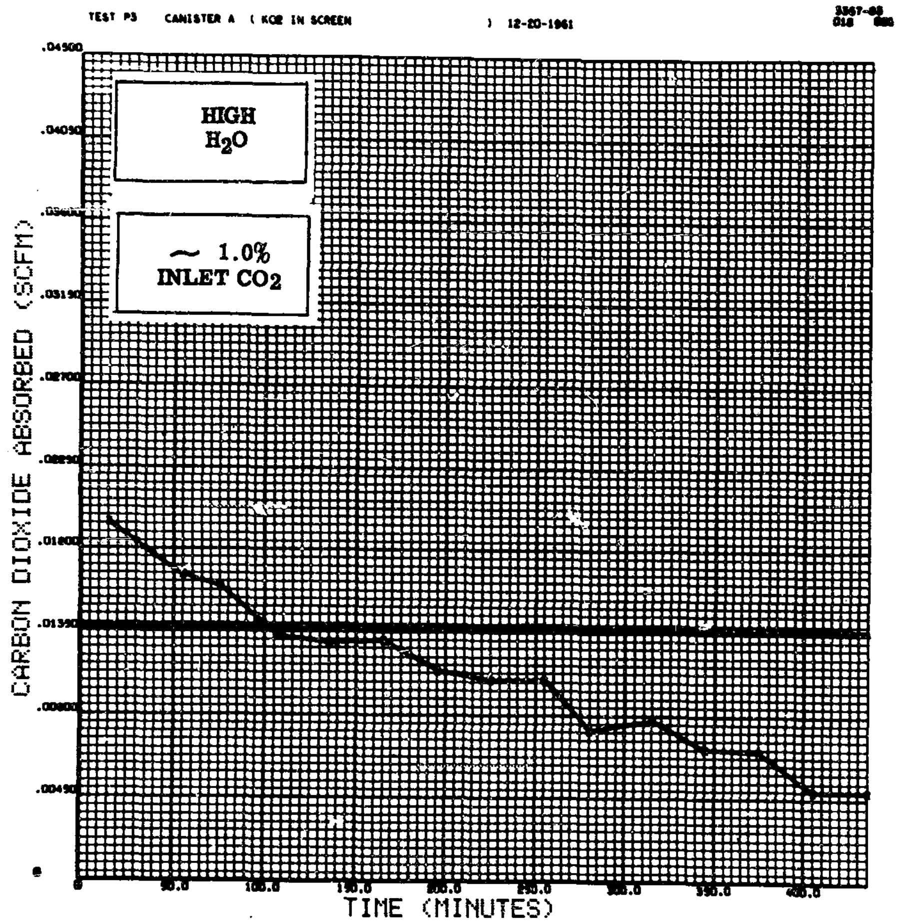

Figure 59 SC-4020 Curve, CO_2, P-3, A

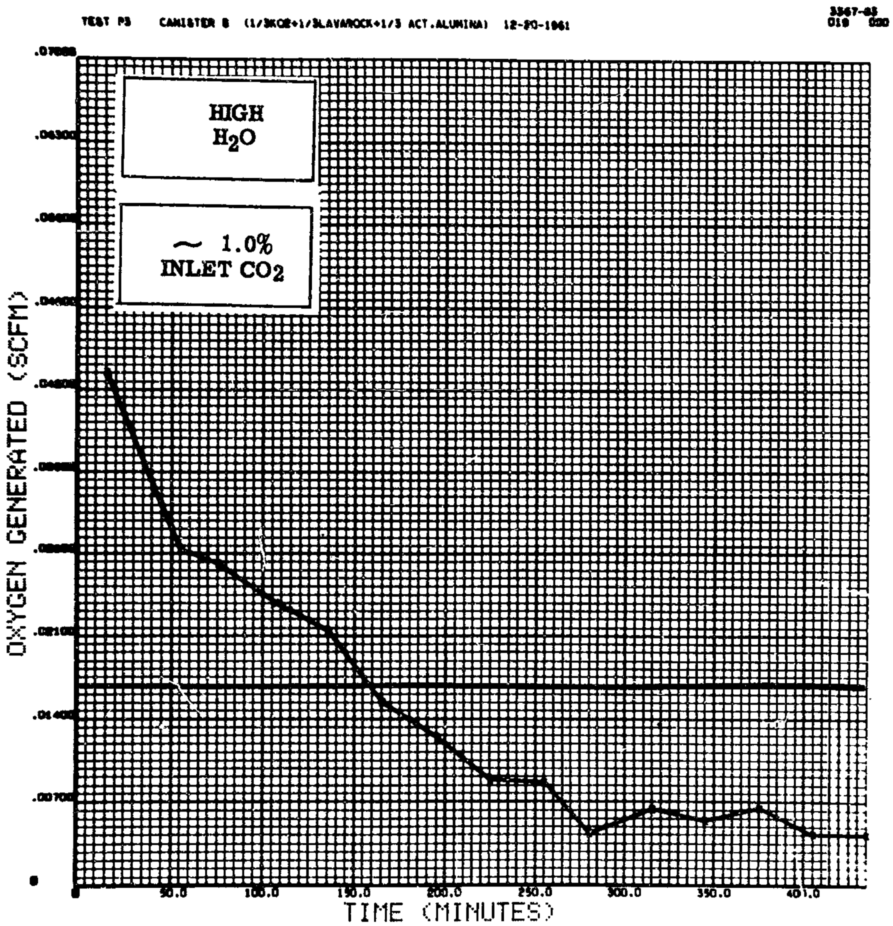

Figure 60 SC-4020 Curve, O_2, P-3, B

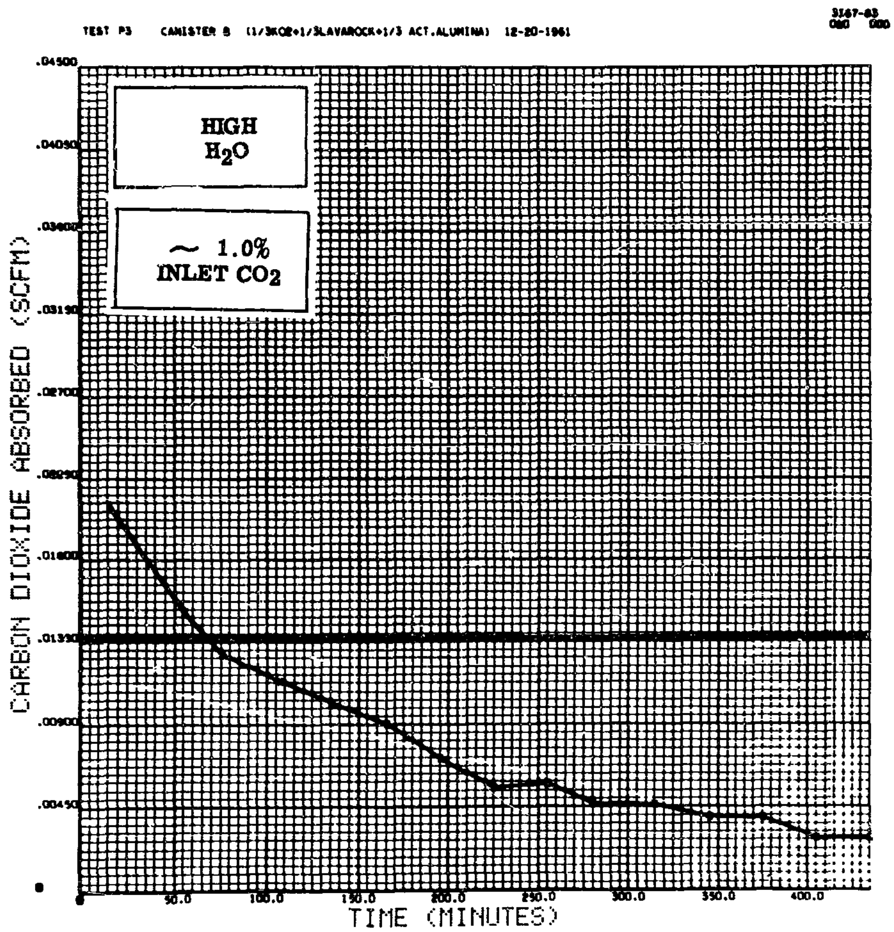

Figure 61 SC-4020 Curve, CO_2, P-3, B

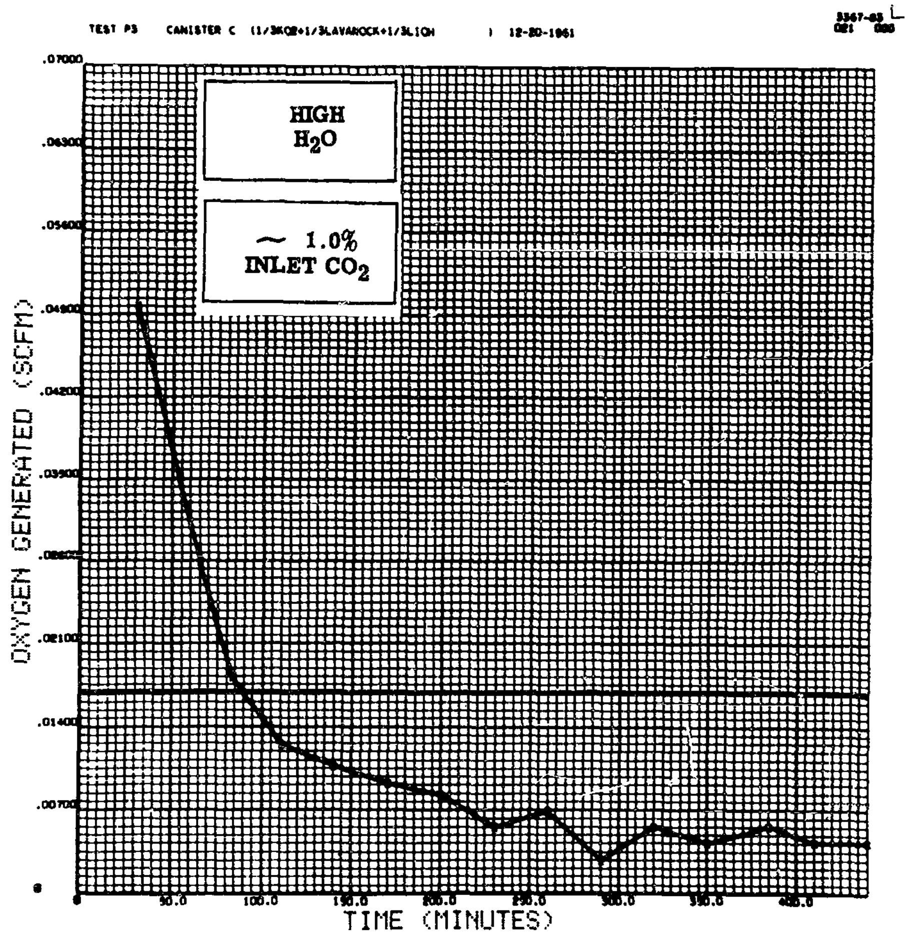

Figure 62 SC-4020 Curve, O_2, P-3, C

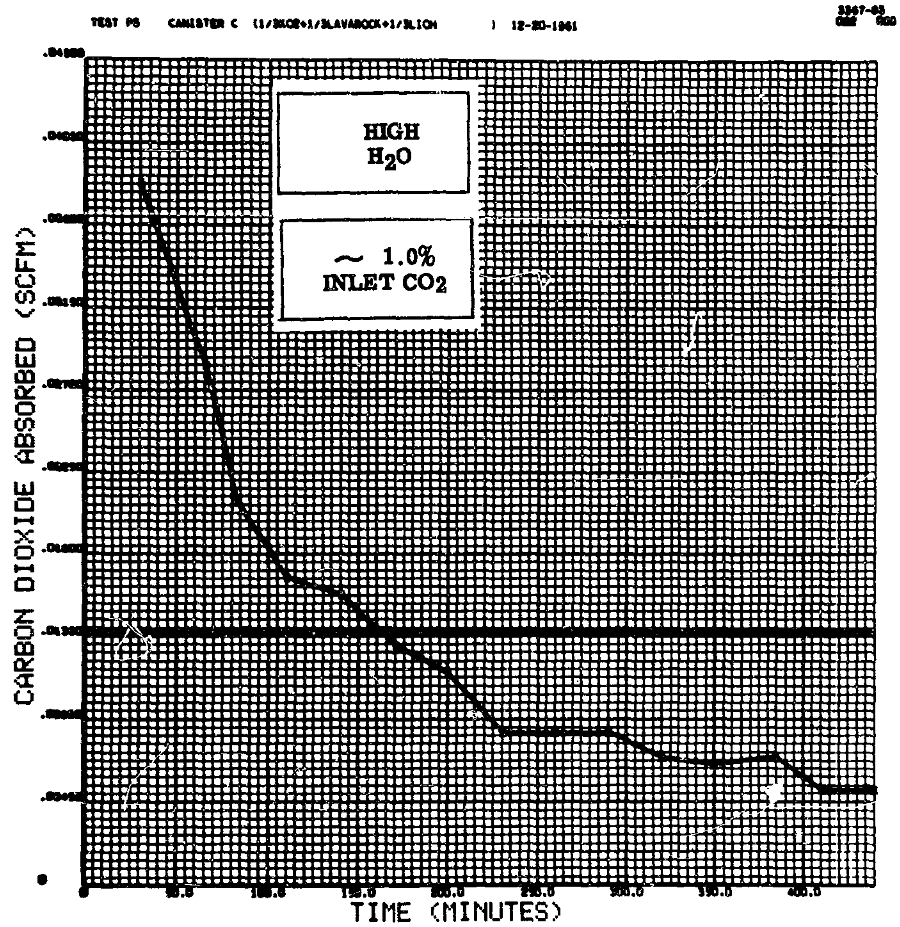

Figure 63 SC-4020 Curve, CO_2, P-3, C

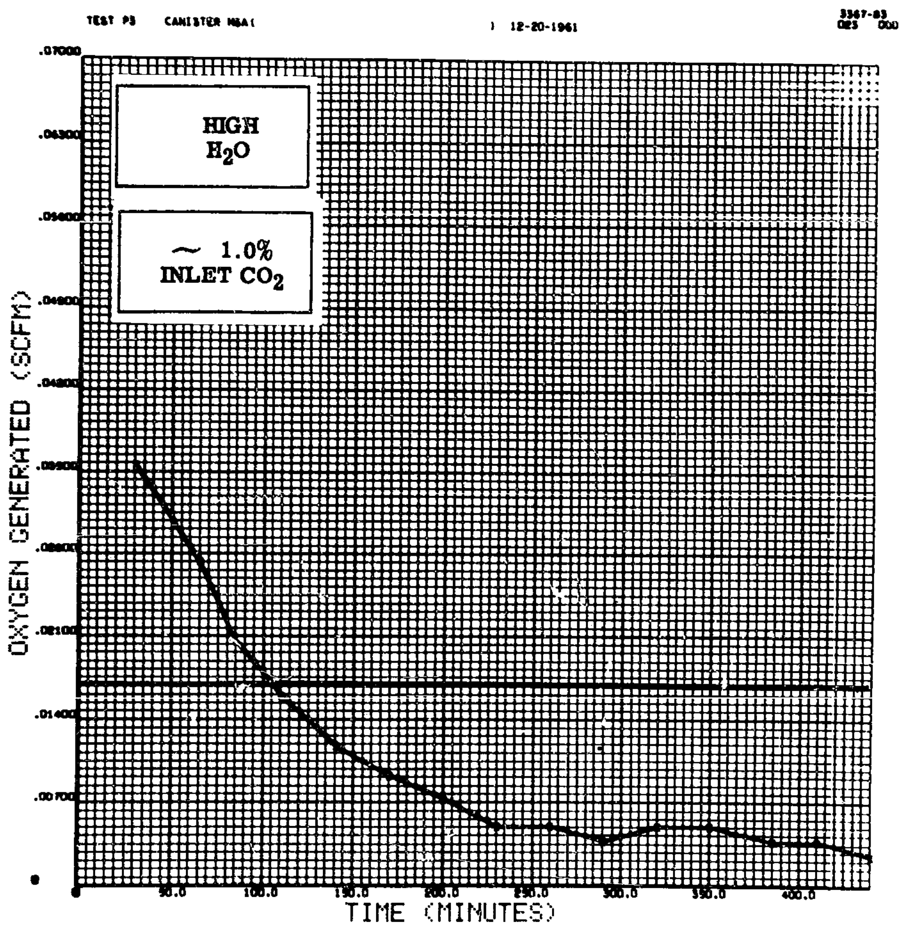

Figure 64 SC-4020 Curve, O_2, P-3, MSA

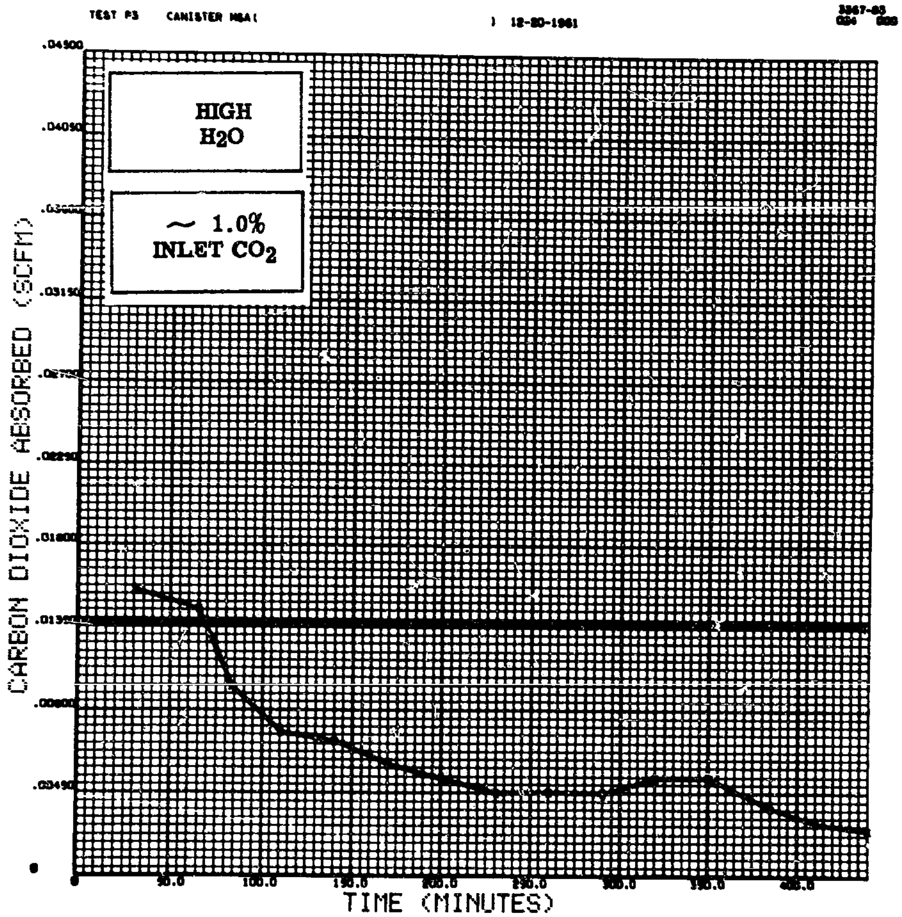

Figure 65 SC-4020 Curve, CO_2, P-3, MSA

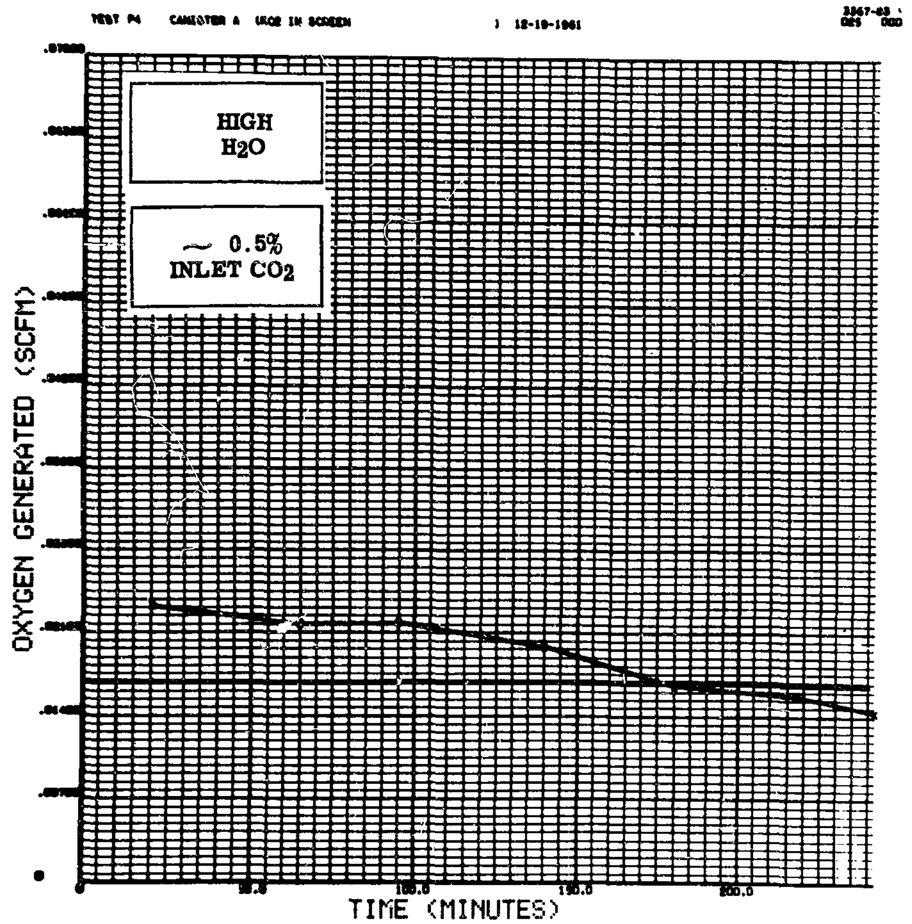

Figure 66 SC-4020 Curve, O_2, P-4, A

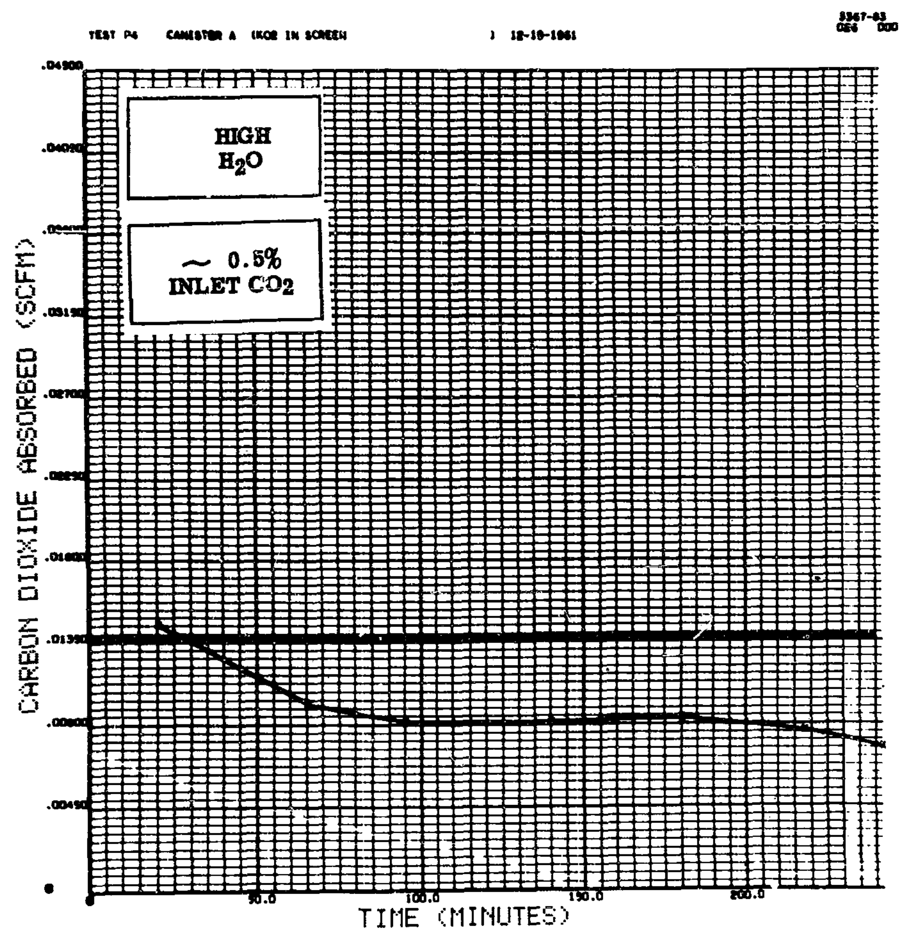

Figure 67 SC-4020 Curve, CO_2, P-4, A

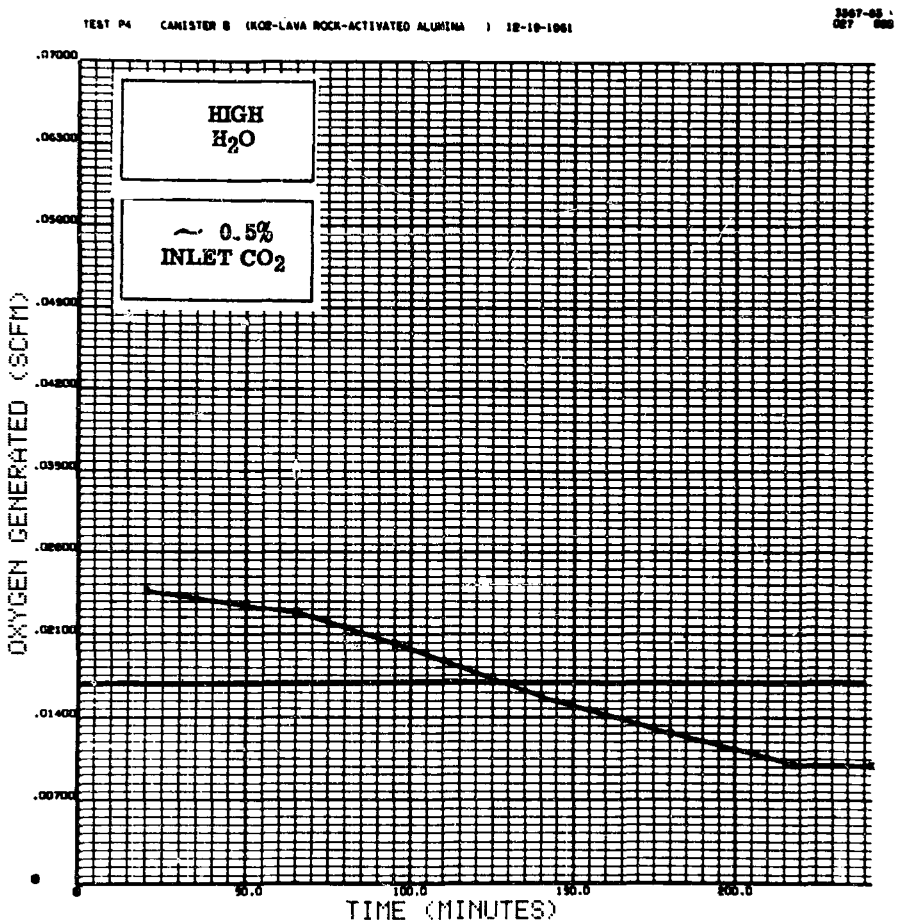

Figure 68 SC-4020 Curve, O_2, P-4, B

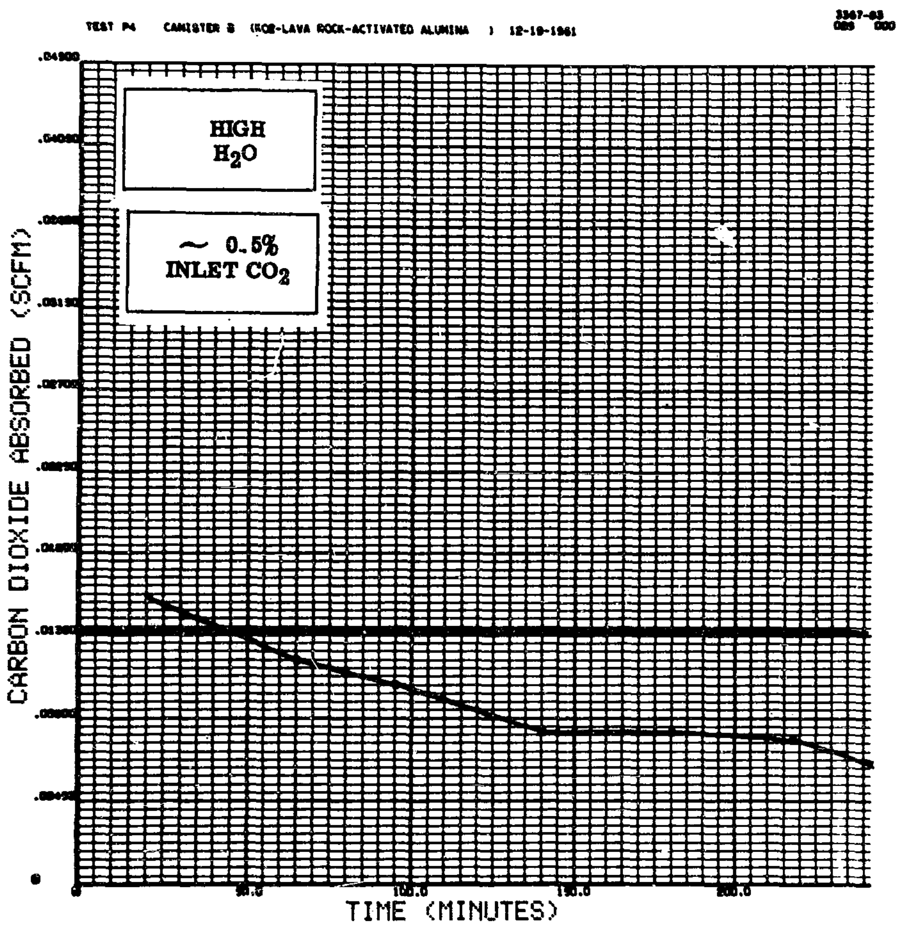

Figure 69 SC-4020 Curve, CO_2, P-4, B

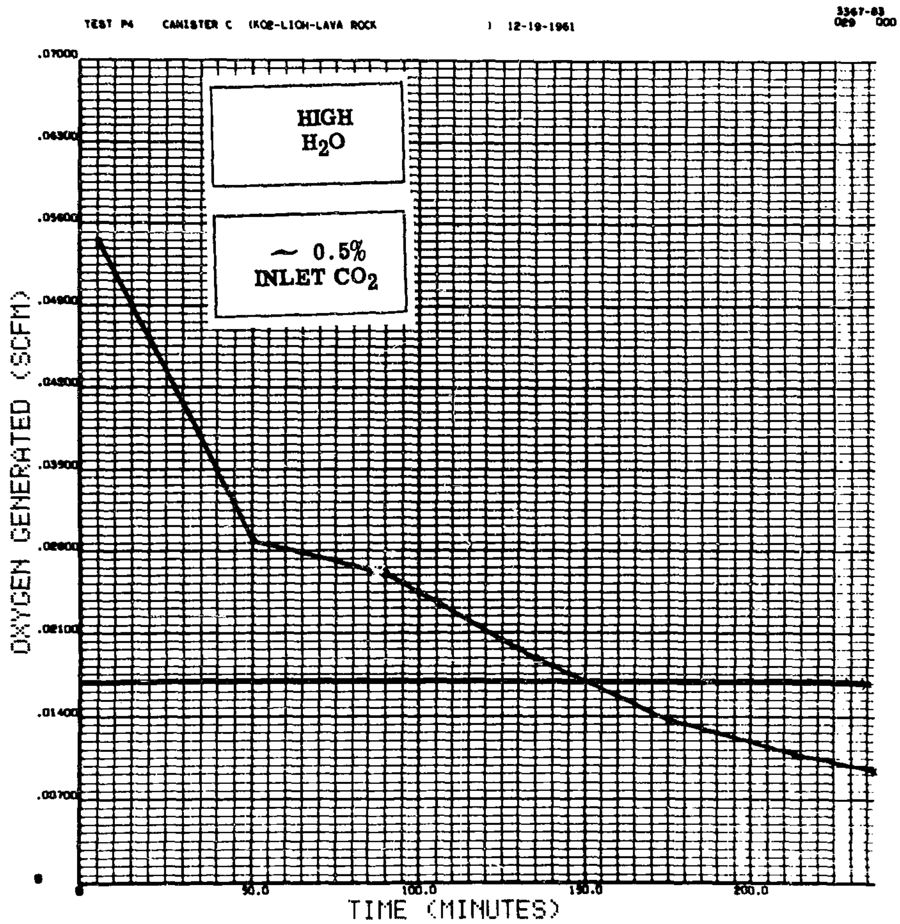

Figure 70 SC-4020 Curve, O_2, P-4, C

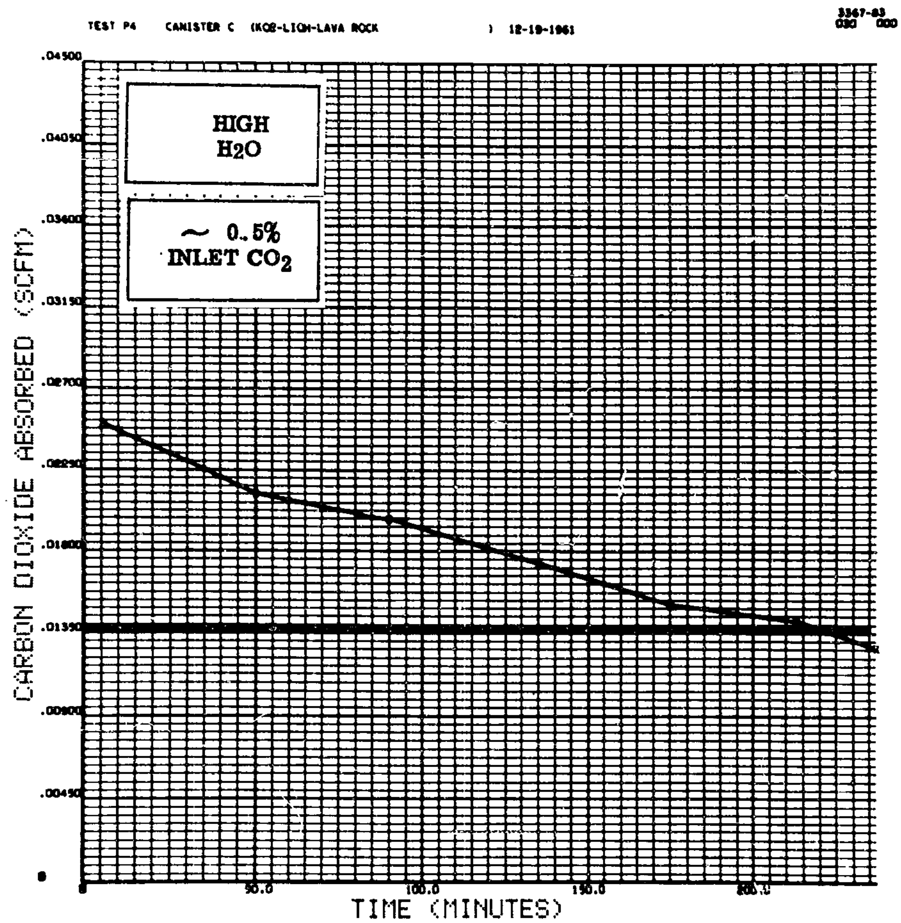

Figure 71 SC-4020 Curve, CO_2, P-4, C

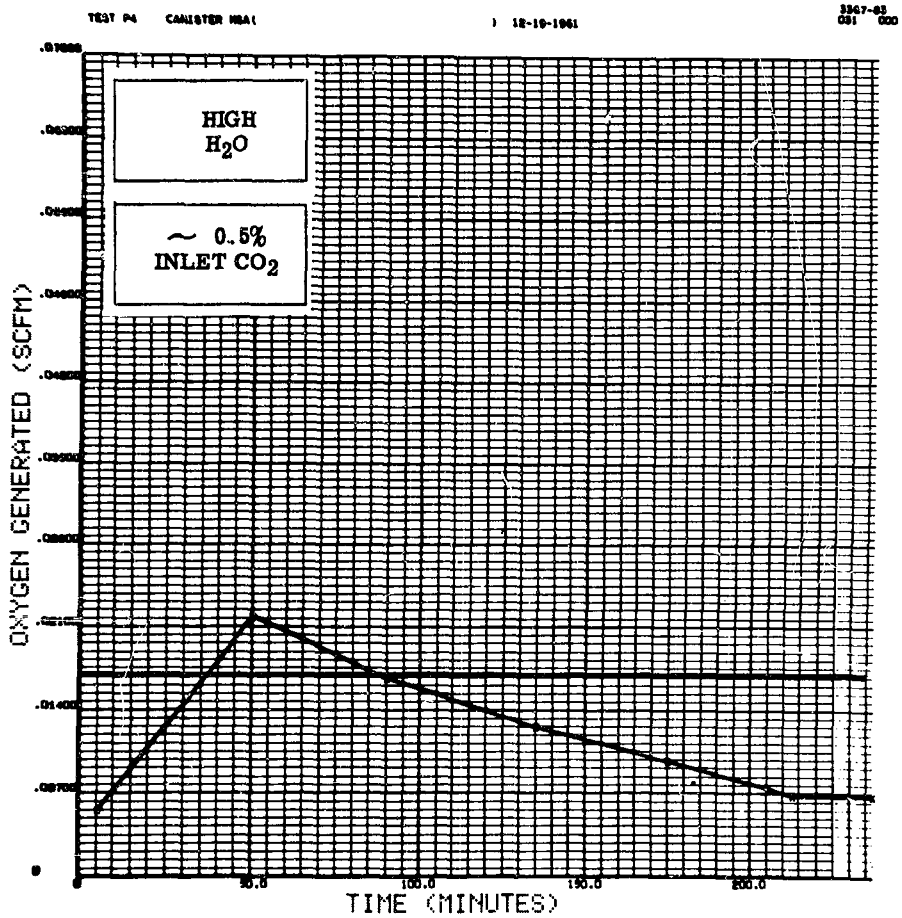

Figure 72 SC-4020 Curve, O_2, P-4, MSA

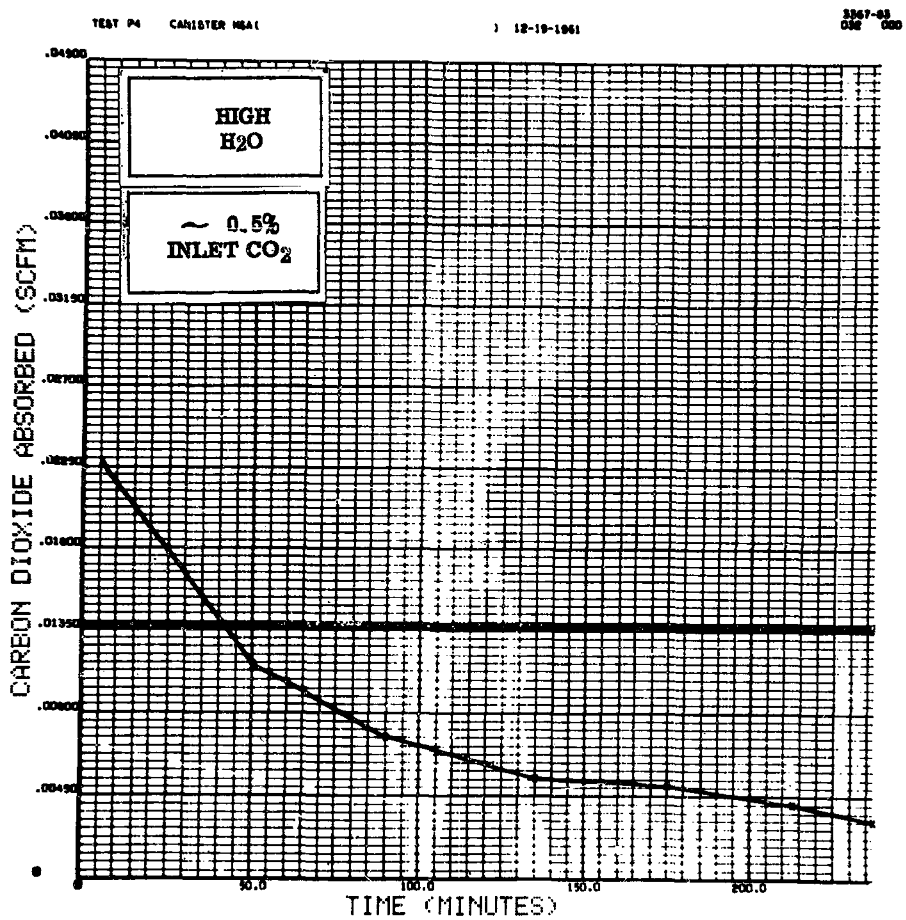

Figure 73 SC-4020 Curve, CO_2. P-4, MSA

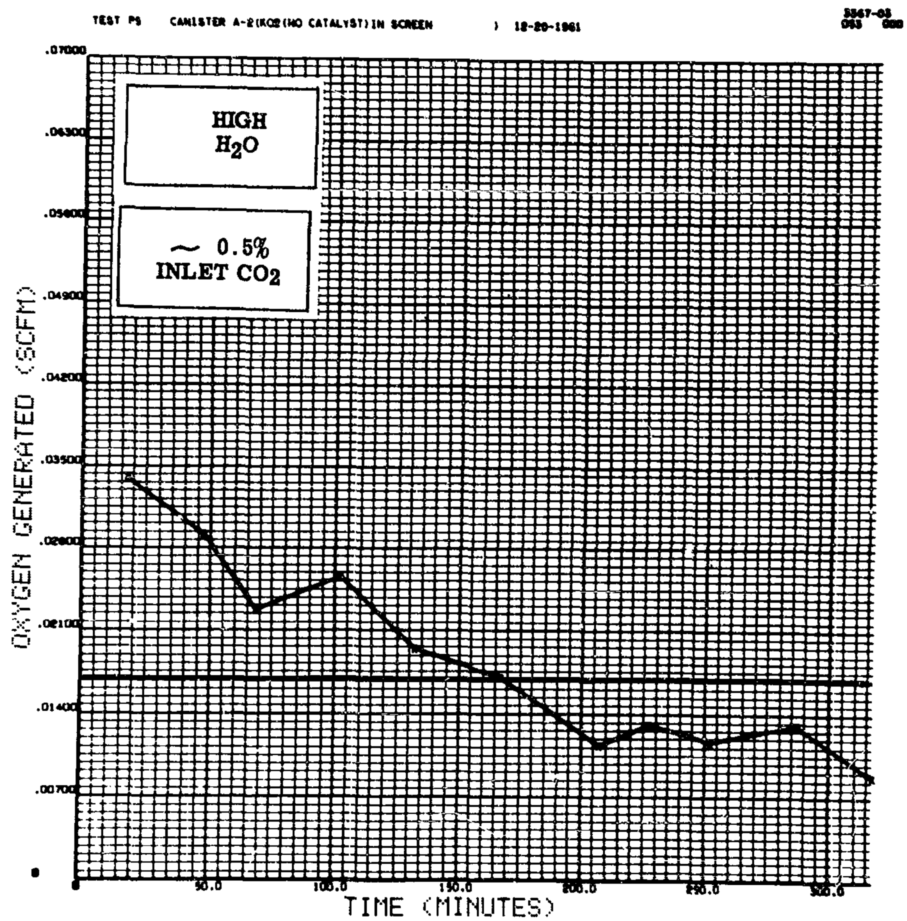

Figure 74 SC-4020 Curve, O_2, P-5, A-2

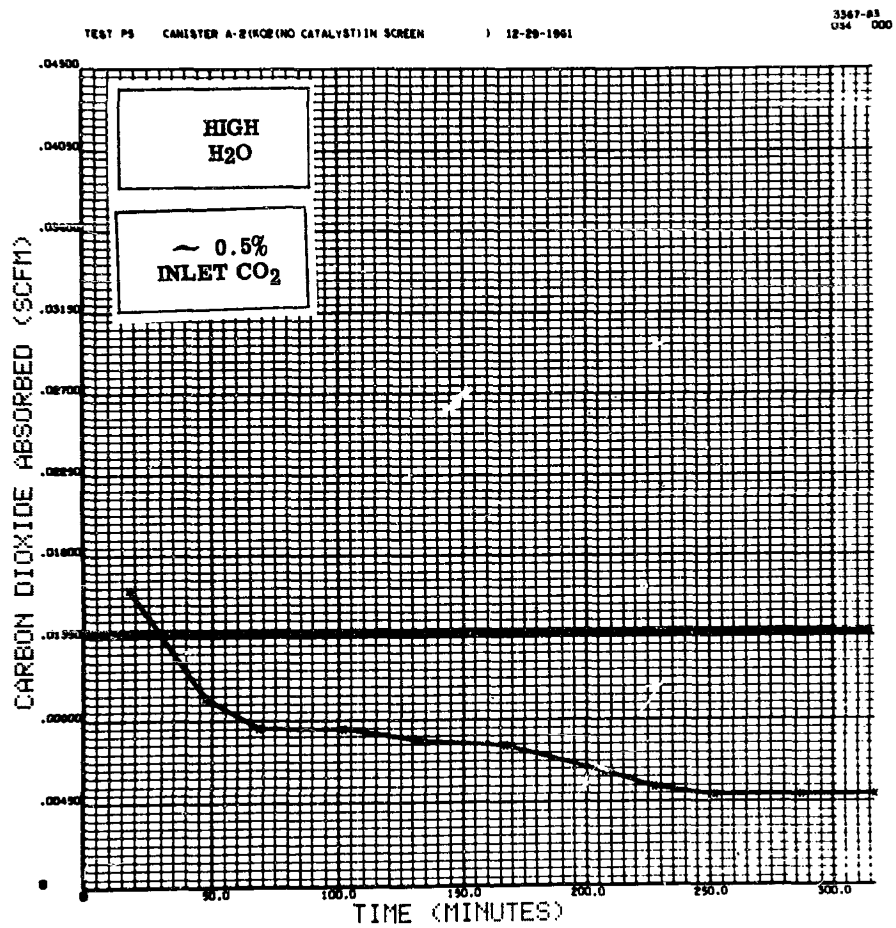

Figure 75 SC-4020 Curve, CO_2, P-5, A-2

