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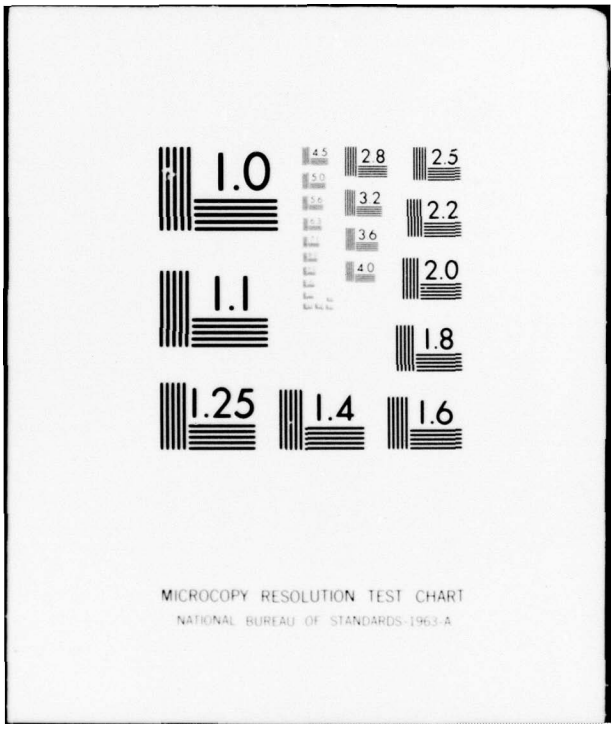
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# EVALUATION OF ACTIVATED CARBON FOR FUEL OIL ADSORPTION FROM A POTABLE WATER SUPPLY

DIRECTORATE OF ENVIRONICS
TYNDALL AIR FORCE BASE, FLORIDA



OCTOBER 1976

Final Report: March 1975 to May 1976

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Evaluation of activated carbon adsorption process to remove diesel fuel from a contaminated Air Force water supply was accomplished. Laboratory scale tests proved activated carbon highly capable of removing diesel fuel from water. Determinations of adsorption zone, contact time, and other operating parameters were unsuccessful because of extreme rapidity of adsorption by the activated carbon.

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## PREFACE

This report summarizes work done under Job Order 21037W57 between March 1975 and May 1976. 1st Lt Dale H. Allen was project engineer for the Air Force Civil Engineering Center (AFCEC).

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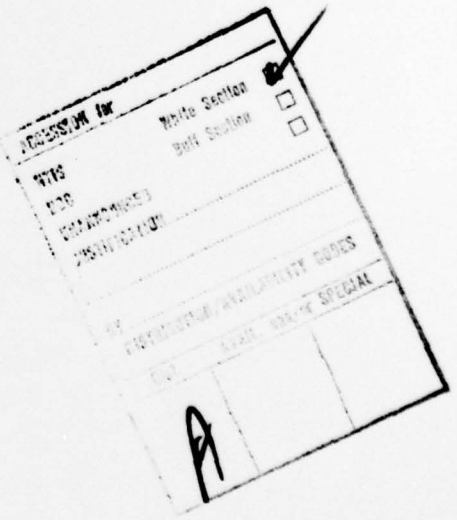




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# SECTION I

# INTRODUCTION

In March 1975, the main water supply at Sparrevohn Air Force Station, Alaska, was contaminated with an unknown quantity of Number 2 fuel oil. This contamination resulted from leakage from a ruptured fuel line adjacent to the station's water gallery (a trench which serves as a well). The fuel oil is thought to have percolated through the soil from the ruptured pipe into the water gallery, where a film of oil was observed on the surface of the water. Complaints of severe taste and odor problems particularly associated with heated water used for cooking and bathing purposes were received from the station's personnel.

In an attempt to evaluate the extent of the problem, Alaskan Air Command (AAC), DEM, performed oils and grease analyses using the Freon 113® extraction described in Standard Methods (Reference 1). Data from these analyses indicated the oils and greases concentration in the water was less than the limit of detection of this test (0.1 mg/l). AFCEC/OL-AA was solicited by AAC/DEM to evaluate the problem and develop an acceptable solution. Because activated carbon was locally available in Alaska, and because a treatment method characterized by simplicity and low capital expenditure was desired, AAD/DEM requested that activated carbon adsorption be evaluated first.

