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EXPLOSIBILITY AND IGNITABILITY OF PLASTIC ABRASIVE MEDIA

ABSTRACT At the request of the US Navy, the Bureau of Mines has investigated the explosibility hazards of plastic abrasive media used for removing paint from the surfaces of aircraft and aircraft sections. The tests included both original and recycled media. Four types of plastic media were tested and compared with Pittsburgh bituminous coal and polyethylene. The tests were performed in a 20-L explosibility test chamber and a 1.2-L ignitability furnace.

The original coarse media used for abrasive blasting of aircraft components could not be ignited when dispersed as a dust cloud, but the fines generated during the blasting process were capable of generating strong explosions.

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At the request of the US Navy, the Bureau of Mines has investigated the explosibility hazards of plastic abrasive media used for removing paint from the surfaces of aircraft and aircraft sections. The tests included both original and recycled media. Four types of plastic media were tested and compared with Pittsburgh bituminous coal and polyethylene. The tests

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FOREWARD

This work was sponsored by the Naval Facilities Engineering Command and the Naval Civil Engineering Laboratory as part of the program to implement Plastic Media Blasting (PMB) in the Navy. This work is an excellent technical evaluation of plastic media explosibility and ignitability. This report provides a number of useful recommendations on maintaining safe dust collection operations at PMB facilities.

The Bureau of Mines is also planning to publish this report under a Bureau of Mines cover.

SUMMARY

This report described the results measured by the Bureau of Mines on the explosibility and ignitability of three Kopper's and a DuPont media. The general conclusions are:

- Recycled media in the range of 12 to 80 mesh will not explode.
- Paint particles did not affect dust explosibility.
- The largest particle size that exploded was 40 mesh Polyextra at 200 grams per cubic meter.
- The lowest explosive concentration at 200 mesh was Polyextra at 45 grams per cubic meter.
- The DuPont media had results similar to the Kopper's media even though the DuPont media is a thermoplastic acrylic media and the Kopper's media are thermoset formaldehydes.
- The greatest potential for dust explosions is in the baghouse.

The report recommends using explosion vents as a safety precaution.

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EXPLOSIBILITY AND IGNITABILITY OF PLASTIC ABRASIVE MEDIA

by Kenneth L. Cashdollar[1], Martin Hertzberg[2],

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INTRODUCTION

At various times in its history, the Bureau of Mines has conducted dust explosibility tests at the request of other government agencies and private industries (1-4)[5]. In 1985 the Bureau conducted some brief, preliminary tests of plastic abrasive media at the request of the Air Force (5) and Navy (6). Those plastic media were used in the blast cleaning of aircraft and aircraft sections.

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[5]Underlined numbers in parentheses refer to items in the list of references at the end of this report

In 1986, the Bureau was requested by the Navy to do a more thorough study of the dust explosibility hazards of various plastic media. In particular, the Navy desired a detailed study of the effect of particle size on explosibility. The tests were conducted in a 20-L chamber and a 1.2-L furnace.

APPARATUS AND EXPERIMENTAL METHOD

Plastic Media and Comparison Dusts

Three types of plastic abrasive media from US Technology Corporation[6] were tested: Polyextra is a polyester styrene which is a relatively soft abrasive with a Mohs hardness of 3. Polyplus is an alpha cellulose filled urea formaldehyde with a hardness of 3.5. Type III is a urea melamine formaldehyde with a hardness of 4. A fourth type of plastic media from E. I. Du Pont de Nemours and Company was also tested. This Type L Solidstrip plastic stripping abrasive is an acrylic resin, polymethyl methacrylate (PMMA), which has a hardness of 3.5.

The media are originally very coarse in size, such as 16 by 12 mesh (1180 to 1700 µm). During the blast cleaning and recycling, the media progressively degrade to smaller and smaller sizes. The fines are removed during recycling and are normally collected in a baghouse. To compare the relative explosibility of the three US Technology media, all were tested as fine powders which were nominally minus 200 mesh (less than 75 µm). The physical and chemical characteristics of these three fine dusts are listed in table 1.

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[6]Reference to trade names is for identification only and does not imply endorsement by the Bureau of Mines.

TABLE 1. - Physical and chemical data for the fine size dusts

Dust..........	Polyethylene	Plastic Media			Pittsburgh bituminous coal
		Polyextra	Polyplus	Type III	
Proximate analysis					
volatility, %.....	100	94	79	74	36
fixed carbon, %...	0	2	11	16	56
moisture, %.......	0	1	7	9	1
ash, %............	0	3	3	1	7
Heating value, Btu/lb	20,000	13,000	6,800	7,200	13,800
cal/g	11,100	7,200	3,800	4,000	7,700
Particle Size					
minus 200 mesh, %.	93	95	96	94	77
D_s, µm............	27	40	~9	~12	29
D_w, µm............	38	58	~16	23	50

For comparison, polyethylene dust and pulverized Pittsburgh seam bituminous coal were tested, and their characteristics are also listed in the table. The proximate analyses were measured according to ASTM standard test method D3172. The heating value was measured in a bomb calorimeter according to ASTM standard test method D2015. The particle size data are a combination of data from several methods: sonic sieving, Coulter counter (electrolytic conductivity through a small orifice), and Microtrac laser light scattering. The minus 200 mesh or minus 75 µm fraction is listed along with the surface mean particle diameter, D_s, and the mass or volume mean diameter, D_w. All of the dusts are fairly fine, although the Polyextra and coal are slightly larger. In addition to the fine size dusts listed in table 1, coarser sieved fractions with narrow size distributions were tested as described later in this report. Sieved fractions of the Type L PMMA were also tested.

20-L Explosibility Test Chamber

The 20-L laboratory chamber (7) used for the flammability and ignitability testing of the dusts is shown in figure 1. The optical dust probes (8-9) are used to measure the dust dispersion uniformity. The dust to be tested is placed in the reservoir at the bottom of the chamber and is dispersed through the holes in the nozzle by a blast of air from a reserve tank (not shown). The standard procedure is to partially evacuate the chamber to 0.1 atm absolute so that the blast of air (which disperses the dust) raises the chamber pressure to 1 atm absolute at ignition. The normal ignition sources are electrically activated pyrotechnic ignitors (10) with calorimetric energies of 500 to 5,000 J. For comparison, the energy released when an entire book of 20 pocket matches ignites at once is only slightly less than that of the 2500 J ignitor. A more detailed description of the experimental procedures can be found in reference 7. This chamber is an improved version of the 8-L chamber (11) previously used at the Bureau.

1.2-L Ignitability Furnace

The 1.2-L furnace (12) used to measure the thermal ignitability of the dusts is shown in figure 2. For the thermal ignition tests, the furnace is set at a predetermined temperature and the dust is placed in the dispersion receptacle. The receptacle is then quickly inserted into the bottom of the furnace, and an air blast from the reservoir disperses the dust into the furnace. A fiberglass filter diaphragm on the top of the furnace confines the dust so that its concentration is controlled. The maximum time of exposure of the dust cloud to the furnace temperature is at least several seconds, after which the dust begins to settle out. The criteria for ignition are that, first, the diaphragm must rupture and that, second, flame must be observed emitting from the top of the furnace within a time of 1.5 s. Because of its larger volume, more uniform dispersion, and longer residence time, the 1.2-L furnace generally gives somewhat lower minimum autoignition temperatures (12) than does the 0.3-L Godbert-Greenwald furnace (13) used in earlier Bureau studies.