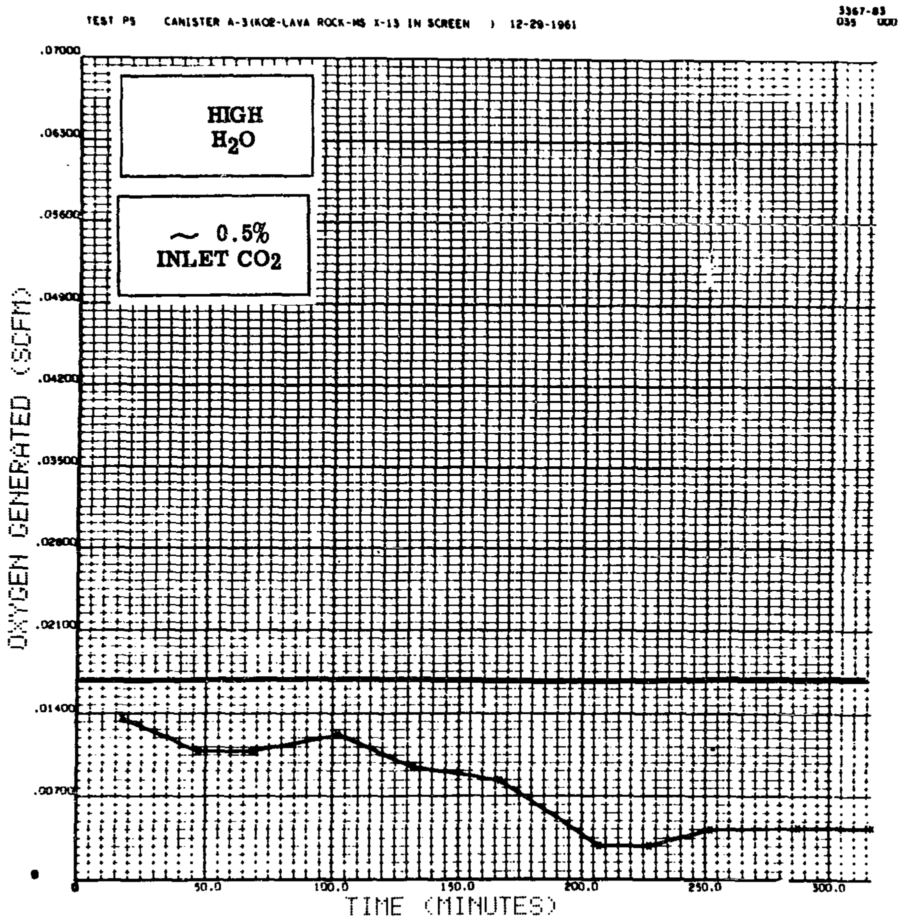

Figure 76 SC-4020 Curve, O_2, P-5, A-3

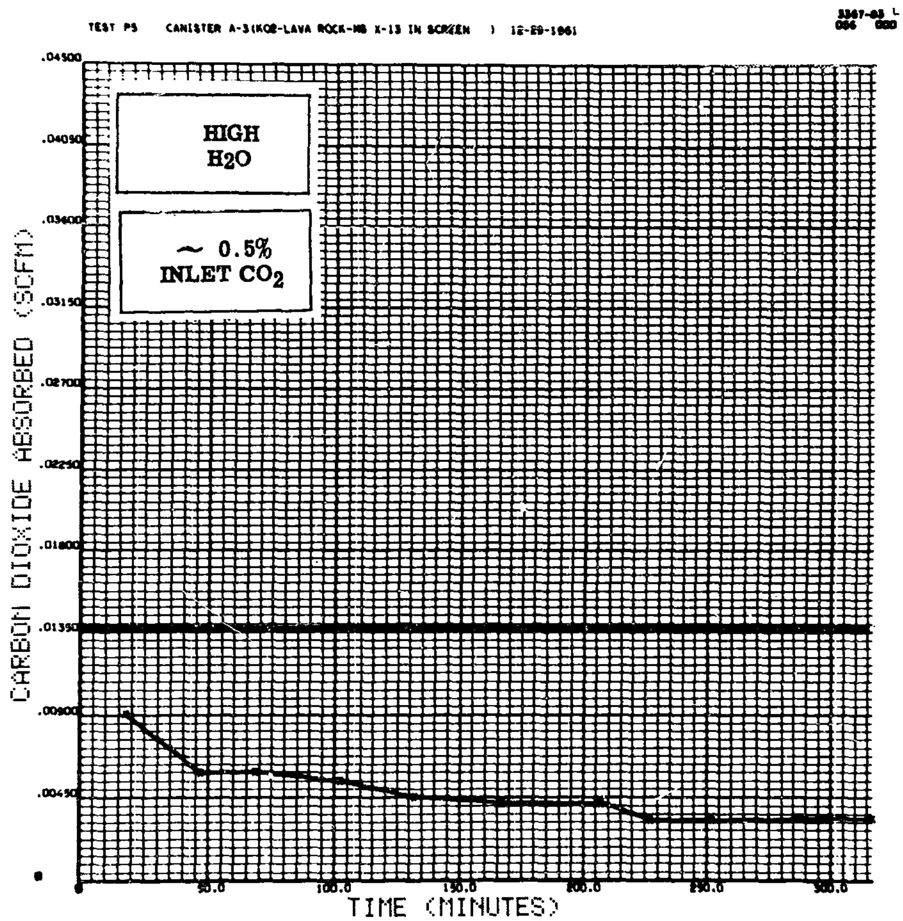

Figure 77 SC-4020 Curve, CO_2, P-5, A-3

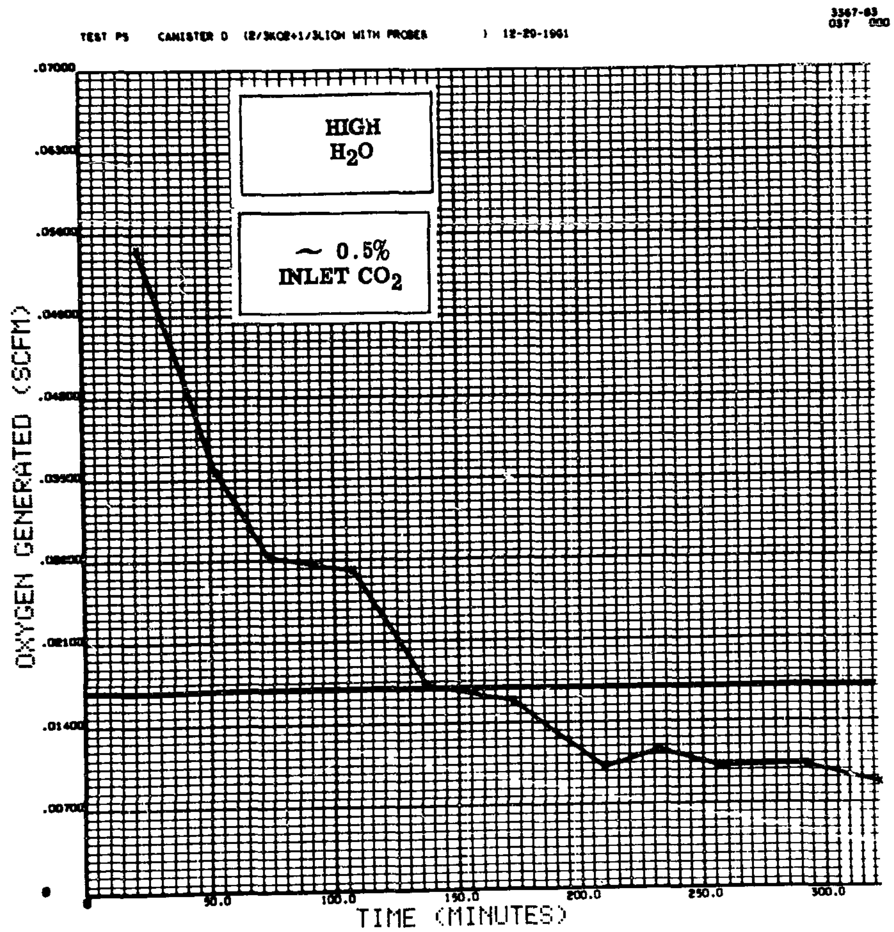

Figure 78 SC-4020 Curve, O_2, P-5, D

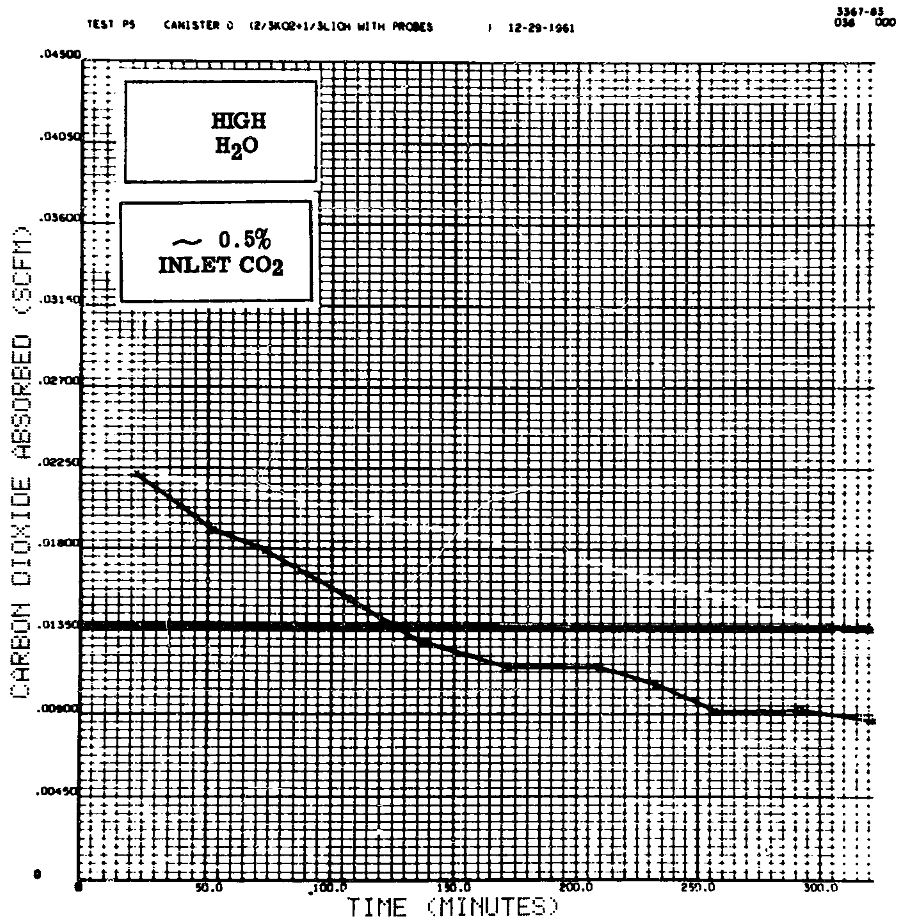

Figure 79 SC-4020 Curve, CO_2, P-5, D

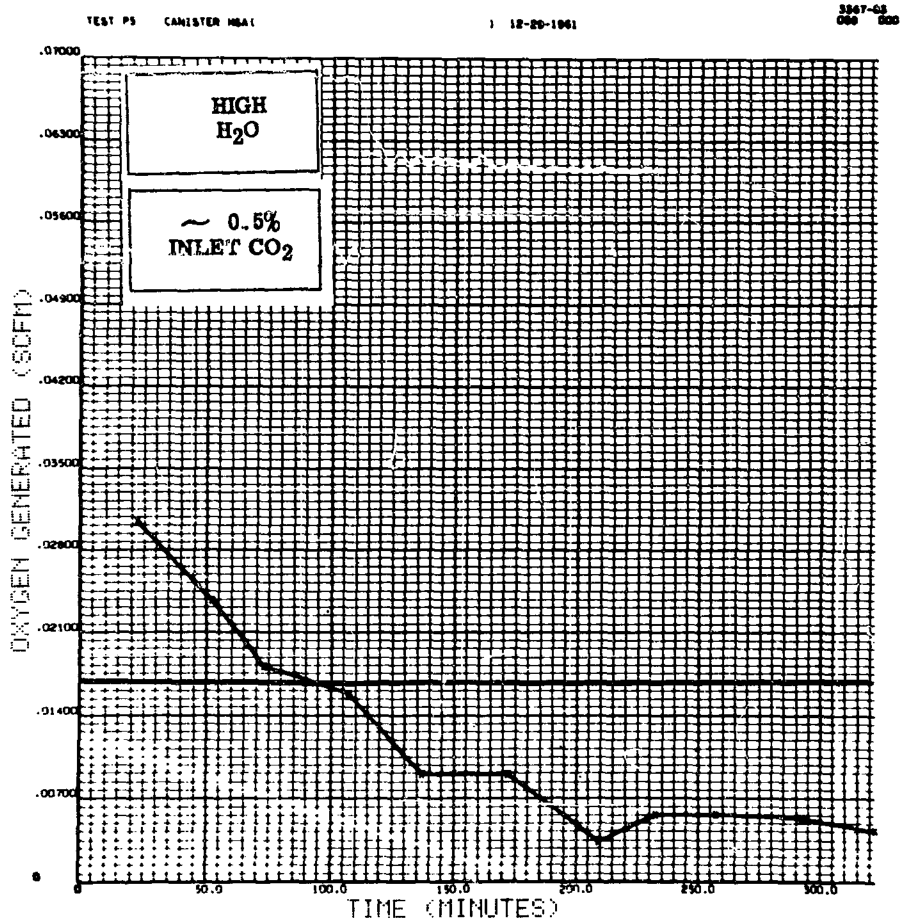

Figure 80 SC-4020 Curve, O_2, P-5, MSA

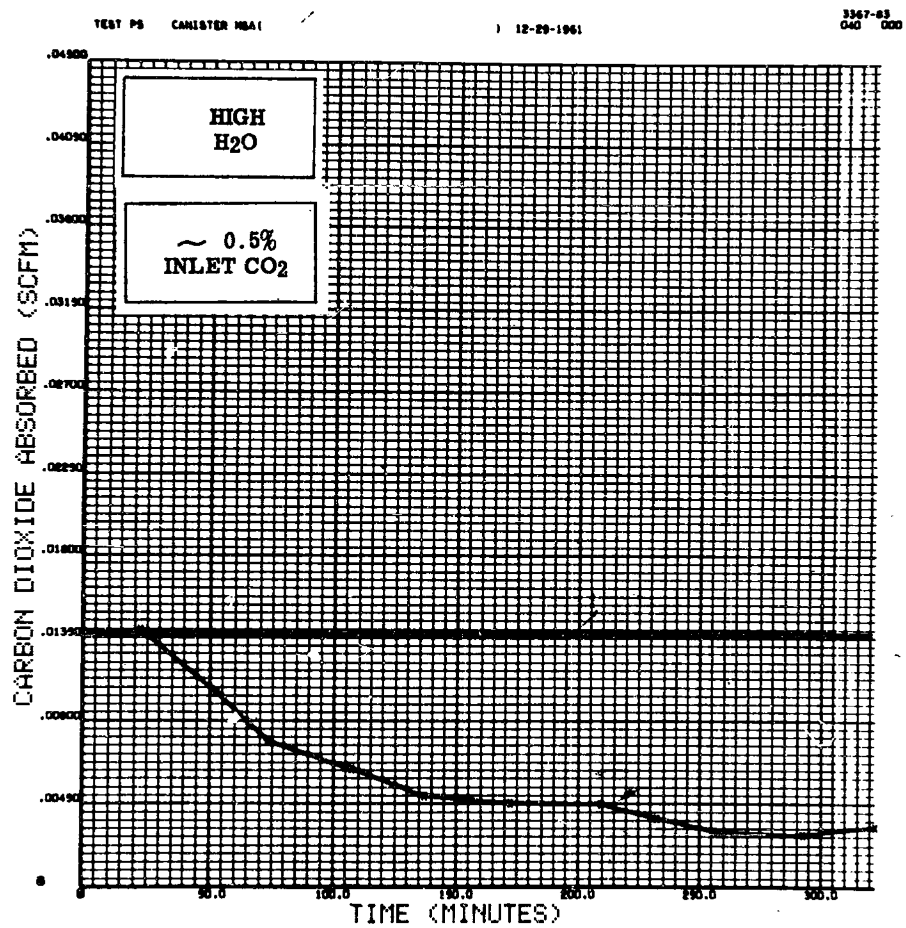

Figure 81 SC-4020 Curve, CO_2, P-5, MSA

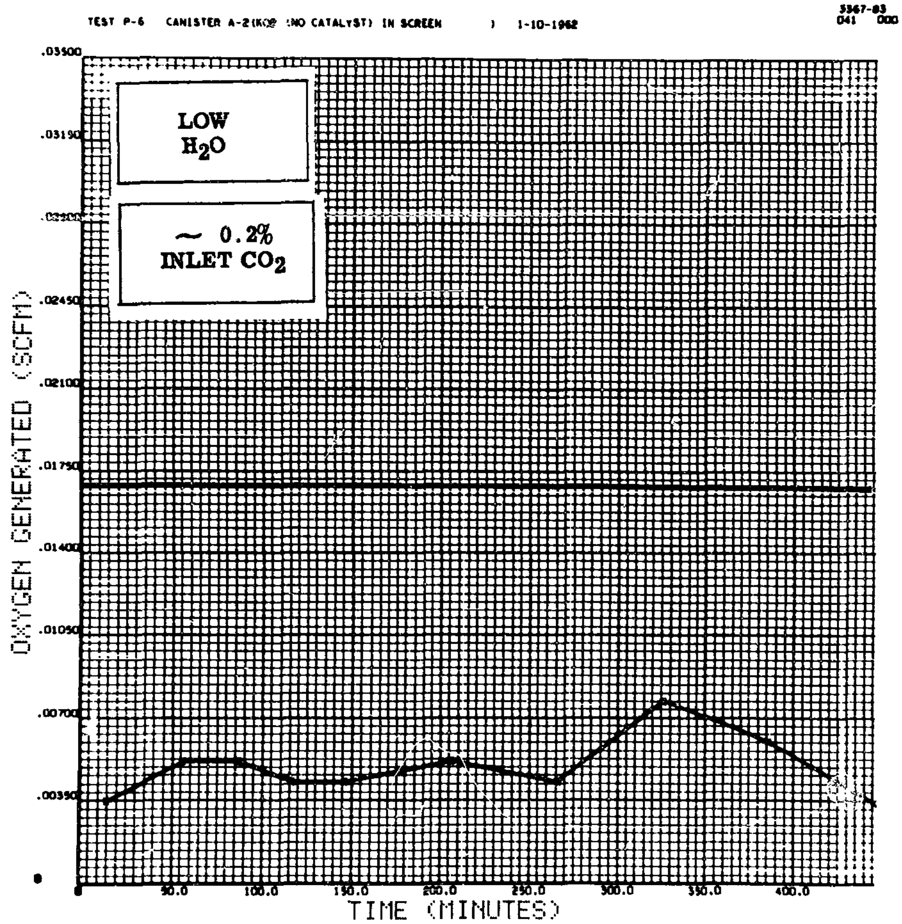

Figure 82 SC-4020 Curve, O_2, P-6, A-2

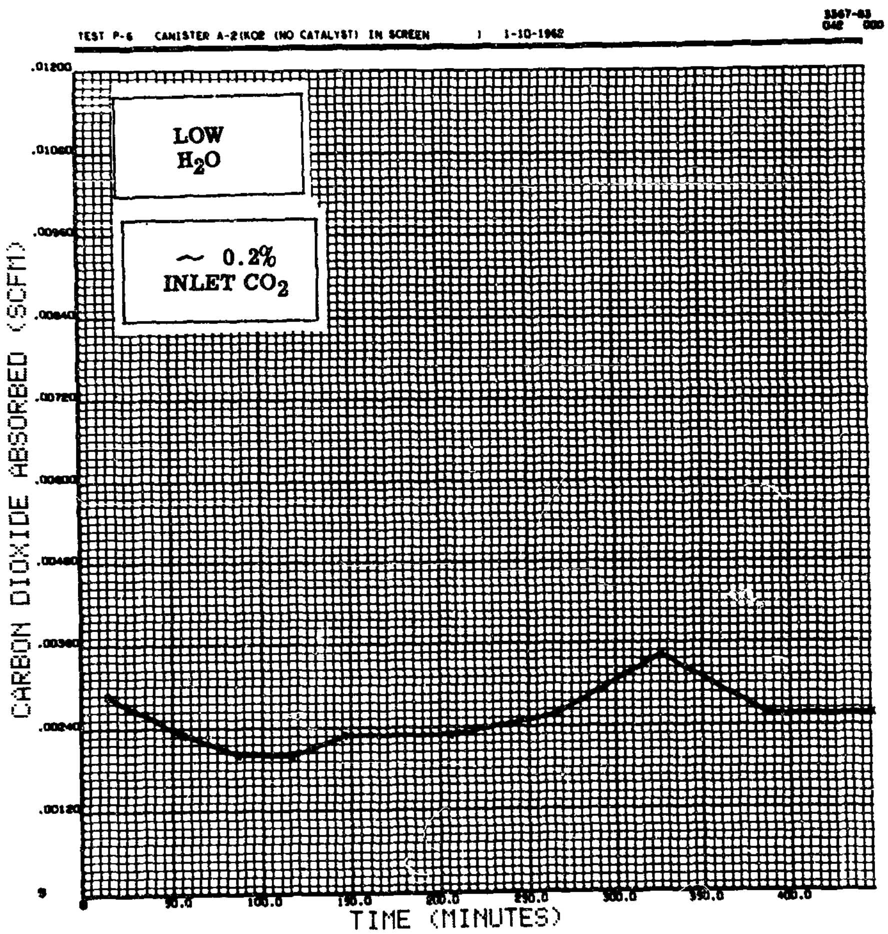

Figure 83 SC-4020 Curve, CO_2, P-6, A-2

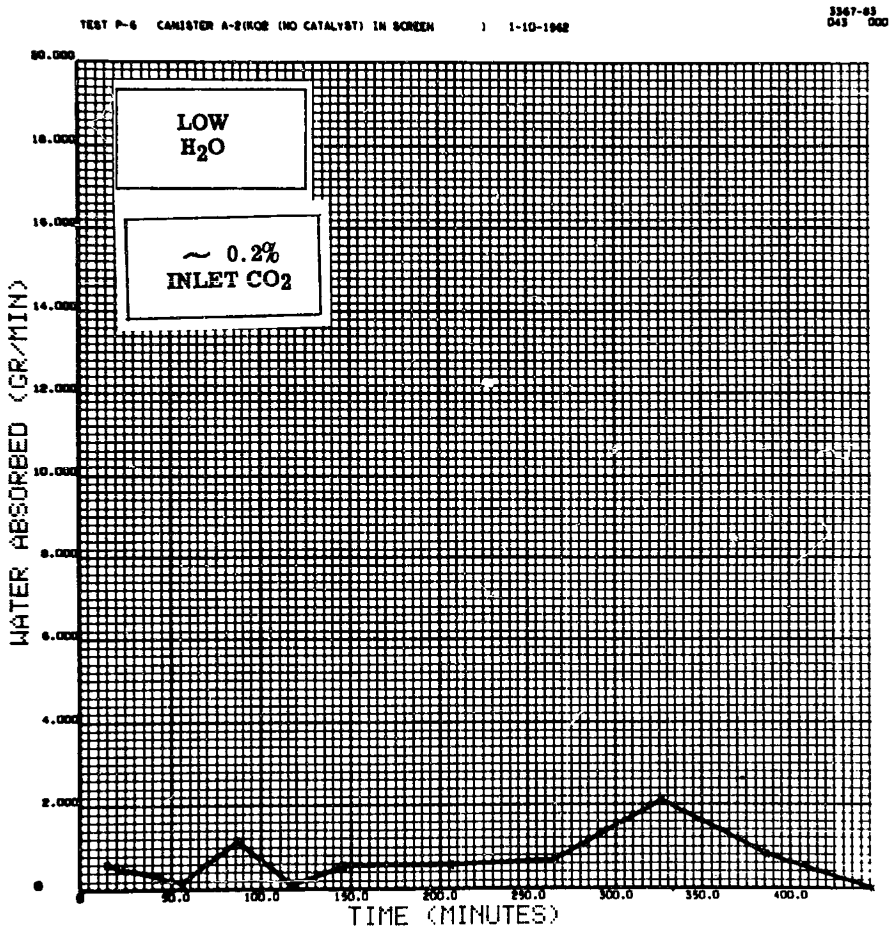

Figure 84 SC-4020 Curve, H_2O, P-6, A-2

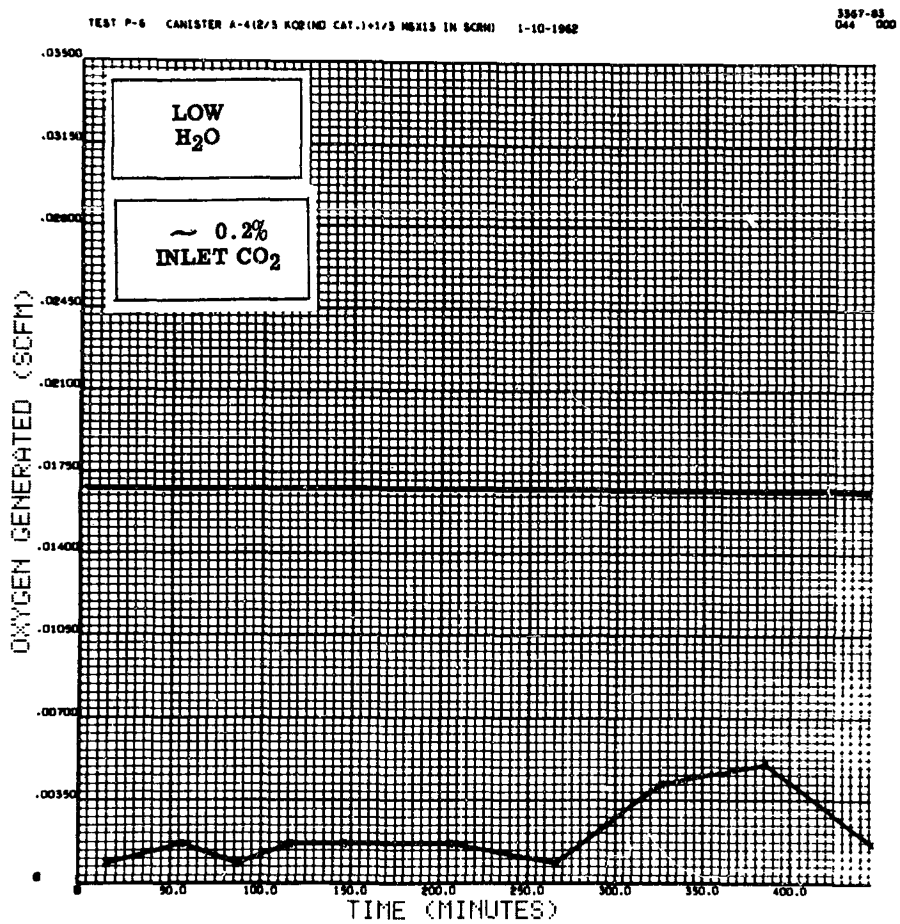

Figure 85 SC-4020 Curve, O_2, P-6, A-4

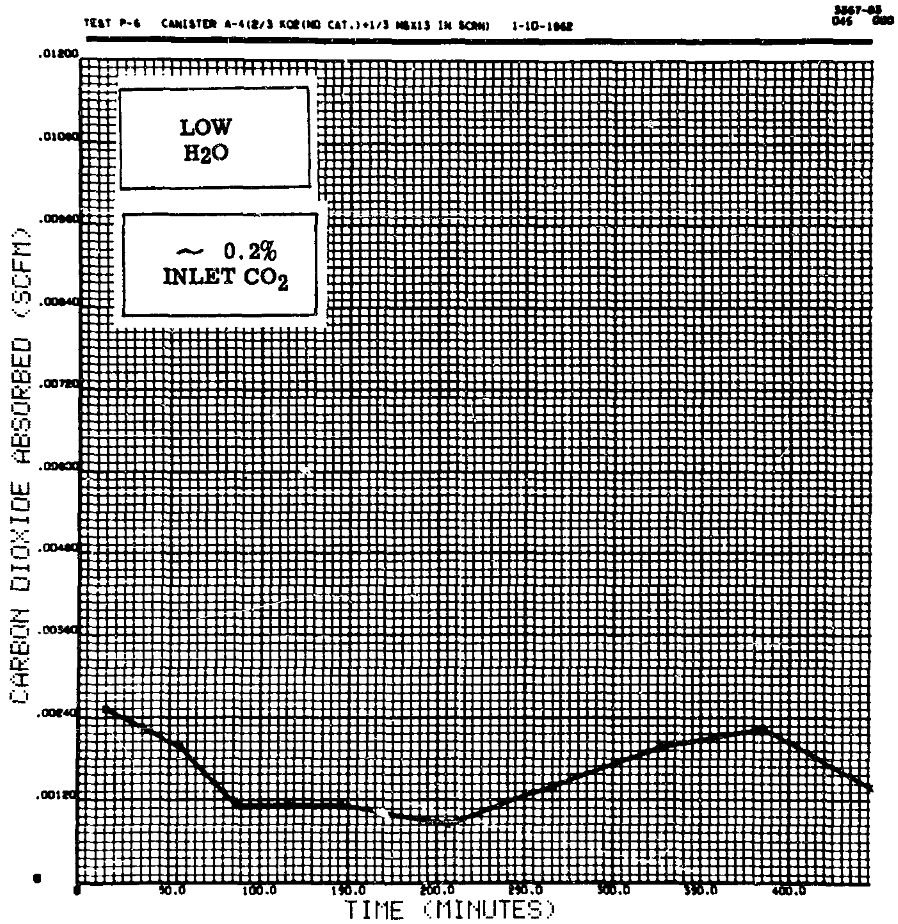

Figure 86 SC-4020 Curve, CO_2, P-6, A-4

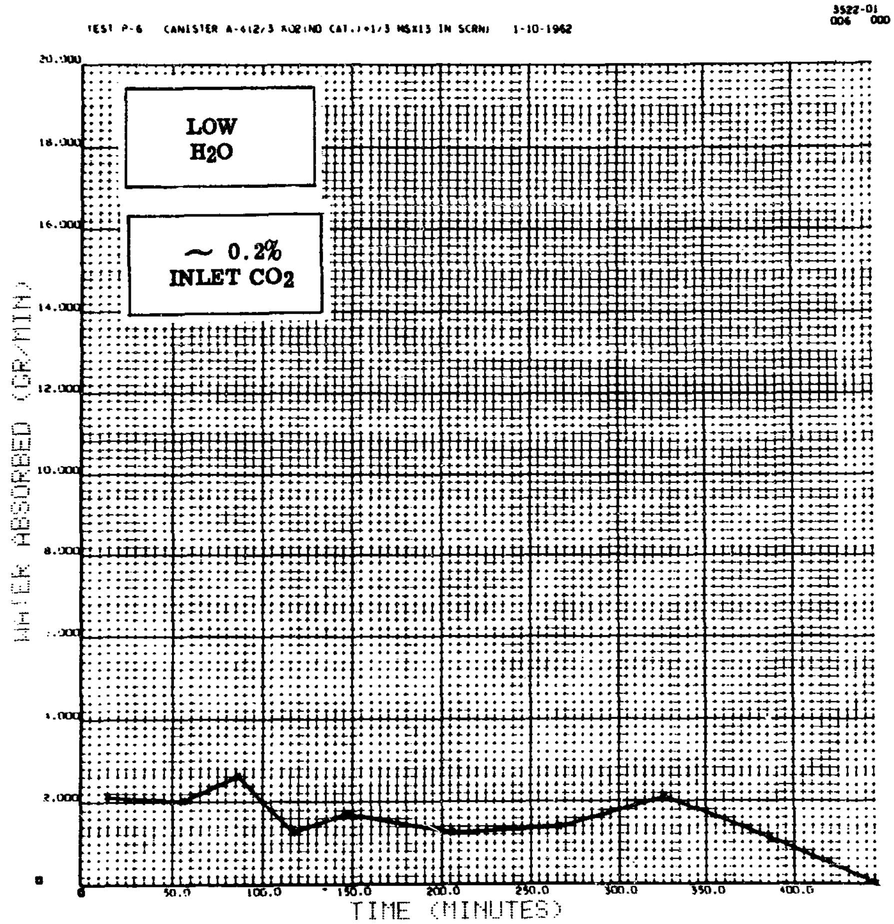

Figure 87 SC-4020 Curve, H_2O, P-6, A-4

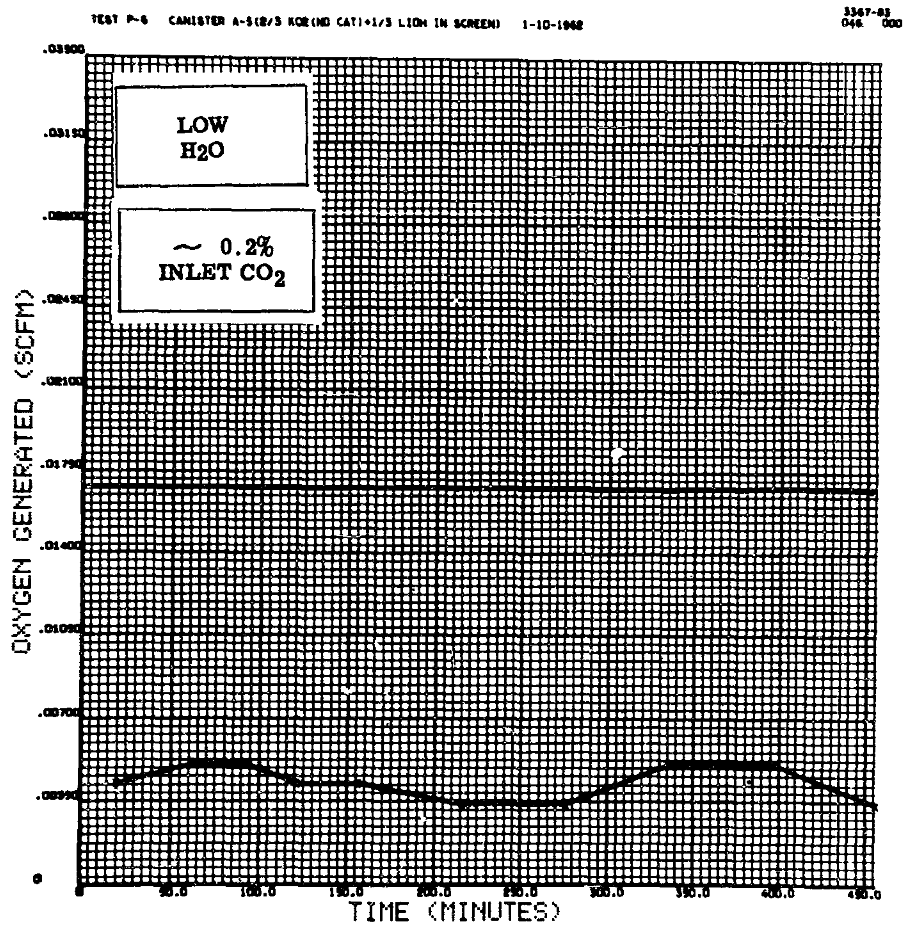

Figure 88 SC-4020 Curve, O_2, P-6, A-5

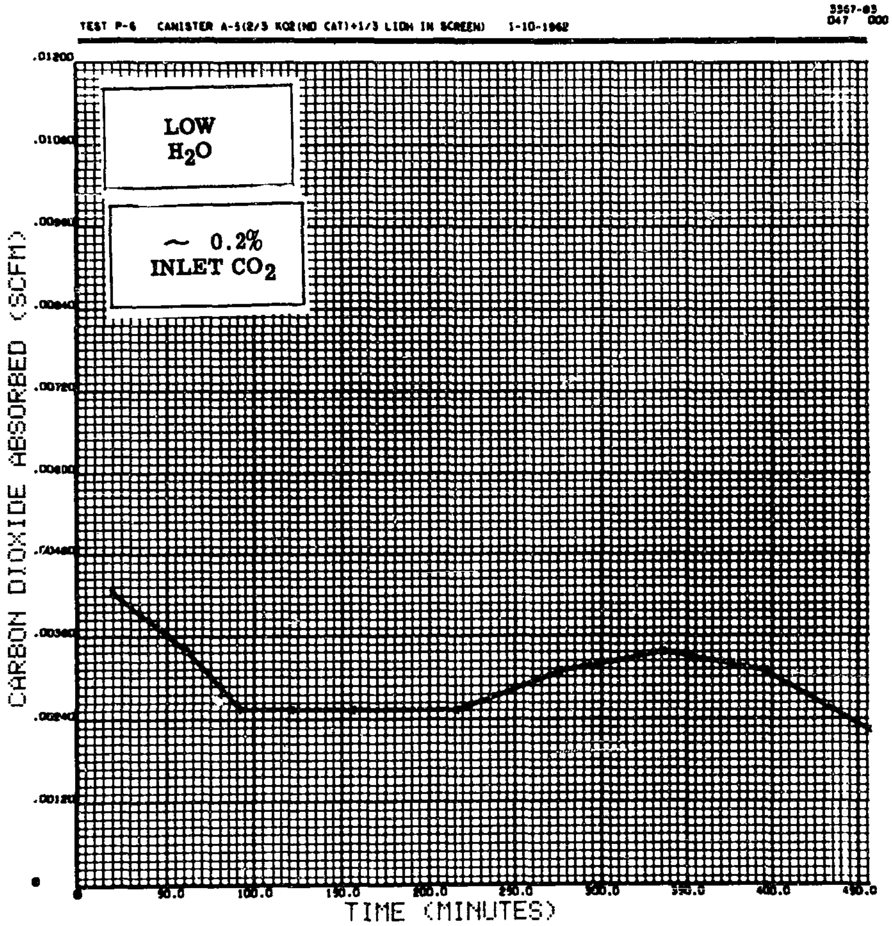

Figure 89 SC-4020 Curve, CO_2, P-6, A-5

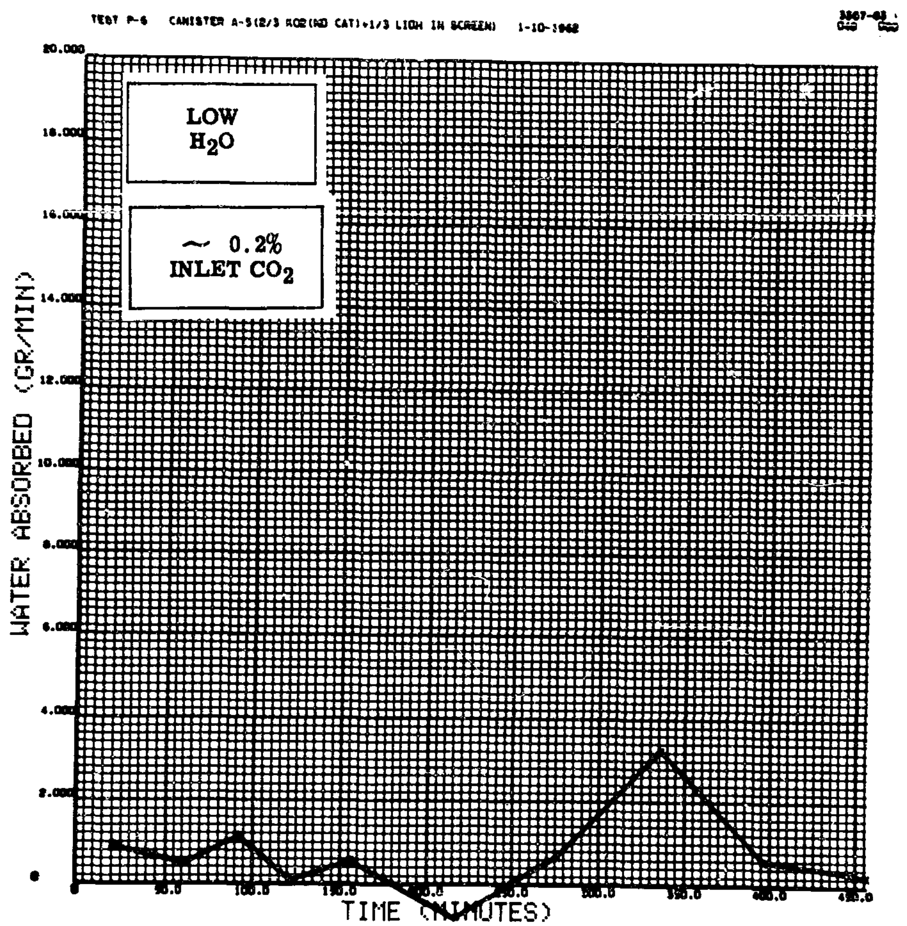

Figure 90 SC-4020 Curve, H_2O, P-6, A-5

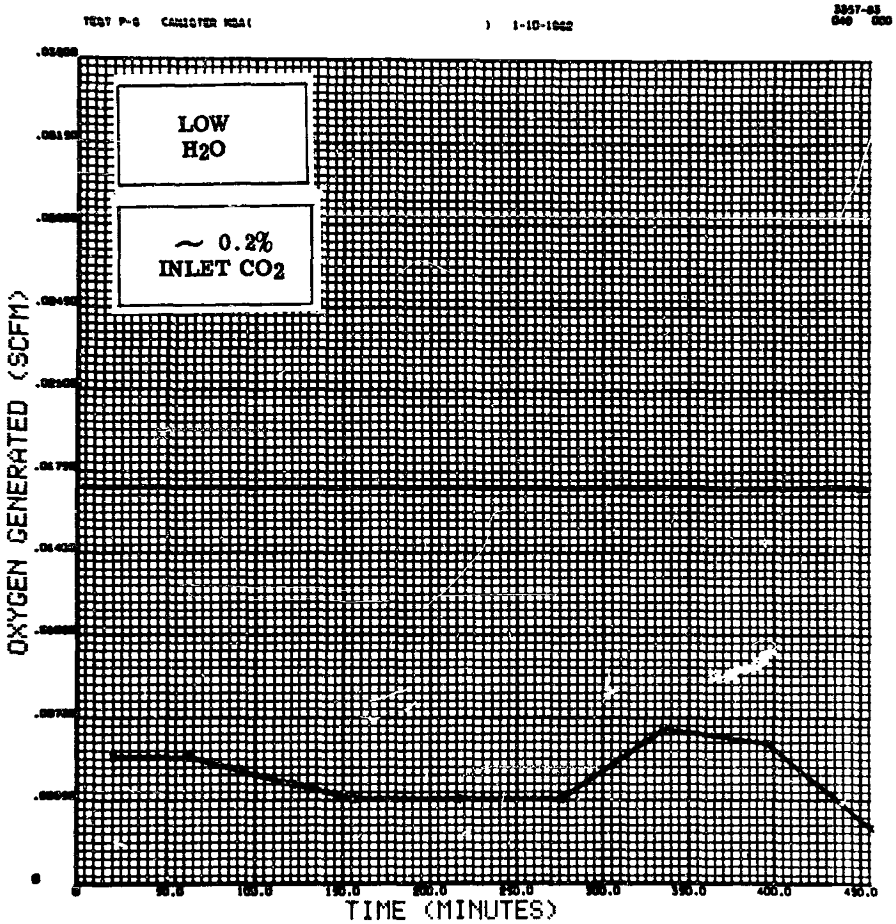

Figure 91 SC-4020 Curve, O_2, P-6, MSA

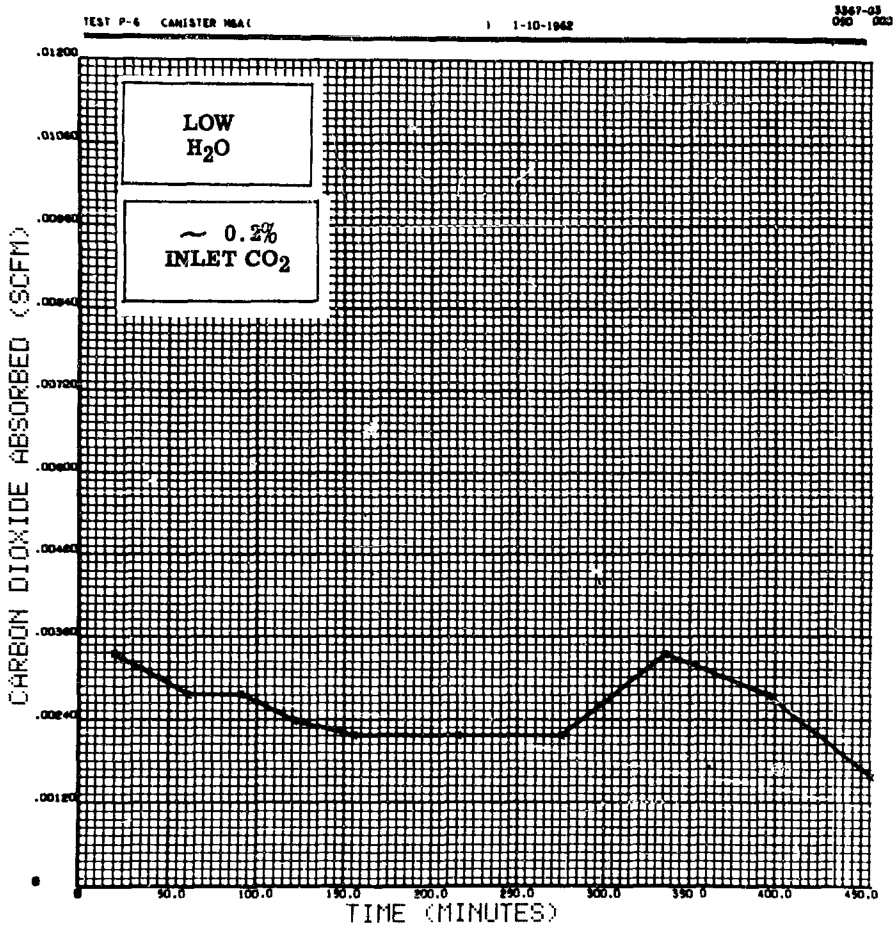

Figure 92 SC-4020 Curve, CO_2, P-6, MSA