## SECTION II

## EXPERIMENTAL PROCEDURE

In order to evaluate activated carbon adsorption, it was necessary to analyze the effluent from batch or column tests. The extraction and evaporation test referenced in Standard Methods failed to quantitatively return a known addition of No. 2 diesel fuel, presumably because the fuel oil is volatile, and evaporates along with the Freon®. An alternate method has been promulgated by EPA (Reference 2). This method is similar to the Standard Methods test except that instead of determining the oils and greases by weighing the residue from the Freon®, the Freon® is scanned in the infrared region (wave numbers 3200 to 2700 $cm^{-1}$), and the results compared with a calibration curve determined by a similar analysis of known amounts of the appropriate oil (in this case, No. 2 fuel oil). Unfortunately, a cell with sufficient path length (5 to 10 cm) was not available. Thus, the analysis was not sensitive enough to detect the oils and greases in the contaminated water. The only method available, therefore, was an odor test performed by requesting various persons to detect the odor of the diesel fuel in the treated and untreated water samples. It was assumed the collective decision of this panel approached the "standard nose."

## SECTION III

## EVALUATION

Batch carbon adsorption tests were performed to determine the adsorption isotherm using Westvaco® 8 x 30 mesh WV-W activated carbon (Reference 3). Although the results of these studies could not be used for design purposes, the fact that even the smallest amount of carbon reduced the odor to undetectable levels indicated the carbon had a high affinity for the soluble components of the fuel oil. These promising results indicated the need for column studies.

The laboratory scale column used was 1.72 inches (4.37 cm) in diameter and 18 inches (45.7 cm) high (see Figure 1). The column contained 35.0 grams of carbon which filled it to a height of 1.75 inches (4.45 cm). The influent contaminated water source was a 400-gallon (1518-liter) polyethelene water tank to which sufficient Number 2 fuel oil had been stirred into 400 gallons of tap water to produce an oil concentration of 10 mg/l (assuming all oil dissolved). Although samples drawn from the bottom of the tank possessed a strong oily smell, the amount of oil actually contained is unknown, since an oil film remained on the surface of the water throughout the experiment. Because the "standard nose" was the analytical technique employed, this dissolution problem was not considered critical.

The contaminated solution was pumped through the column at a flow rate of 25 ml/min for 24 hours without detectable odor in the effluent. The flow rate from new batches of contaminated water was increased incrementally to the bench scale capacity of 400 ml/min for 24 hours. At this highest rate, where contact time was only 10 seconds, there was no detectable odor in the effluent. Despite the fact that it was impossible to determine such operating parameters as equilibrium capacity and exchange zone length in the laboratory, the data did indicate that carbon adsorption was feasible for the Sparrevohn problem.