EXPERIMENTAL DATA

Coarse Size Plastic Abrasive Media

The first dust explosibility tests were performed with the coarse size Polyextra and Polyplus abrasive media. The size was 16 by 12 mesh or 1180 to 1700 µm. Both media were tested in the 20-L chamber at high dust concentrations and no explosions were observed, even with the very strong 5000 J ignitors.

Recycled Polyplus media (nominally 80 by 12 mesh or 180 to 1700 μm) from the aircraft blasting recirculation system were tested and did not explode with the 5000 J ignitors. A sonic sieve size analysis showed that about 80% of this recycled media was larger than 50 mesh or 300 μm and about 90% was larger than 80 mesh or 180 μm. Only 2% was less than 200 mesh or 75 μm.

Fine Size Plastic Dust

The three fine size US Technology plastic dusts (Polyextra, Polyplus, and Type III) listed in table 1 are capable of generating strong explosions. The 20-L test data for these dusts are shown in figures 3-5. The explosion pressure ratios and rates of pressure rise are plotted as a function of dust concentration. The pressure ratio for each test is the peak absolute explosion pressure (corrected for the pressure rise of the ignitor) divided by the pressure at ignition (about 1 atm or bar absolute). Therefore, the pressure ratio is approximately the absolute explosion pressure in atm or bar. Both the maximum rate of pressure rise, dP/dt, and the normalized value, $K_{St} = (dP/dt)V^{1/3}$, are shown in the upper sections of the three figures. The lean flammable limit or minimum explosible concentration is the lowest dust concentration that will produce an explosion. In this report, the specific criteria (10) used to signify flame propagation are that the pressure ratio be greater than two and that the K_{St}-value be greater than 1.5 bar m/s. The lean limits are determined from graphs such as those in figures 3-5.

A summary of the explosibility data for the 2500 J ignitors is listed in table 2 where the data are compared to those for polyethylene and Pittsburgh coal. Polyethylene has the lowest lean flammable limit or minimum explosible concentration, 35 g/m^3 with the 2500 J ignitors. From the data in Figure 3, the Polyextra lean limit of 50 g/m^3 is only slightly higher than that of polyethylene. Next is the Pittsburgh coal whose lean limit is 90 g/m^3. The Type III and Polyplus have the highest lean limits of 120 and 180 g/m^3, respectively. However, other fine size Polyplus from a separate sample had a lean limit of 130 g/m^3 as described later in this report in the section on particle size effects.

All five fine dusts produced large explosion pressures at high dust concentrations, and the average maximum pressure rise values are listed in table 2. The Polyplus and Type III produced the highest maximum pressure rises while the Polyextra produced the lowest, even though its lean limit was lower. Normally, higher maximum pressures correlate with lower lean limits. In terms of pressure rise rates or K_{St}-values, the polyethylene was the highest and the Polyextra was the lowest. One possible explanation for this anomaly is that there were few very fine size particles (only 3% by weight less than 400 mesh or 38 µm) in the Polyextra although 95% was less than 200 mesh or 75 µm. The other four dusts had a much larger fraction of fine particles less than 400 mesh. Note that the maximum K_{St}-values were measured at a moderate turbulence level in the Bureau 20-L chamber. This level was lower than the high turbulence level used for dust explosibility testing described in the VDI 3673 and ISO 6184/1 standards (14-15).

The pyrotechnic ignitability of four of the dusts from table 1 was investigated by measuring the lean flammable limits in the 20-L chamber with chemical ignitors of various energies (fig. 6). The data show that the variations of the lean limits with energy for the Polyextra and

TABLE 2. - Explosibility and ignitability data for the fine dusts from table 1

Dust................	Polyethylene	Plastic Media			Pittsburgh bituminous coal
		Polyextra	Polyplus	Type III	
20-L data with 2500 J ignitors					
Lean flammable limit, g/m^3...	35	50	180	120	90
Maximum pressure rise, bar...	6.0	4.6	6.8	6.8	5.7
Max. pressure rise rate,bar/s	~220	~65	~150	130-170	~120
Maximum K_{St}, bar m/s.........	~60	~18	~40	35-45	~33
1.2-L furnace data					
MAIT, °C.....................	400	~400	480	----	540

Type III are of a similar form to those for polyethylene and Pittsburgh coal. Although the Polyplus was not specifically investigated, it is probably comparable to the Type III. All of the fine size dusts were easily ignited with the 500 J ignitors, the lowest energy tested. The ignitor energy in figure 6 is shown on the left ordinate as the nominal calorimetric energy and on the right ordinate as an effective energy deposited into the gas (10). In the text of this report, the ignitors are referred to by their nominal calorimetric energies.

In addition to the dust explosiblity tests in the 20-L chamber, the minimum autoignition temperatures, MAIT's, were measured in the 1.2-L furnace and these data are also listed in table 2.

The general conclusions from the 20-L chamber and 1.2-L furnace tests of the fine size dusts are that the Polyextra, Polyplus, and Type III show a range of explosibility and ignitability properties that are comparable to the range between polyethylene and Pittsburgh coal. The relative ranking depends on the particular characteristic measured (i.e. lean limit, maximum pressure, maximum rate of pressure rise, or MAIT).

Baghouse Residue versus Original Dust

In addition to the explosibility tests of the original plastic media, the Navy specifically requested a study of the residue dust from the baghouse collector. This residue consisted of fines from the degraded plastic media plus the paint removed from the aircraft. The purpose was to determine if the explosibility of the Polyplus fines would be significantly affected by the paint particles removed from the aircraft components. A sample of baghouse residue from a blasting booth using Polyplus media was sieved through a 100 mesh screen for testing.

This residue sample had 80% minus 200 mesh and average sizes D_s = 20 µm and D_w = 44 µm. A sample of original Polyplus dust of a similar size distribution was made by carefully mixing minus 200 mesh and minus 100 mesh samples of pure Polyplus dust. This comparison sample of pure Polyplus dust had 79% minus 200 mesh and average sizes D_s = 16 µm and D_w = 42 µm. The results of the 20-L explosibility tests comparing the baghouse residue and original Polyplus dust are shown in figure 7. The lean limits and maximum pressures for both samples are essentially the same. The maximum pressure rise rate is slightly higher for the original dust than for the baghouse residue. The conclusion is that the paint in this residue does not significantly affect the explosion characteristics. The reason could be that the paint is only a small fraction of the total residue dust and/or that the paint itself has explosibility characteristics similar to those of the Polyplus.