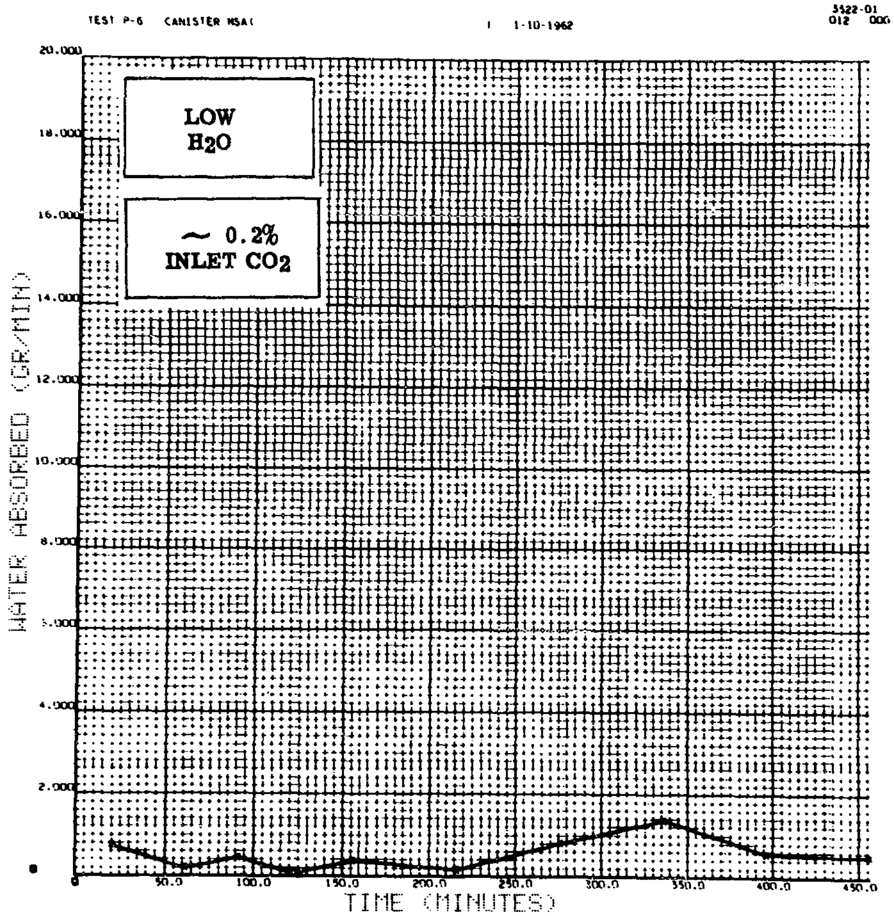

Figure 93 SC-4020 Curve, H_2O, P-6, MSA

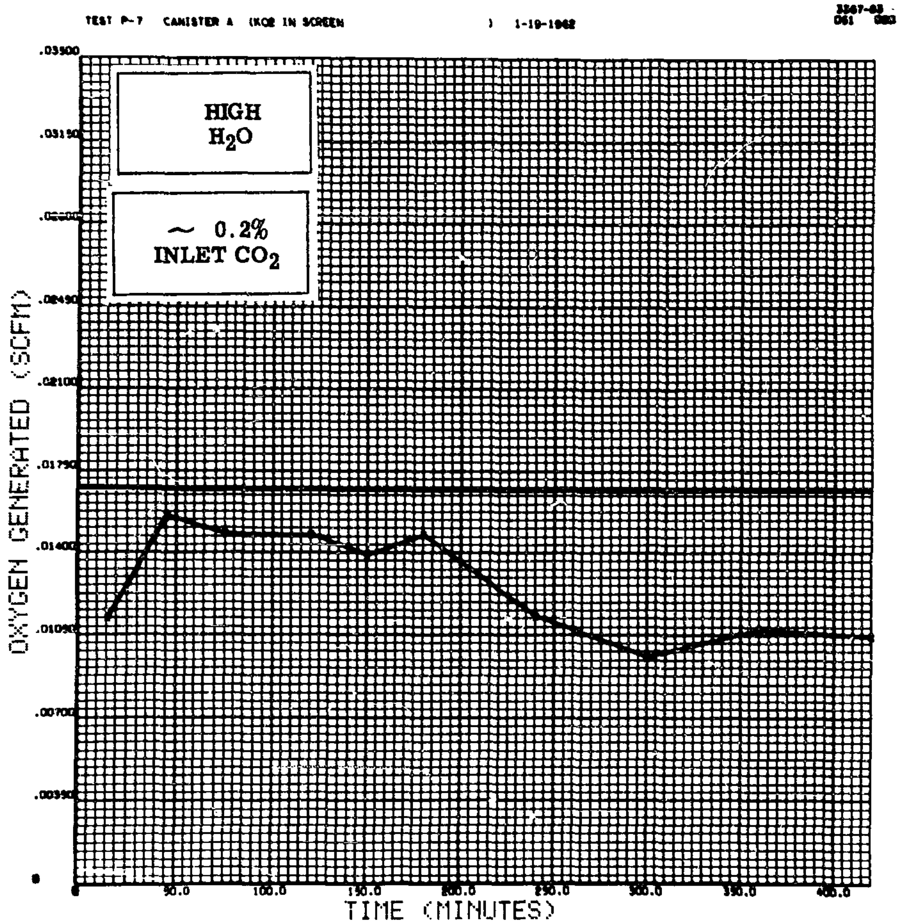

Figure 94   SC-4020 Curve, O_2, P-7, A

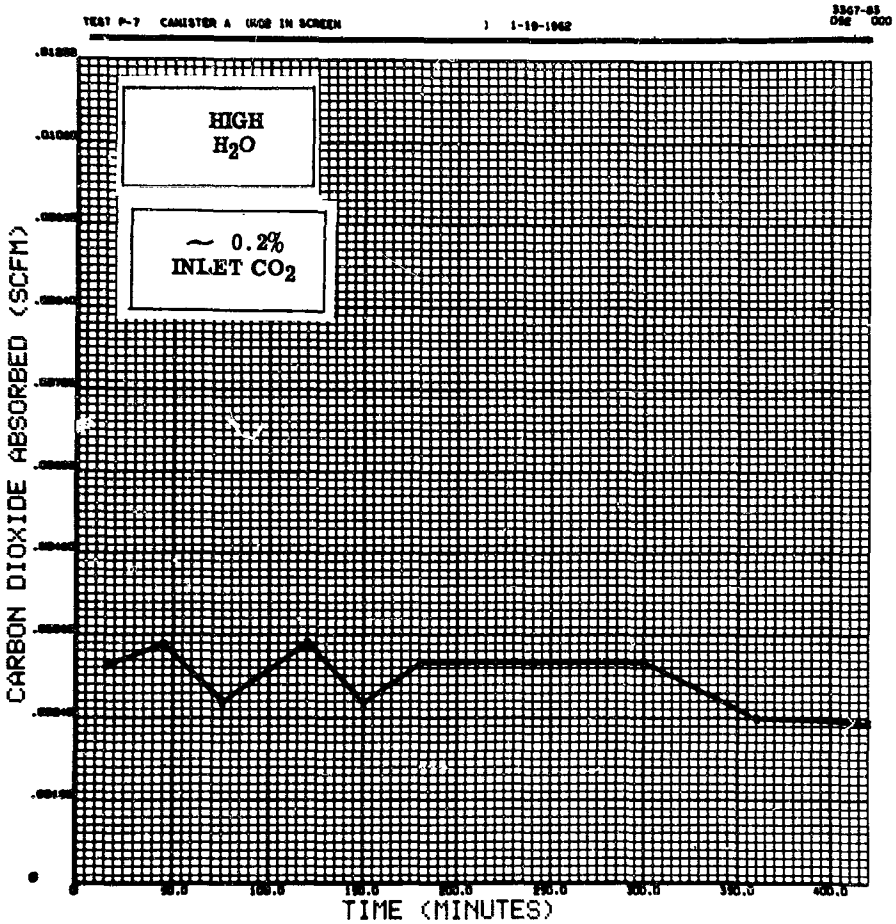

Figure 95 SC-4020 Curve, CO_2, P-7, A

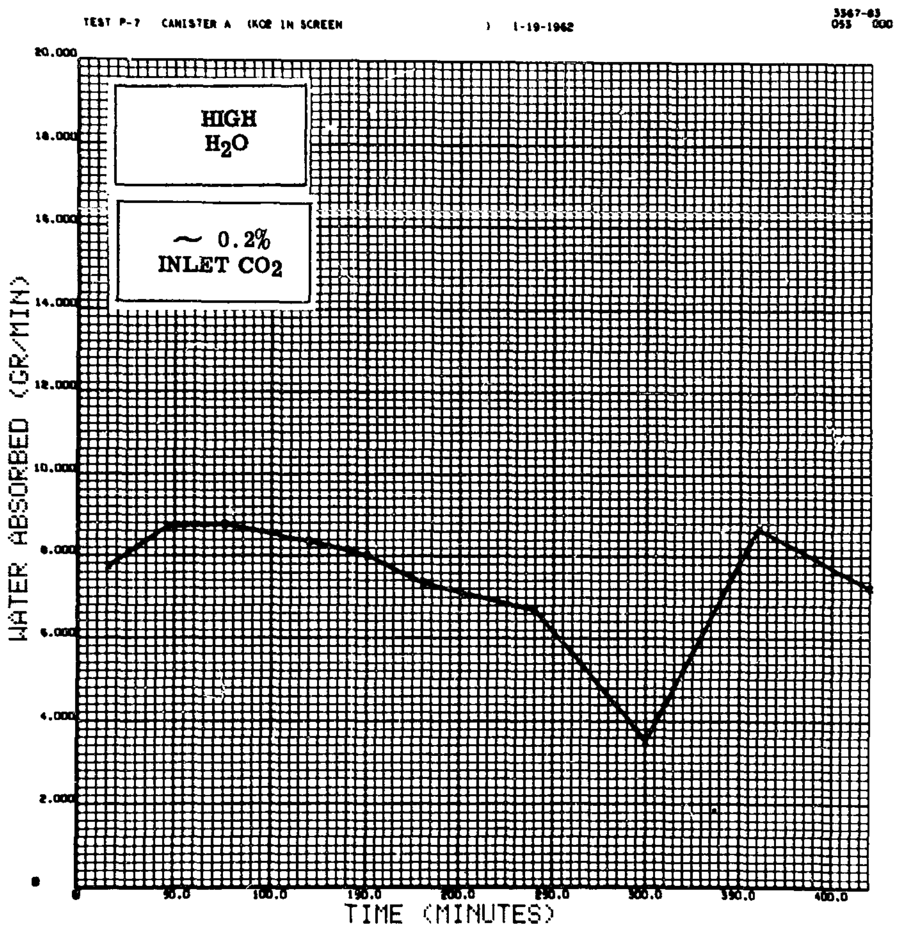

Figure 96 SC-4020 Curve, H_2O, P-7, A

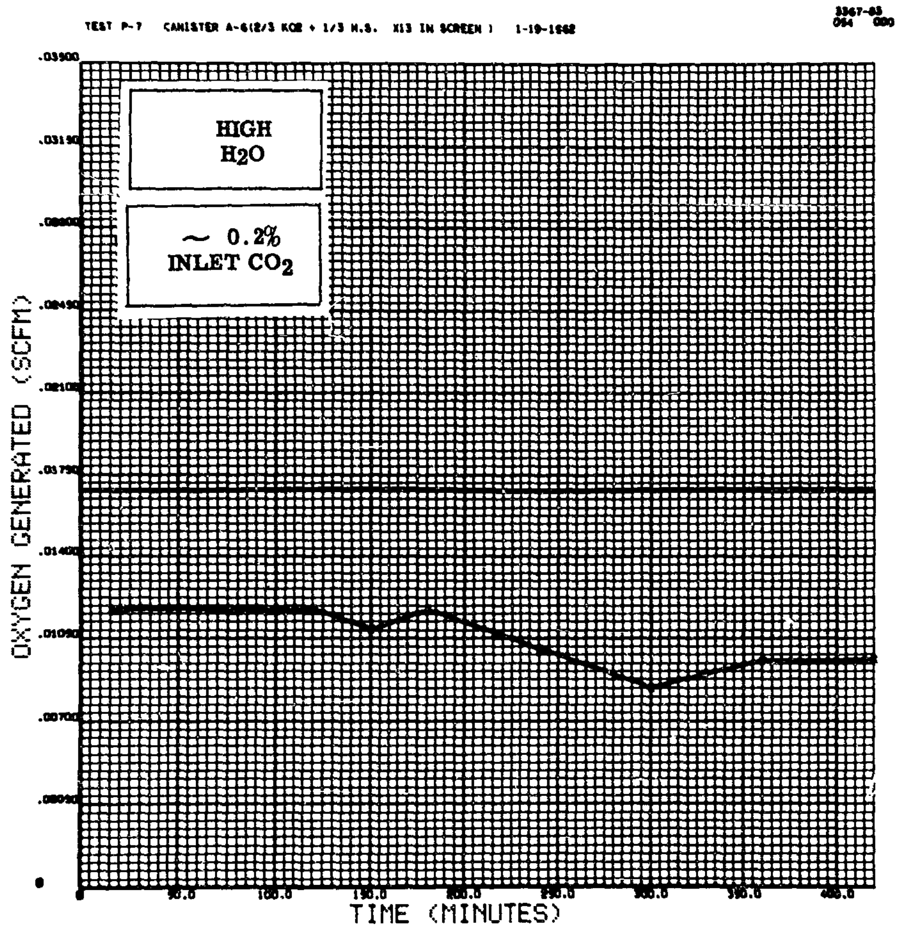

Figure 97 SC-4020 Curve, O_2, P-7, A-6

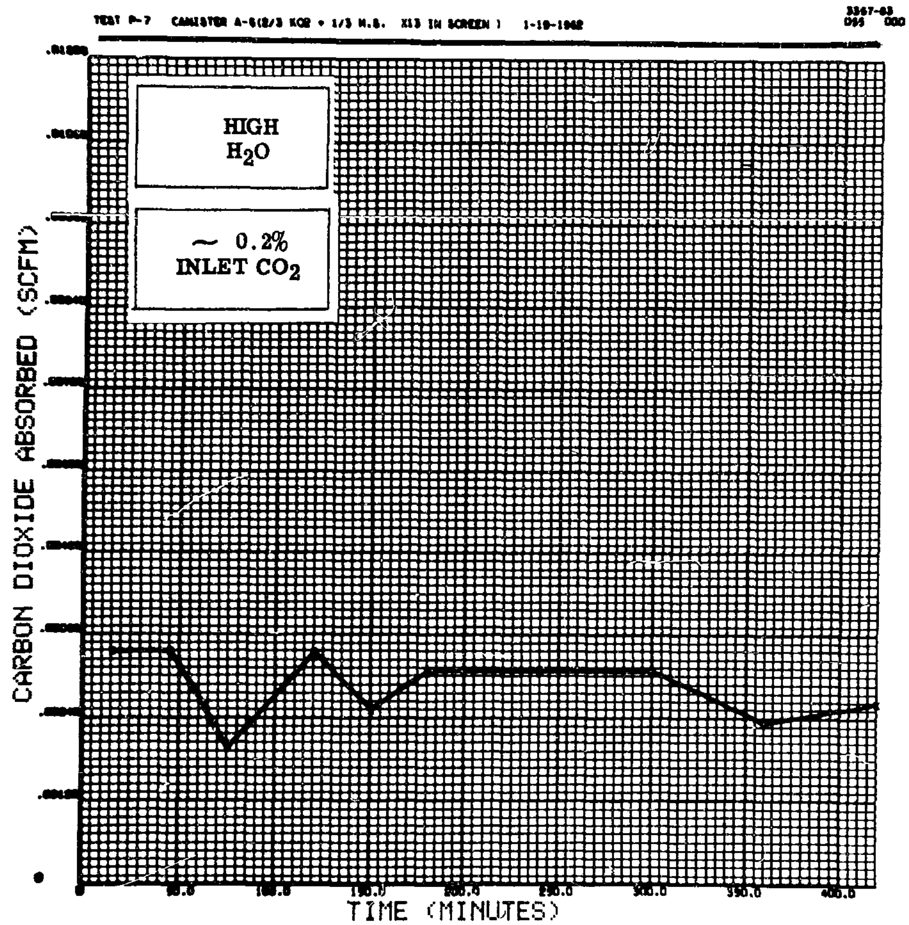

Figure 98 SC-4020 Curve, CO_2, P-7, A-6

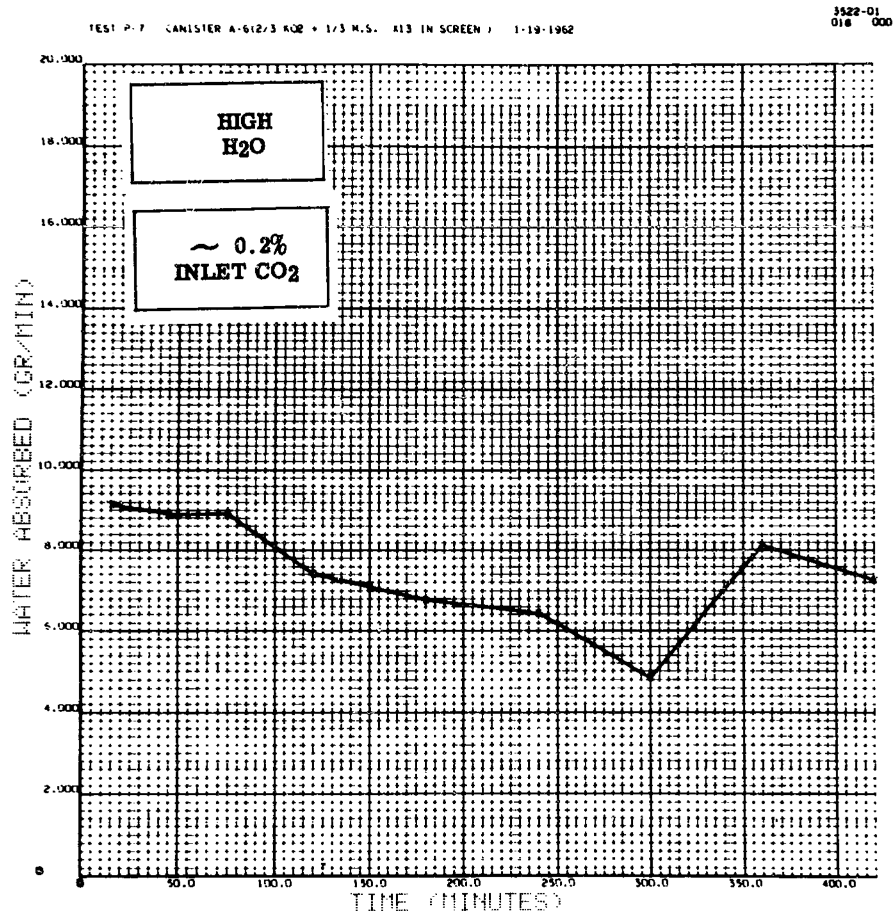

Figure 99 SC-4020 Curve, H_2O, P-7, A-6

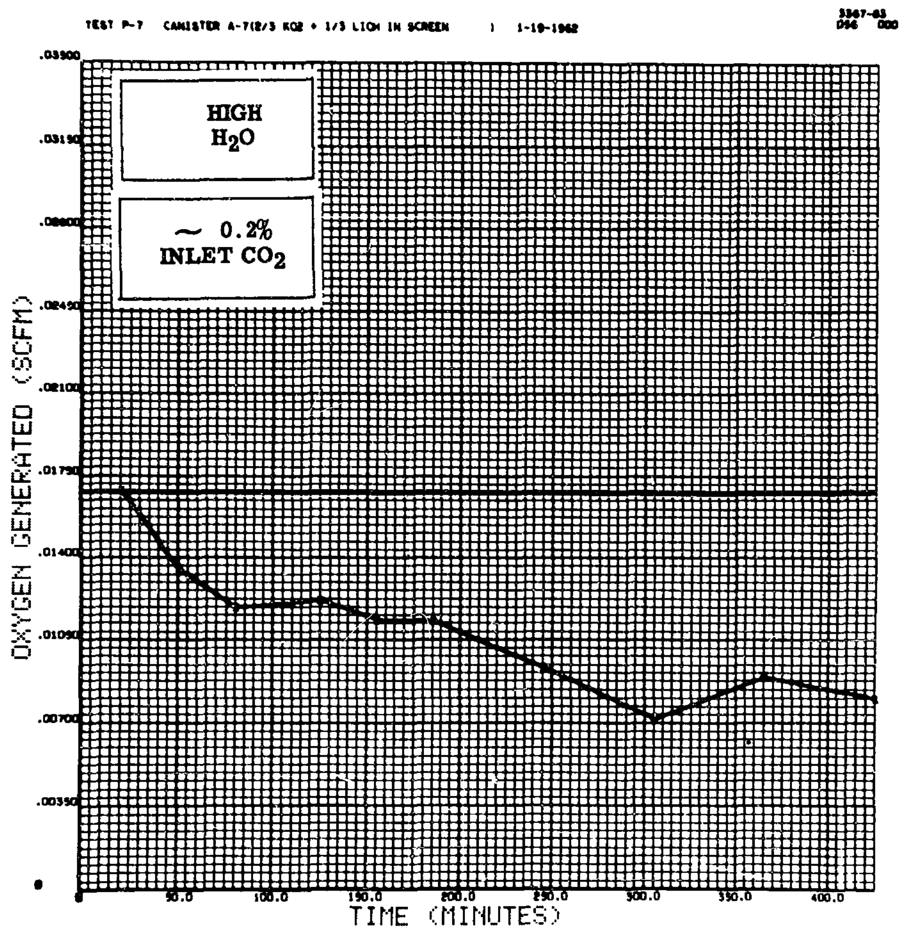

Figure 100 SC-4020 Curve, O_2, P-7, A-7

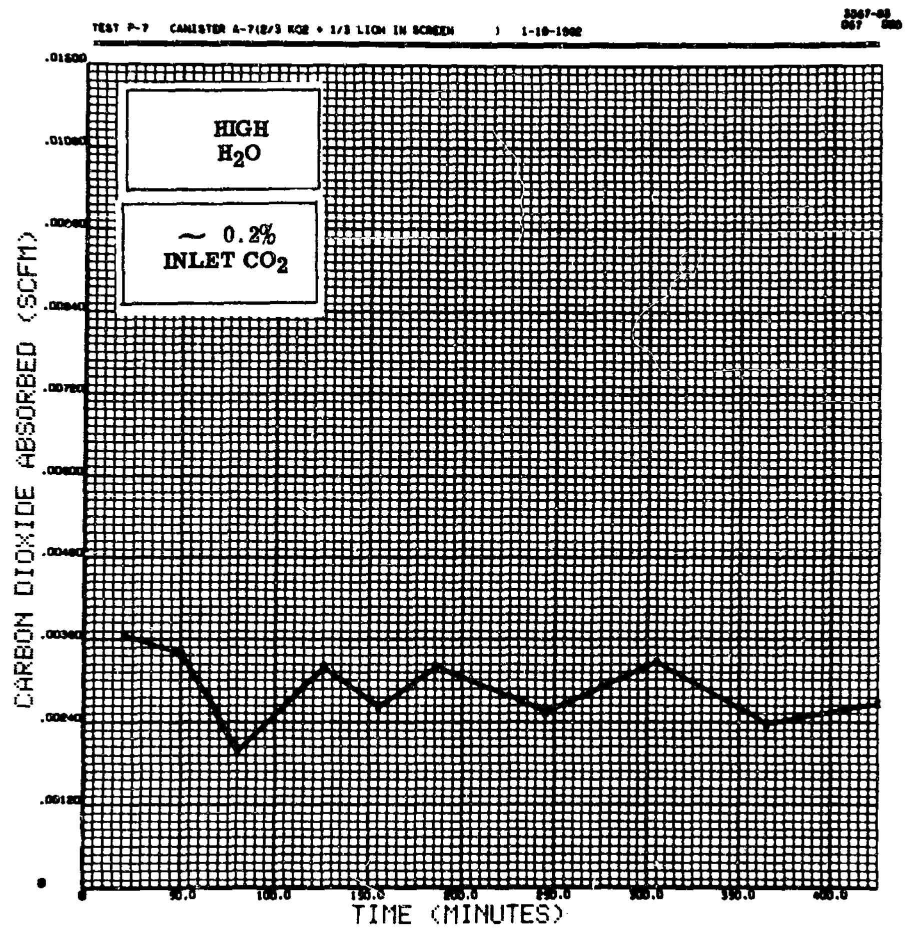

Figure 101 SC-4020 Curve, CO_2, P-7, A-7

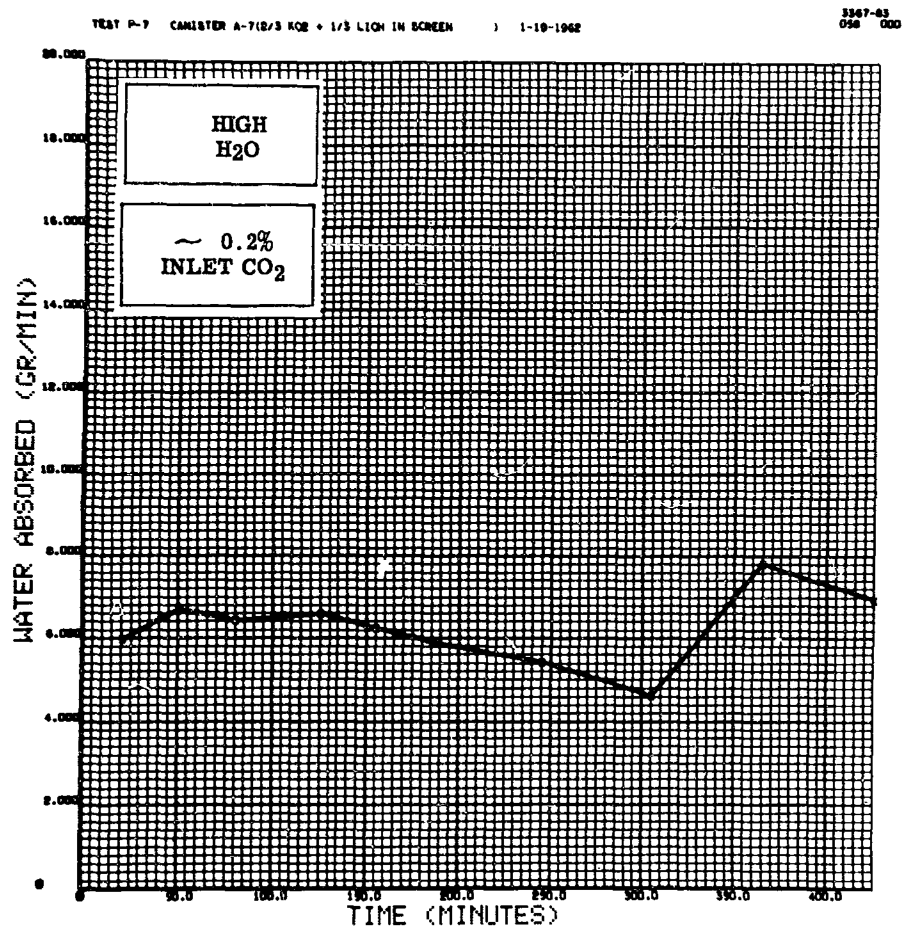

Figure 102 SC-4020 Curve, H_2O, P-7, A-7

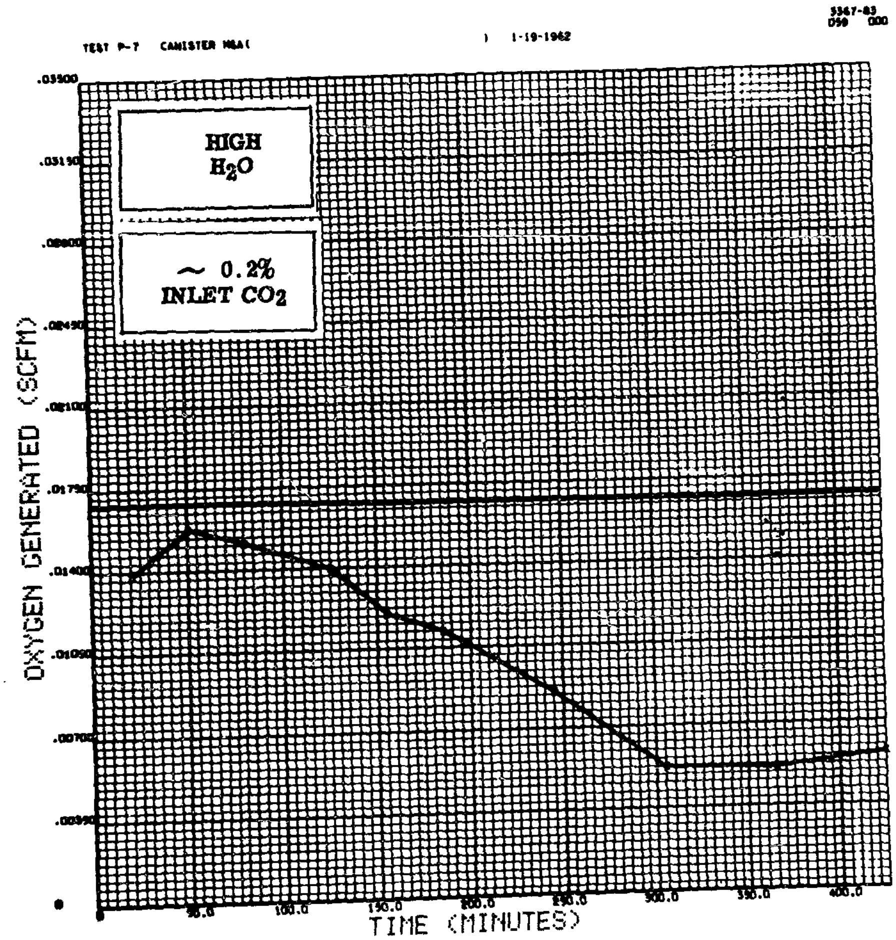

Figure 103 SC-4020 Curve, O_2, P-7, MSA

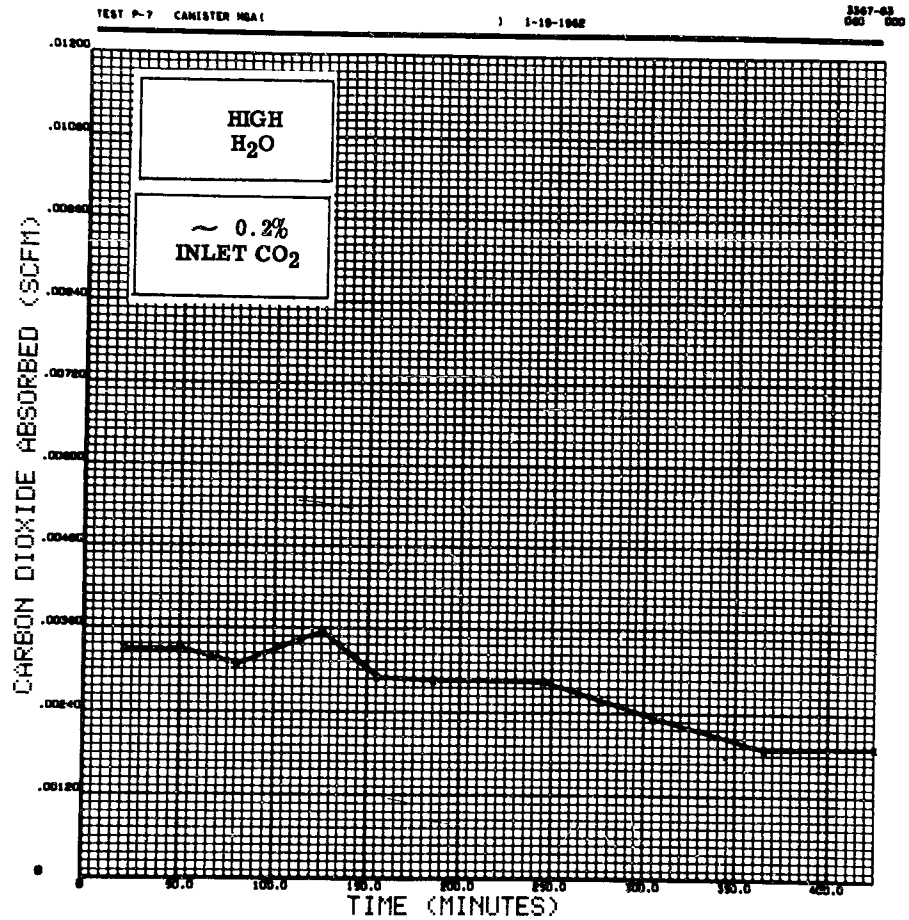

Figure 104 SC-4020 Curve, CO_2, P-7, MSA

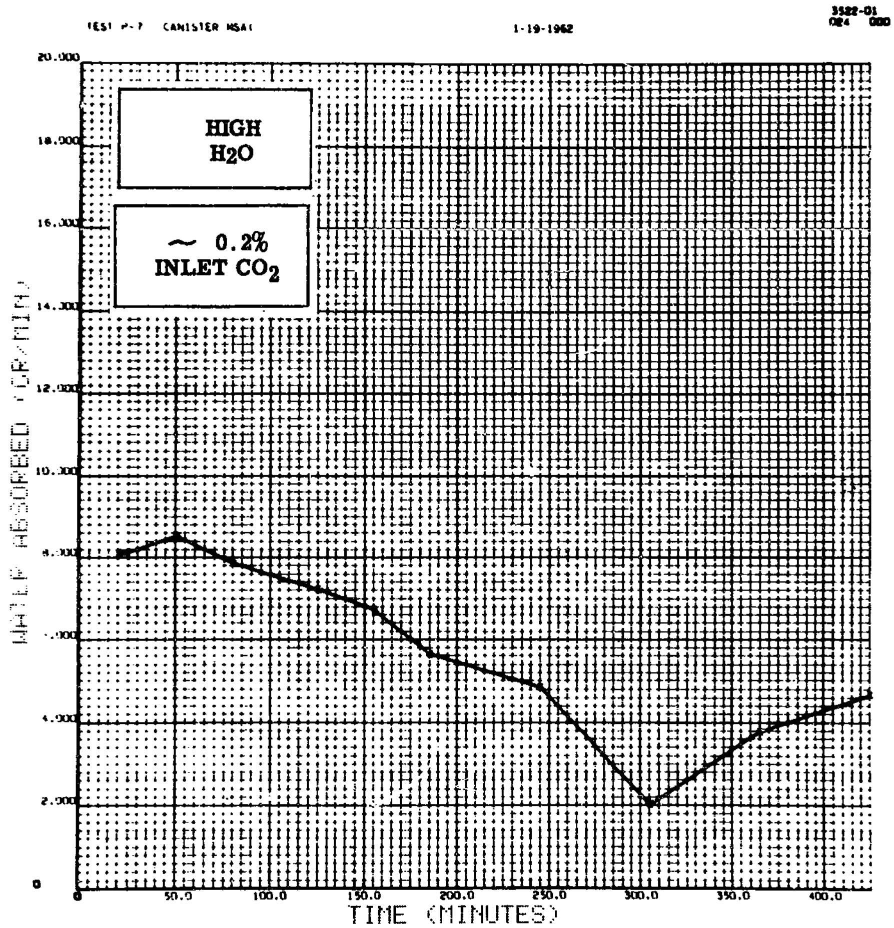

Figure 105 SC-4020 Curve, H_2O, P-7, MSA

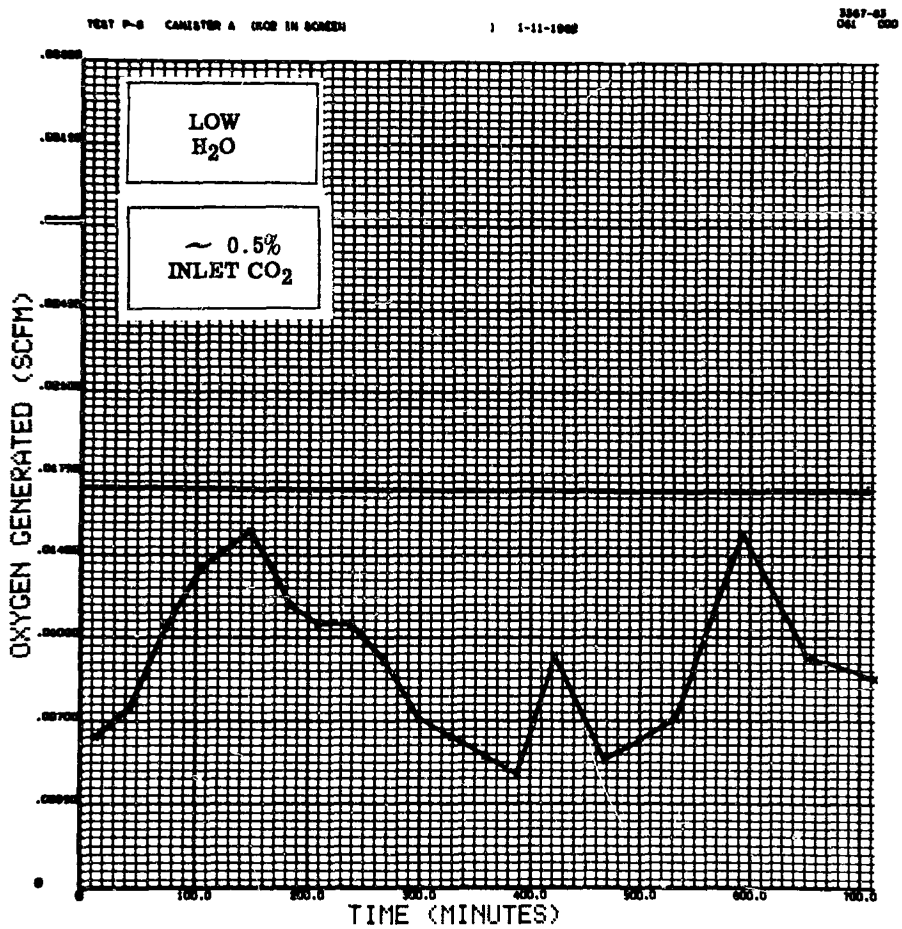

Figure 106 SC-4020 Curve, O_2, P-8, A

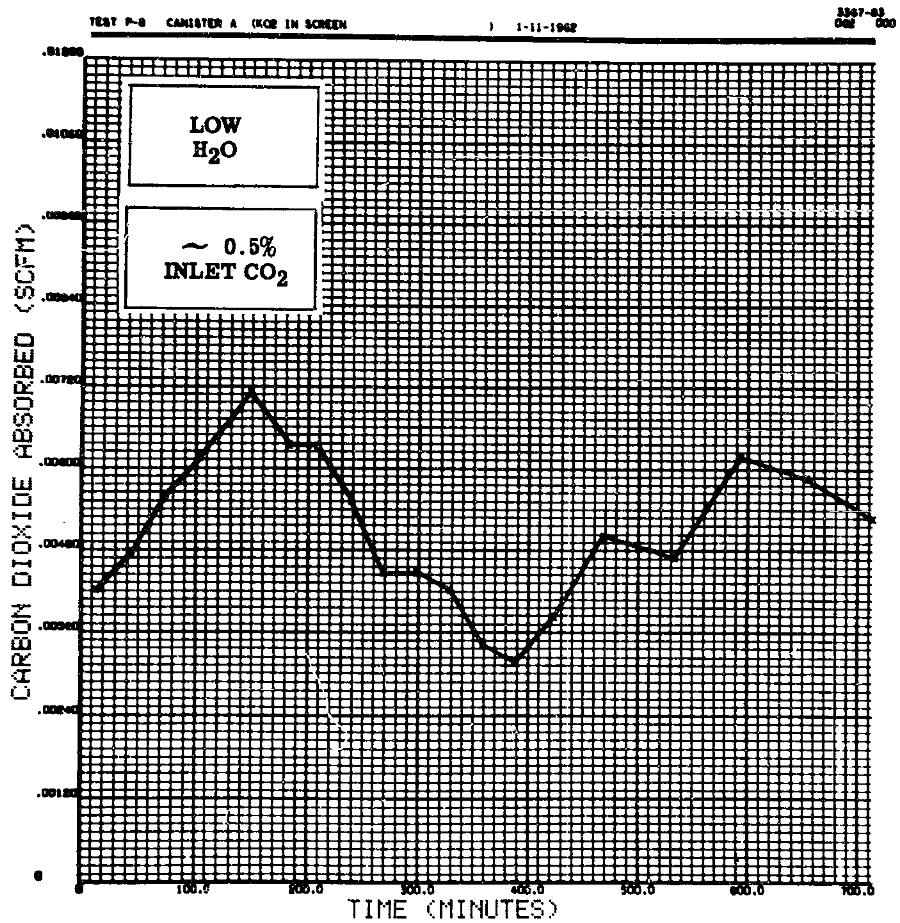

Figure 107 SC-4020 Curve, CO_2, P-8, A

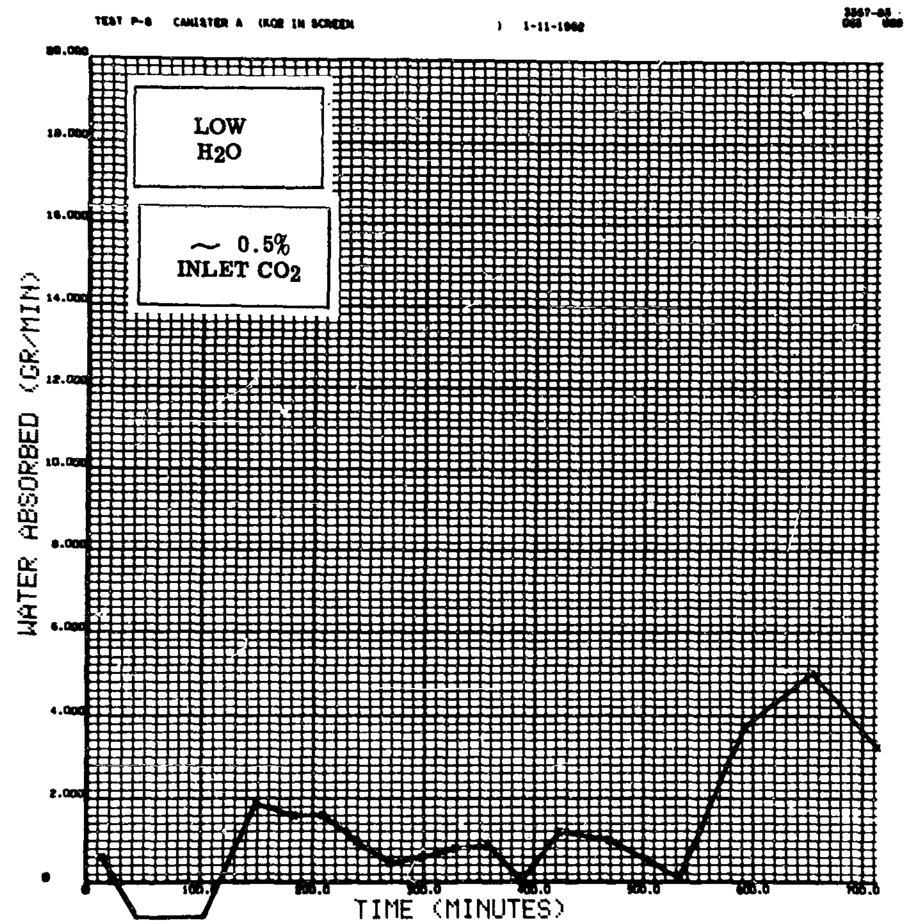

Figure 108 SC-4020 Curve, H_2O, P-8, A

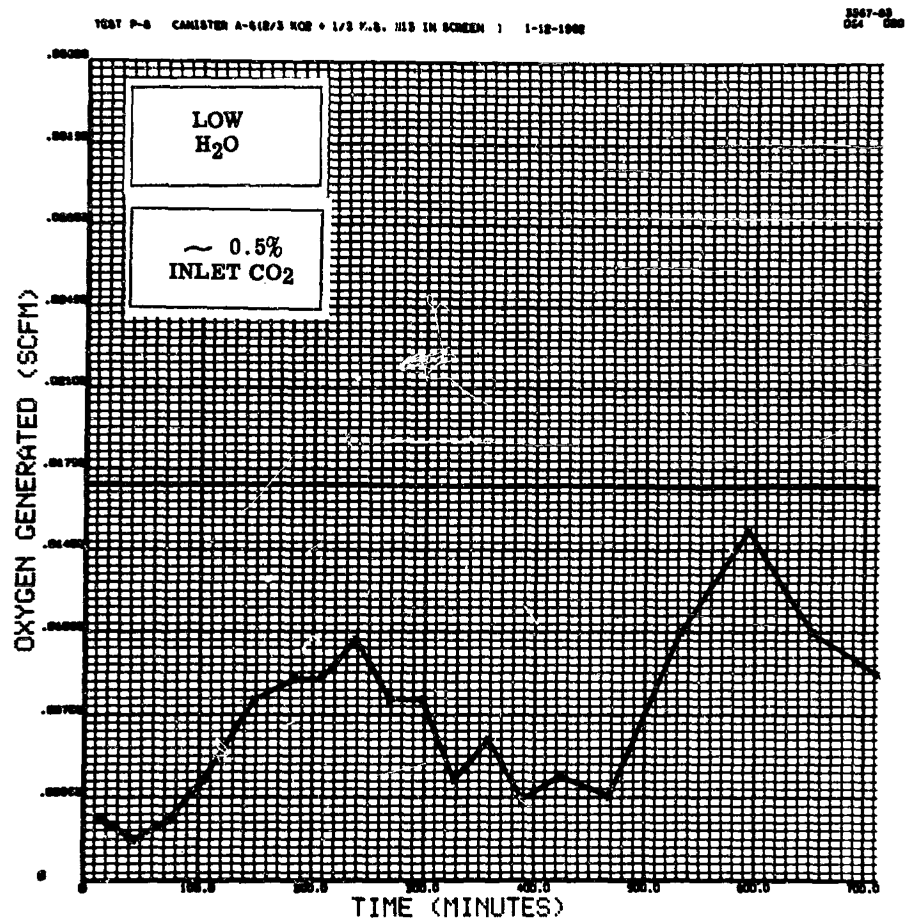

Figure 109 SC-4020 Curve, O_2, P-8, A-6