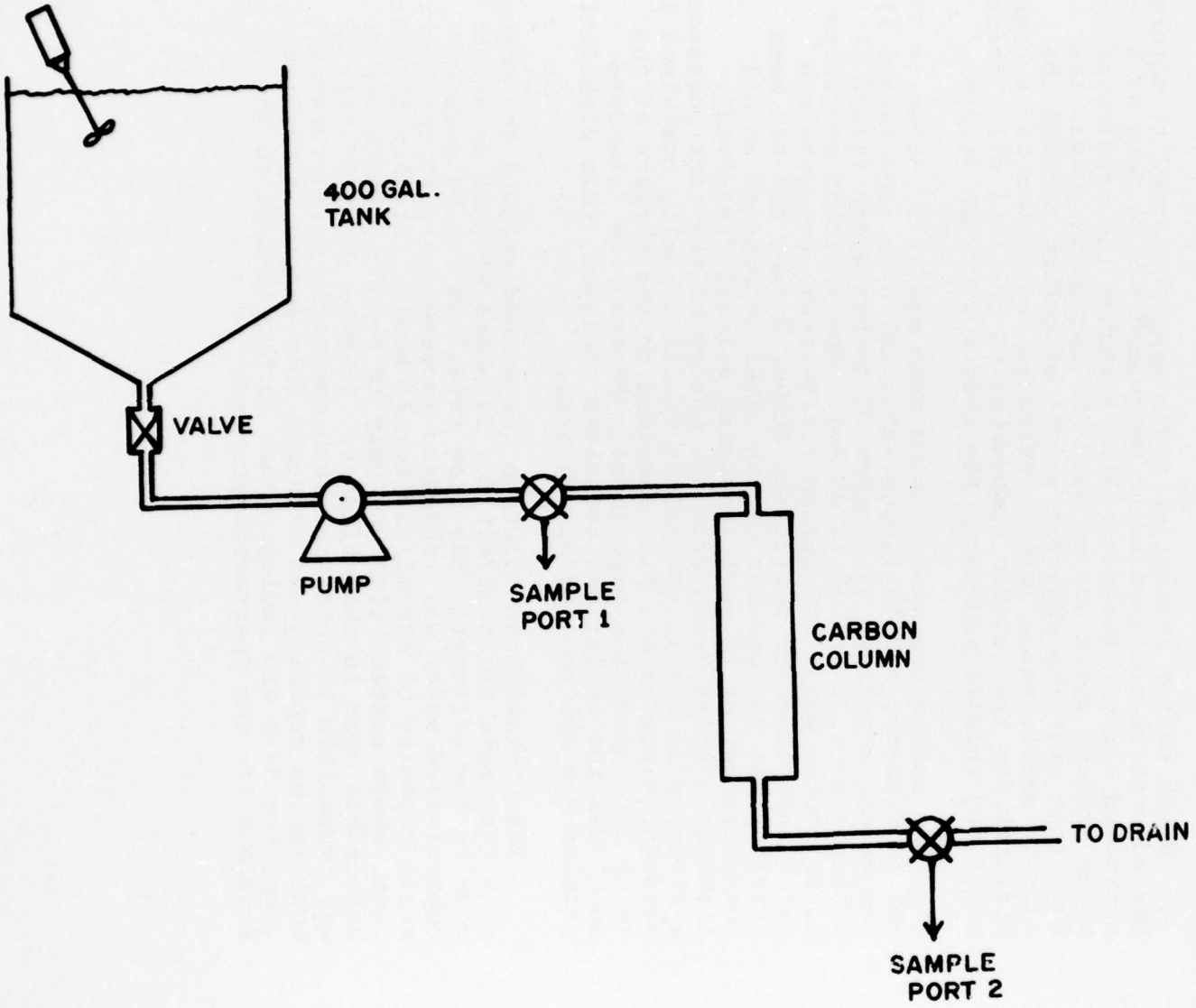


Figure 1. Experimental Setup

## SECTION IV

## DISCUSSION OF RESULTS

It was recommended that the Sparrevohn station use two 18-inch (45.7 cm) ID x 6 feet (1.83 meters) ion exchange columns that are currently available on site. Operation of these two columns in series may well yield adequate treatment for an extended period until the water gallery is purged of all fuel oil. If the capacity of the carbon in one column becomes exhausted, replacement or regeneration of this exhausted carbon will be necessary. The decision to regenerate exhausted carbon or replace it with new carbon is dependent on logistics support and on-site capabilities. It appears, due to the temporary nature of the system and expected low carbon requirement, that carbon replacement rather than regeneration would be the most expeditious alternative. The arrangement in Figure 2 will allow shutdown of either column for carbon replacement and allow placing either column first in series in order to utilize the full capacity of the carbon.

The anticipated flow is 50 gal/min for four hours each 24-hour period. This is equivalent to 28.29 gallons per minute per square foot. Extrapolating from Figure 4-4 of the EPA carbon adsorption manual (Reference 4), the pressure loss for two 6-foot columns will be 168 inches of water (6.07 psi).

Backwashing, which is an operational necessity to prevent clogging caused by biological growth or suspended particles in wastewater, should not be necessary.