Particle Size Effect on Explosibility and Ignitability

In order to determine the largest sizes of Polyextra, Polyplus, Type III and PMMA that are explosible, the four media were sieved into various size fractions using the sieves listed in table 3 and samples of minus 20 or minus 40 mesh dust. The lean flammable limits for the various size fractions were measured in the 20-L chamber using 2500 and 5000 J ignitors. The MAIT's for the various fractions were measured in the 1.2-L furnace. Similar data from an 8-L chamber and the 1.2-L furnace for coal dust and polyethylene dusts were reported previously (16). In general, there is a characteristic diameter below which the lean limit and MAIT are independent of particle size and above which marked particle size effects are observed. At still larger sizes, there is a critical diameter or maximum explosible diameter above which the dust will not ignite.

The particle size effect data for Polyextra, Polyplus, and Type III are shown in figures 8, 9, and 10, respectively. The Type L PMMA data are shown in figure 11. The data for the polyethylene and Pittsburgh coal comparison dusts are shown in figures 12 and 13. For the coarse sieve fractions, the data points are plotted as the midpoints of the sieve size intervals. For the fine sizes, such as minus 400 mesh or minus 200 mesh, the data are plotted as the mass median diameters.

TABLE 3. - Sieve sizes

Sieve mesh	Size, µm
20	850
30	600
40	425
50	300
60	250
70	212
100	150
140	106
200	75
270	53
400	38

For the Polyextra data in figure 8, the lean limit starts to increase significantly with increasing particle size above 200 µm. Using the 2500 J ignitor, the Polyextra ignited at 70 by 50 mesh but not at larger sizes. Using the 5000 J ignitors, about half the tests at 50 by 40 mesh resulted in explosions. No larger sieve fraction was available for testing. The majority of the tests were made with the 2500 J ignitors because the 5000 J ignitor may overdrive the 20-L chamber somewhat (10). At the higher temperatures of the 1.2-L furnace, all of the sieved fractions ignited. This is expected because it is easier for the dusts to volatilize and ignite at elevated temperatures.

The Polyplus data for different sieved fractions are shown in figure 9. The fine sized fractions sieved from the minus 20 mesh sample all have lean limits of about 130 g/m^3. The one data point at a lean limit of 180 g/m^3 is for the minus 200 mesh sample listed in tables 1 and 2. There appears to be some intrinsic difference in these two samples of Polyplus, as reflected in the different lean limits. However, the MAIT for the minus 200 mesh sample is comparable to that of the fine sized fraction sieved from the minus 20 mesh sample.

At a size of 140 by 100 mesh, the Polyplus (fig.9) would only ignite at high concentrations, when tested in the 20-L chamber with 2500 J ignitors. Even with the 5000 J ignitors, the 100 by 70 mesh fraction would not ignite reproducibly. At the elevated temperatures in the 1.2-L furnace, the 50 by 40 mesh fraction ignited above 700° C but the 40 by 30 mesh fraction would not ignite even at 1000° C.

The Type III results (fig.10) were similar to the Polyplus. The 140 by 100 mesh fraction would only ignite at high dust concentrations in the 20-L chamber with the 2500 J ignitors. The 100 by 70 mesh fraction would not ignite reproducibly, even with the 5000 J ignitors. In the 1.2-L furnace, the 50 by 40 mesh fraction ignited above 800° C and this was the largest sieve fraction available for testing.

The data for the various sieved fractions of the PMMA are shown in figure 11. In the 20-L chamber, the lean limit is about 80 g/m^3, independent of particle size below 100 µm. For larger particle sizes, the lean limit increases. At 70 by 60 mesh, the PMMA would not ignite with the 2500 J ignitors. At 60 by 40 mesh, the PMMA would not ignite reproducibly even with the 5000 J ignitors. Although the MAIT data from 1.2-L furnace are not shown in figure 11, the lowest MAIT for the finest sieved fractions of PMMA was 500° C.

The data for the polyethylene comparison dust are shown in figure 12, and they are comparable to data reported previously (16) using weaker ignitors and the 8-L chamber. The lean limit is invariant with particle size below about 100 µm. At 100 by 70 mesh, the polyethylene would not ignite in the 20-L chamber with the 2500 J ignitors, but it would ignite with the 5000 J ignitors. At 70 by 50 mesh, the polyethylene would not ignite even at 5000 J energy. In the 1.2-L furnace, the polyethylene had an MAIT of 450° C even at the largest size tested, 40 by 30 mesh.

The lean limit of the Pittsburgh coal (fig.13) is invariant with particle size below about 100 µm. At 100 by 70 mesh, the coal ignited, but at 70 by 50 mesh, the coal would not ignite in the 20-L chamber with 2500 J ignitors. Using the 5000 J ignitors, the 70 by 50 mesh coal ignited, but the 50 by 40 mesh fraction did not. At the elevated temperatures in the 1.2-L furnace, the coal ignited at even larger sieve fractions.

The particle size dependences for the six dusts from the 20-L explosibility tests are summarized in table 4. The second column lists the lean limits for the 100 by 70 mesh sieve fraction, using the 2500 J ignitors. The third and fourth columns list the maximum explosible size, above which a dust could not be ignited even with the 5000 J ignitors. The maximum explosible size is listed as both a mesh size and the equivalent in micrometers. The maximum size is the midpoint of the smallest sieve fraction tested that did not produce any explosions or the upper limit of the sieve fraction that produced only a few partial explosions. These tests were made at high dust concentrations, generally 300 to 700 g/m^3. The maximum explosible size for the Polyextra is an extrapolated value because the 50 by 40 mesh fraction was the largest available for testing.

AIRCRAFT COMPONENT BLASTING BOOTH

The various plastic abrasive media studied in this report are used for the blast cleaning of aircraft and components. These plastic media are hard enough to remove the paint but soft enough not to harm the metal or composite skin of the aircraft. The abrasive media are used in blasting chambers that range in size from glove boxes of the order 1 m^3 to large rooms where large sections of aircraft or even entire aircraft are cleaned. Figure 14 shows a rough schematic of one such blasting chamber and its associated recycling and fines collection systems. An operator in the blasting room directs the abrasive blasting media at the aircraft sections using a pressurized nozzle. The used

TABLE 4. - Summary of particle size dependences for the six dusts

Dust	Lean limit at 100 by 70 mesh, g/m^3	Maximum explosible size, µm	mesh
Polyethylene	NE	250	60
PMMA (Type L)	110	425	40
Polyextra	70	~500	~35
Polyplus	NE	210	70
Type III	NE	210	70
Pgh. Coal	240	350	45

NOTE: NE means nonexplosible.

media fall to the floor and are collected through a grate. They are then conveyed to the media recovery or recycling system. In this example, the recycling separator consists of a cyclone and sieve system which separates the recycled media (nominally 80 by 12 mesh) from the minus 80 mesh fines. Those fines are air conveyed to the baghouse dust collector. Airborne fines from the blasting room are also air conveyed to the baghouse and collected. The coarse media are recovered and conveyed to the storage hopper. From there they go to the pressure pot blaster, which uses pressurized air to convey the media to the blasting room. There the recycled media are again used in the blast cleaning of the aircraft.