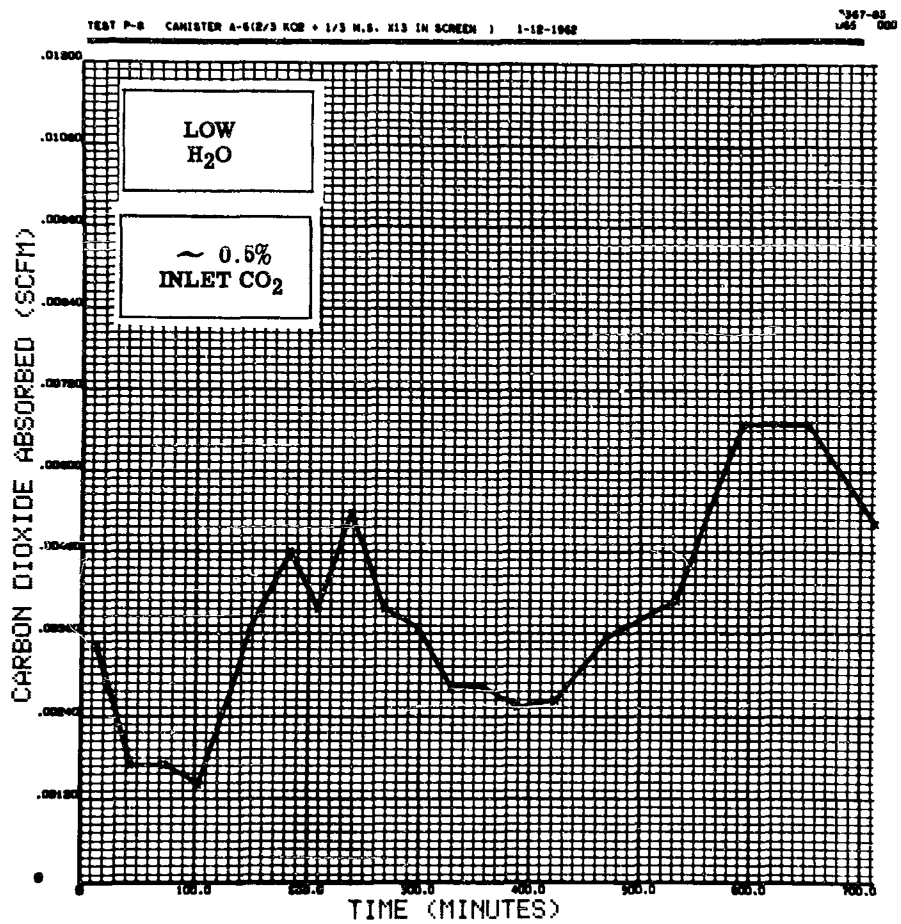

Figure 110 SC-4020 Curve, CO_2, P-8, A-6

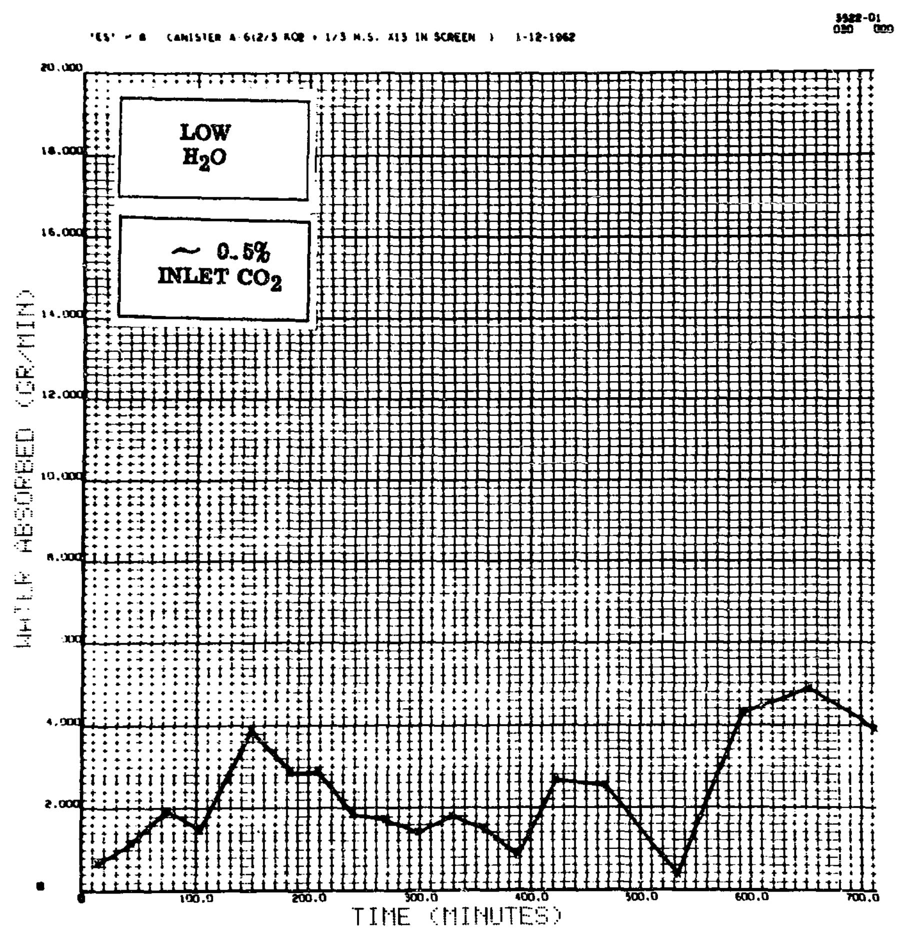

Figure 111 SC-4020 Curve, H_2O, P-8, A-6

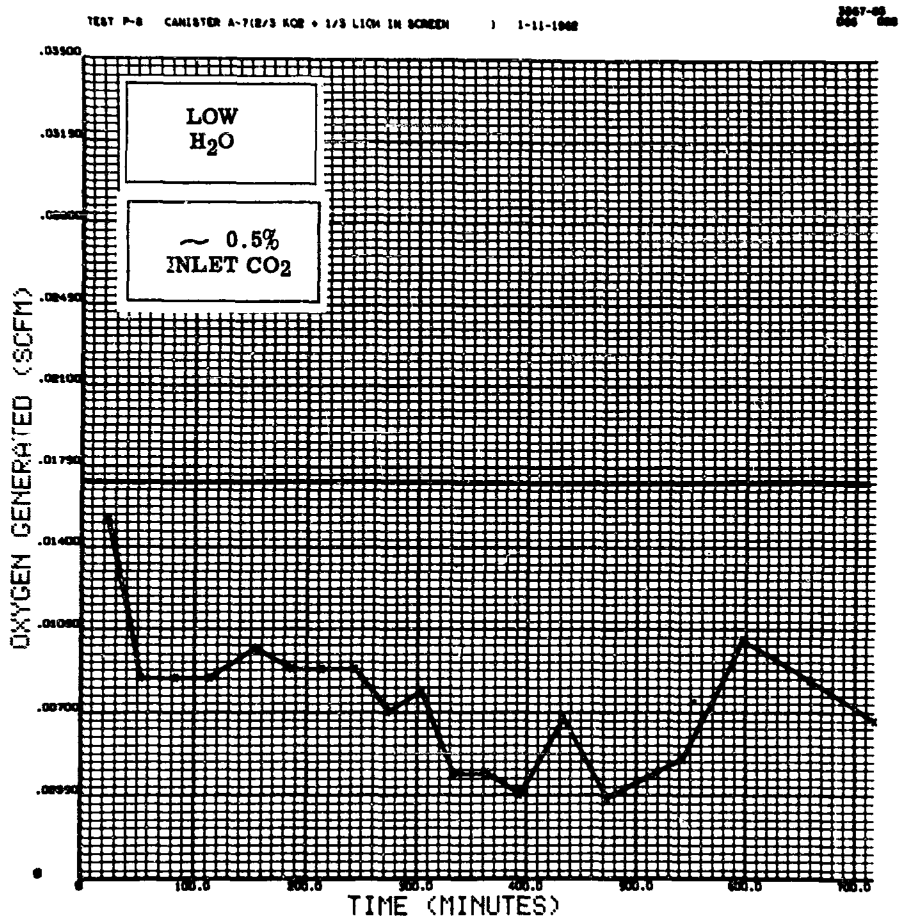

Figure 112 SC-4020 Curve, O_2, P-8, A-7

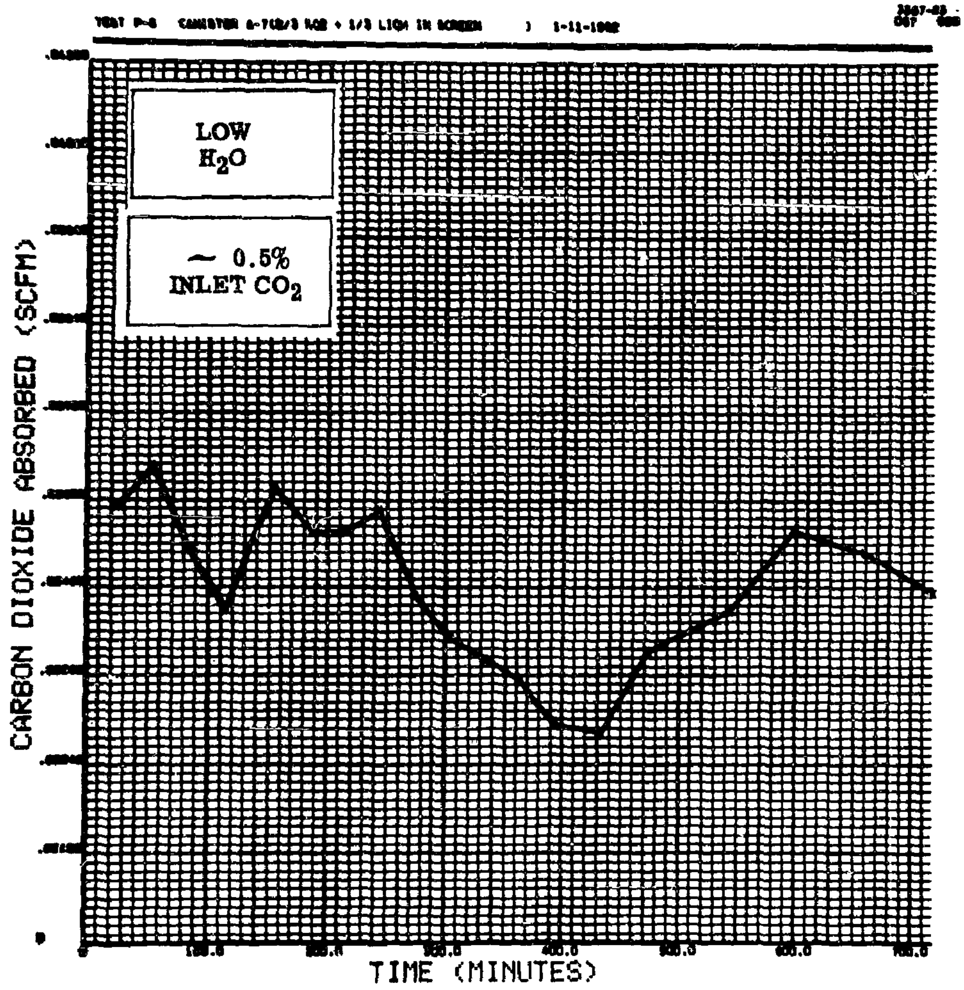

Figure 113 SC-4020 Curve, CO_2, P-8, A-7

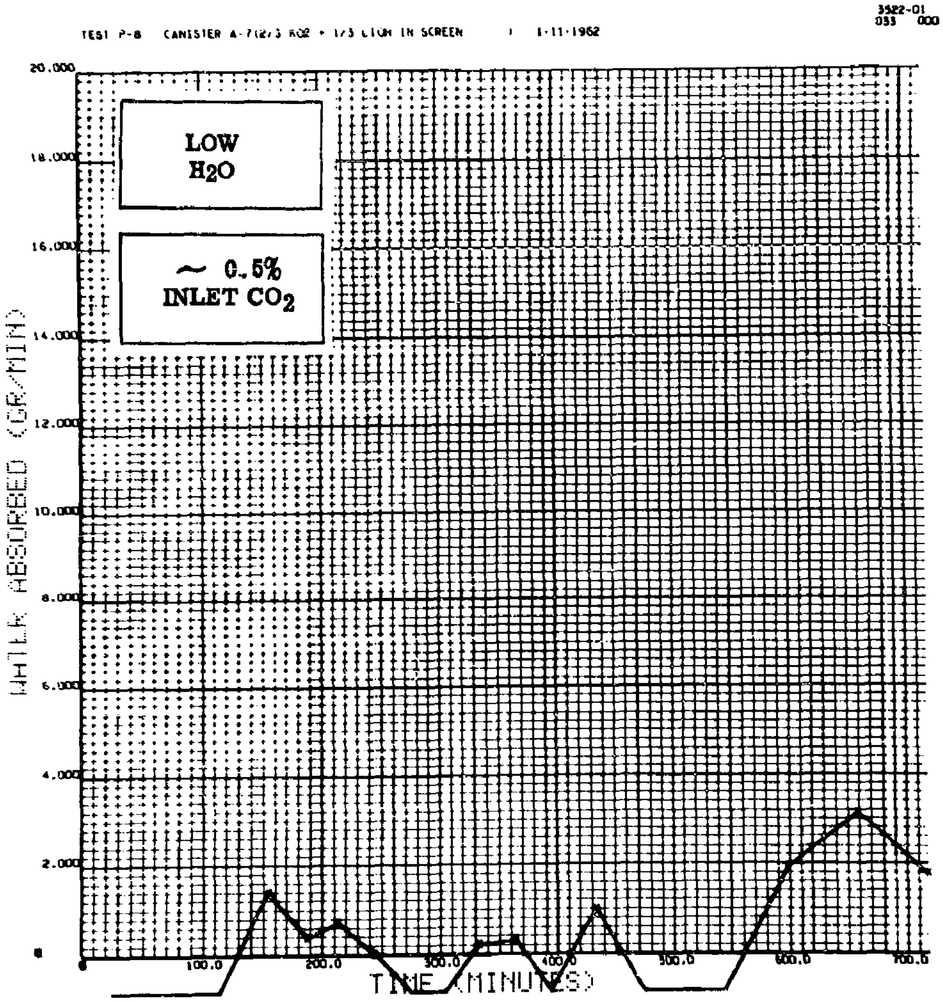

Figure 114 SC-4020 Curve, H_2O, P-8, A-7

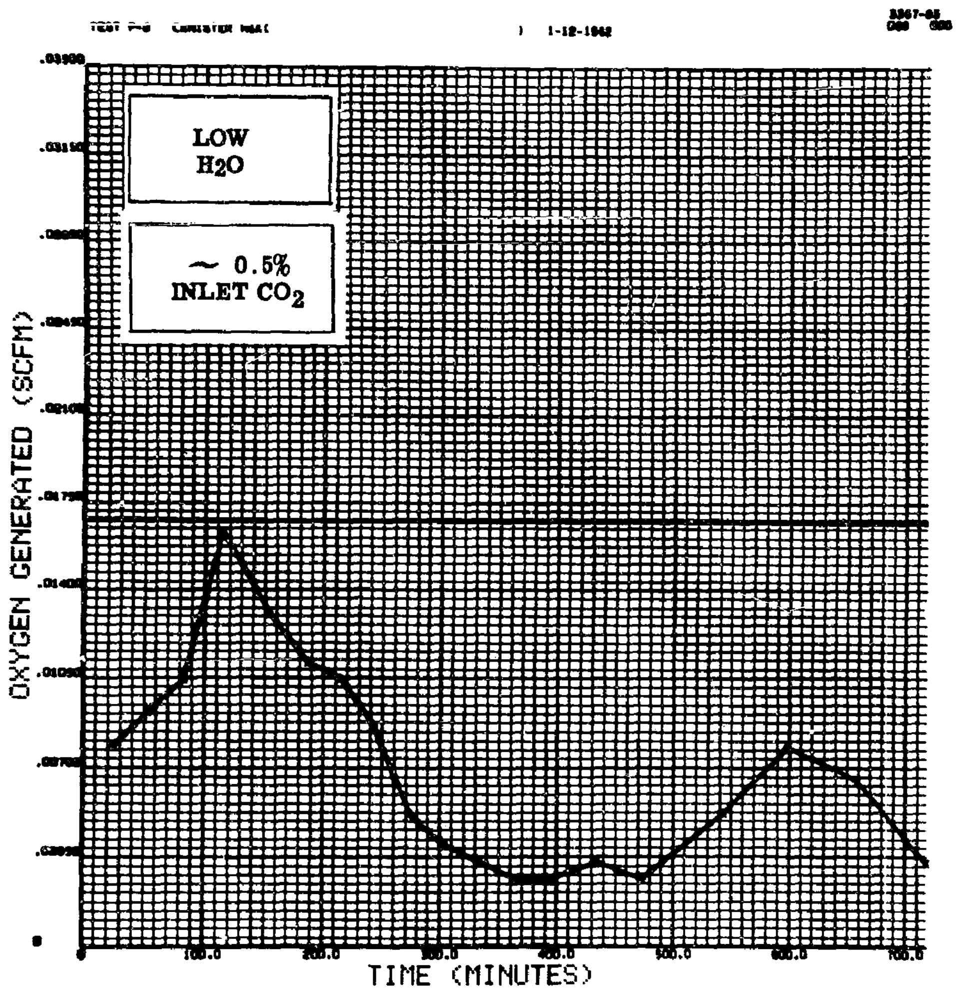

Figure 115 SC-4020 Curve, O_2, P-8, MSA

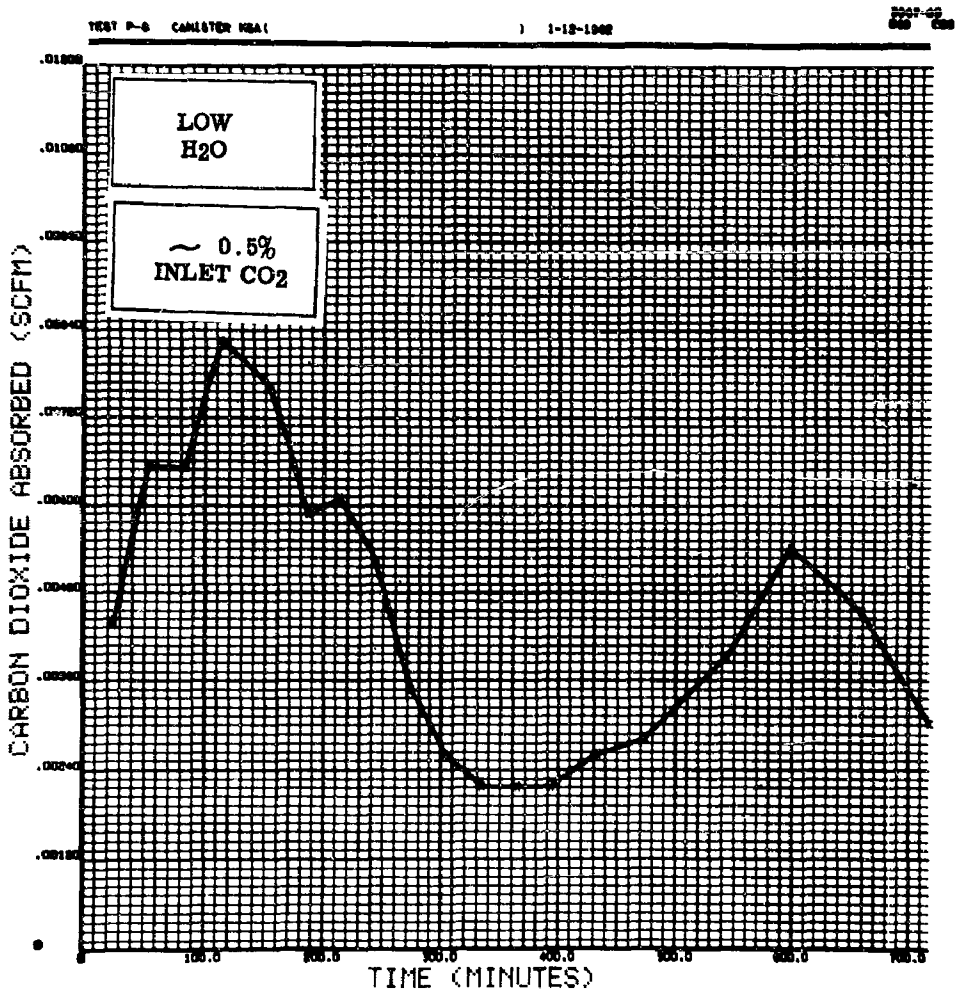

Figure 116 SC-4020 Curve, CO_2, P-8, MSA

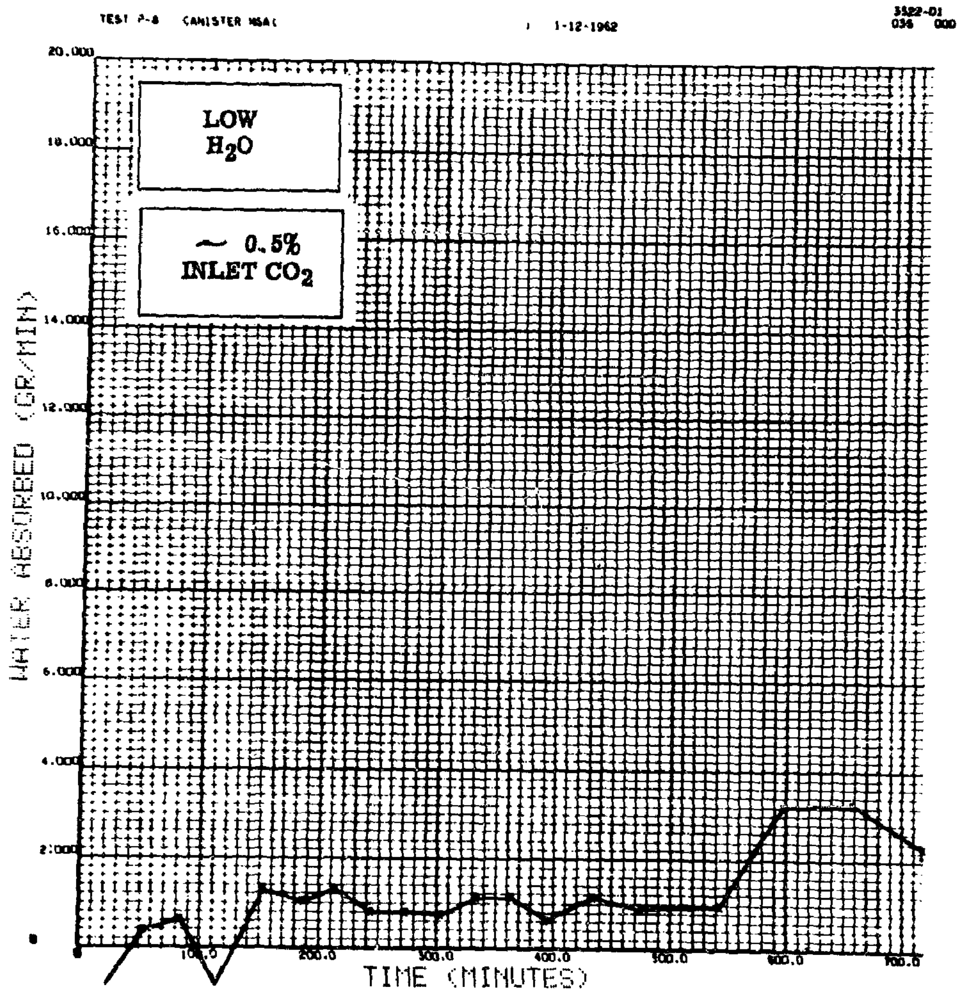

Figure 117 SC-4020 Curve, H_2O, P-8, MSA

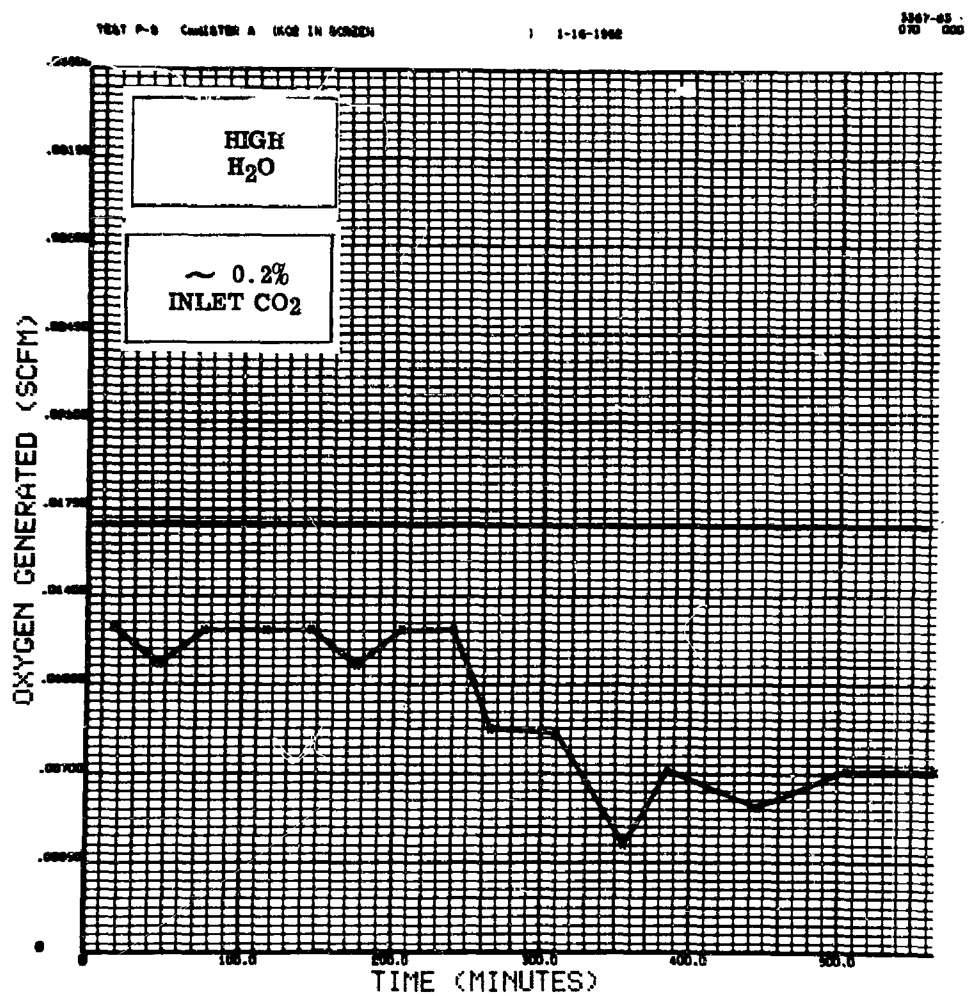

Figure 118 SC-4020 Curve, O_2, P-9, A

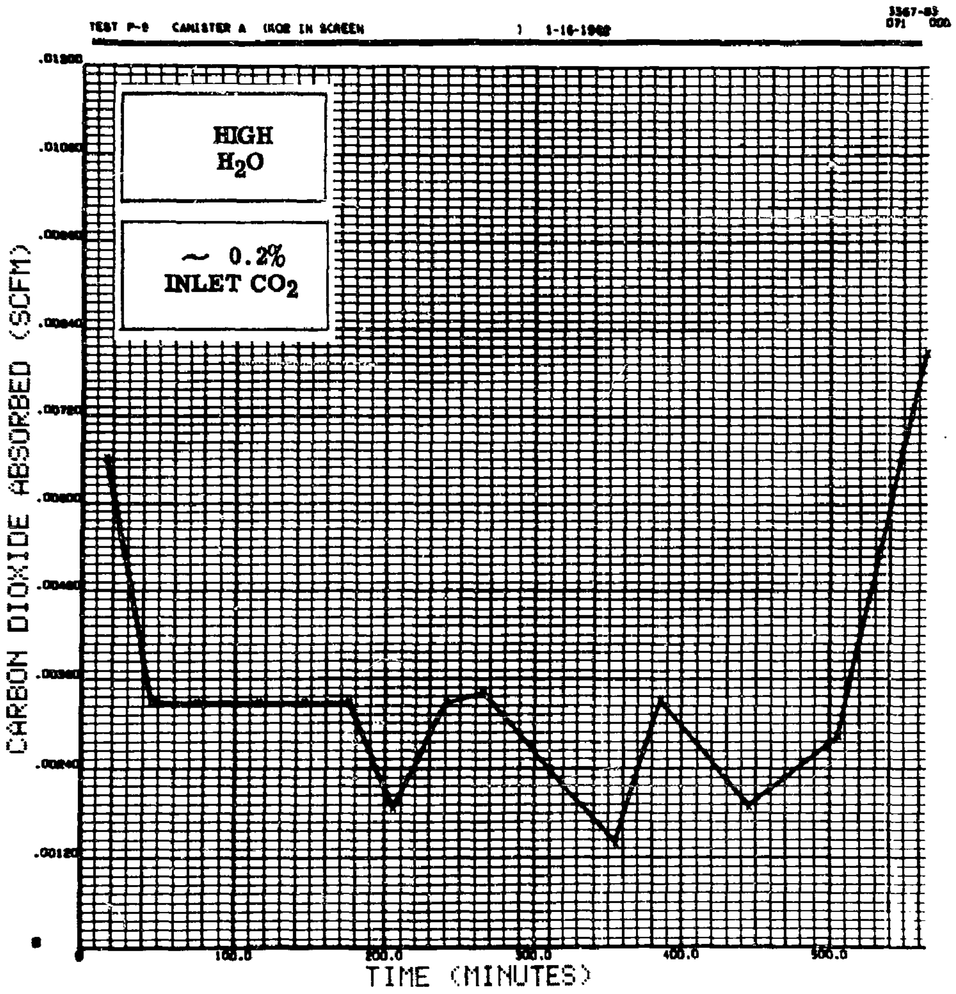

Figure 119 SC-4020 Curve, CO_2, P-9, A

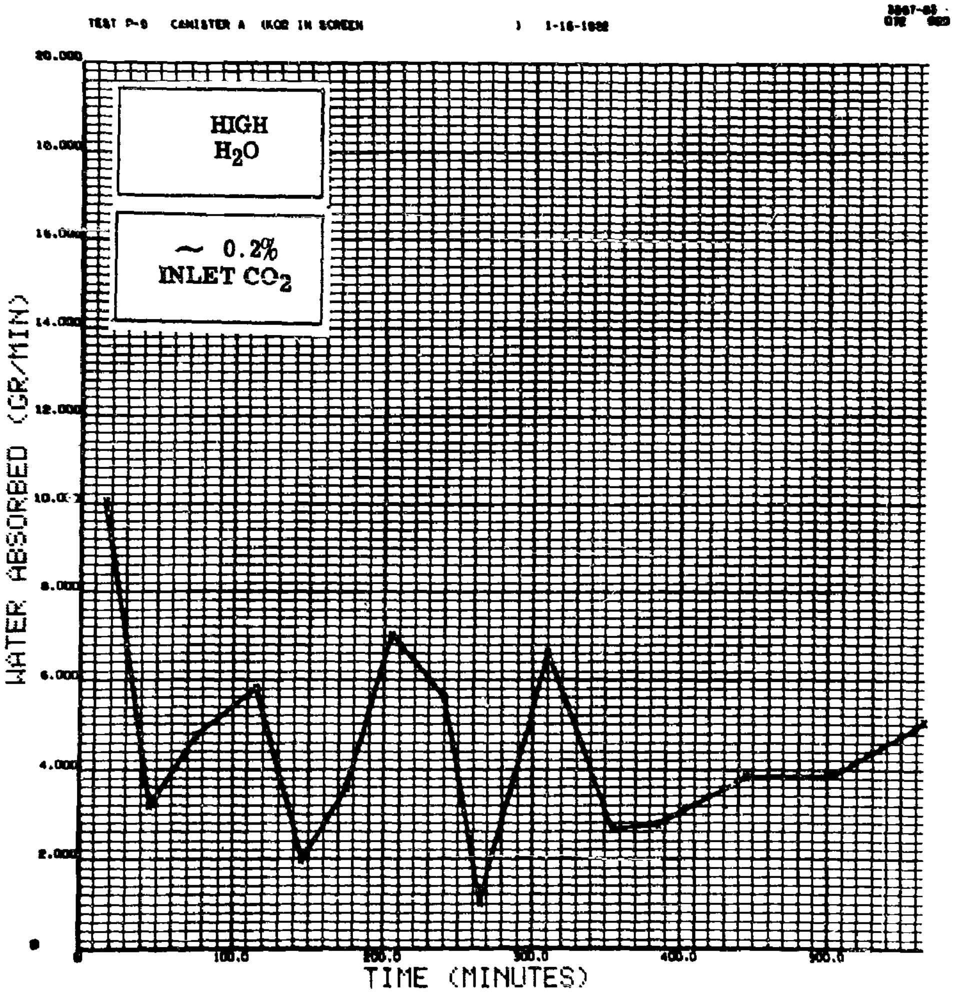

Figure 120 SC-4020 Curve, H_2O, P-9, A

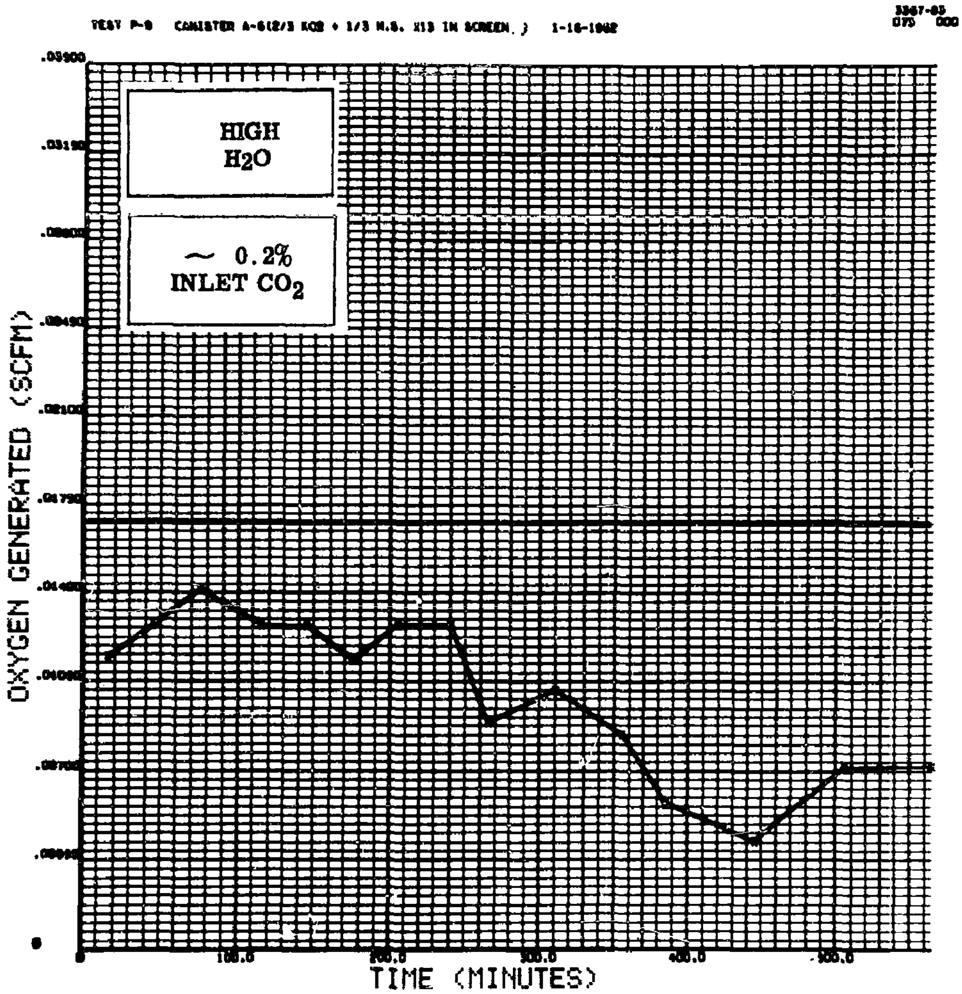

Figure 121 SC-4020 Curve, O_2, P-9, A-6

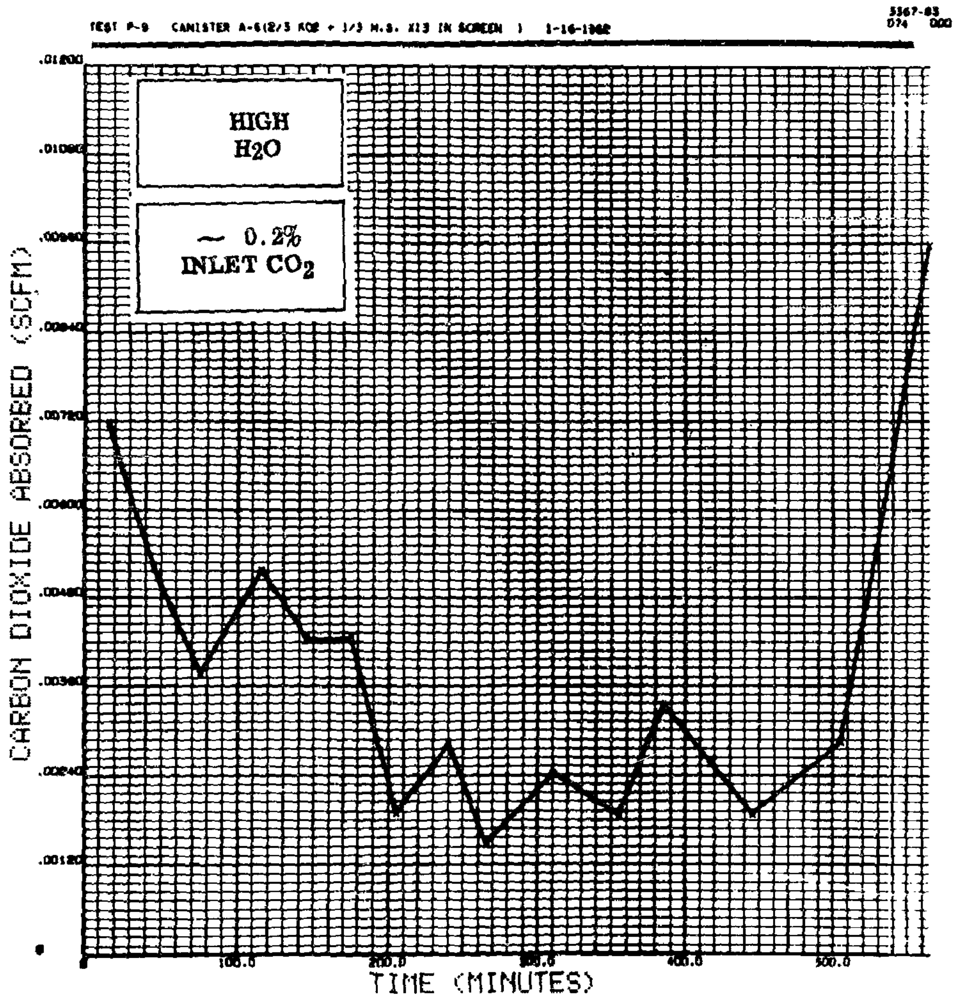

Figure 122 SC-4020 Curve, CO_2, P-9, A-6

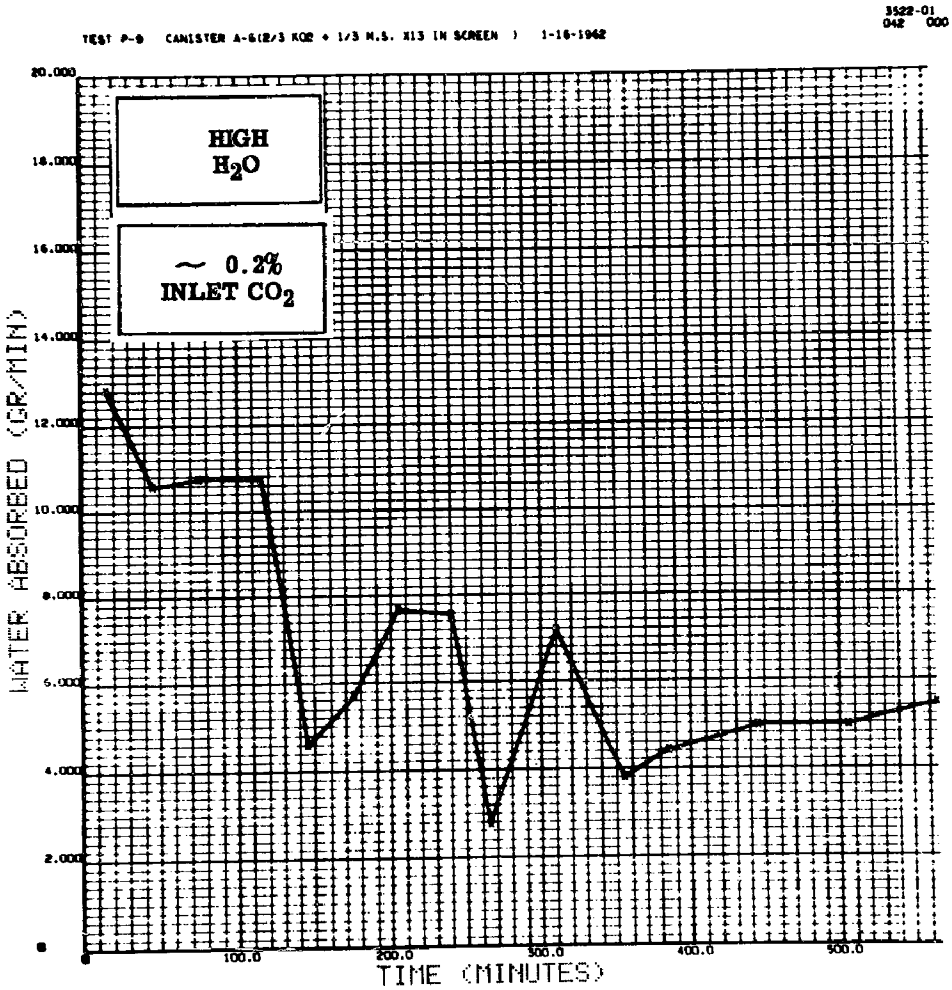

Figure 123 SC-4020 Curve, H_2O, P-9, A-6

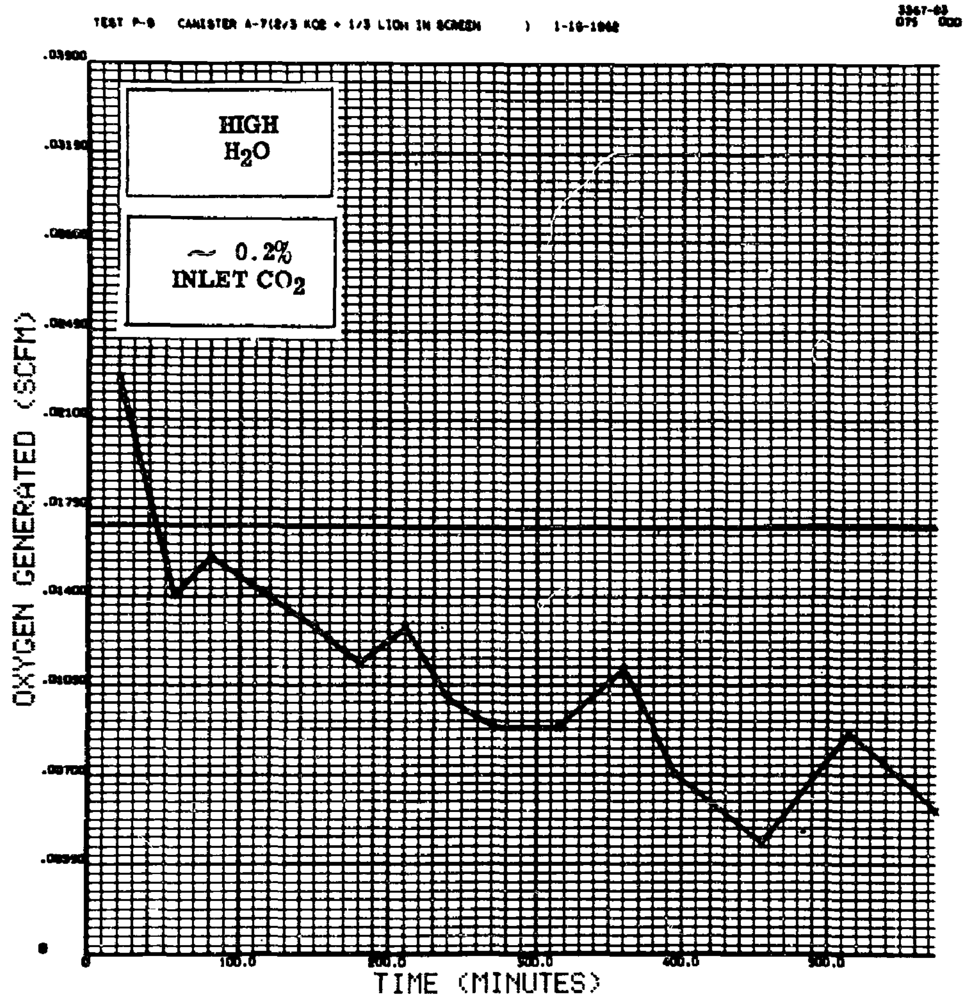

Figure 124 SC-4020 Curve, O_2, P-9, A-7

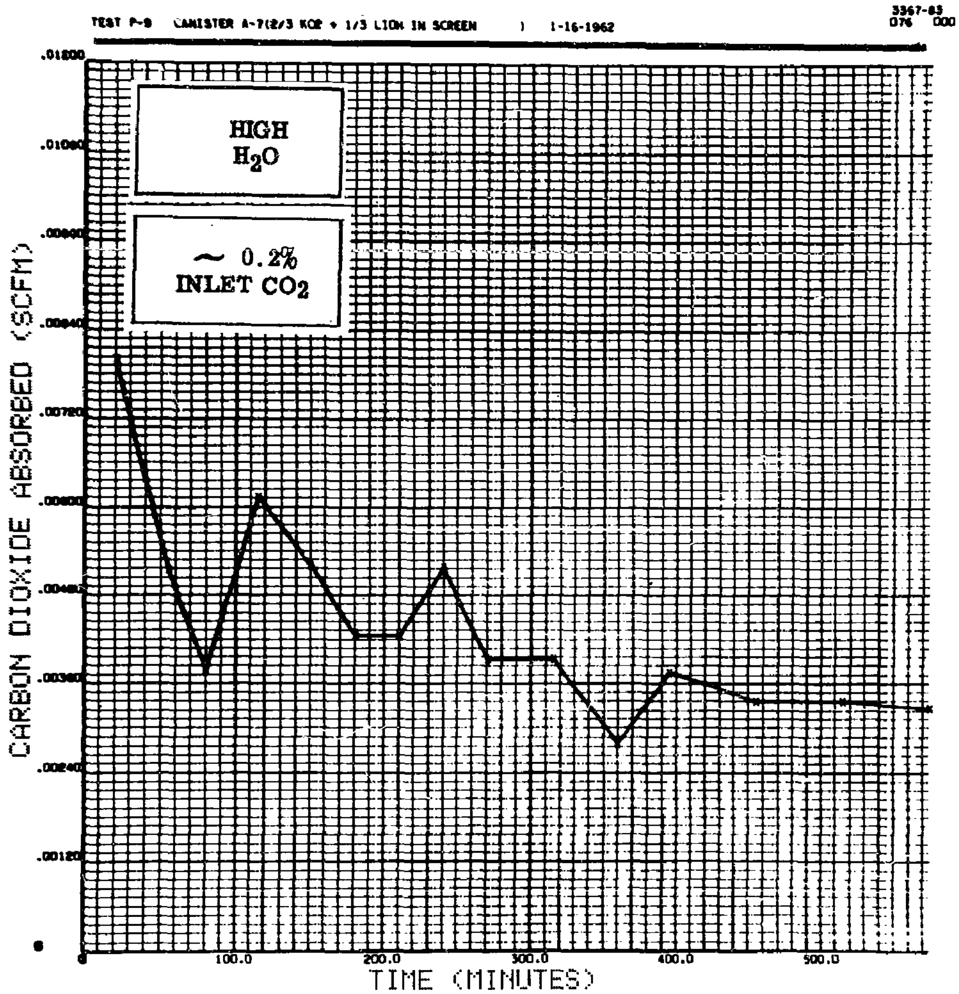

Figure 125 SC-4020 Curve, CO_2, P-9, A-7

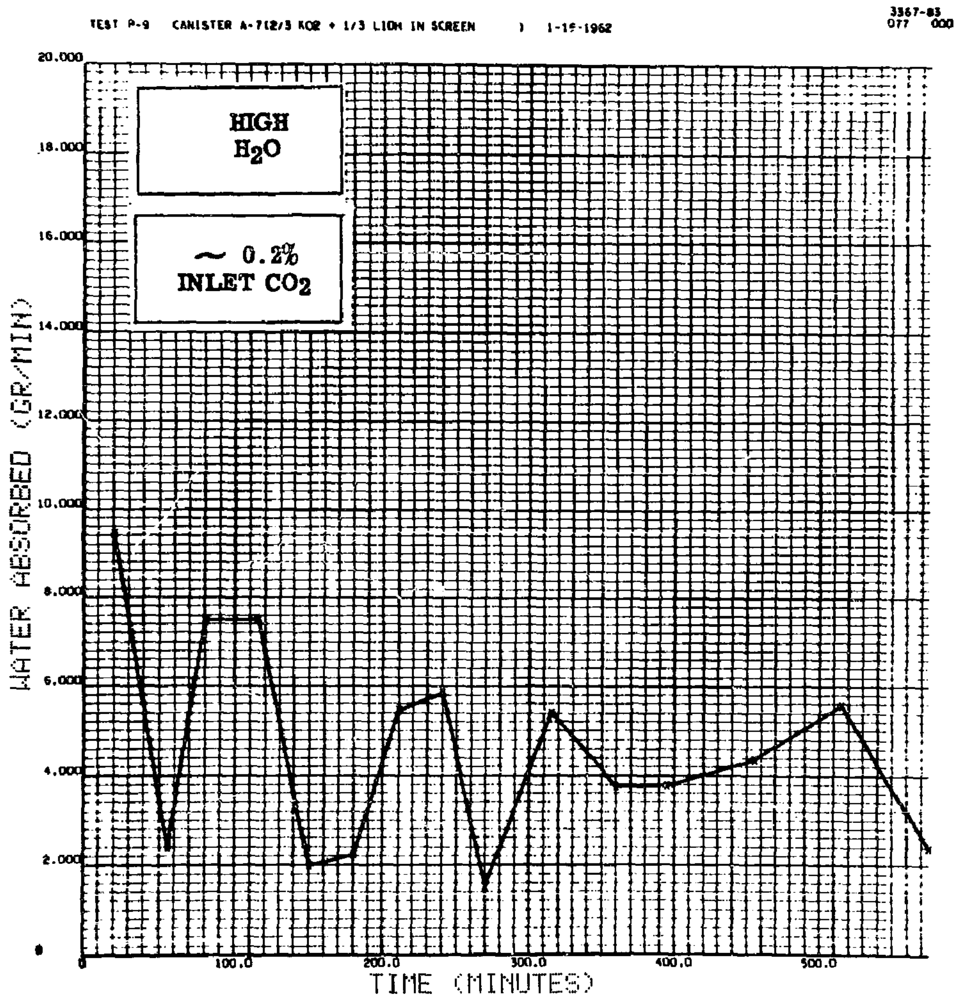