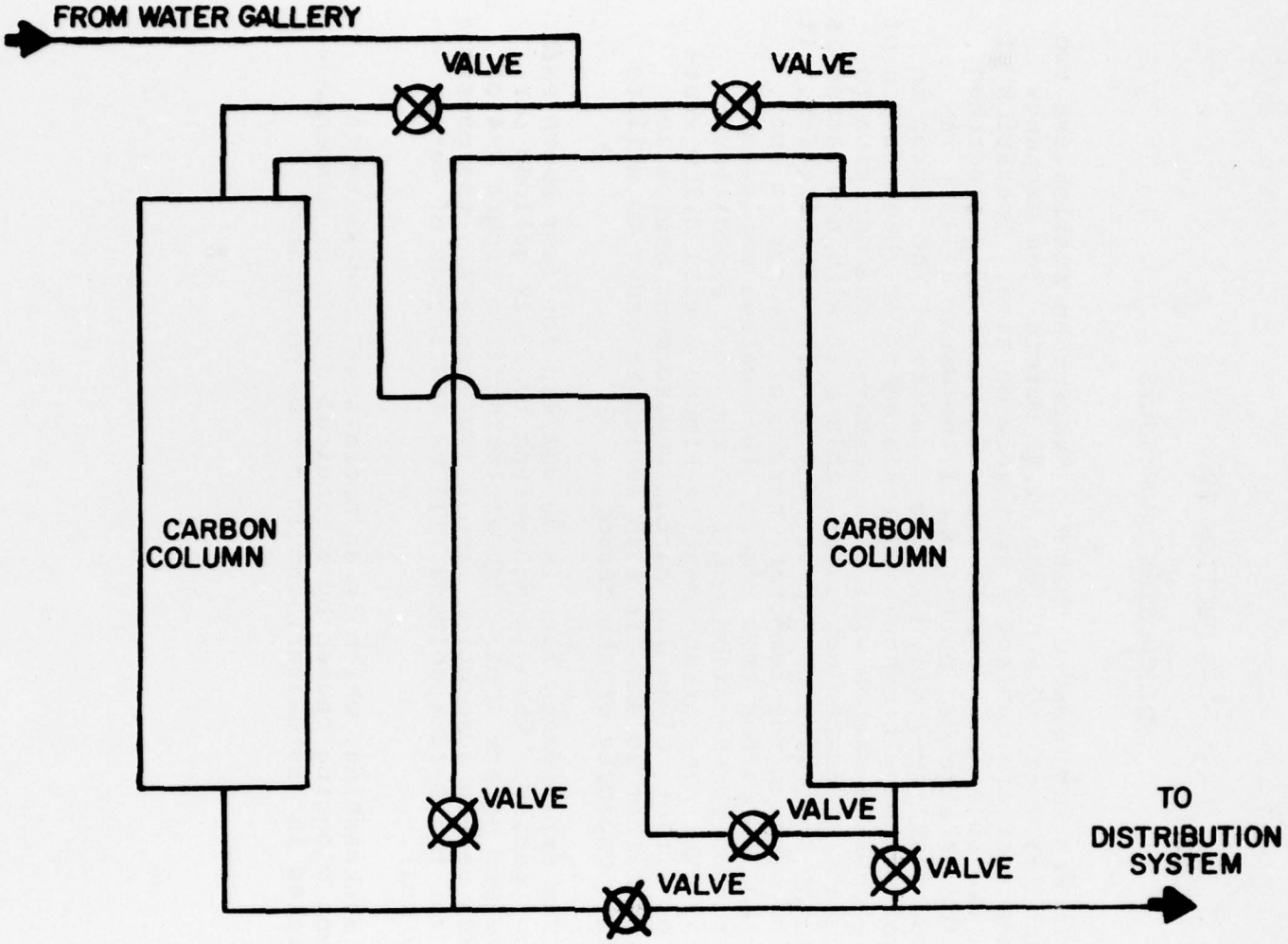


Figure 2. Proposed Design

## SECTION V

## CONCLUSIONS

1. Activated carbon is a viable method for controlling taste and odor problems in fuel contaminated water supplies.

2. Quantitative data for low level fuel contamination of water supplies is difficult to reproduce. Of the methods available, the EPA technique appears to be the most reliable. A 5 to 10 cm IR cell will be required.

3. A modulated carbon sorption unit for quick field deployment may be to the future advantage of the Air Force for remote locations such as Sparrevohn.

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4. Process Design Manual for Carbon Adsorption, Environmental Protection Agency, Technology Transfer, Swindell-Dressler Co., October 1971.

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