CONCLUSIONS AND RECOMMENDATIONS

It is difficult to make an accurate, total hazard evaluation for a generalized system whose detailed operational characteristics are not specified. A total hazard assessment requires a knowledge of details such as the mass feed rate of the abrasive media, the size distribution in each region of the system, the air feed rates, the rate of degradation of coarse media into finer dust, the particle separation characteristics of the cyclones and sieves, the state of dust dispersion in each region, and the probability of ignition sources being present in the various regions of the system. Even if a particular system could be so quantified, there are inevitable uncertainties associated with variations of those parameters during start-up and shut-down operations and other nonsteady state or transient operating conditions. Clearly, such a specific hazard assessment is beyond the scope of this report. Nevertheless, the data presented here suggest some general approaches that may be useful to designers and operators of blast cleaning systems.

General Conclusions

The following are general conclusions on the hazards associated with the use of these plastic blasting media.

1. All other factors being equal, the Polyplus and Type III plastic media are somewhat less hazardous than the Polyextra and PMMA. The Polyextra and PMMA have lower lean limit concentrations and larger maximum explosible diameters than either the Polyplus or Type III. The Polyextra has the lowest MAIT.
2. An important parameter in the overall safety performance of any system is the rate of degradation of the coarse material into fines during the blasting operation. While the recycled media (nominally 80 by 12 mesh) could not be ignited in the 20-L tests, the fines from the baghouse could. In the blasting booth, there are both recycled media and fines generated by the blasting process. It is important to measure the amount of fines present during normal operation to determine if there are enough to be a potential hazard.
3. The paint residue in the baghouse dust did not significantly affect the explosibility characteristics of the Polyplus dust that was tested.

Equipment Recommendations

The following are conclusions and recommendations that are specifically related to the blasting equipment.

1. On the basis of the data presented in figures 8-11 and summarized in table 4, the largest margin of safety is obtained by

operating the separation system in such a way that only media with diameters larger than the maximum explosible diameter are recycled into the storage hopper. The data indicate that the 16 by 12 mesh as-received media are too coarse to be explosible. If only media coarser than the maximum explosible diameter are recycled and reused, then the major components of the system would be operating in the safest possible mode.

2. As a general rule, dust loadings should be kept as low as possible in all regions of the system, especially in the regions that contain fine dusts. Since fines are generated in the blast cleaning operation, their presence is inevitable in the separation and recovery system. It is desirable to maintain the fines concentration as low as possible in the cyclone and/or sieve system that is used for the separation. The separation system should therefore have a minimum storage of material and a rapid flow throughput. Similarly, air flow rates into the separator and out of the separator should be high enough to ensure that the airborne concentration is below the lean limit. The separator system should be independent of and removed from the final fines collection system.

3. Naturally, the fines are eventually collected and the collection system is usually a baghouse filter system. While a baghouse may not be the safest final collector that could be designed, it appears to be in common use. It may be difficult or impractical to always maintain a baghouse at a dust concentration that is below the lean limit. Accordingly, the baghouse is best located

on the outside of the facility and should be protected with explosion relief vents sized according to the latest applicable NFPA 68 code. The relief vents should be designed so that, if an explosion occurs, the hot gases vent upwards or in whatever is the least hazardous direction. In addition, another margin of safety could be obtained by locating rapid-acting explosion isolation valves or barriers between the fines collector and the rest of the system.

4. The air pressure drops necessary for the operation of the cyclones and filter bag collectors should be obtained from fans whose rotating parts are external to the dust transport system. They should either be upstream of the separator in a pushing mode or downstream of the bag filters in an exhausting mode or both. Rotating fan blades should not directly contact the dust-air mixture being transported. The use of such external sources for the flow minimizes the opportunity for frictional ignition within the pneumatic transport system.

While these conclusions and recommendations may not be the total answer to the safe design of an aircraft blast cleaning system, they may be useful in providing data on the explosibility and ignitability hazards of the plastic abrasive media and their use in a blast cleaning system.

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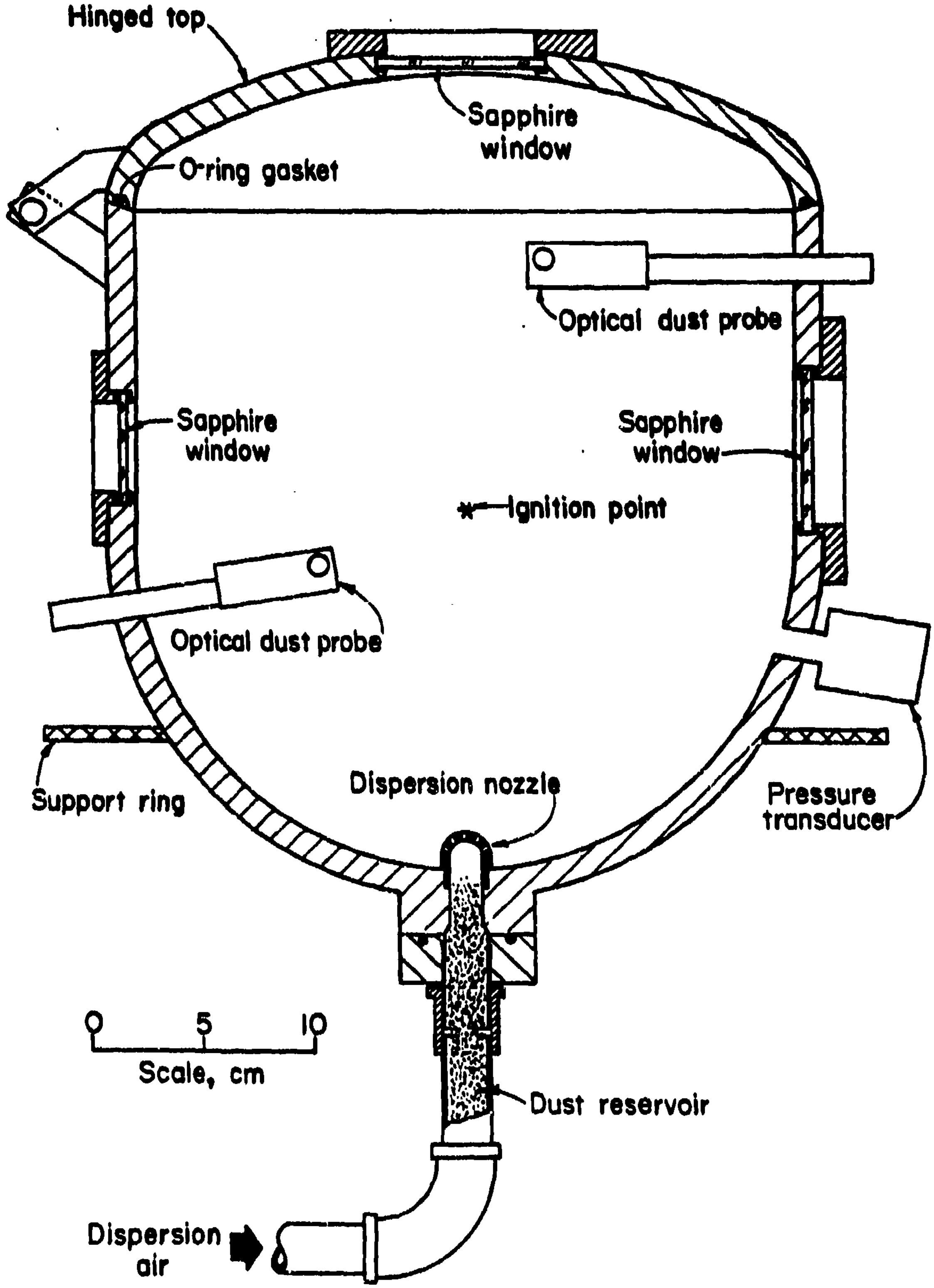

FIGURE 1. - 20-L dust explosibility test chamber.