Figure 126 SC-4020 Curve, H_2O, P-9, A-7

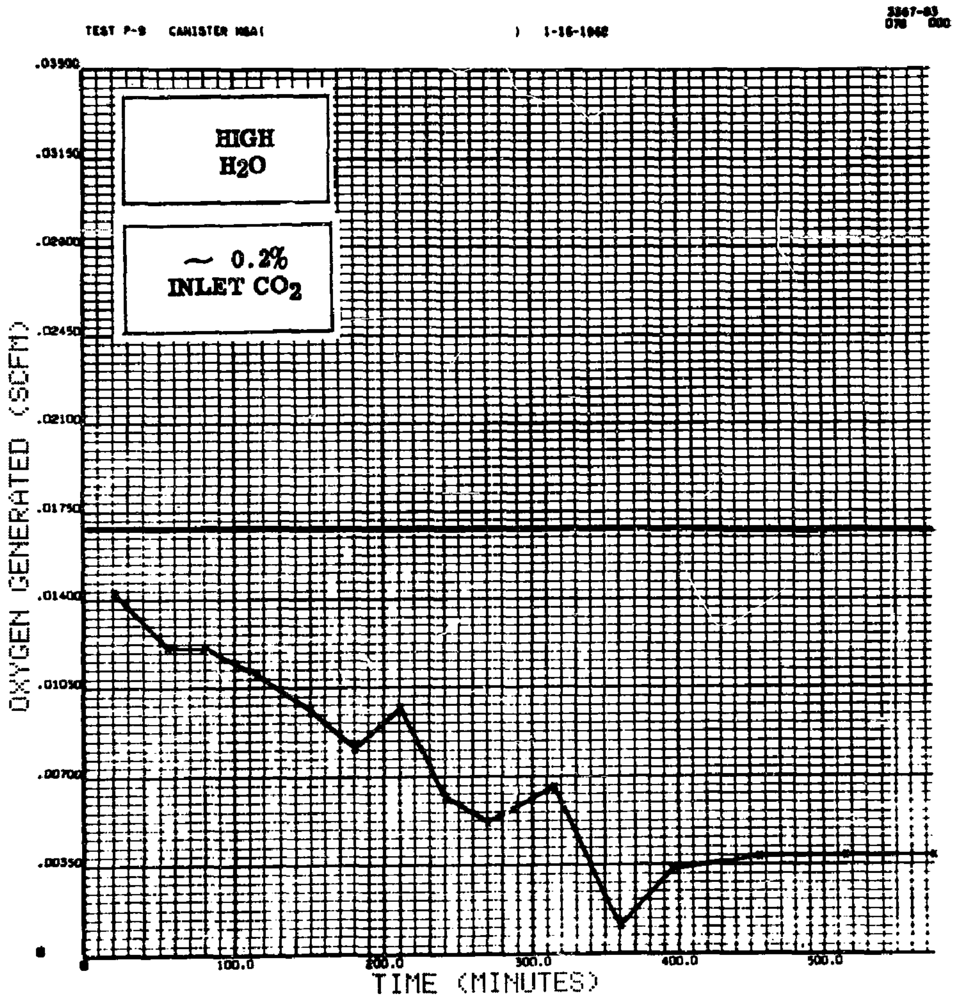

Figure 127 SC-4020 Curve, O_2, P-9, MSA

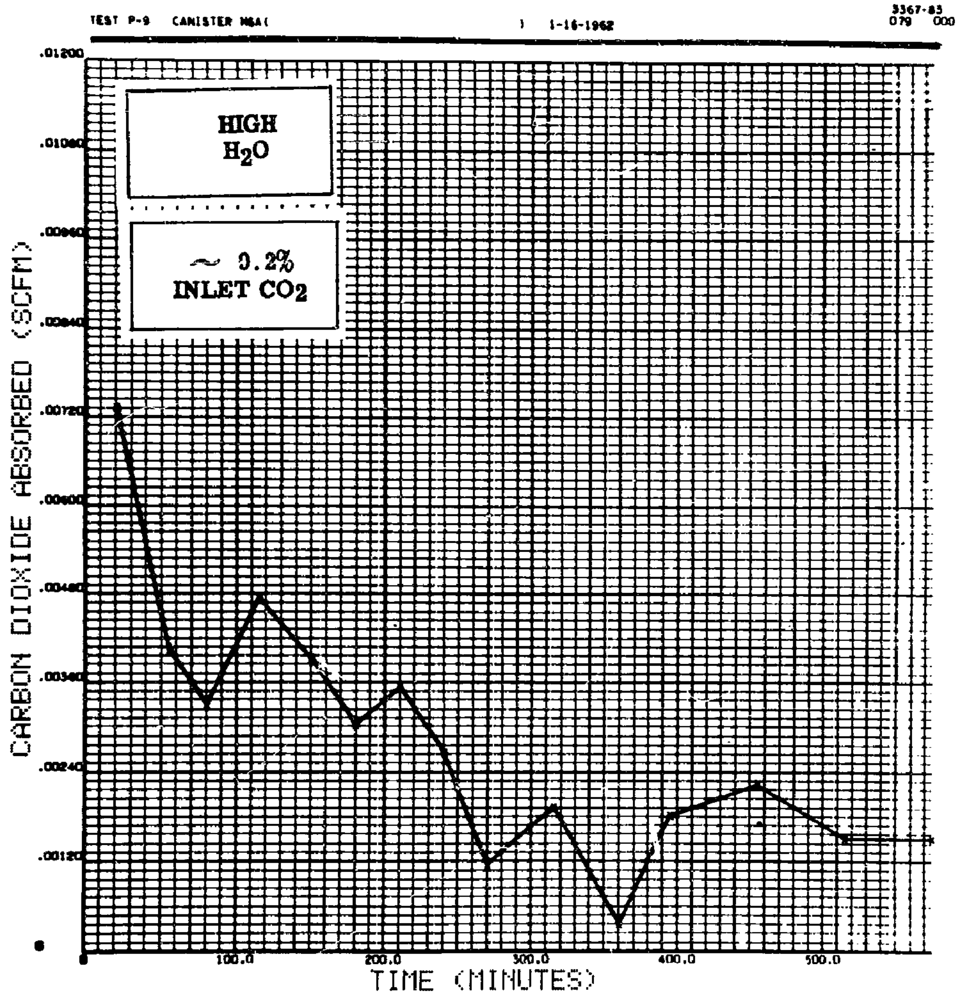

Figure 128 SC-4020 Curve, CO_2, P-9, MSA

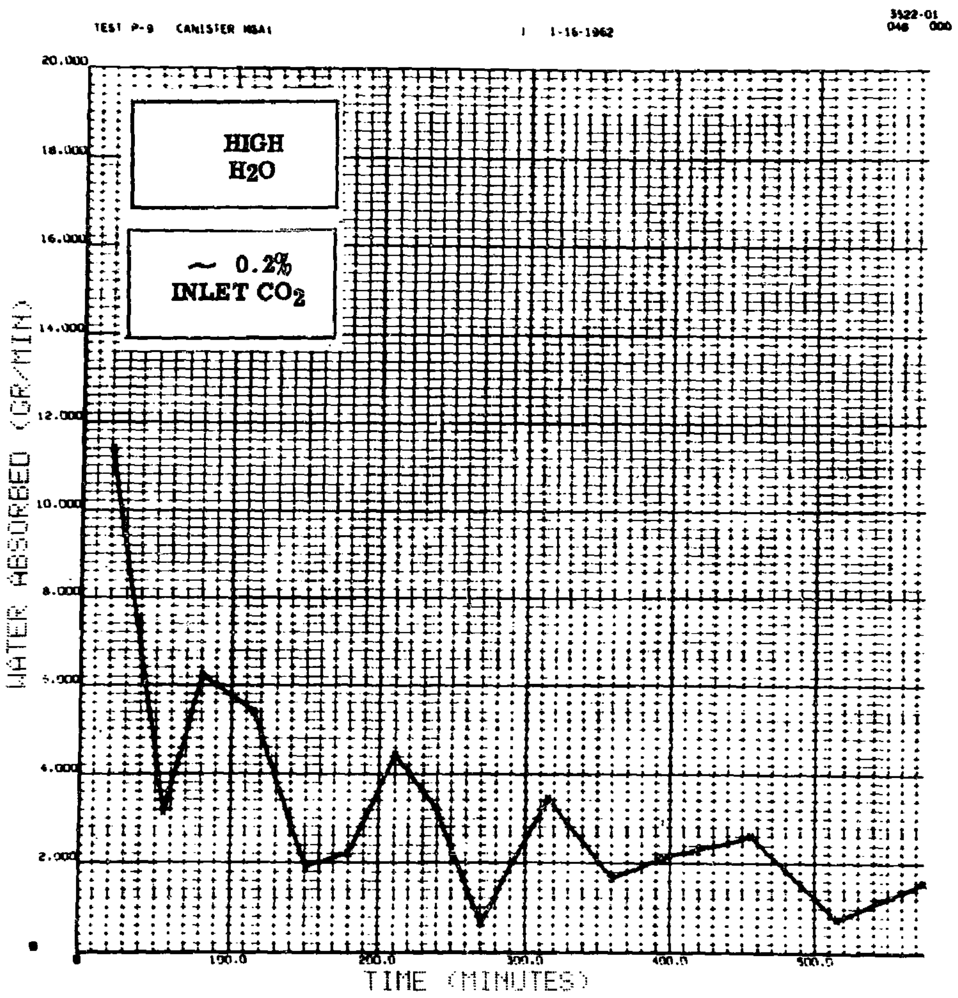

Figure 129 SC-4020 Curve, H_2O, P-9, MSA

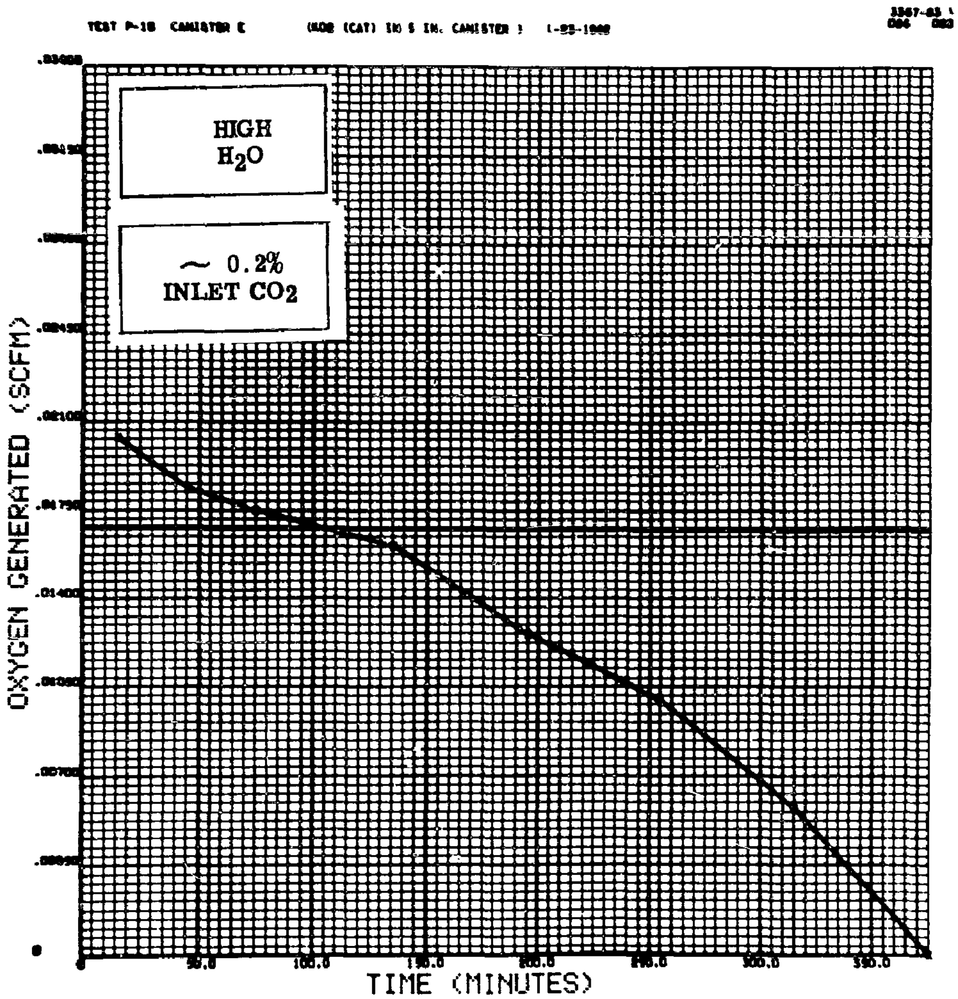

Figure 130 SC-4020 Curve, O_2, P-10, E

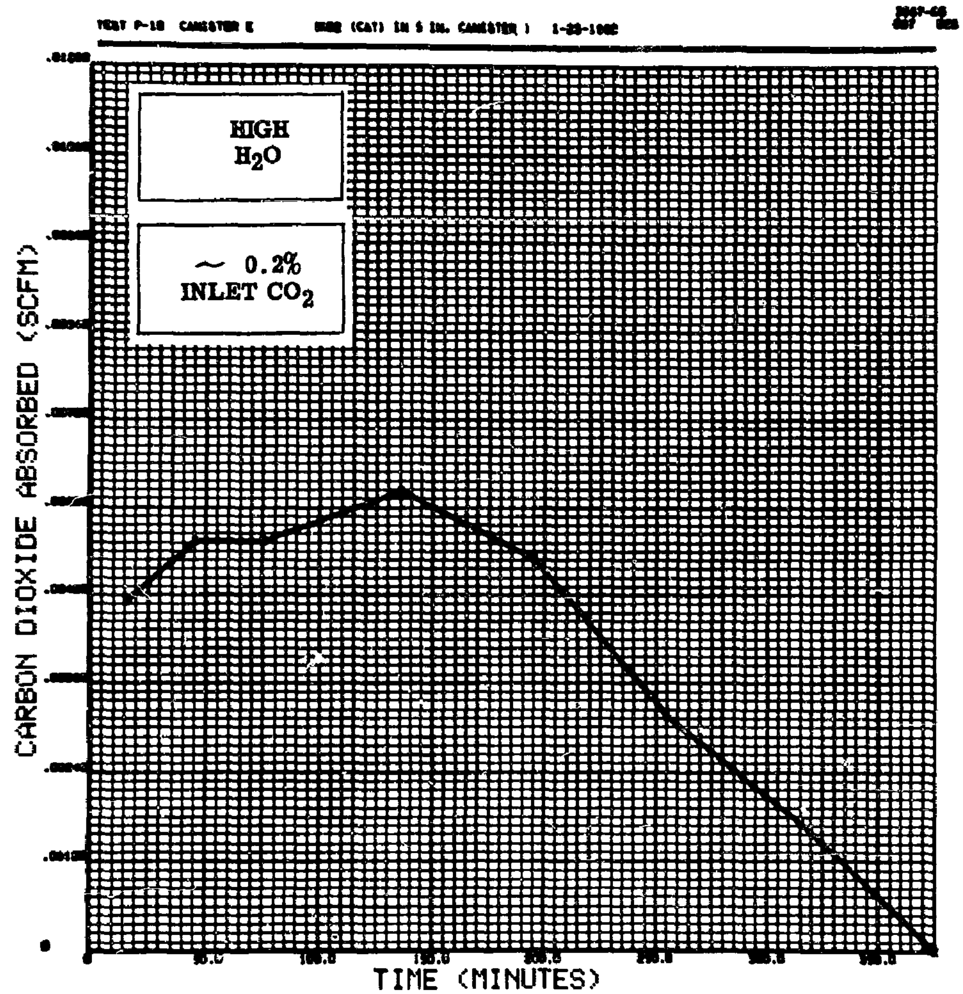

Figure 131 SC-4020 Curve, CO_2, P-10, E

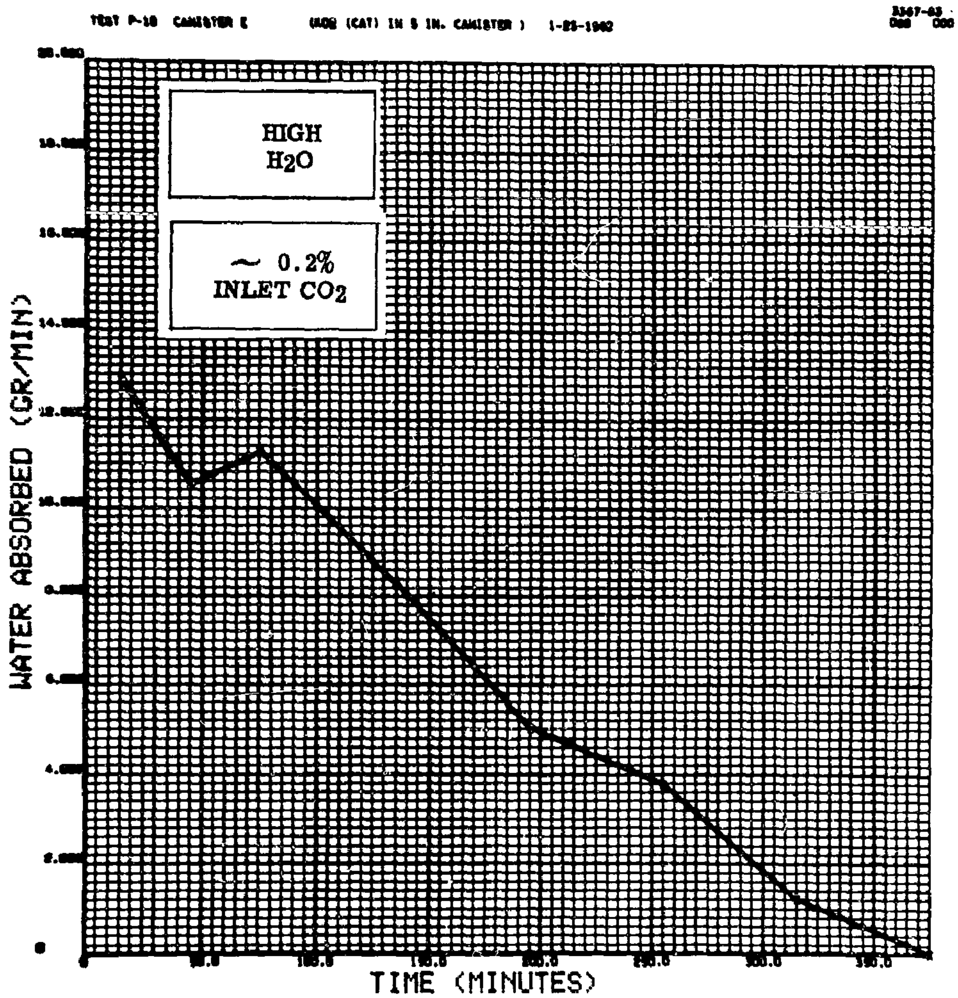

Figure 132 SC-4020 Curve, H_2O, P-10, E

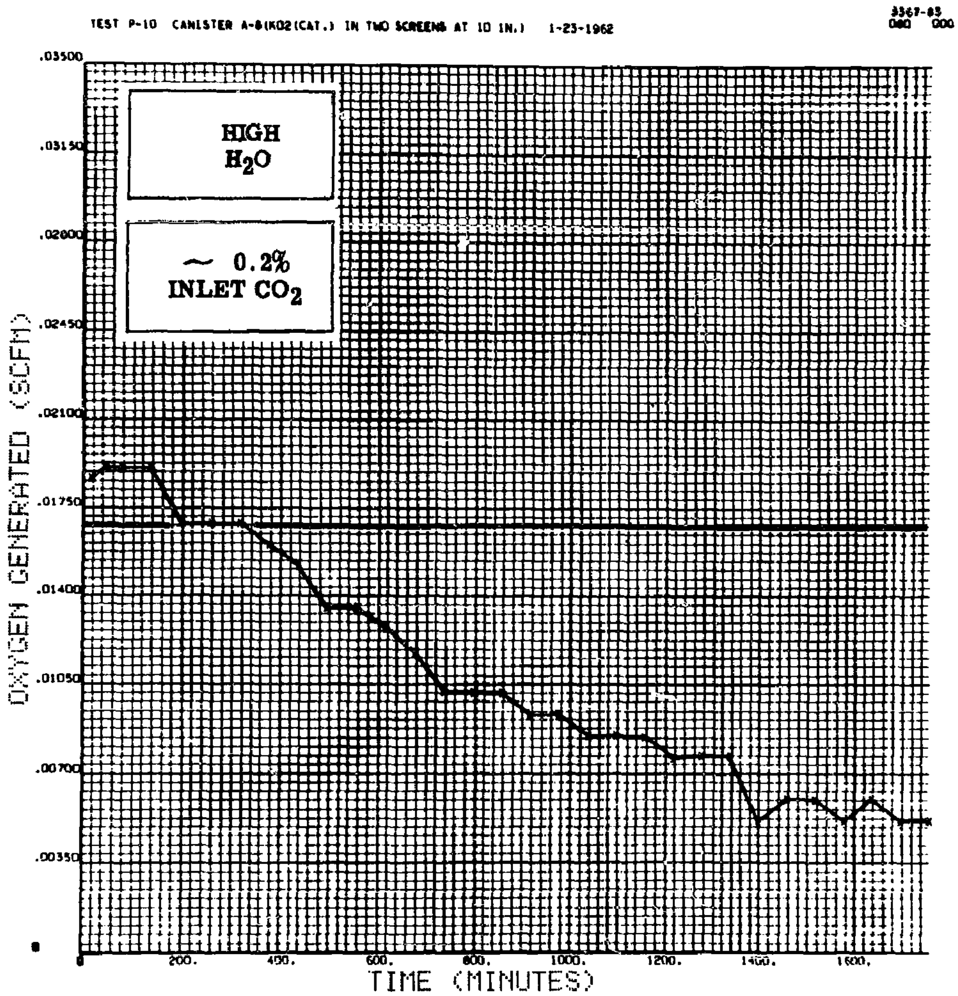

Figure 133 SC-4020 Curve, O_2, P-10, A-8

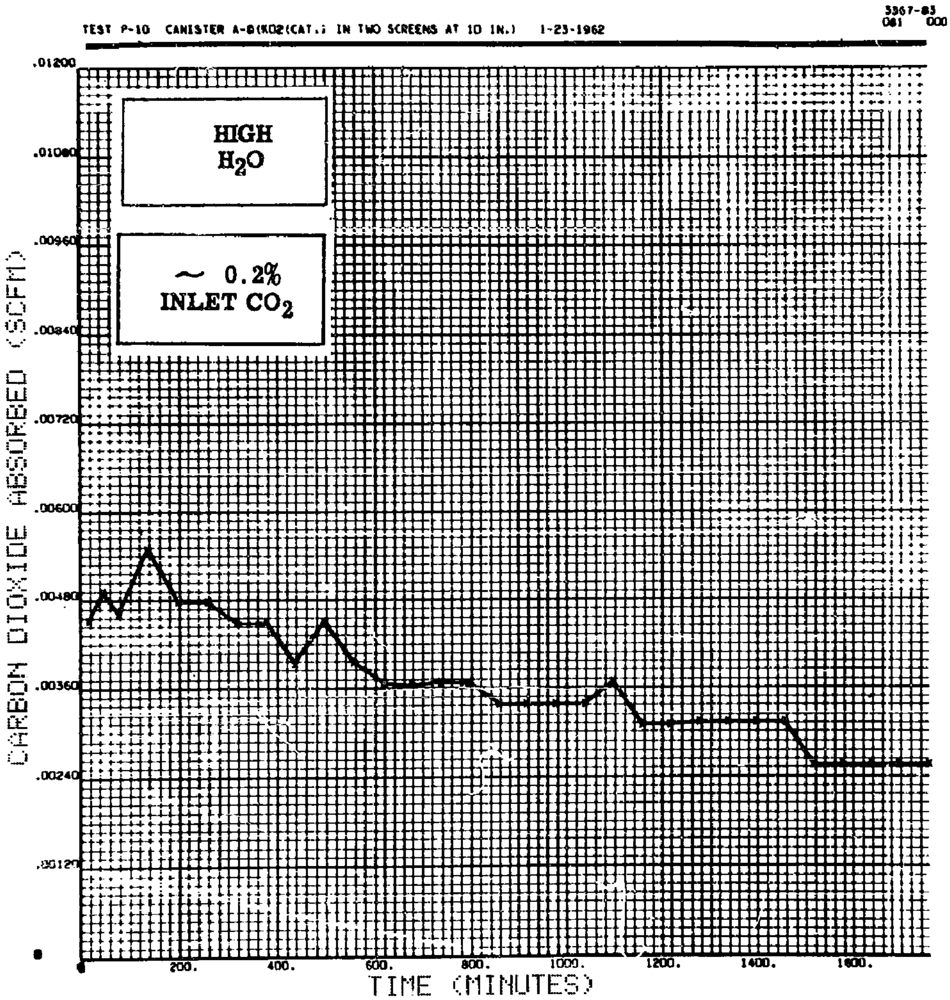

Figure 134 SC-4020 Curve, CO_2, P-10, A-8

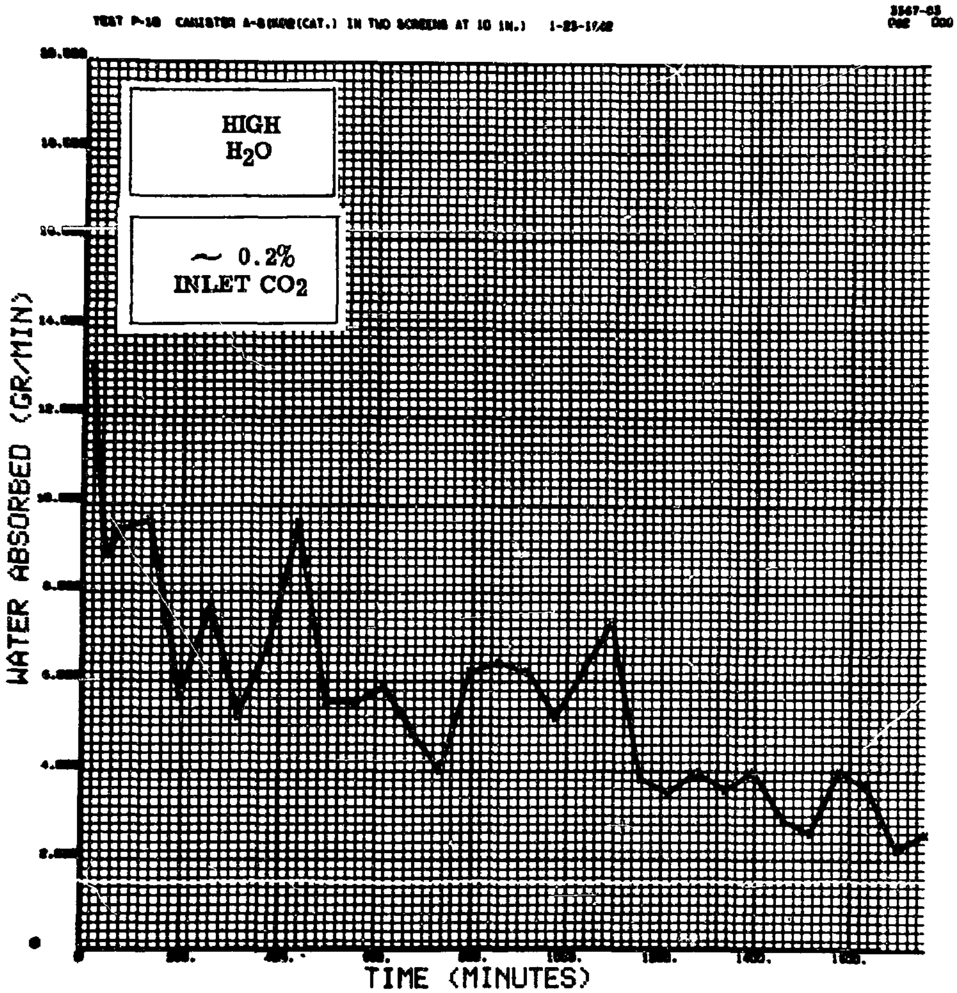

Figure 135 SC-4020 Curve, H_2O, P-10, A-8

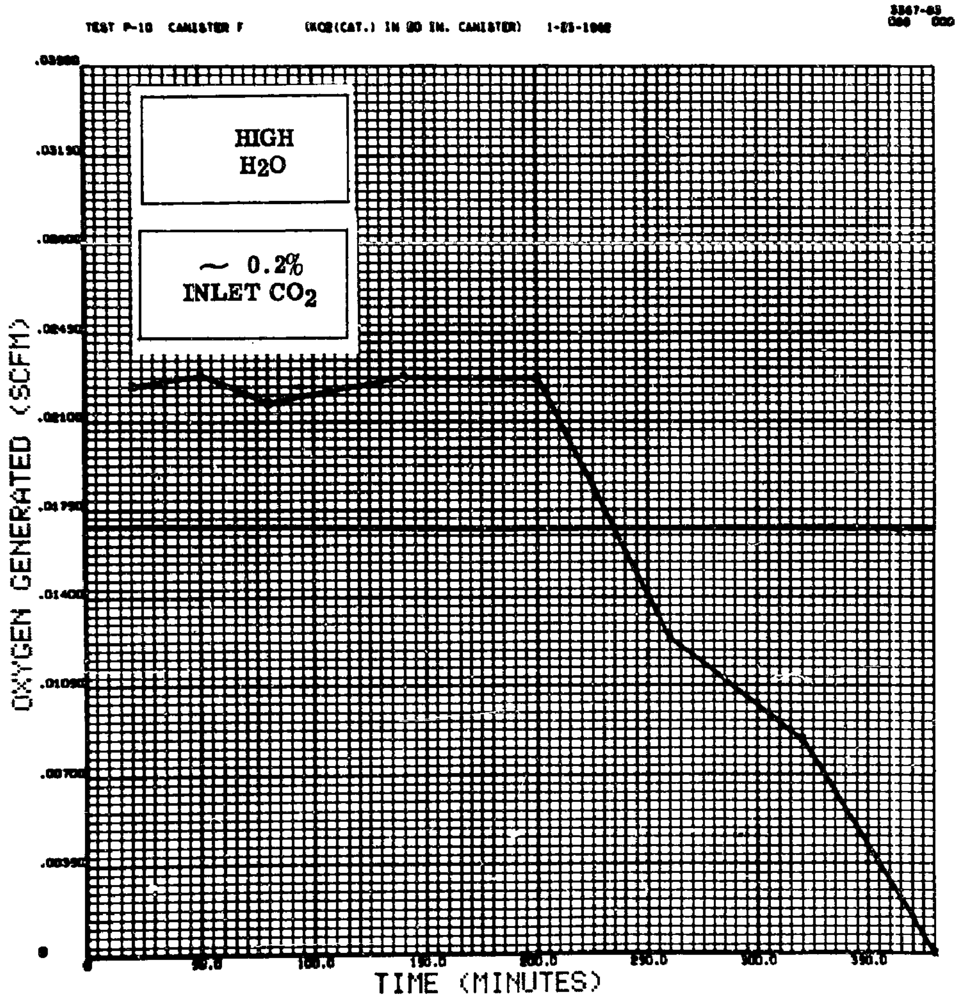

Figure 136 SC-4020 Curve, O_2, P-10, F

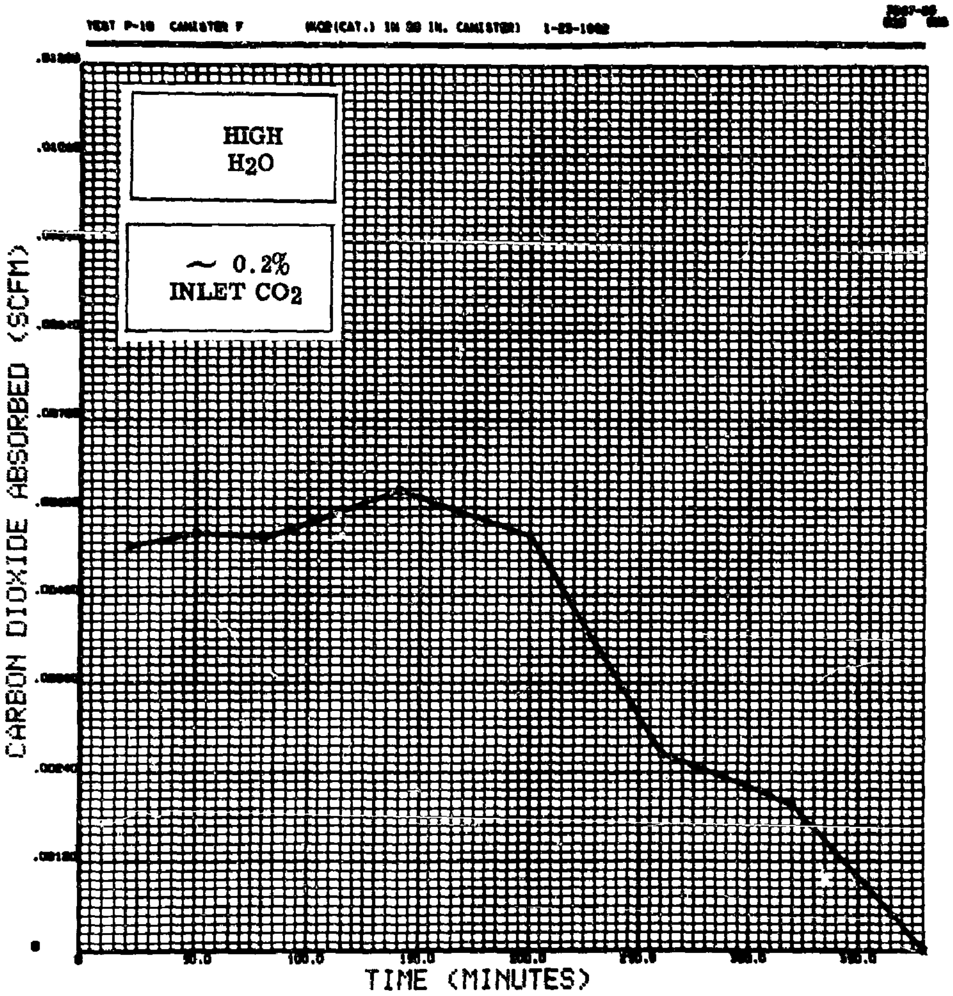

Figure 137 SC-4020 Curve, CO_2, P-10, F

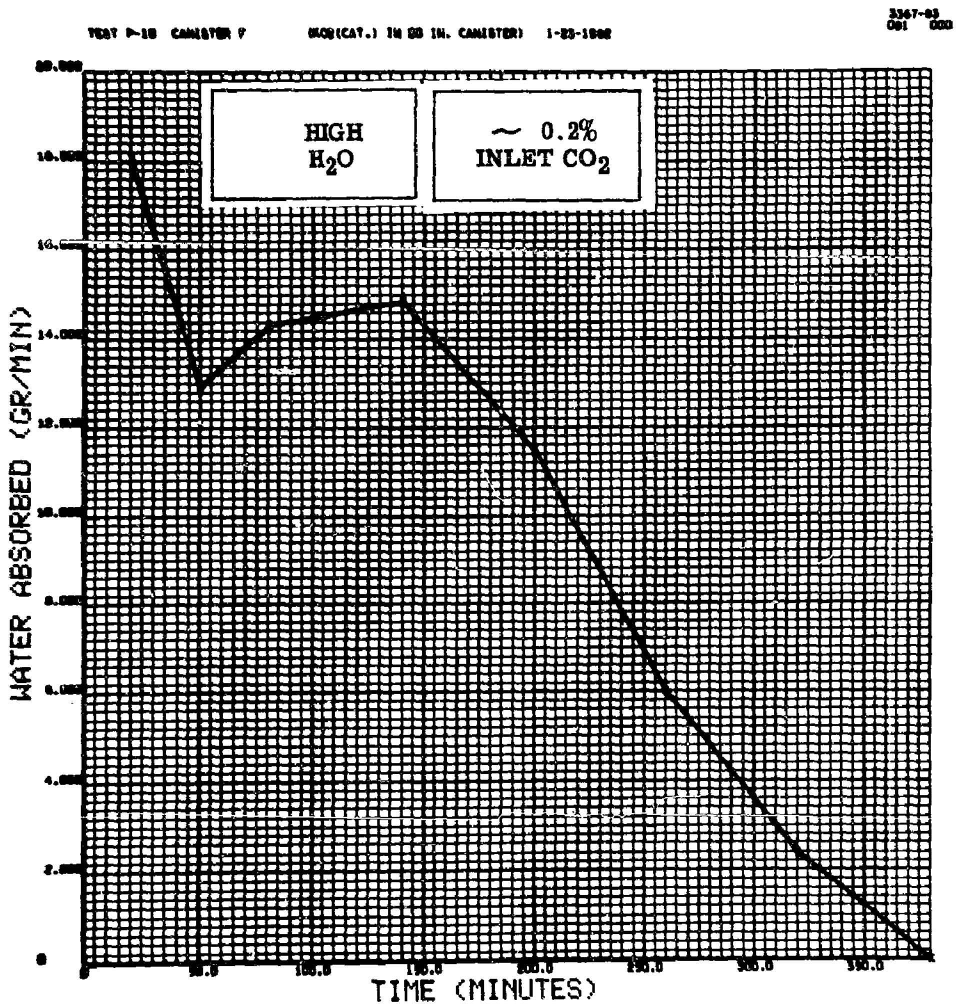

Figure 138 SC-4020 Curve, H_2O, P-10, F

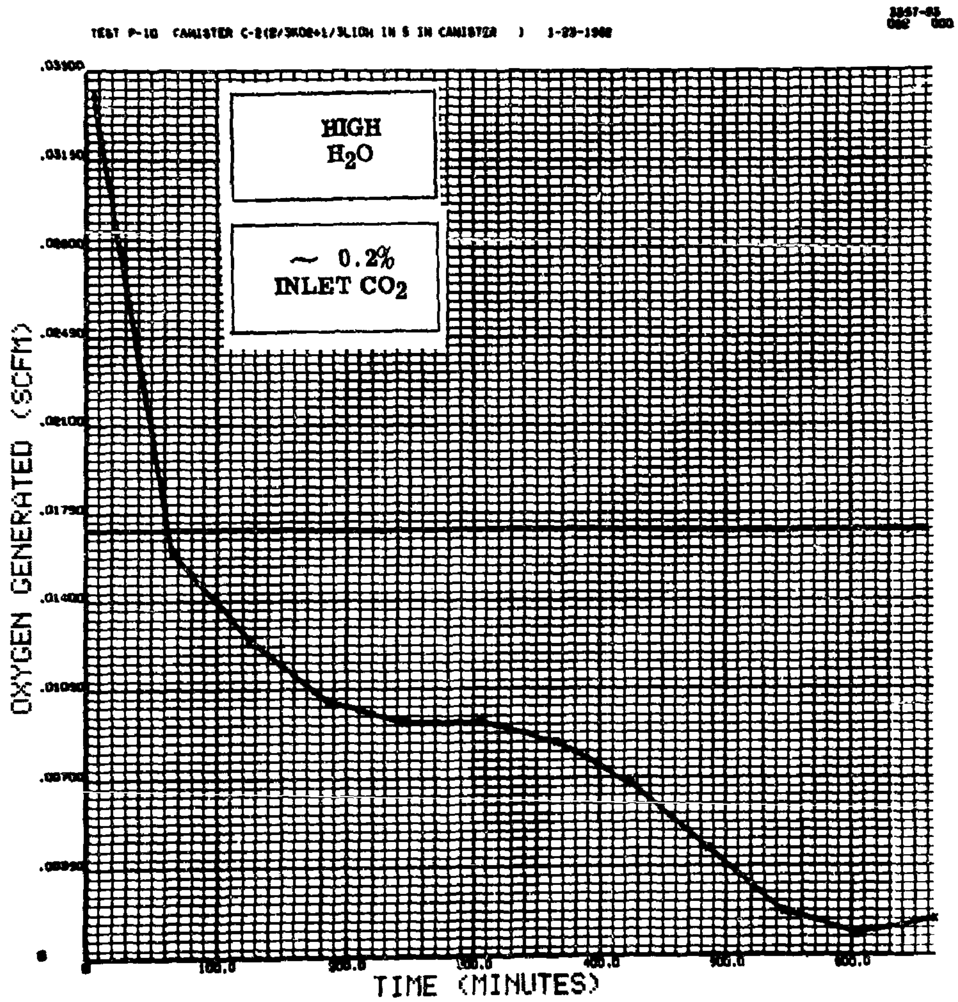

Figure 139 SC-4020 Curve, O_2, P-10, C-2

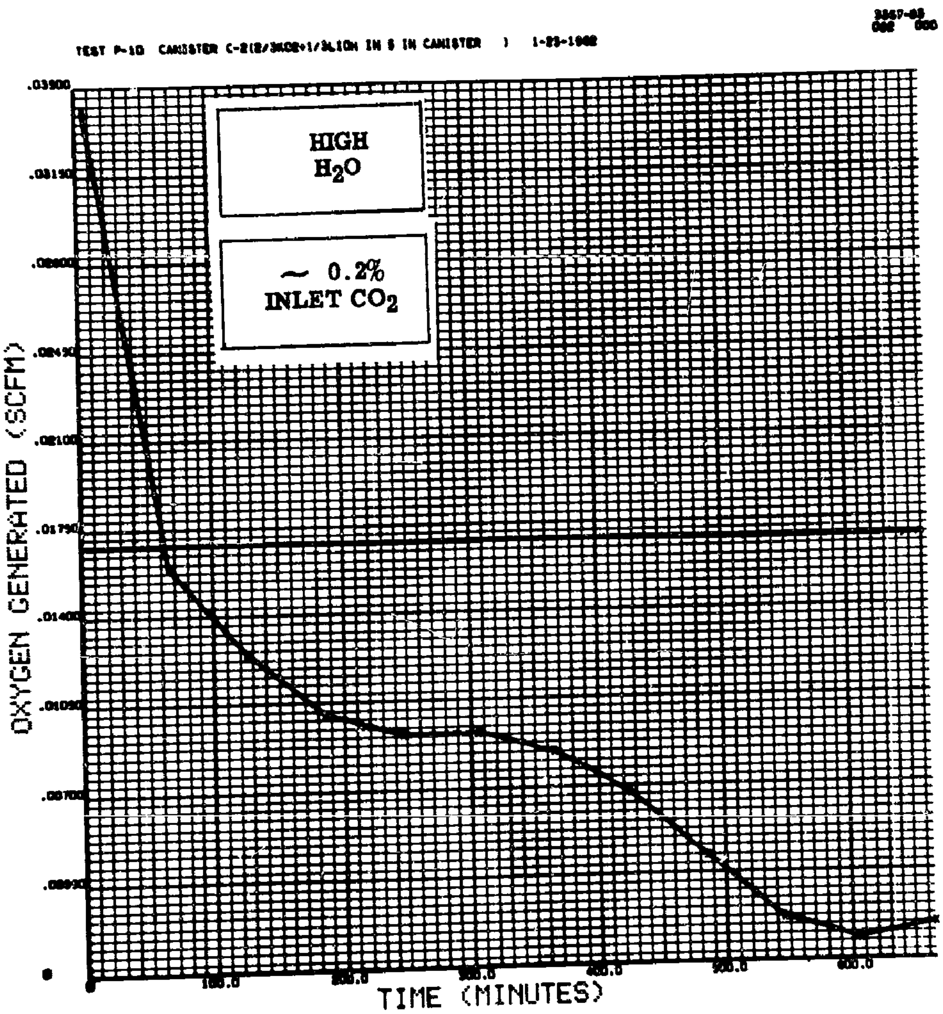

Figure 139 SC-4020 Curve, O_2, P-10, C-2

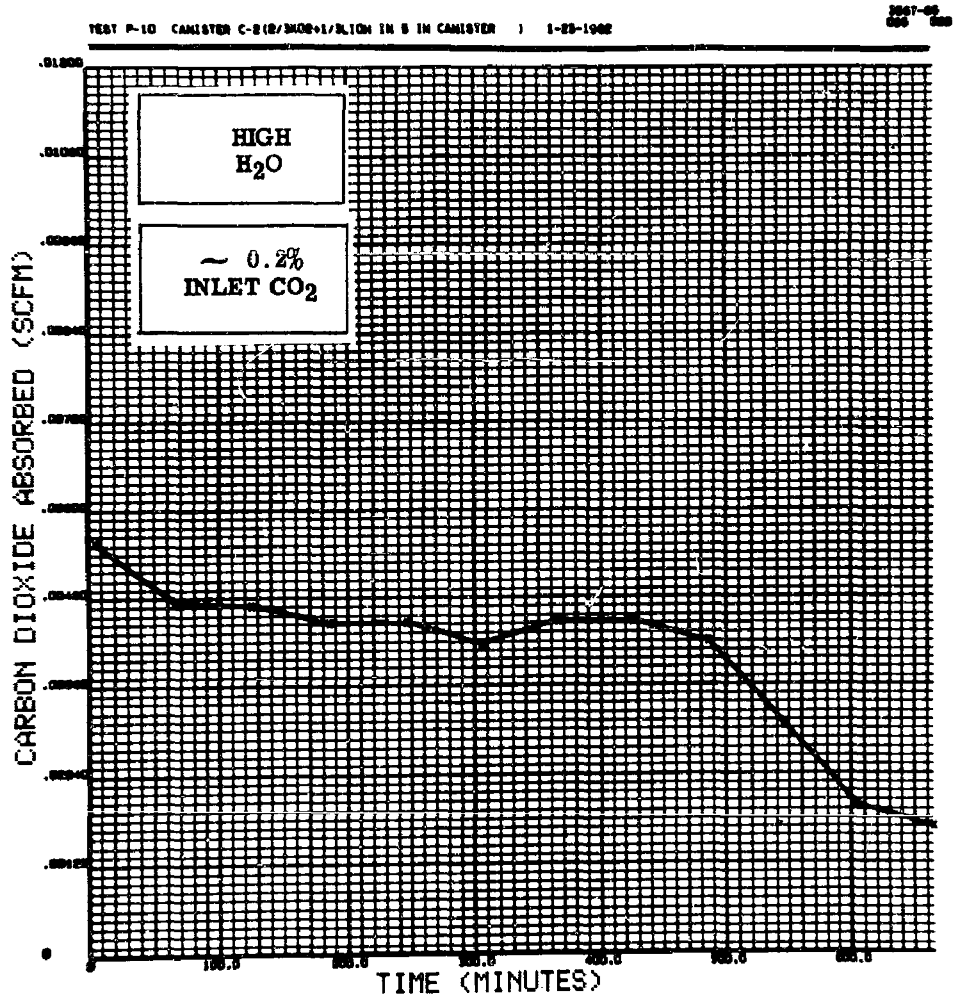

Figure 140 SC-4020 Curve, CO_2, P-10, C-2

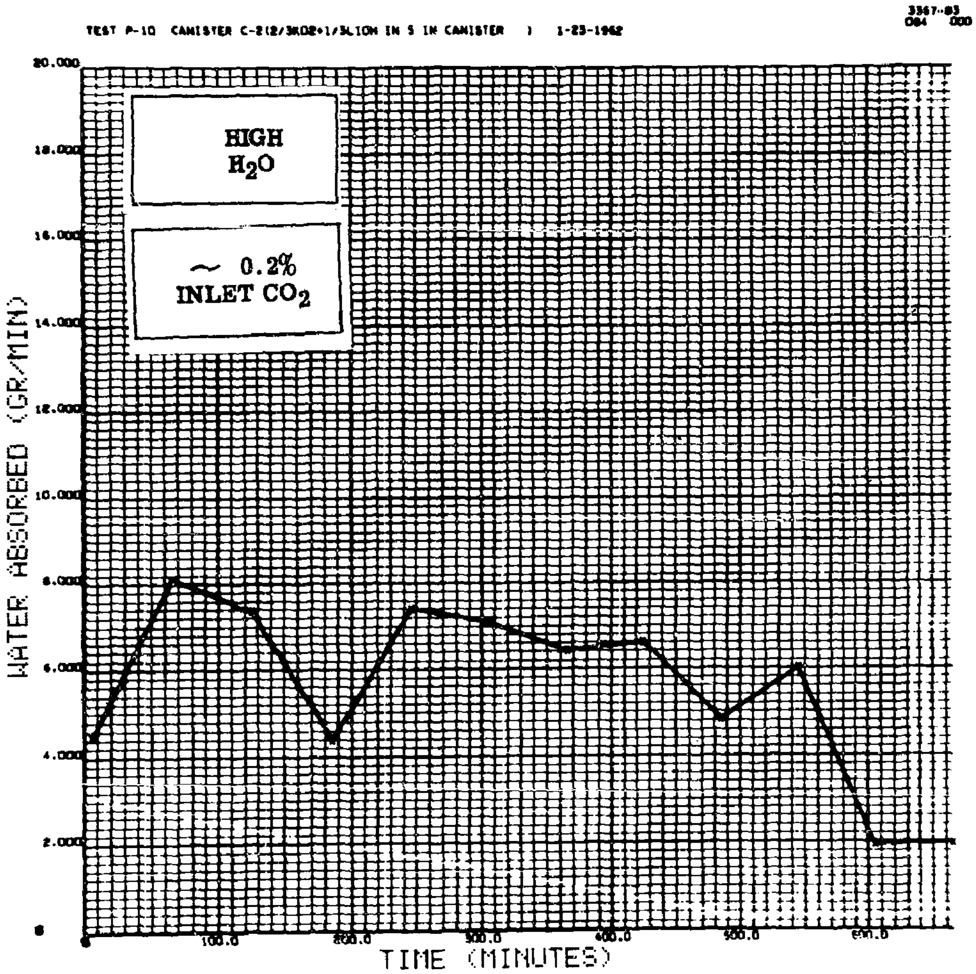

Figure 141 SC-4020 Curve, H_2O, P-10, C-2

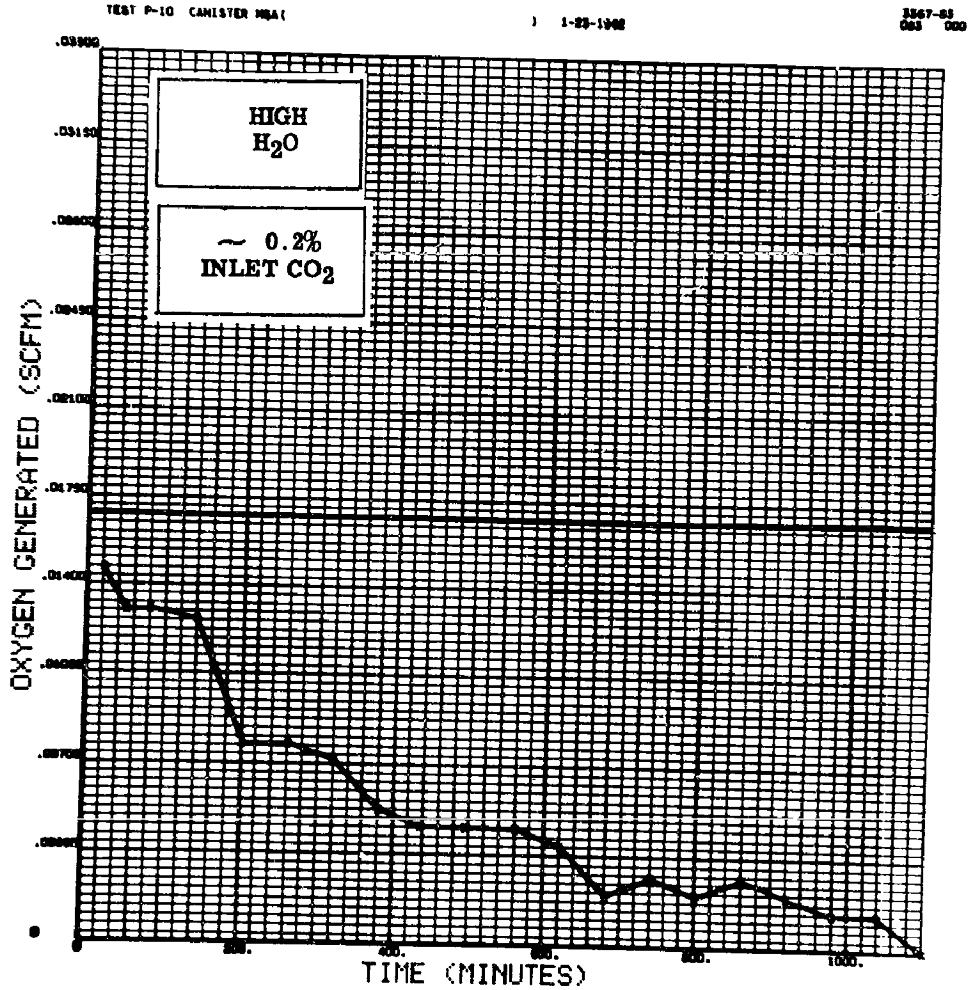

Figure 142 SC-4020 Curve, O_2, P-10, MSA

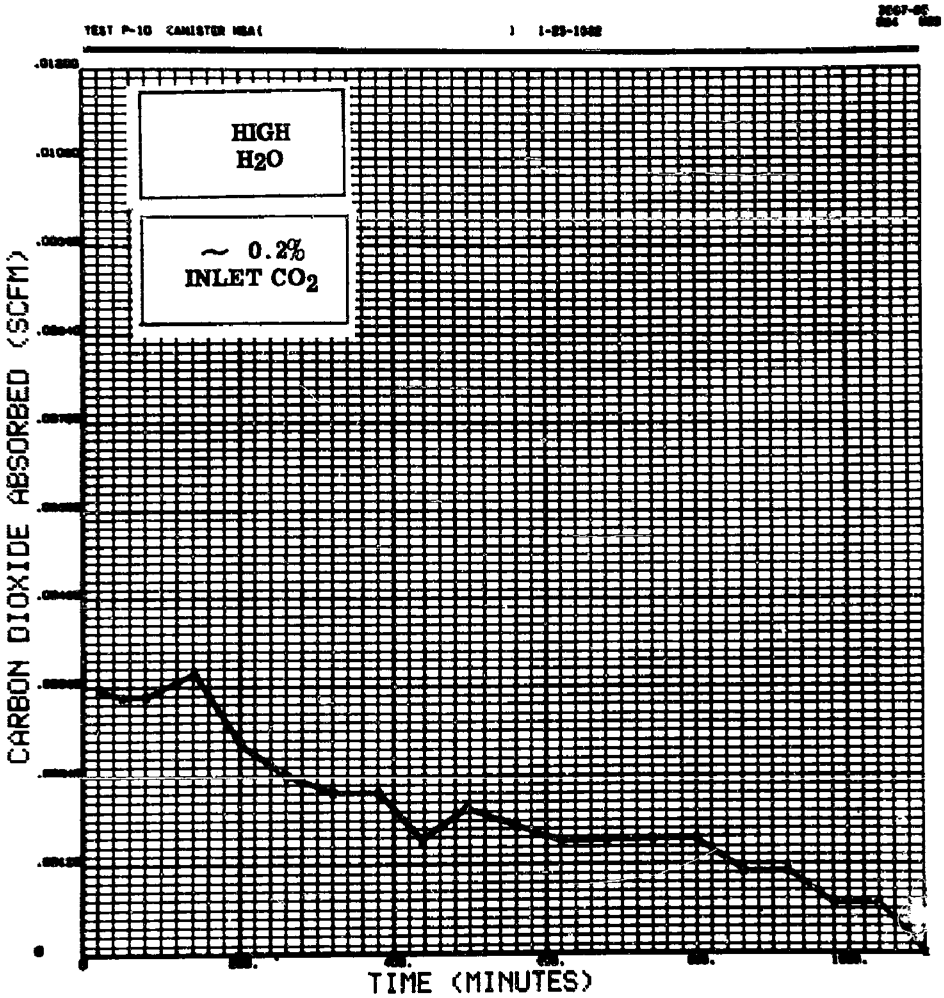

Figure 143 SC-4020 Curve, CO_2, P-10, MSA

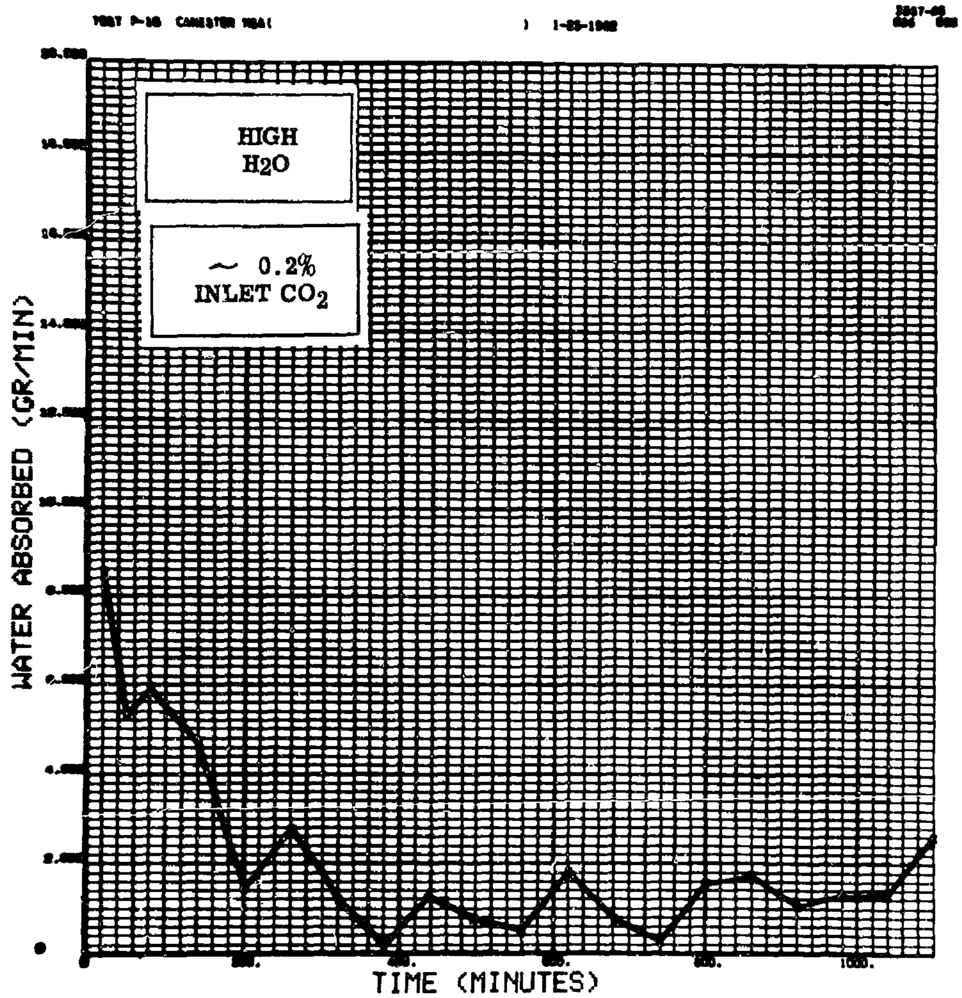

Figure 144 SC-4020 Curve, H_2O, P-10, MSA

Table 25 Cumulative Data, P-1

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister A					
0	--	--	--	--	--
15	0.25	0.19	0.21	0.12	0.65
45	0.76	0.93	0.62	0.68	0.73
90	1.51	1.95	1.24	1.47	0.75
125	2.10	2.71	1.72	1.98	0.73
150	2.52	3.19	2.06	2.33	0.73
180	3.02	3.65	2.48	2.70	0.74
215	3.61	4.03	2.96	3.13	0.78
245	4.11	4.40	3.37	3.46	0.79
Canister B					
0	--	--	--	--	--
15	0.25	0.19	0.21	0.06	0.33
45	0.76	0.77	0.62	0.38	0.49
90	1.51	1.30	1.24	0.86	0.67
125	2.10	1.66	1.72	1.16	0.70
150	2.52	1.87	2.06	1.[illegible]	0.73
180	3.02	2.04	2.48	1.60	0.78
215	3.61	2.22	2.96	1.81	0.81
245	4.11	2.41	3.37	1.96	0.81
Canister C					
0	--	--	--	--	--
5	0.08	0.07	0.07	0.06	0.81
40	0.67	1.00	0.55	0.90	0.90
80	1.34	1.86	1.10	1.83	0.98
115	1.93	2.40	1.58	2.60	1.08
145	2.43	2.71	2.00	3.22	1.19
175	2.94	2.89	2.41	3.73	1.29
205	3.44	3.02	2.82	4.17	1.38
235	3.95	3.18	3.23	4.54	1.43
Canister MSA					
0	--	--	--	--	--
5	0.08	0.10	0.07	0.06	0.56
40	0.67	1.32	0.55	0.81	0.62
80	1.34	2.35	1.10	1.52	0.65
115	1.93	3.02	1.58	2.03	0.67
145	2.43	3.43	2.00	2.41	0.70
175	2.94	3.68	2.41	2.67	0.73
205	3.44	3.85	2.82	2.86	0.74
235	3.95	4.05	3.23	3.01	0.74