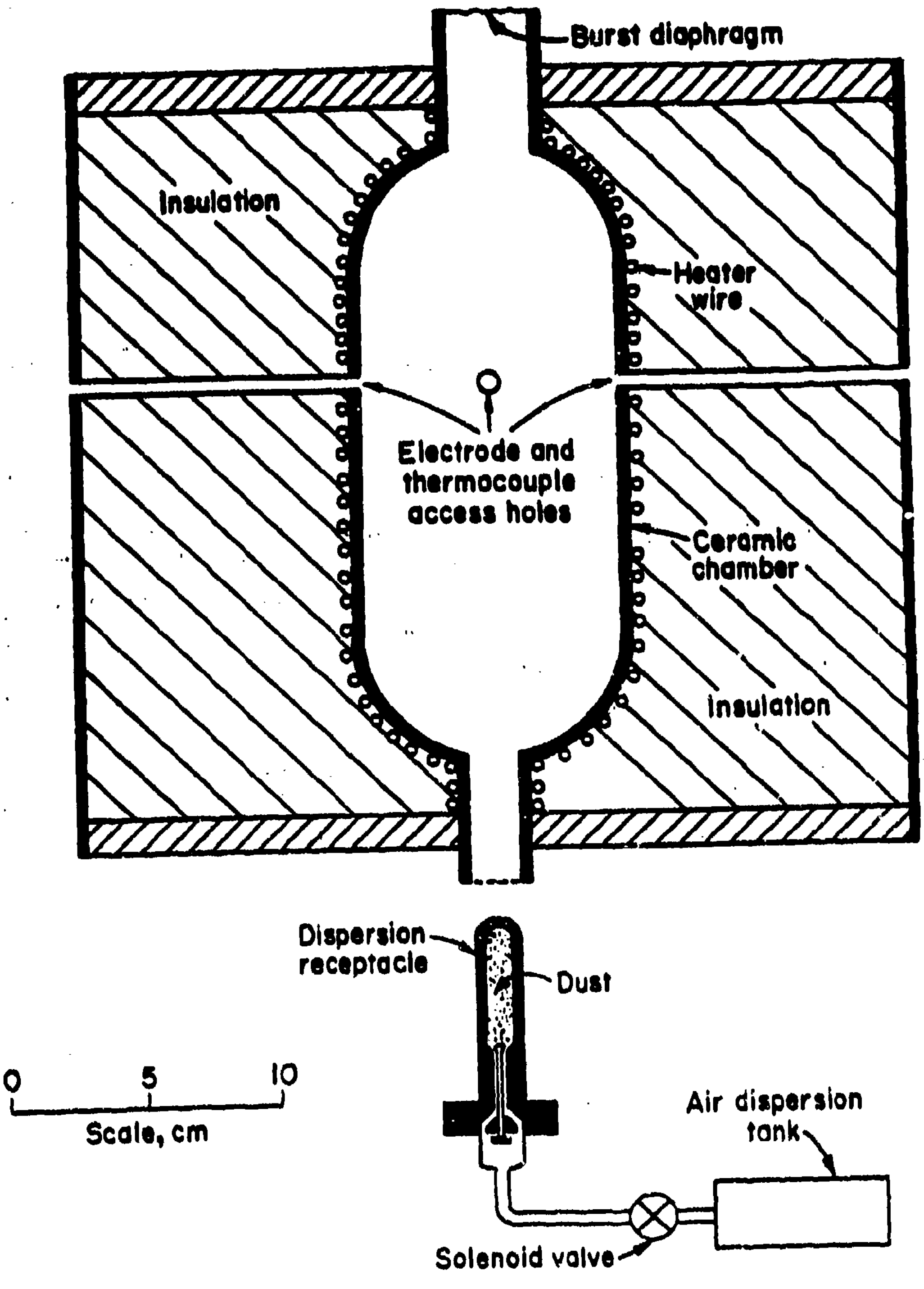

FIGURE 2. - 1.2-L ignitability furnace.