Table 26 Cumulative Data, P-2

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister A					
5	0.84	0.10	0.07	0.05	0.48
45	0.76	1.52	0.62	0.85	0.56
75	1.25	2.37	1.03	1.36	0.57
105	1.76	3.16	1.44	1.71	0.54
133	2.23	3.80	1.83	2.00	0.53
165	2.77	4.47	2.27	2.34	0.52
195	3.27	5.18	2.68	2.65	0.52
225	3.78	5.66	3.10	2.89	0.51
255	4.28	6.08	3.51	3.10	0.51
285	4.79	6.53	3.92	3.33	0.51
315	5.29	7.02	4.33	3.56	0.51
345	5.79	7.49	4.75	3.77	0.50
385	6.46	8.07	5.30	4.06	0.50
405	6.80	8.30	5.57	4.20	0.51
435	7.30	8.59	5.99	4.39	0.51
Canister B					
5	0.84	0.15	0.07	0.07	0.46
45	0.76	2.07	0.62	0.98	0.47
75	1.25	3.02	1.03	1.45	0.48
105	1.76	3.78	1.44	1.84	0.49
133	2.23	4.31	1.83	2.13	0.50
165	2.77	4.73	2.27	2.40	0.51
195	3.27	5.12	2.68	2.61	0.51
225	3.78	5.41	3.10	2.77	0.51
255	4.28	5.64	3.51	2.88	0.51
285	4.79	5.87	3.92	3.01	0.51
315	5.29	6.09	4.33	3.13	0.51
345	5.79	6.30	4.75	3.24	0.52
385	6.46	6.52	5.30	3.39	0.52
405	6.80	6.61	5.57	3.46	0.52
435	7.30	6.73	5.99	3.56	0.53
Canister C					
12	0.20	0.42	0.17	0.26	0.62
51	0.86	2.51	0.70	1.66	0.66
80	1.34	3.39	1.10	2.36	0.70
115	1.93	4.10	1.58	2.99	0.73
140	2.35	4.40	1.92	3.37	0.76
170	2.85	4.92	2.34	3.75	0.79
200	3.36	5.12	2.75	4.10	0.80
230	3.86	5.52	3.17	4.41	0.80
262	4.40	5.88	3.61	4.70	0.80
290	4.87	6.11	3.99	4.90	0.80
320	5.37	6.33	4.40	5.09	0.81
350	5.88	6.54	4.82	5.26	0.81
377	6.33	6.71	5.19	5.38	0.80
408	6.85	6.86	5.61	5.43	0.80
440	7.39	7.00	6.05	5.60	0.80
Canister MSA					
12	0.20	0.23	0.17	0.11	0.49
51	0.86	1.56	0.70	0.78	0.50
80	1.34	2.24	1.10	1.14	0.51
115	1.93	2.73	1.58	1.42	0.52
140	2.35	2.90	1.93	1.54	0.55
170	2.85	3.11	2.34	1.73	0.57
200	3.36	3.38	2.75	1.90	0.57
230	3.86	3.60	3.17	2.04	0.58
262	4.40	3.81	3.61	2.15	0.57
290	4.87	3.98	3.99	2.23	0.57
320	5.37	4.16	4.40	2.30	0.56
350	5.88	4.35	4.82	2.38	0.56
377	6.33	4.48	5.19	2.43	0.55
408	6.85	4.59	5.61	2.48	0.55
440	7.39	4.71	6.05	2.54	0.55

Table 27 Cumulative Data, P-3

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister A					
0	--	--	--	--	--
15	0.25	0.29	0.21	0.15	0.50
55	0.92	1.80	0.76	0.86	0.48
75	1.26	2.51	1.03	1.19	0.47
107	1.80	3.58	1.47	1.66	0.46
135	2.27	4.47	1.86	2.02	0.45
165	2.77	5.30	2.27	2.41	0.45
195	3.27	6.02	2.68	2.78	0.46
225	3.78	6.66	3.10	3.11	0.47
255	4.28	7.17	3.51	3.44	0.48
280	4.70	7.52	3.85	3.67	0.49
315	5.29	7.97	4.33	3.97	0.50
345	5.79	8.30	4.75	4.21	0.51
375	6.30	8.59	5.16	4.42	0.51
405	6.80	8.86	5.57	4.60	0.52
435	7.30	9.03	5.99	4.75	0.53
Canister B					
0	--	--	--	--	--
15	0.25	0.33	0.21	0.16	0.48
55	0.92	1.76	0.76	0.88	0.50
75	1.26	2.31	1.03	1.16	0.50
107	1.80	3.13	1.47	1.54	0.49
135	2.27	3.76	1.86	1.84	0.49
165	2.77	4.31	2.27	2.13	0.49
195	3.27	4.73	2.68	2.37	0.50
225	3.78	5.05	3.10	2.56	0.51
255	4.28	5.31	3.51	2.73	0.51
280	4.70	5.47	3.85	2.86	0.52
315	5.29	5.66	4.33	3.02	0.53
345	5.79	5.83	4.75	3.15	0.54
375	6.30	6.01	5.16	3.27	0.54
405	6.80	6.17	5.57	3.37	0.55
435	7.30	6.30	5.99	3.45	0.55
Canister C					
0	--	--	--	--	--
30	0.50	0.74	0.41	0.57	0.77
65	1.09	2.10	0.89	1.74	0.83
83	1.39	2.51	1.14	2.18	0.87
110	1.85	2.93	1.51	2.69	0.92
140	2.35	3.27	1.93	3.17	0.97
170	2.85	3.57	2.34	3.60	1.01
200	3.36	3.83	2.75	3.97	1.04
230	3.86	4.04	3.16	4.27	1.06
260	4.37	4.23	3.58	4.52	1.07
290	4.87	4.37	3.99	4.76	1.09
320	5.37	4.50	4.40	4.99	1.11
350	5.88	4.64	4.82	5.19	1.12
385	6.46	4.81	5.30	5.43	1.13
410	6.88	4.93	5.64	5.58	1.13
440	7.39	5.06	6.05	5.73	1.13
Canister MSA					
0	--	--	--	--	--
30	0.50	0.53	0.41	0.23	0.44
65	1.09	1.63	0.89	0.76	0.46
83	1.39	2.06	1.14	0.98	0.47
110	1.85	2.56	1.51	1.22	0.48
140	2.35	2.97	1.93	1.45	0.49
170	2.85	3.29	2.34	1.65	0.50
200	3.36	3.53	2.75	1.82	0.51
230	3.86	3.72	3.16	1.96	0.53
260	4.37	3.86	3.58	2.10	0.54
290	4.87	3.99	3.99	2.23	0.56
320	5.37	4.12	4.40	2.38	0.58
350	5.88	4.27	4.82	2.54	0.59
385	6.46	4.42	5.30	2.69	0.61
410	6.88	4.51	5.64	2.78	0.62
440	7.39	4.60	6.05	2.86	0.62

Table 28 Cumulative Data, P-4

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister A					
0	--	--	--	--	--
20	0.34	0.23	0.28	0.14	0.62
65	1.09	1.24	0.89	0.70	0.56
95	1.60	1.89	1.31	0.99	0.52
140	2.35	2.83	1.93	1.40	0.49
180	3.02	3.56	2.48	1.77	0.50
218	3.66	4.17	3.00	2.11	0.51
242	4.06	4.53	3.33	2.30	0.51
Canister B					
0	--	--	--	--	--
20	0.34	0.25	0.28	0.15	0.63
65	1.09	1.31	0.89	0.78	0.59
95	1.60	1.96	1.31	1.12	0.57
140	2.35	2.76	1.93	1.55	0.56
180	3.02	3.33	2.48	1.88	0.56
218	3.66	3.76	3.00	2.18	0.58
242	4.06	4.00	3.33	2.35	0.59
Canister C					
5	0.08	0.14	0.07	0.06	0.46
50	0.84	2.01	0.69	0.99	0.49
90	1.51	3.11	1.24	1.80	0.58
135	2.27	4.11	1.86	2.64	0.64
175	2.94	4.76	2.41	3.29	0.69
213	3.58	5.23	2.93	3.84	0.73
237	3.98	5.47	3.26	4.16	0.76
Canister MSA					
5	0.08	0.01	0.07	0.06	4.18
50	0.84	0.63	0.69	0.83	1.32
90	1.51	1.40	1.24	1.21	0.87
135	2.27	2.05	1.86	1.51	0.73
175	2.94	2.50	2.41	1.72	0.69
213	3.58	2.82	2.93	1.89	0.67
237	3.98	2.98	3.26	1.97	0.66

Table 29 Cumulative Data, P-5

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister A-2					
0	--	--	--	--	--
17	0.29	0.29	0.23	0.14	0.47
47	0.79	1.24	0.65	0.53	0.43
68	1.14	1.78	0.94	0.73	0.41
102	1.71	2.60	1.40	1.02	0.39
132	2.22	3.28	1.82	1.26	0.39
167	2.80	3.91	2.30	1.53	0.39
207	3.48	4.48	2.85	1.81	0.40
227	3.81	4.72	3.12	1.92	0.41
252	4.23	5.03	3.47	2.05	0.41
287	4.82	5.47	3.95	2.22	0.41
317	5.32	5.79	4.36	2.36	0.41
Canister A-3					
0	--	--	--	--	--
17	0.29	0.11	0.23	0.08	0.67
47	0.79	0.48	0.65	0.30	0.62
68	1.14	0.71	0.94	0.42	0.60
102	1.71	1.10	1.40	0.61	0.56
132	2.22	1.42	1.82	0.76	0.54
167	2.80	1.73	2.30	0.91	0.53
207	3.48	1.96	2.85	1.08	0.55
227	3.81	2.01	3.12	1.16	0.57
252	4.23	2.10	3.47	1.24	0.59
287	4.82	2.25	3.95	1.35	0.60
317	5.32	2.38	4.36	1.45	0.61
Canister D					
0	--	--	--	--	--
22	0.37	0.60	0.30	0.24	0.40
52	0.87	1.96	0.72	0.86	0.44
73	1.23	2.63	1.00	1.25	0.47
107	1.80	3.57	1.47	1.81	0.51
137	2.30	4.23	1.89	2.23	0.53
172	2.89	4.81	2.37	2.66	0.55
209	3.51	5.29	2.88	3.08	0.58
232	3.90	5.54	3.19	3.34	0.60
257	4.32	5.81	3.54	3.58	0.62
292	4.90	6.16	4.02	3.90	0.63
322	5.41	6.45	4.43	4.17	0.65
Canister MSA					
0	--	--	--	--	--
22	0.37	0.33	0.30	0.15	0.46
52	0.87	1.15	0.72	0.52	0.45
73	1.23	1.58	1.00	0.71	0.45
107	1.80	2.16	1.47	0.95	0.44
137	2.30	2.53	1.89	1.12	0.44
172	2.89	2.84	2.37	1.29	0.45
209	3.51	3.07	2.88	1.45	0.47
232	3.90	3.18	3.19	1.55	0.49
257	4.32	3.31	3.54	1.63	0.49
292	4.90	3.51	4.02	1.73	0.49
322	5.41	3.65	4.43	1.82	0.50

Table 30 Cumulative Data, P-6

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister A-2					
14	0.24	0.02	0.19	0.02	0.84
56	0.94	0.20	0.77	0.13	0.63
86	1.44	0.36	1.18	0.19	0.54
116	1.95	0.50	1.60	0.25	0.50
146	2.45	0.63	2.01	0.32	0.50
206	3.46	0.91	2.83	0.45	0.50
266	4.47	1.19	3.66	0.60	0.50
326	5.47	1.55	4.49	0.78	0.50
386	6.48	1.96	5.31	0.96	0.49
446	7.49	2.25	6.14	1.11	0.50
Canister A-4					
14	0.24	0.01	0.19	0.02	2.98
56	0.94	0.06	0.77	0.11	1.90
86	1.44	0.10	1.18	0.16	1.63
116	1.95	0.13	1.60	0.19	1.42
146	2.45	0.18	2.01	0.22	1.22
206	3.46	0.28	2.83	0.28	1.00
266	4.47	0.36	3.66	0.35	0.97
326	5.47	0.51	4.49	0.45	0.88
386	6.48	0.79	5.31	0.58	0.73
446	7.49	0.99	6.14	0.68	0.69
Canister A-5					
19	0.32	0.04	0.26	0.04	1.00
61	1.02	0.24	0.84	0.20	0.85
91	1.53	0.39	1.25	0.29	0.75
121	2.03	0.53	1.66	0.36	0.69
156	2.62	0.67	2.15	0.45	0.67
216	3.63	0.90	2.97	0.61	0.67
276	4.63	1.10	3.80	0.77	0.70
336	5.64	1.36	4.62	0.97	0.71
396	6.65	1.66	5.45	1.16	0.70
456	7.66	1.91	6.27	1.32	0.69
Canister MSA					
19	0.32	0.05	0.26	0.03	0.63
61	1.02	0.27	0.84	0.16	0.58
91	1.53	0.42	1.25	0.24	0.57
121	2.03	0.56	1.66	0.32	0.57
156	2.62	0.69	2.15	0.40	0.58
216	3.63	0.90	2.97	0.53	0.58
276	4.63	1.12	3.80	0.66	0.59
336	5.64	1.42	4.62	0.82	0.58
396	6.65	1.79	5.45	1.01	0.56
456	7.66	2.04	6.27	1.14	0.56

Table 31 Cumulative Data, P-7

TIME MIN.	OXYGEN SCF CONSUMED	GENERATED	CARBON DIOXIDE SCF PRODUCED	ABSORBED	CUM. R.Q.
Canister A					
15	0.25	0.08	0.21	0.02	0.28
45	0.76	0.48	0.62	0.12	0.25
75	1.26	0.94	1.03	0.21	0.23
120	2.01	1.61	1.65	0.35	0.22
150	2.52	2.04	2.06	0.44	0.22
180	3.02	2.46	2.48	0.53	0.21
240	4.03	3.25	3.30	0.72	0.22
300	5.04	3.87	4.13	0.41	0.24
360	6.04	4.48	4.95	1.08	0.24
420	7.05	5.11	5.78	1.22	0.24
Canister A-6					
15	0.25	0.09	0.21	0.03	0.29
45	0.76	0.44	0.62	0.13	0.29
75	1.26	0.79	1.03	0.21	0.26
120	2.01	1.32	1.65	0.32	0.25
150	2.52	1.66	2.06	0.41	0.25
180	3.02	2.00	2.48	0.50	0.25
240	4.03	2.65	3.30	0.68	0.26
300	5.04	3.20	4.13	0.86	0.27
360	6.04	3.74	4.95	1.03	0.27
420	7.05	4.31	5.78	1.17	0.27
Canister A-7					
20	0.34	0.17	0.28	0.04	0.22
50	0.84	0.62	0.69	0.14	0.23
80	1.34	1.00	1.10	0.22	0.22
125	2.10	1.54	1.72	0.34	0.22
155	2.60	1.90	2.13	0.43	0.22
185	3.11	2.24	2.55	0.51	0.23
245	4.11	2.85	3.37	0.68	0.24
305	5.12	3.35	4.70	0.86	0.26
365	6.13	3.83	5.02	1.03	0.27
425	7.14	4.33	5.85	1.18	0.27
Canister MSA					
20	0.34	0.14	0.28	0.03	0.24
50	0.84	0.58	0.69	0.13	0.23
80	1.34	1.04	1.10	0.23	0.22
125	2.10	1.70	1.72	0.38	0.22
155	2.60	2.09	2.13	0.47	0.23
185	3.11	2.43	2.55	0.56	0.23
245	4.11	3.03	3.37	0.73	0.24
305	5.12	3.44	4.20	0.88	0.26
365	6.13	3.75	5.02	1.01	0.27
425	7.14	4.07	5.85	1.12	0.28

Table 32 Cumulative Data, P-8

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister A					
13	0.22	0.04	0.18	0.03	0.67
43	0.72	0.25	0.59	0.16	0.65
73	1.23	0.53	1.00	0.32	0.60
103	1.73	0.89	1.42	0.49	0.55
148	2.48	1.53	2.04	0.79	0.52
183	3.07	2.00	2.52	1.03	0.51
208	3.49	2.29	2.86	1.19	0.52
238	4.00	2.62	3.27	1.36	0.52
268	4.50	2.93	3.69	1.51	0.52
298	5.00	3.18	4.10	1.65	0.52
328	5.51	3.38	4.51	1.78	0.53
358	6.01	3.56	4.93	1.89	0.53
388	6.51	3.71	5.34	1.99	0.54
423	7.10	3.96	5.82	2.11	0.53
468	7.86	4.30	6.44	2.31	0.54
533	8.95	4.70	7.33	2.63	0.56
593	9.96	5.36	8.16	2.95	0.55
653	10.96	6.10	8.99	3.31	0.54
713	11.97	6.66	9.81	3.65	0.55
Canister A-6					
13	0.22	0.02	0.18	0.02	1.33
43	0.72	0.08	0.59	0.10	1.22
73	1.23	0.14	1.00	0.15	1.04
103	1.73	0.25	1.42	0.20	0.80
148	2.48	0.51	2.04	0.31	0.60
183	3.07	0.80	2.52	0.46	0.58
208	3.49	1.01	2.86	0.57	0.56
238	4.00	1.29	3.27	0.71	0.55
268	4.50	1.55	3.69	0.85	0.55
298	5.00	1.78	4.10	0.96	0.54
328	5.51	1.96	4.51	1.06	0.54
358	6.01	2.11	4.93	1.15	0.54
388	6.51	2.25	5.34	1.23	0.54
423	7.10	2.39	5.82	1.32	0.55
468	6.86	2.57	6.44	1.43	0.56
533	8.95	3.02	7.33	1.65	0.54
593	9.96	3.78	8.16	1.97	0.52
653	10.96	4.54	8.99	2.37	0.52
713	11.97	5.12	9.81	2.73	0.53
Canister A-7					
23	0.39	0.17	0.32	0.07	0.39
53	0.89	0.53	0.73	0.25	0.48
83	1.39	0.78	1.14	0.43	0.55
113	1.90	1.03	1.55	0.58	0.56
153	2.57	1.40	2.11	0.79	0.57
186	3.12	1.70	2.56	0.98	0.58
213	3.58	1.94	2.93	1.13	0.59
243	4.08	2.20	3.34	1.30	0.59
273	4.58	2.44	3.76	1.46	0.60
303	5.09	2.66	4.17	1.59	0.60
333	5.59	2.85	4.58	1.71	0.60
363	6.09	2.98	4.99	1.82	0.61
393	6.60	3.10	5.41	1.92	0.62

Table 32 (cont.) Cumulative Data, P-8

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister A-7 (Cont'd)					
433	7.27	3.30	5.96	2.03	0.62
473	7.94	3.50	6.51	2.17	0.62
543	9.12	3.80	7.47	2.46	0.65
598	10.04	4.21	8.23	2.74	0.65
658	11.05	4.76	9.05	3.06	0.64
718	12.06	5.21	9.88	3.36	0.65
Canister MSA					
23	0.39	0.09	0.32	0.05	0.55
53	0.89	0.35	0.73	0.21	0.62
83	1.39	0.64	1.14	0.41	0.64
113	1.90	1.04	1.55	0.63	0.61
153	2.57	1.63	2.11	0.95	0.58
186	3.12	2.03	2.56	1.17	0.58
213	3.58	2.32	2.93	1.33	0.58
243	4.08	2.60	3.34	1.50	0.58
273	4.58	2.81	3.76	1.63	0.58
303	5.09	2.95	4.17	1.73	0.59
333	5.59	3.05	4.58	1.80	0.59
363	6.09	3.14	4.99	1.86	0.59
393	6.60	3.22	5.41	1.93	0.60
433	7.27	3.34	5.96	2.02	0.61
473	7.94	3.46	6.51	2.13	0.62
543	9.12	3.73	7.47	2.37	0.64
598	10.04	4.09	8.23	2.63	0.64
658	11.05	4.51	9.05	2.92	0.65
718	12.06	4.81	9.88	3.15	0.66

Table 33 Cumulative Data, P-9

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister A					
15	0.25	0.10	0.21	0.05	0.52
45	0.76	0.46	0.62	0.20	0.43
75	1.26	0.82	1.03	0.30	0.36
115	1.93	1.32	1.58	0.43	0.32
145	2.43	1.70	2.00	0.53	0.31
175	2.94	2.06	2.41	0.63	0.30
205	3.44	2.42	2.82	0.70	0.29
240	4.03	2.86	3.30	0.79	0.28
265	4.45	3.13	3.65	0.88	0.28
310	5.20	3.52	4.27	1.01	0.29
355	5.96	3.80	4.88	1.09	0.29
385	6.46	3.97	5.30	1.16	0.29
445	7.47	4.35	6.12	1.32	0.30
505	8.48	4.74	6.95	1.46	0.31
565	9.49	5.16	7.77	1.79	0.35
Canister A-6					
15	0.25	0.09	0.21	0.05	0.63
45	0.76	0.45	0.62	0.24	0.53
75	1.26	0.85	1.03	0.37	0.44
115	1.93	1.39	1.58	0.55	0.40
145	2.43	1.77	2.00	0.69	0.39
175	2.94	2.13	2.41	0.82	0.39
205	3.44	2.49	2.82	0.91	0.37
240	4.03	2.93	3.30	1.00	0.34
265	4.45	3.20	3.65	1.05	0.33
310	5.20	3.63	4.27	1.14	0.31
355	5.96	4.05	4.88	1.23	0.30
385	6.46	4.26	5.30	1.31	0.31
445	7.47	4.56	6.12	1.47	0.32
505	8.48	4.90	6.95	1.61	0.33
565	9.49	5.33	7.77	1.98	0.37
Canister A-7					
20	0.34	0.23	0.28	0.08	0.35
55	0.92	0.87	0.76	0.31	0.36
80	1.34	1.24	1.10	0.42	0.34
115	1.93	1.76	1.58	0.59	0.34
150	2.52	2.23	2.06	0.79	0.36
180	3.02	2.59	2.48	0.93	0.36
210	3.53	2.95	2.89	1.06	0.36
240	4.03	3.29	3.30	1.20	0.37
270	4.53	3.57	3.72	1.34	0.38
315	5.29	3.97	4.33	1.52	0.38
360	6.04	4.42	4.95	1.67	0.38
395	6.63	4.73	5.44	1.78	0.38
455	7.64	5.07	6.26	1.99	0.39
515	8.65	5.49	7.09	2.11	0.40
575	9.65	5.92	7.91	2.41	0.41

Table 33 (cont.) Cumulative Data, P-9

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister MSA					
20	0.34	0.14	0.28	0.07	0.51
55	0.92	0.60	0.76	0.27	0.45
80	1.34	0.91	1.10	0.36	0.40
115	1.93	1.31	1.58	0.50	0.39
150	2.52	1.67	2.06	0.66	0.39
180	3.02	1.93	2.48	0.76	0.39
210	3.53	2.20	2.89	0.86	0.39
240	4.03	2.44	3.30	0.95	0.39
270	4.53	2.61	3.72	1.01	0.39
315	5.29	2.87	4.33	1.08	0.38
360	6.04	3.04	4.95	1.13	0.37
395	6.63	3.12	5.44	1.17	0.37
455	7.64	3.33	6.26	1.29	0.39
515	8.65	3.58	7.09	1.41	0.39
575	9.65	3.81	7.91	1.50	0.39

Table 34 Cumulative Data, P-10

TIME MIN.	OXYGEN SCF CONSUMED	OXYGEN SCF GENERATED	CARBON DIOXIDE SCF PRODUCED	CARBON DIOXIDE SCF ABSORBED	CUM. R.Q.
Canister E					
0	--	--	--	--	--
15	0.25	0.15	0.21	0.04	0.23
45	0.76	0.73	0.62	0.19	0.26
75	1.26	1.27	1.03	0.36	0.28
135	2.27	2.28	1.86	0.71	0.31
195	3.27	3.14	2.68	1.05	0.34
255	4.78	3.81	3.51	1.31	0.34
315	5.29	4.28	4.33	1.45	0.34
375	6.30	4.45	5.16	1.50	0.34
Canister A-8					
0	--	--	--	--	--
15	0.25	0.14	0.21	0.03	0.24
45	0.76	0.71	0.62	0.18	0.25
75	1.26	1.28	1.03	0.32	0.25
135	2.27	2.42	1.86	0.62	0.26
195	3.27	3.50	2.68	0.93	0.27
255	4.28	4.51	3.51	1.22	0.27
315	5.29	5.53	4.33	1.50	0.27
375	6.30	6.51	5.16	1.77	0.27
Canister F					
0	--	--	--	--	--
20	0.34	0.22	0.28	0.05	0.24
50	0.84	0.90	0.69	0.22	0.24
80	1.34	1.57	1.10	0.39	0.25
140	2.35	2.91	1.93	0.74	0.26
200	3.36	4.27	2.75	1.10	0.26
260	4.37	5.32	3.58	1.35	0.25
320	5.37	5.94	4.40	1.48	0.25
380	6.38	6.19	5.23	1.54	0.25
Canister C-2					
0	--	--	--	--	--
5	0.08	0.09	0.07	0.01	0.16
65	1.09	1.59	0.89	0.32	0.20
125	2.10	2.44	1.72	0.61	0.25
185	3.11	3.11	2.55	0.88	0.28
245	4.11	3.69	3.37	1.15	0.31
305	5.12	4.24	4.20	1.41	0.33
365	6.13	4.76	5.02	1.67	0.35
Canister MSA					
0	--	--	--	--	--
20	0.34	0.15	0.28	0.04	0.24
50	0.84	0.56	0.69	0.14	0.25
80	1.34	0.95	1.10	0.24	0.26
140	2.35	1.72	1.93	0.46	0.27
200	3.36	2.34	2.75	0.66	0.28
260	4.37	2.80	3.58	0.82	0.29
320	5.37	3.25	4.40	0.95	0.29
380	6.38	3.62	5.23	1.08	0.30

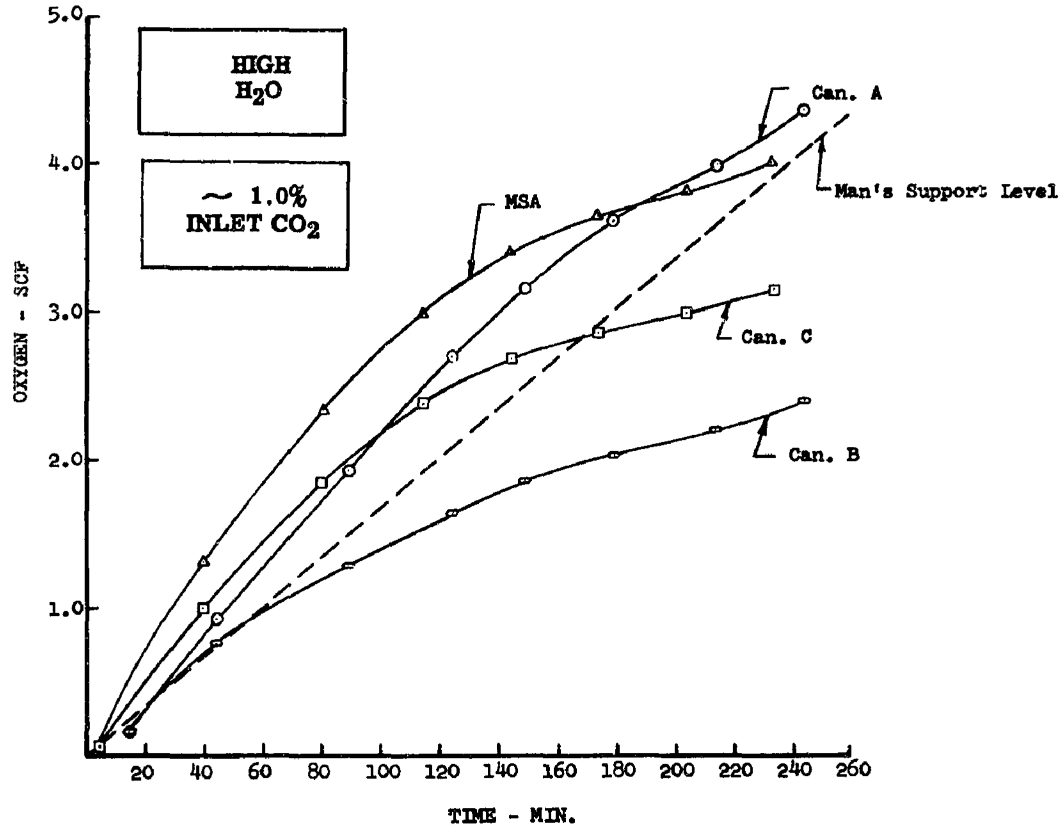

Figure 145 Man-Rate Support Level Graph, O_2, P-1

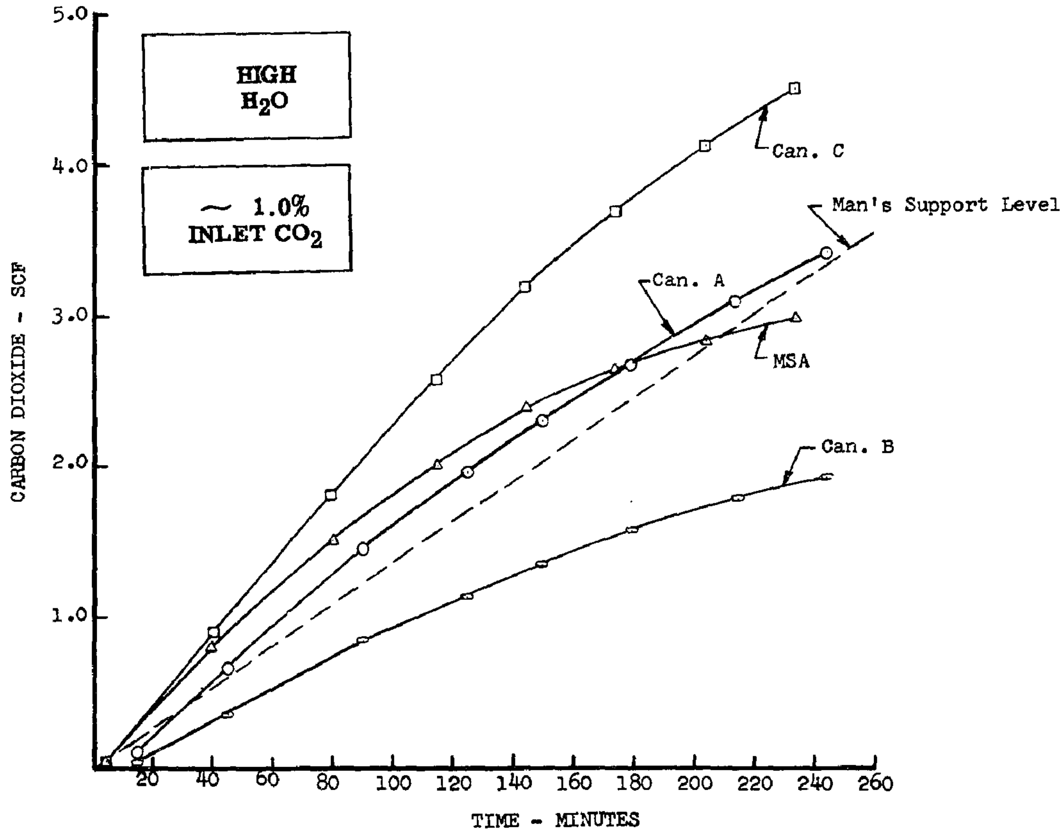

Figure 146 Man-Rate Support Level Graph, CO_2, P-1

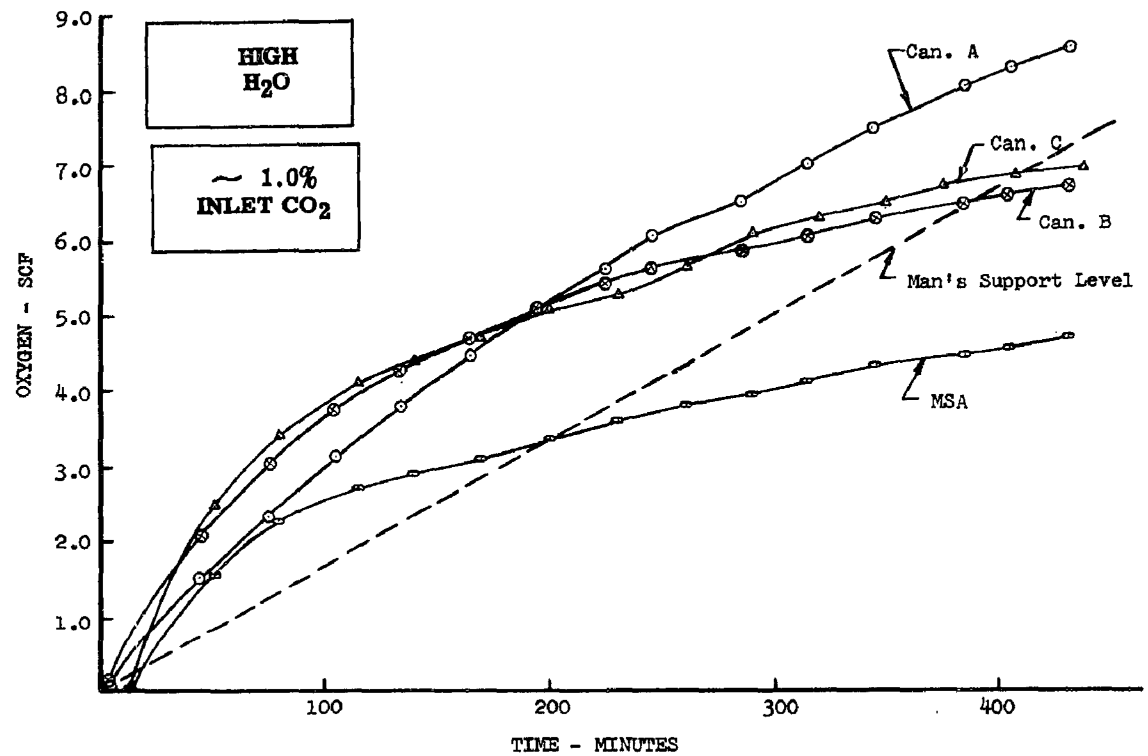

Figure 147 Man-Rate Support Level Graph, O_2, P-2

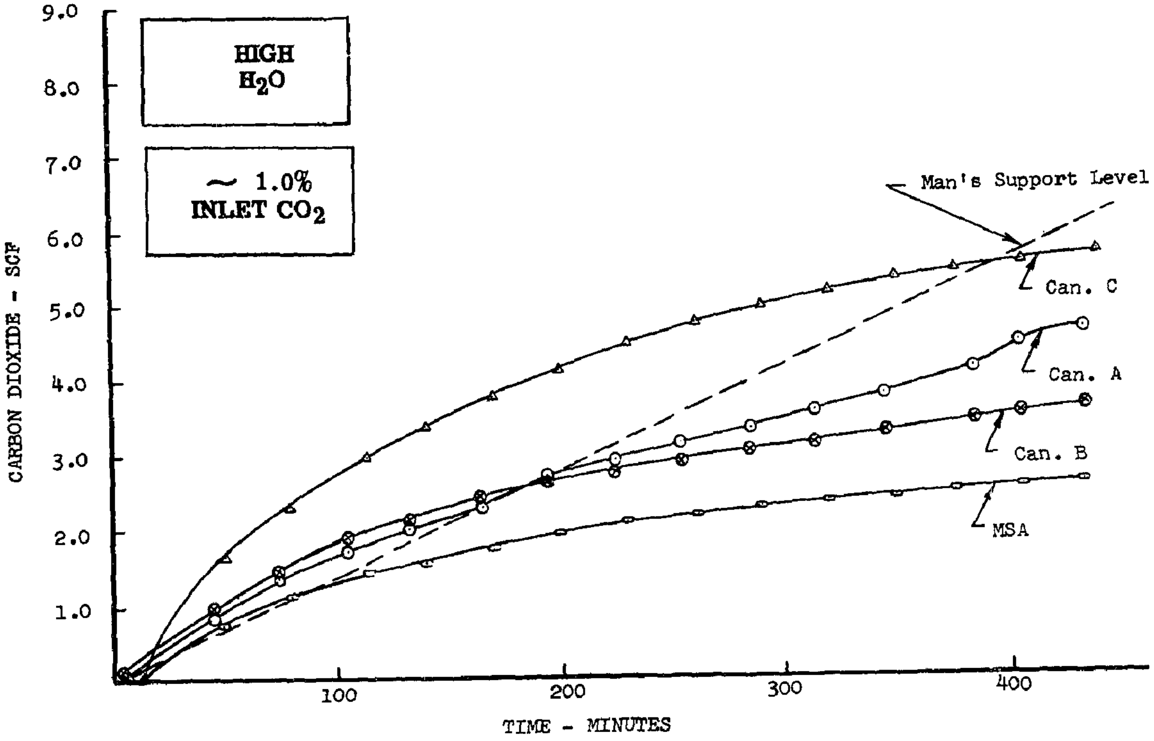

Figure 148 Man-Rate Support Level Graph, CO_2, P-2

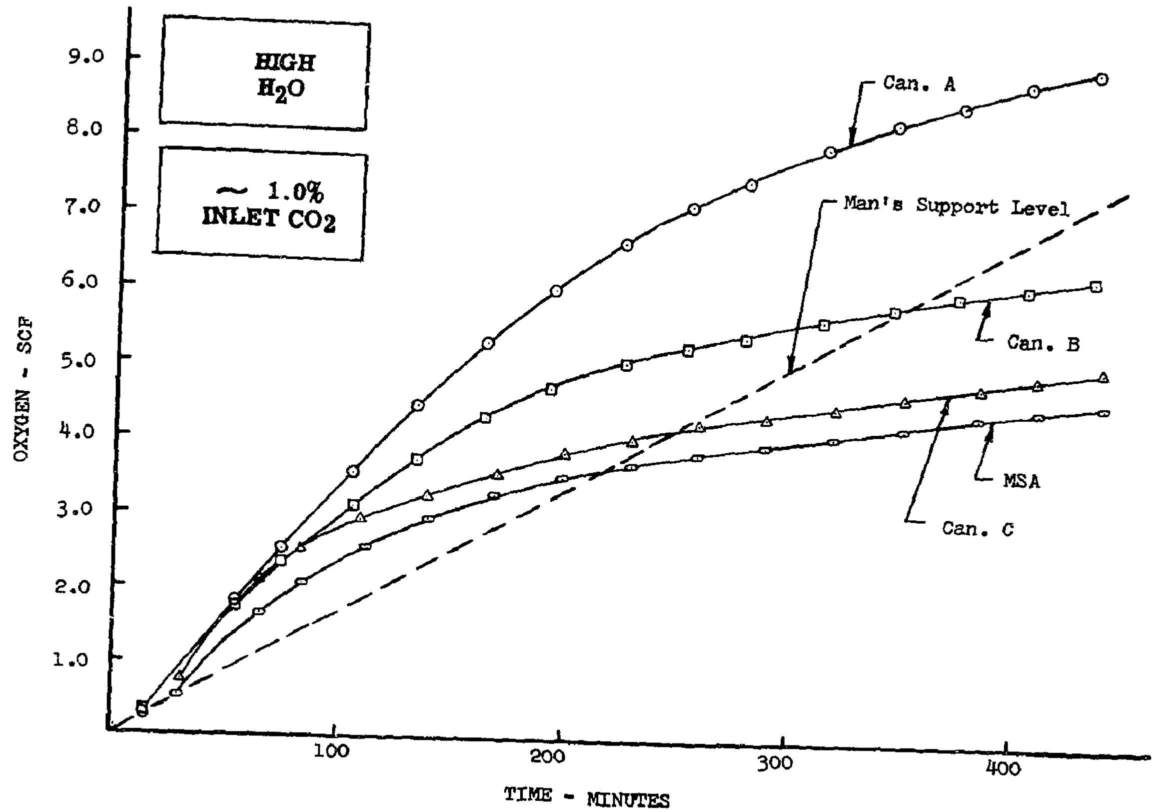

Figure 149 Man-Rate Support Level Graph, O_2, P-3

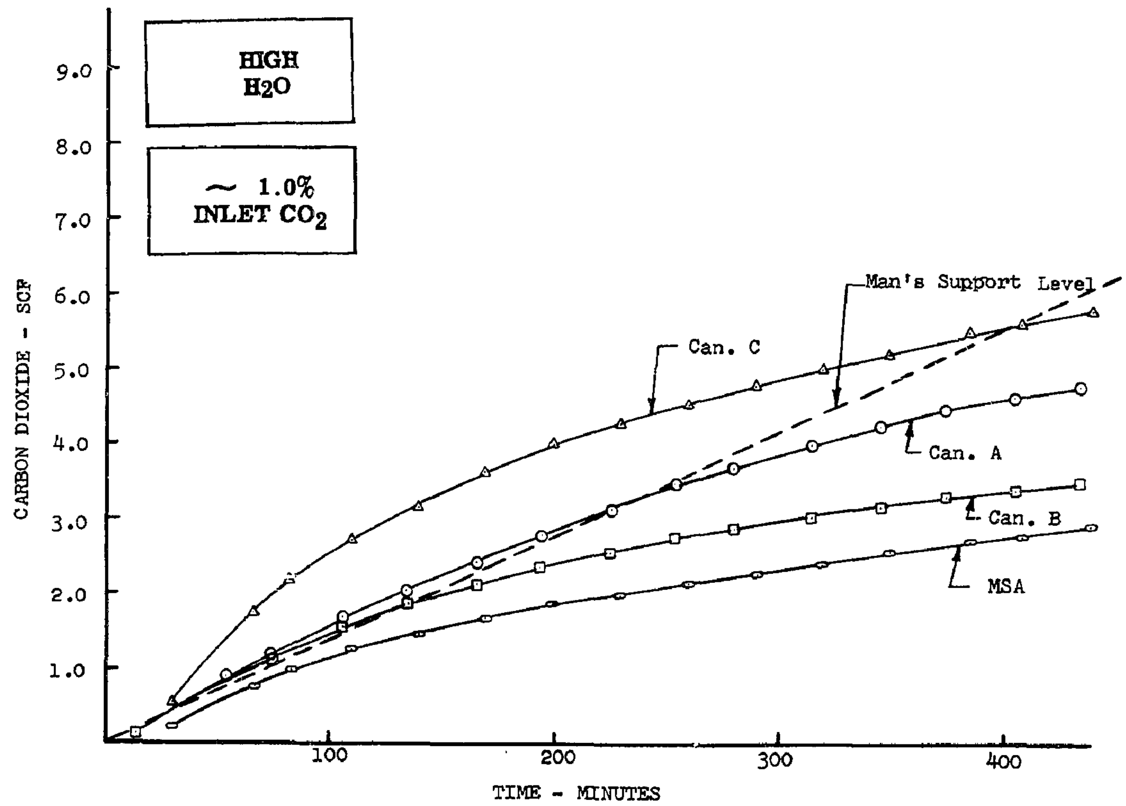

Figure 150 Man-Rate Support Level Graph, CO_2, P-3

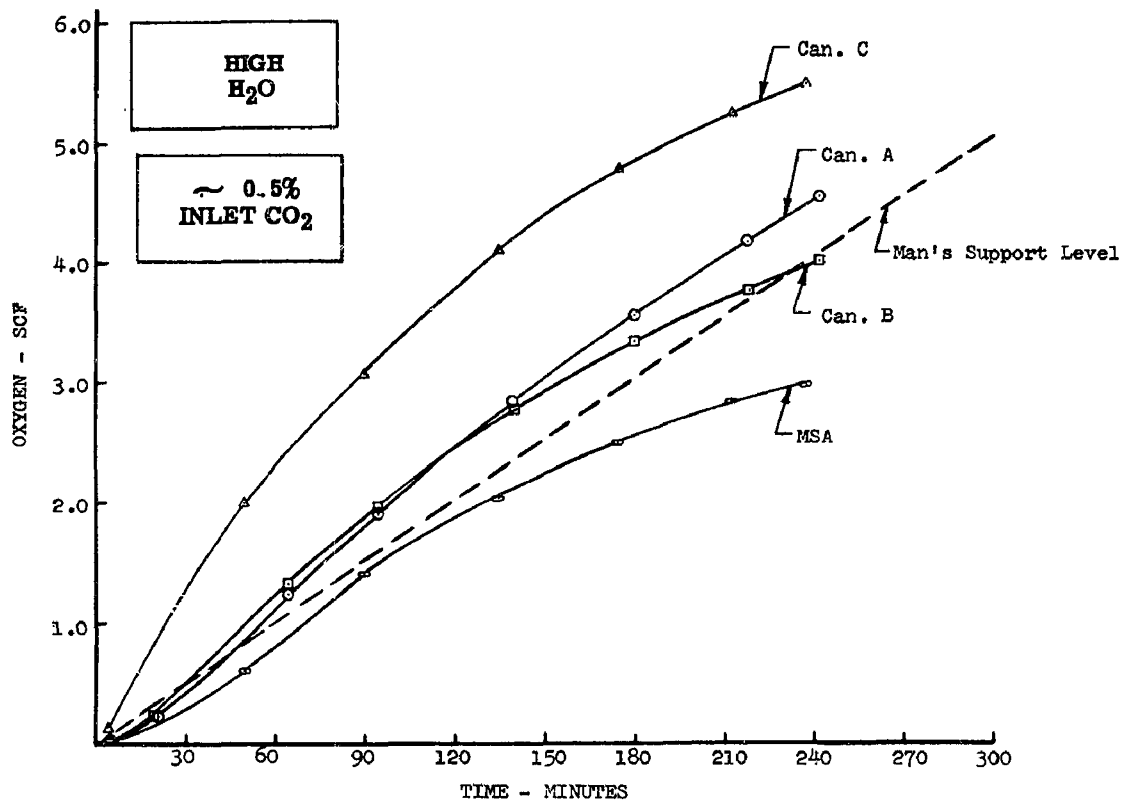

Figure 151 Man-Rate Support Level Graph, O_2, P-4

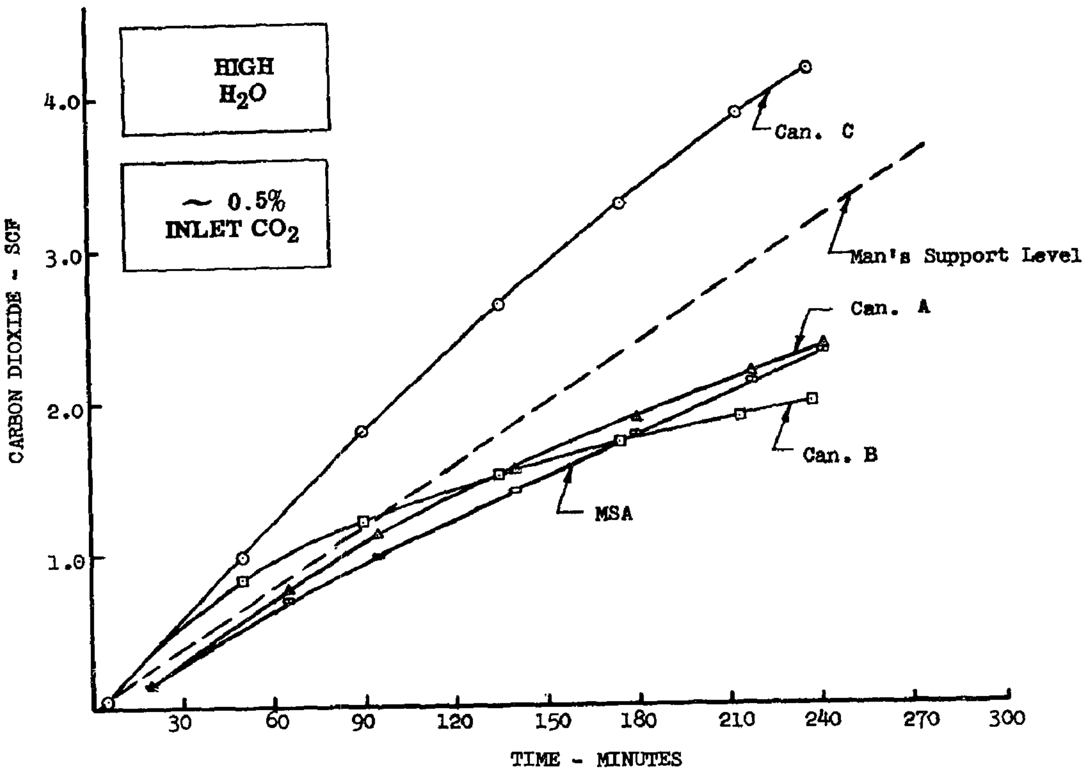

Figure 152 Man-Rate Support Level Graph, CO_2, P-4

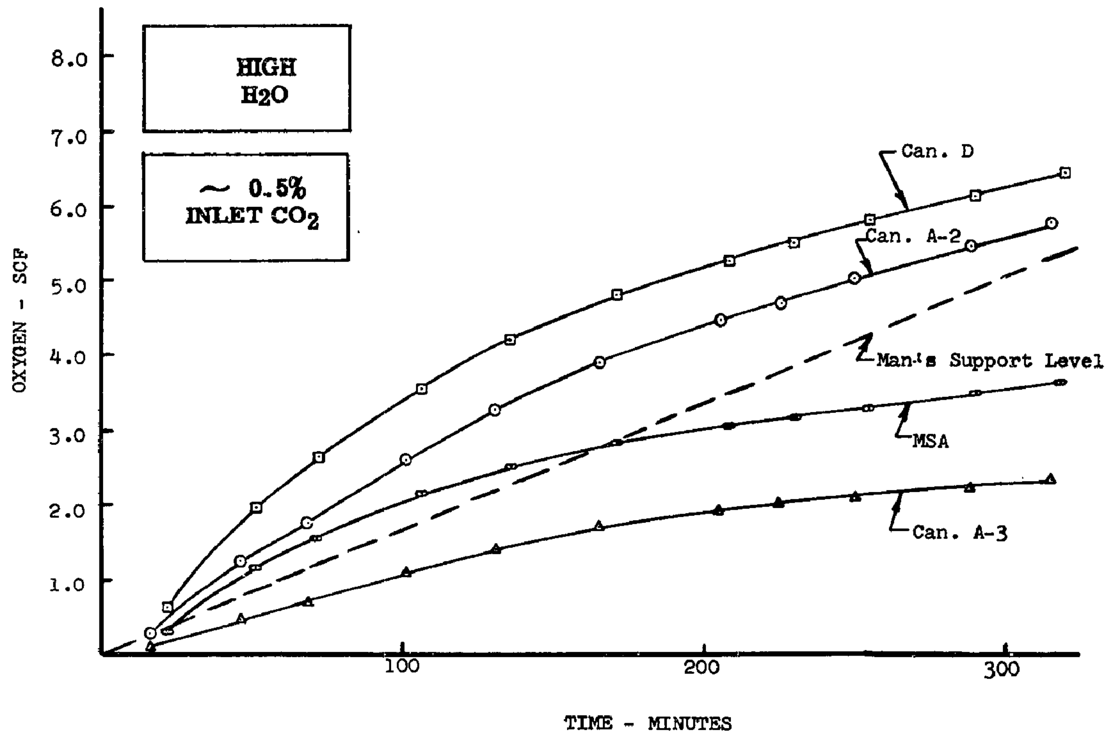

Figure 153 Man-Rate Support Level Graph, O_2, P-5

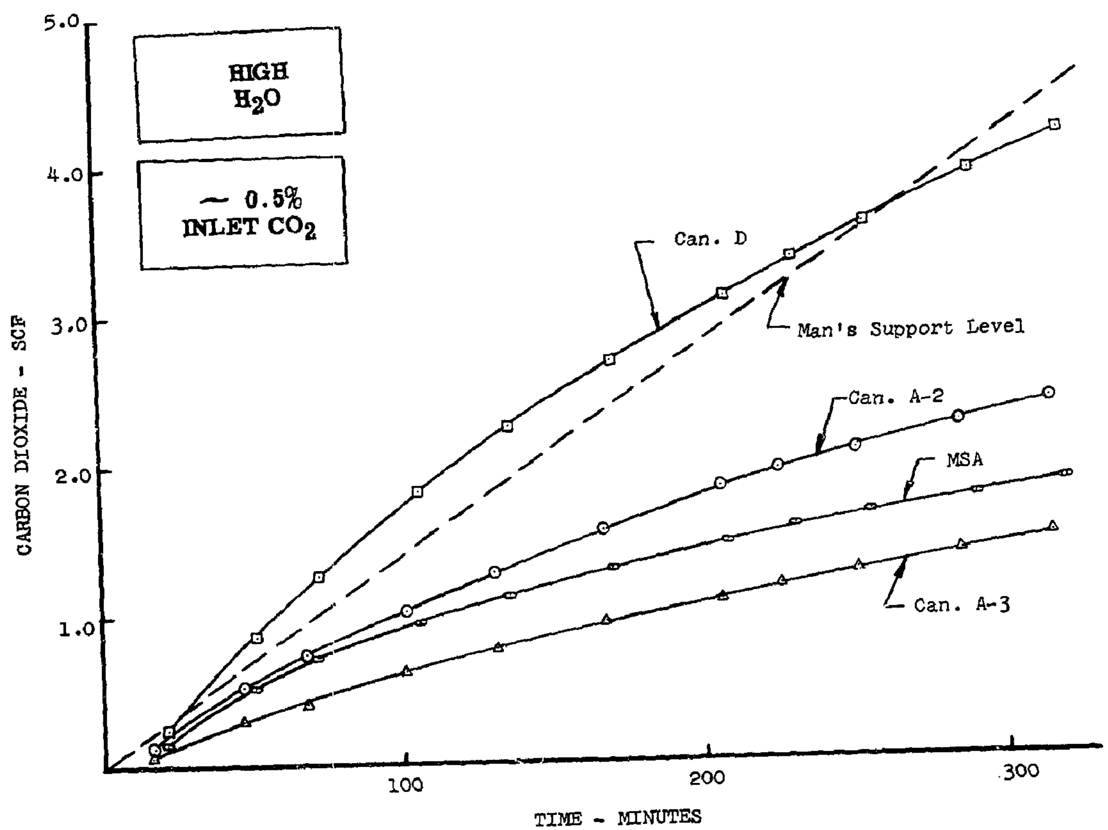

Figure 154 Man-Rate Support Level Graph, CO_2, P-5

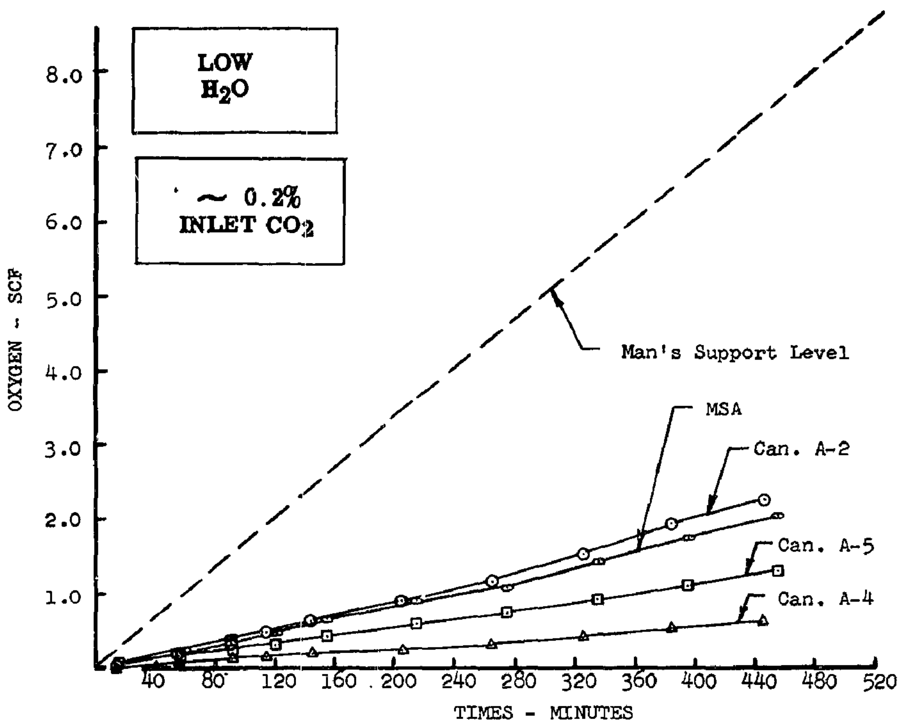

Figure 155 Man-Rate Support Level Graph, O_2, P-6

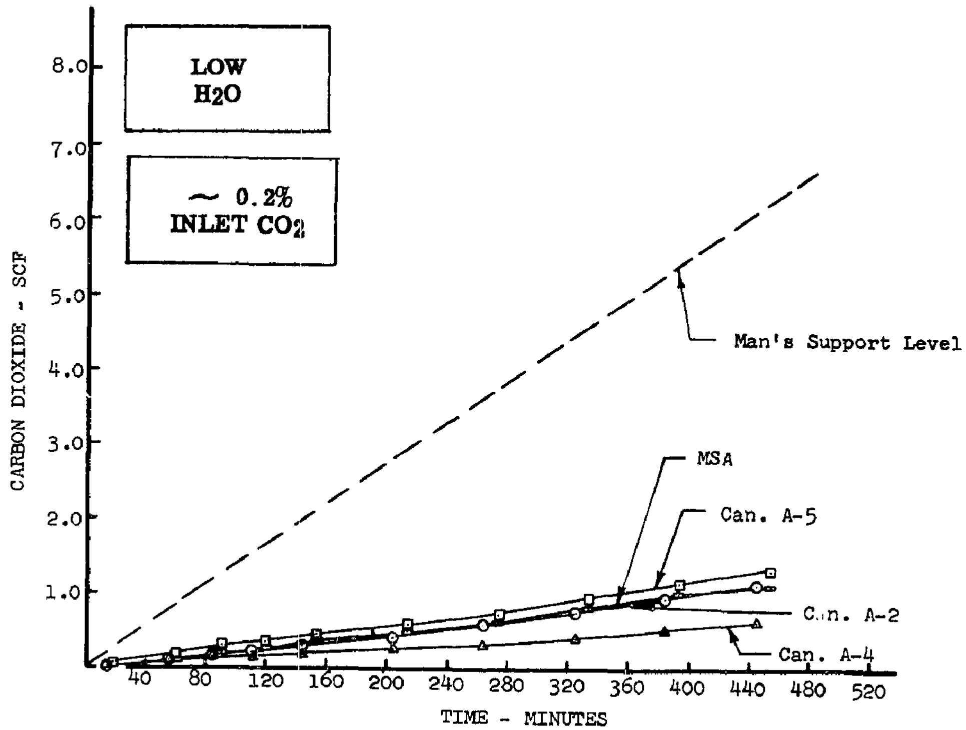

Figure 156 Man-Rate Support Level Graph, CO_2, P-6

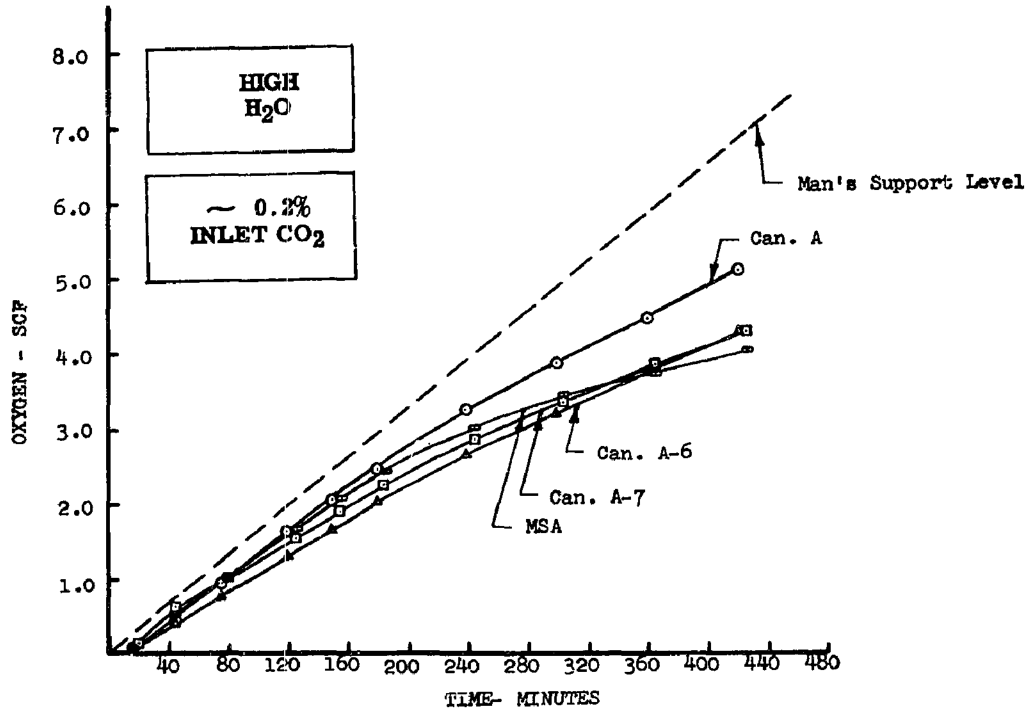

Figure 157 Man-Rate Support Level Graph, O_2, P-7

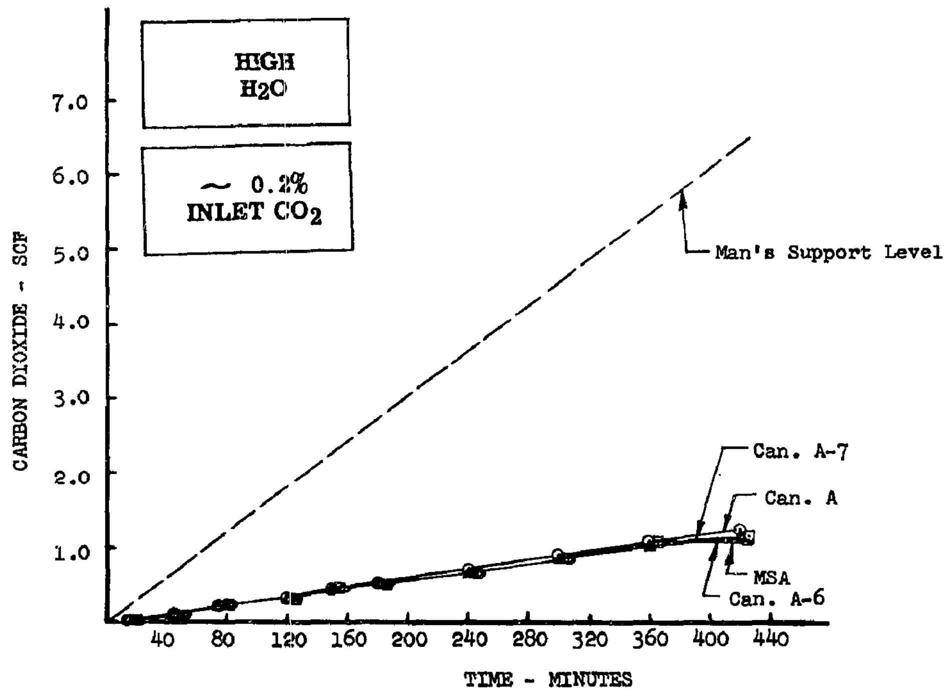

Figure 158 Man-Rate Support Level Graph, CO_2, P-7

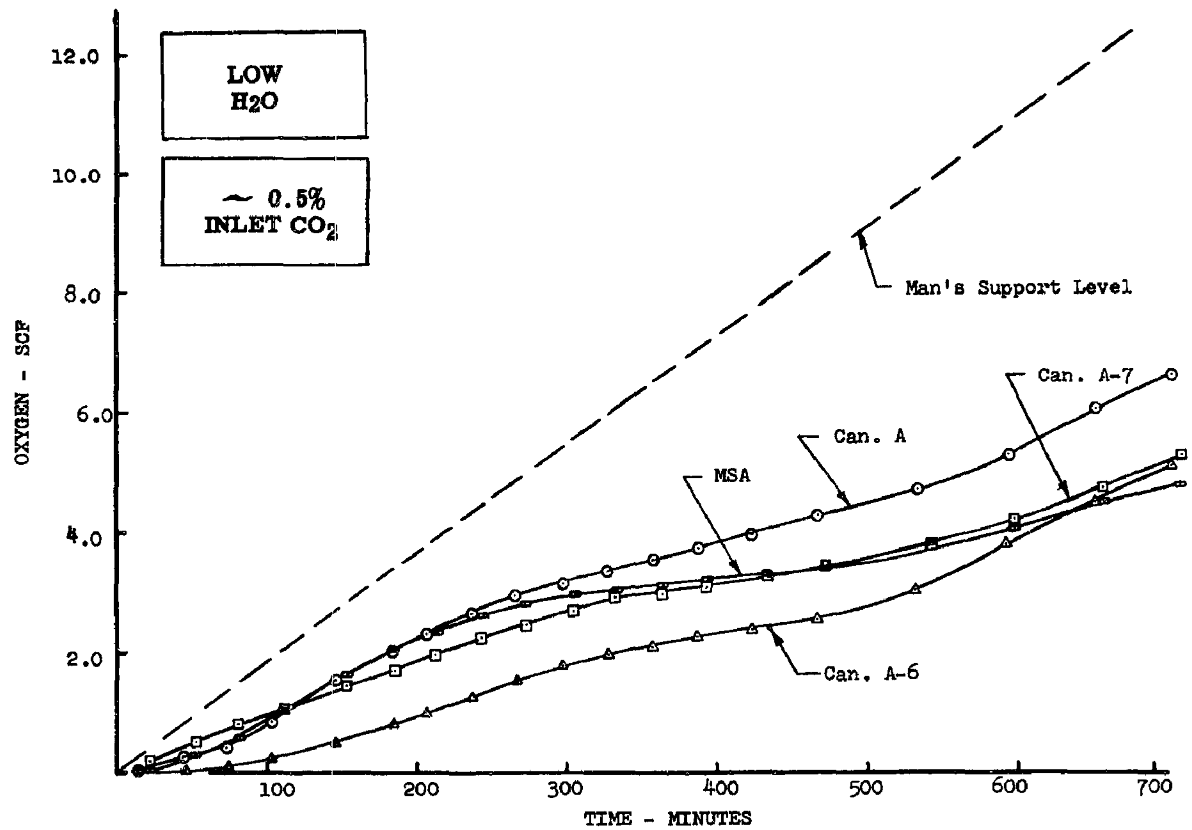

Figure 159 Man-Rate Support Level Graph, O_2, P-8

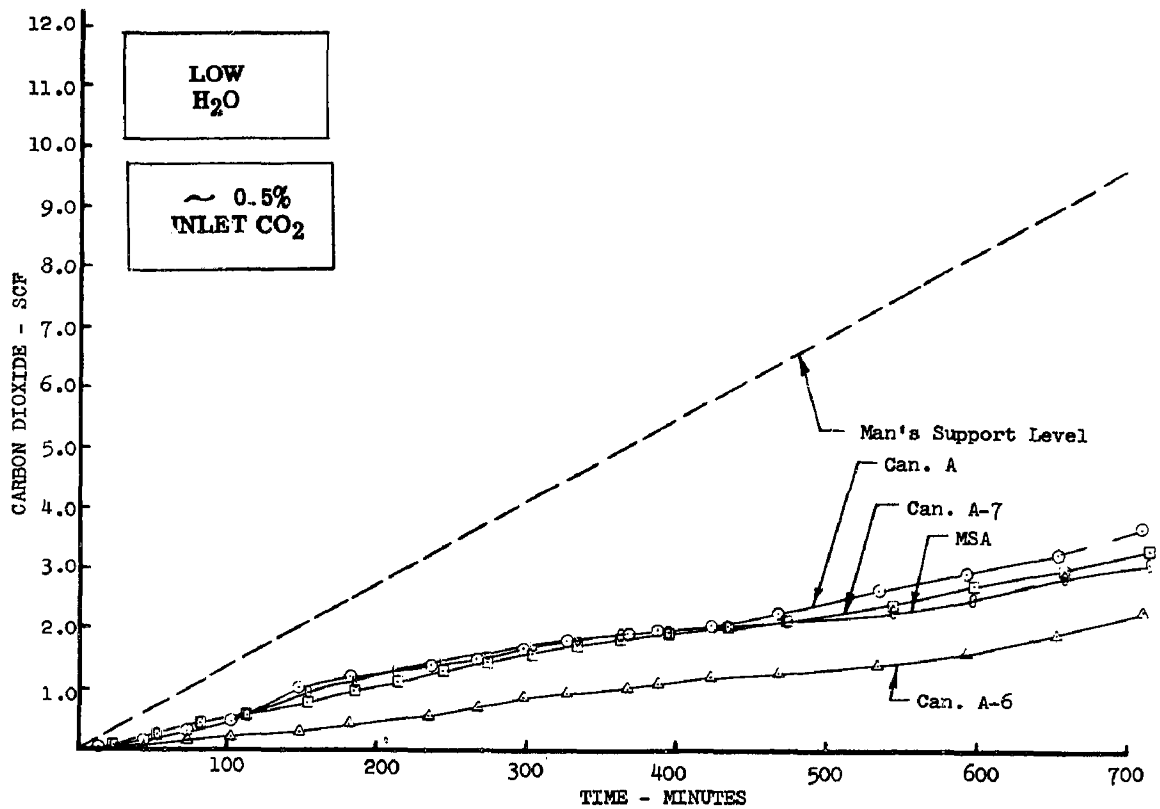

Figure 160 Man-Rate Support Level Graph, CO_2, P-8

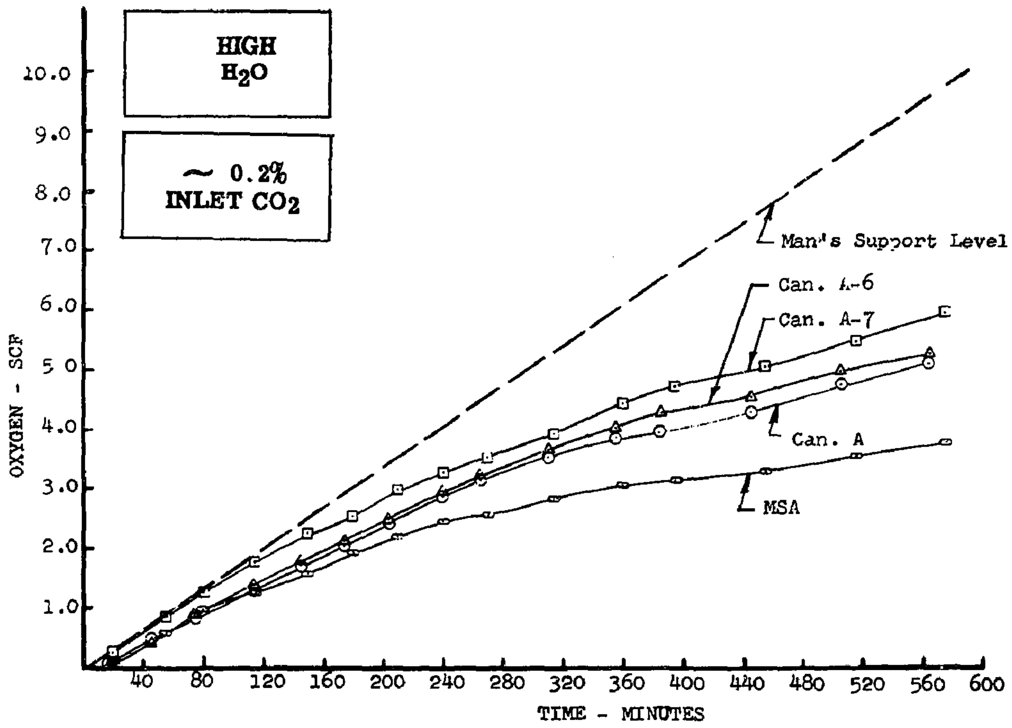

Figure 161 Man-Rate Support Level Graph, O_2, P-9

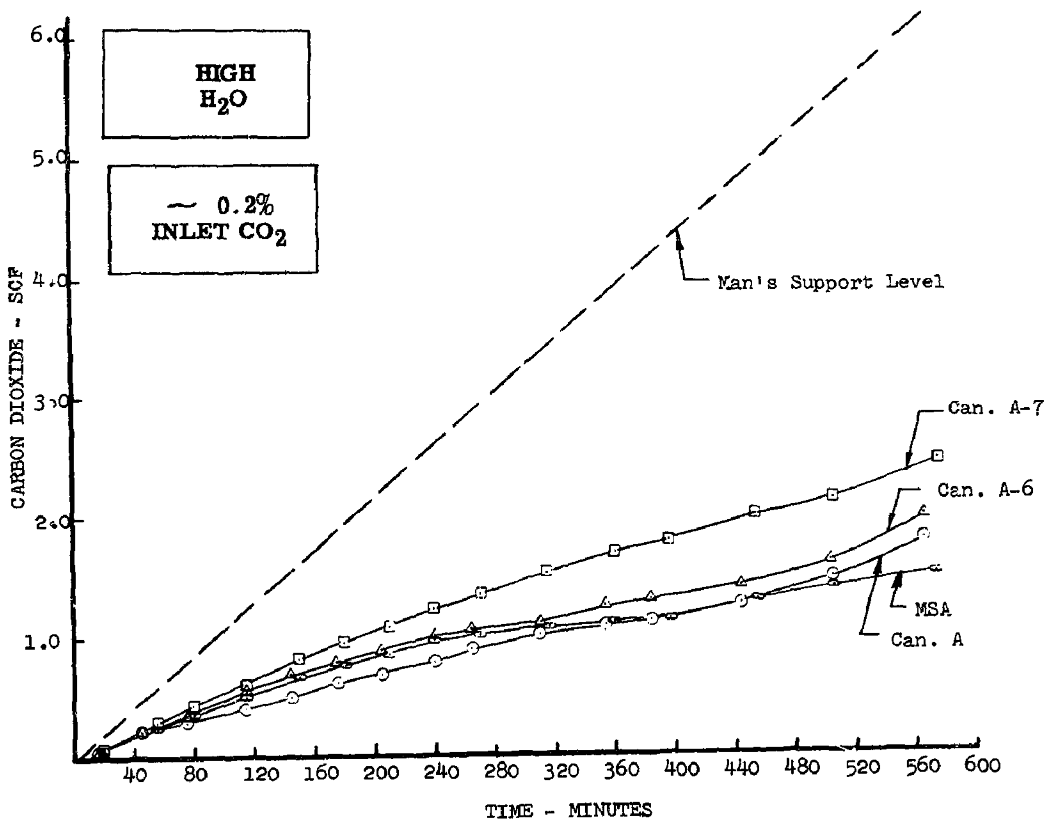

Figure 162 Man-Rate Support Level Graph, CO_2, P-9

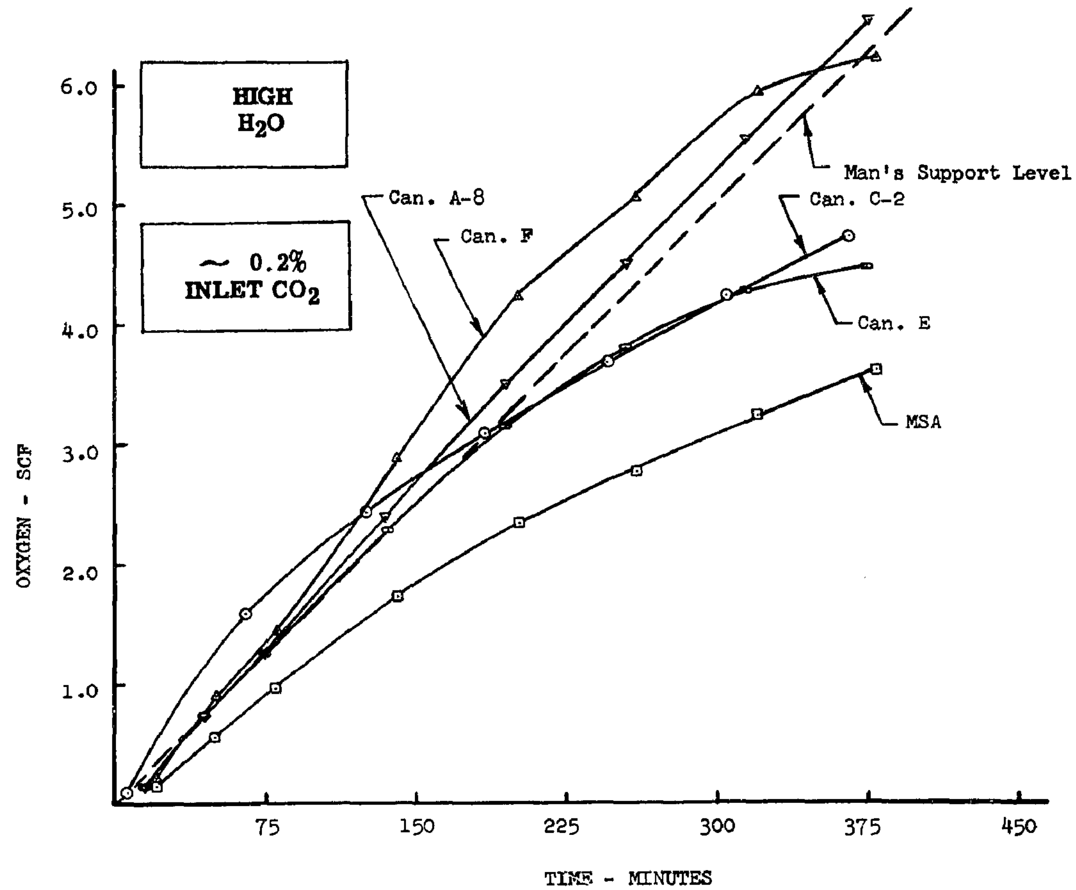

Figure 163 Man-Rate Support Level Graph, O_2, P-10

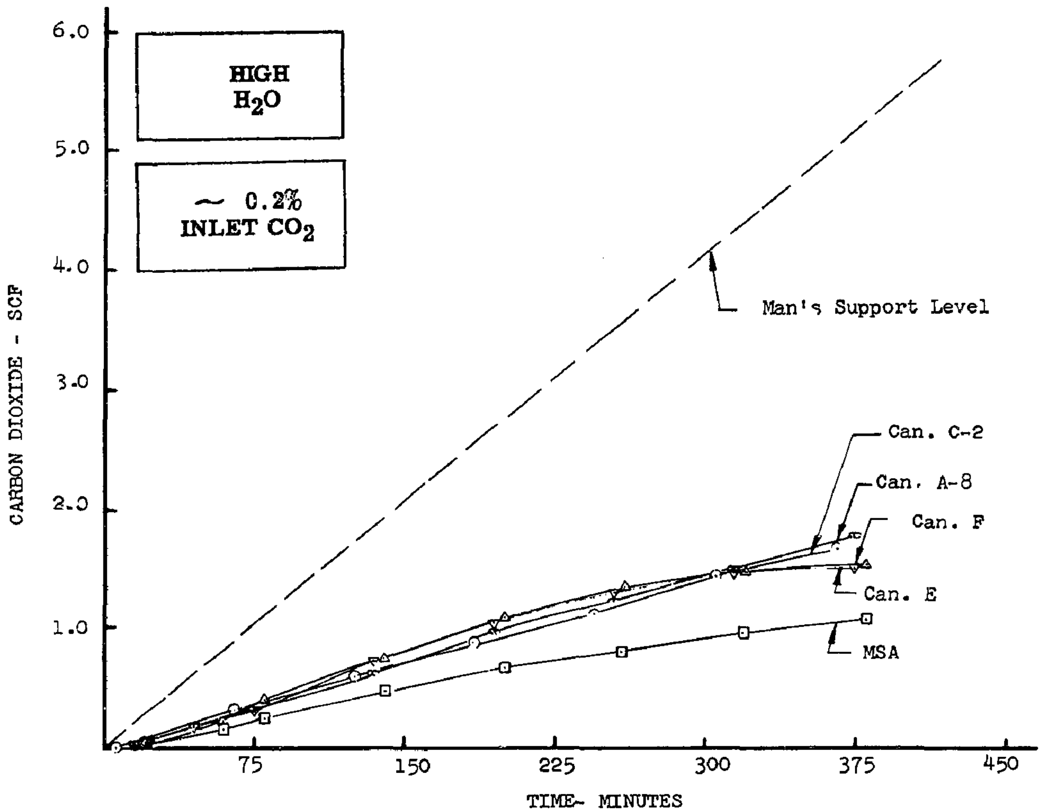

Figure 164 Man-Rate Support Level Graph, CO_2, P-10

Aeronautical Systems Division, Dir/Aeromechanics, Flight Accessories Laboratory, Wright-Patterson Air Force Base, Ohio.
Rpt No. ASD-TDR-62-583. POTASSIUM SUPEROXIDE CANISTER EVALUATION FOR MANNED SPACE VEHICLES. Final report, Sep 62, 275p, incl illus, tables, 66 refs.

Unclassified Report

New experimental techniques, and their results, used to develop and evaluate the effects of simultaneous multiple operating parameters on potassium superoxide (KO_2) canisters for life support systems in manned space vehicles, are presented. Actual experiments using rodents, men, and simulated-man, are described and compared. Experimental

(over)

1. Breathing apparatus
2. Environmental control
3. Oxygen equipment
4. Carbon dioxide removal
5. Atmospheric composition control

I. AFSC Project 6146 Task 614608
II. Contract AF33(616)-8323
III. North American Aviation, Inc.
IV. A. W. Optican
V. NA-62-283
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characteristics of single and dual canister (demand) atmosphere composition control systems are analyzed. Best method for experimental definitive Respiratory Quotient matching is described. New annular screen device for a chemical canister which prevents blocking of the airflow in a granular solid chemical bed due to high absolute humidity is shown and described. Canister design method was developed to determine basic KO_2 canister sizes for atmosphere composition control system tests on a real-time, one-man basis. Dominant role of PCO_2 in establishing the CO_2 adsorption rate and the O_2 generation rate is shown as well as roles of absolute humidity and catalysts in establishing the O_2 generation rate. Empirical induction was used to try and substantiate previously accepted theoretical equation of a KO_2 bed.

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