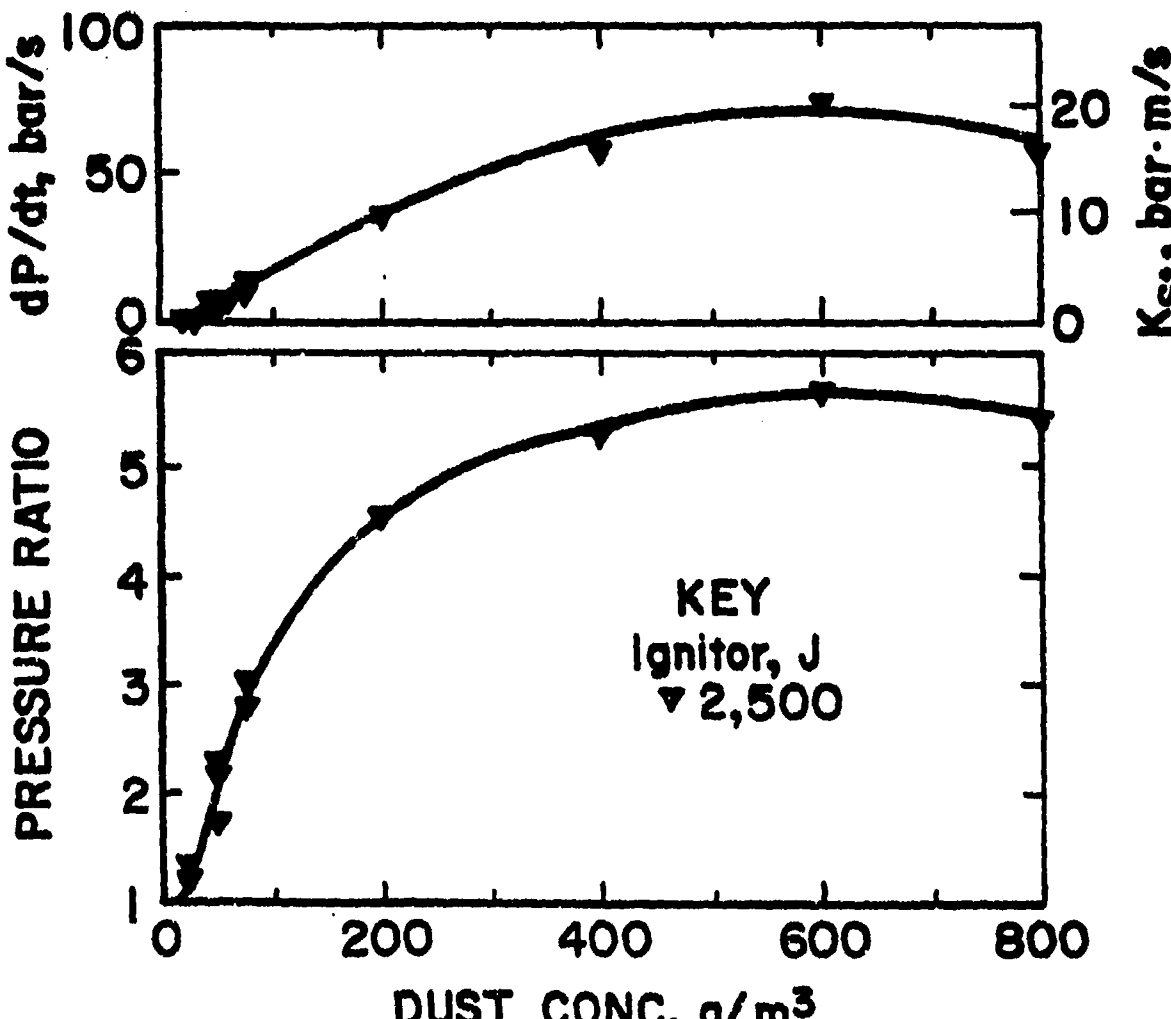

FIGURE 3. - Explosibility data for minus 200 mesh Polyextra from the 20-L chamber.

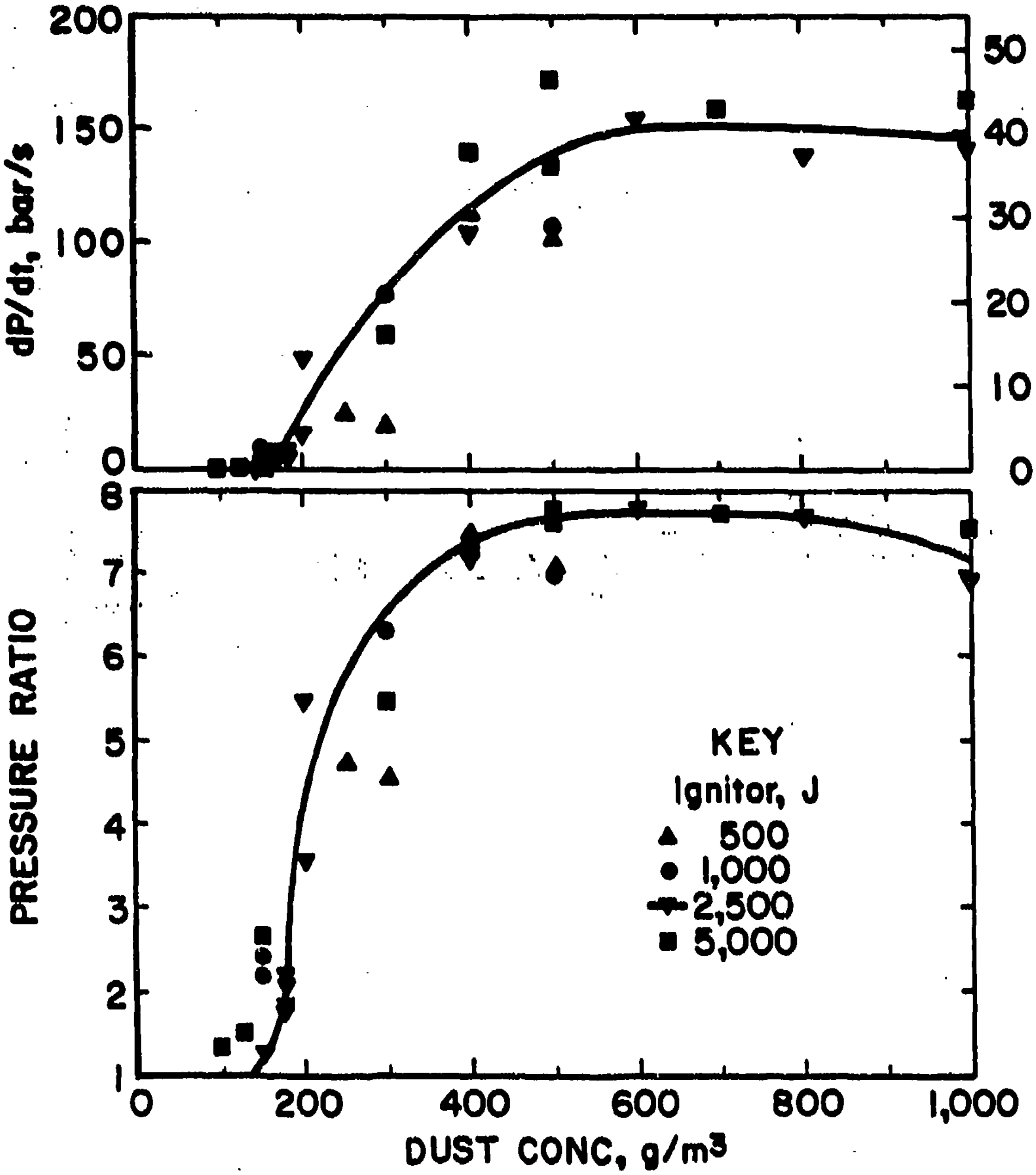

FIGURE 4. - Explosibility data for minus 200 mesh Polyplus from the 20-L chamber.

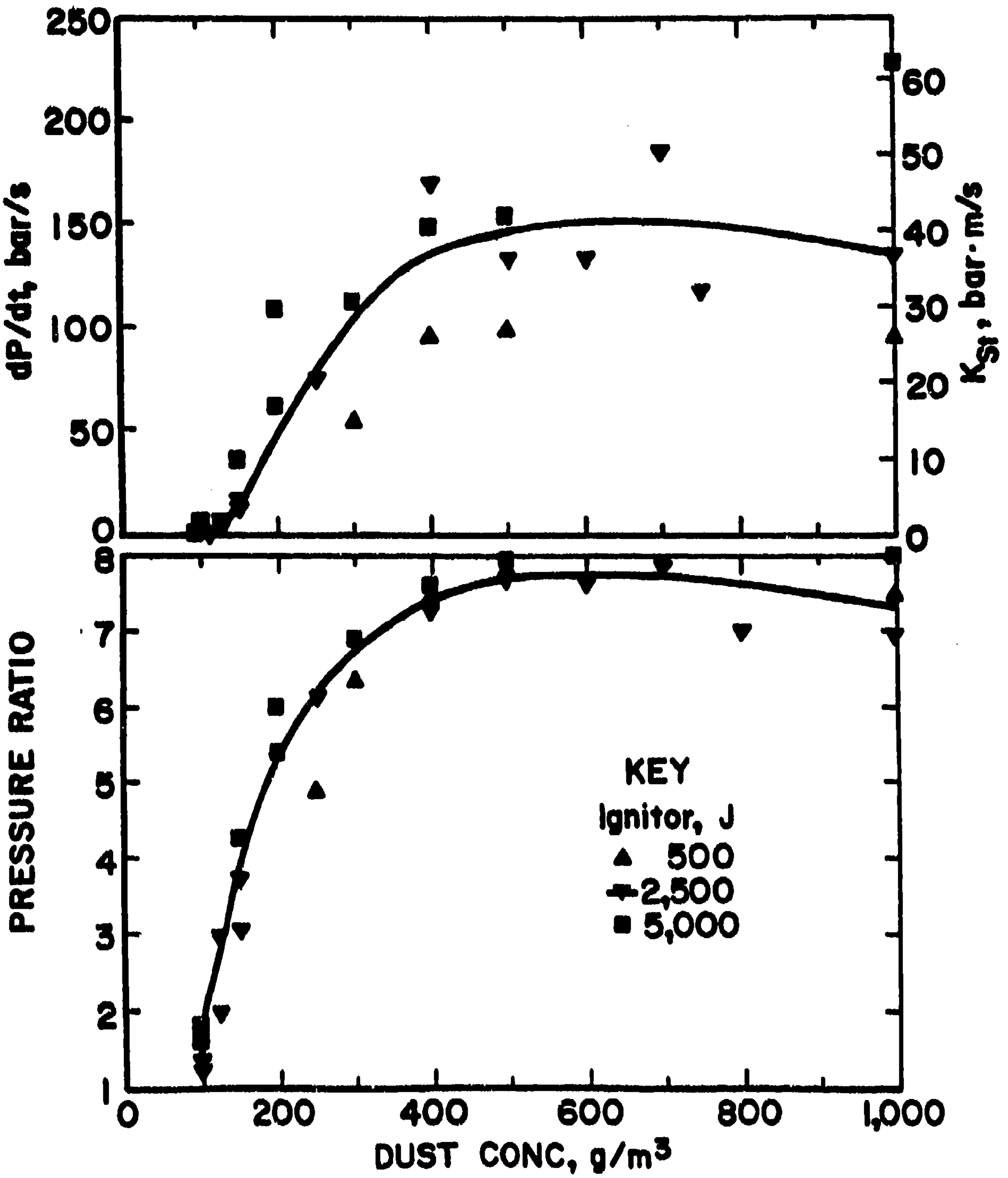

FIGURE 5. - Explosibility data for minus 200 mesh Type III from the 20-L chamber.

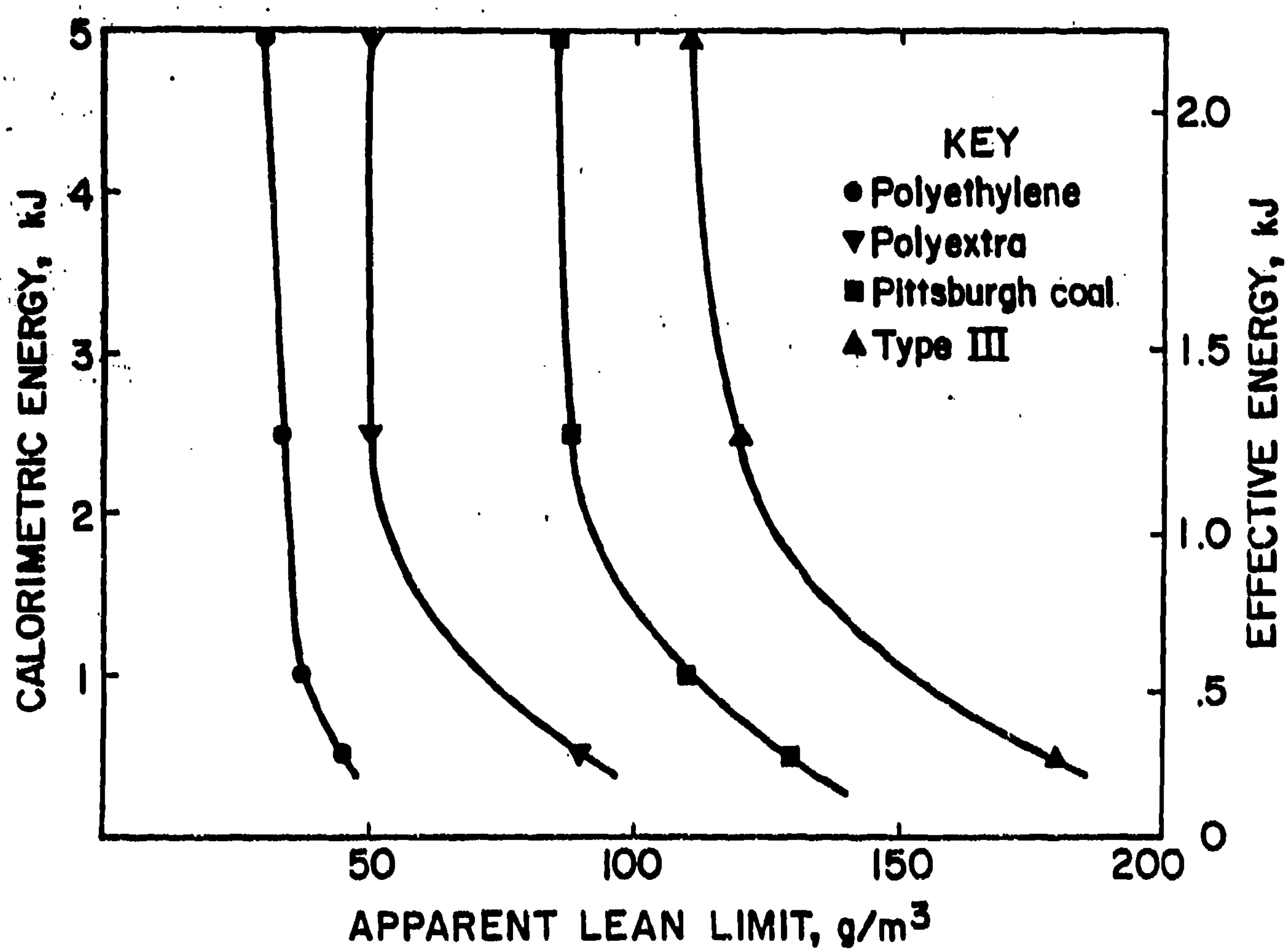

FIGURE 6. - Ignitability data for four dusts in the 20-L chamber using chemical ignitors of varying energy.

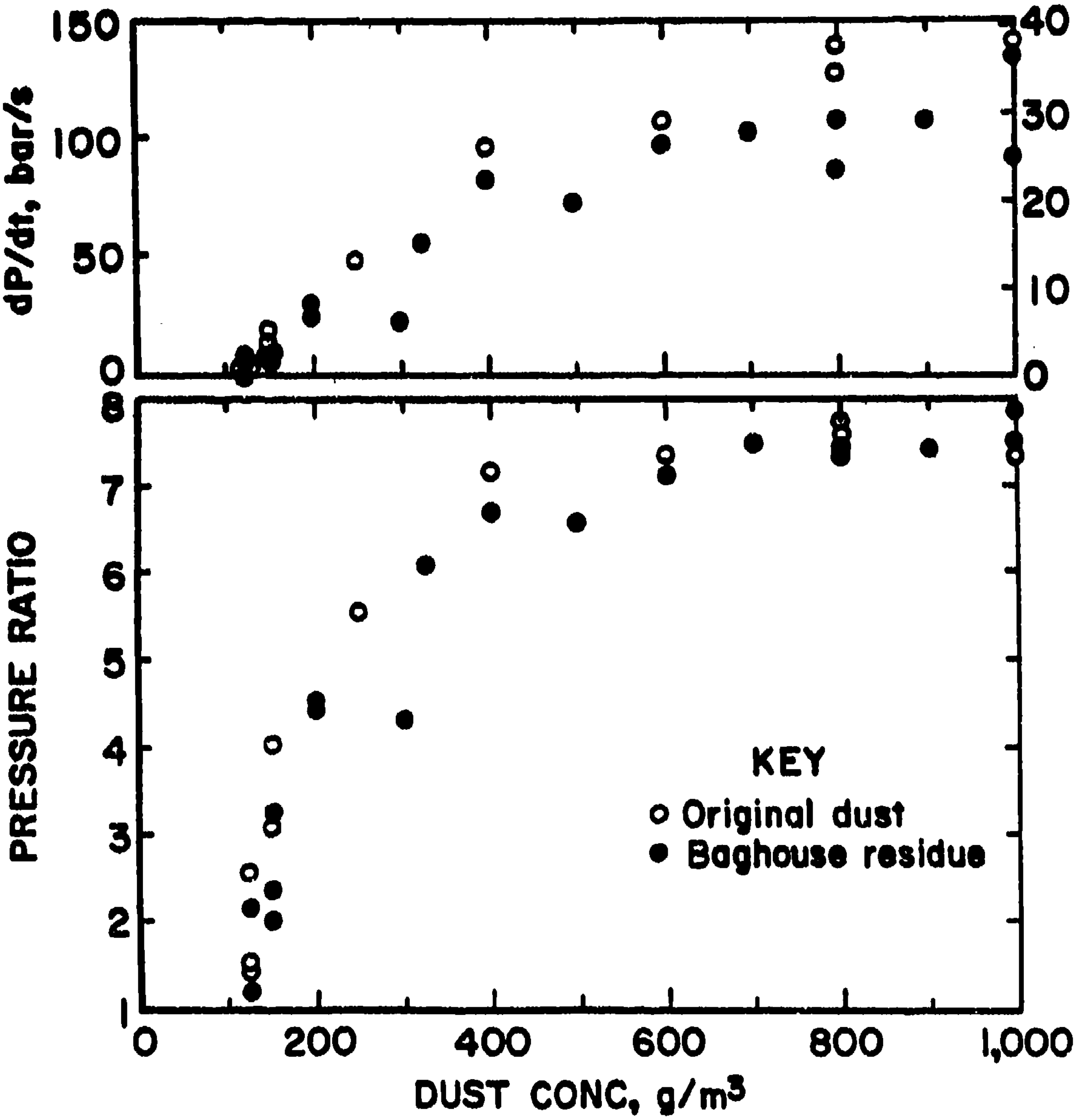

FIGURE 7. - Comparison of explosibility data for baghouse residue dust with those for original Polyplus of the same size.

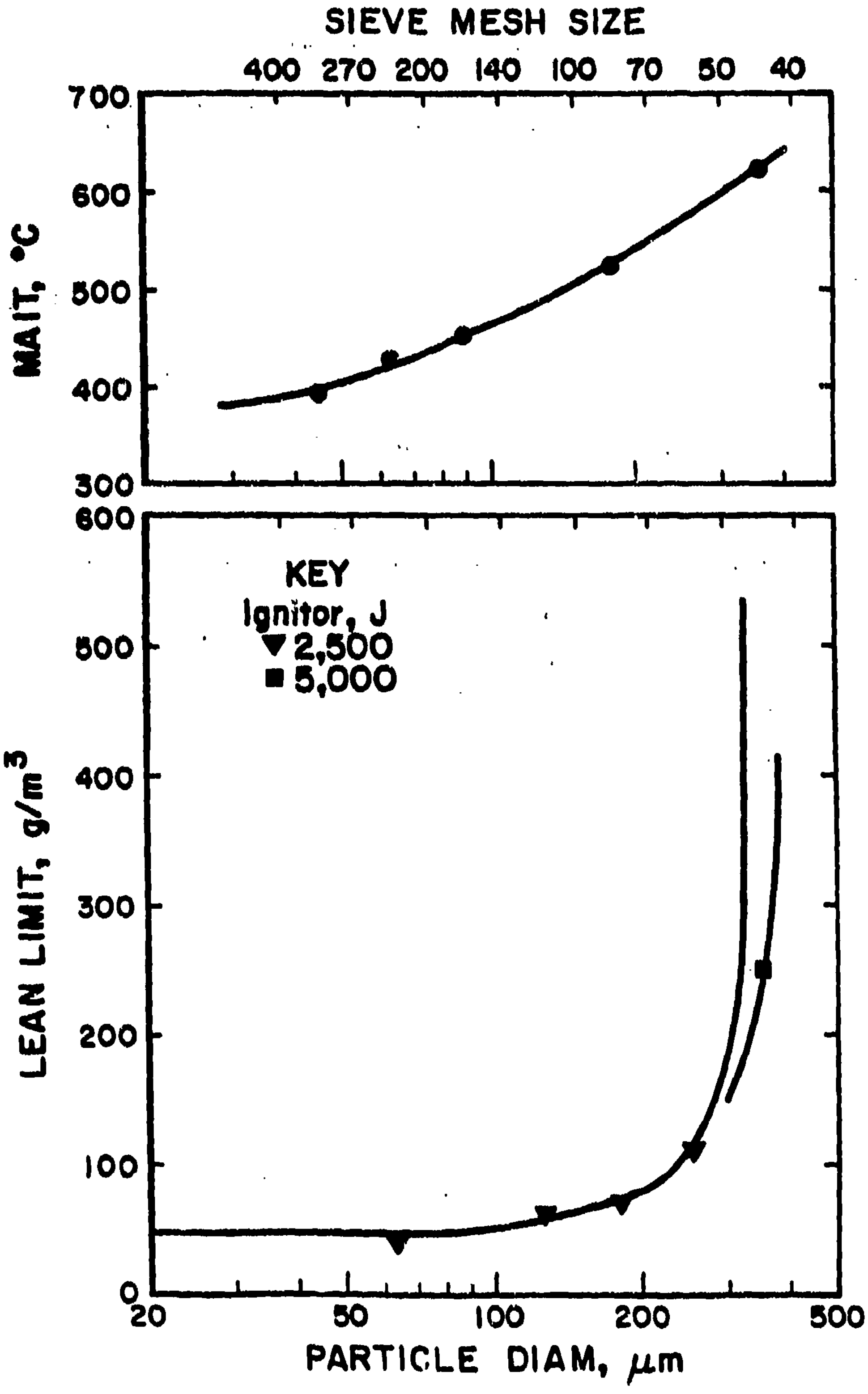

FIGURE 8. - Effect of particle size on explosibility and ignitability for Polyextra.

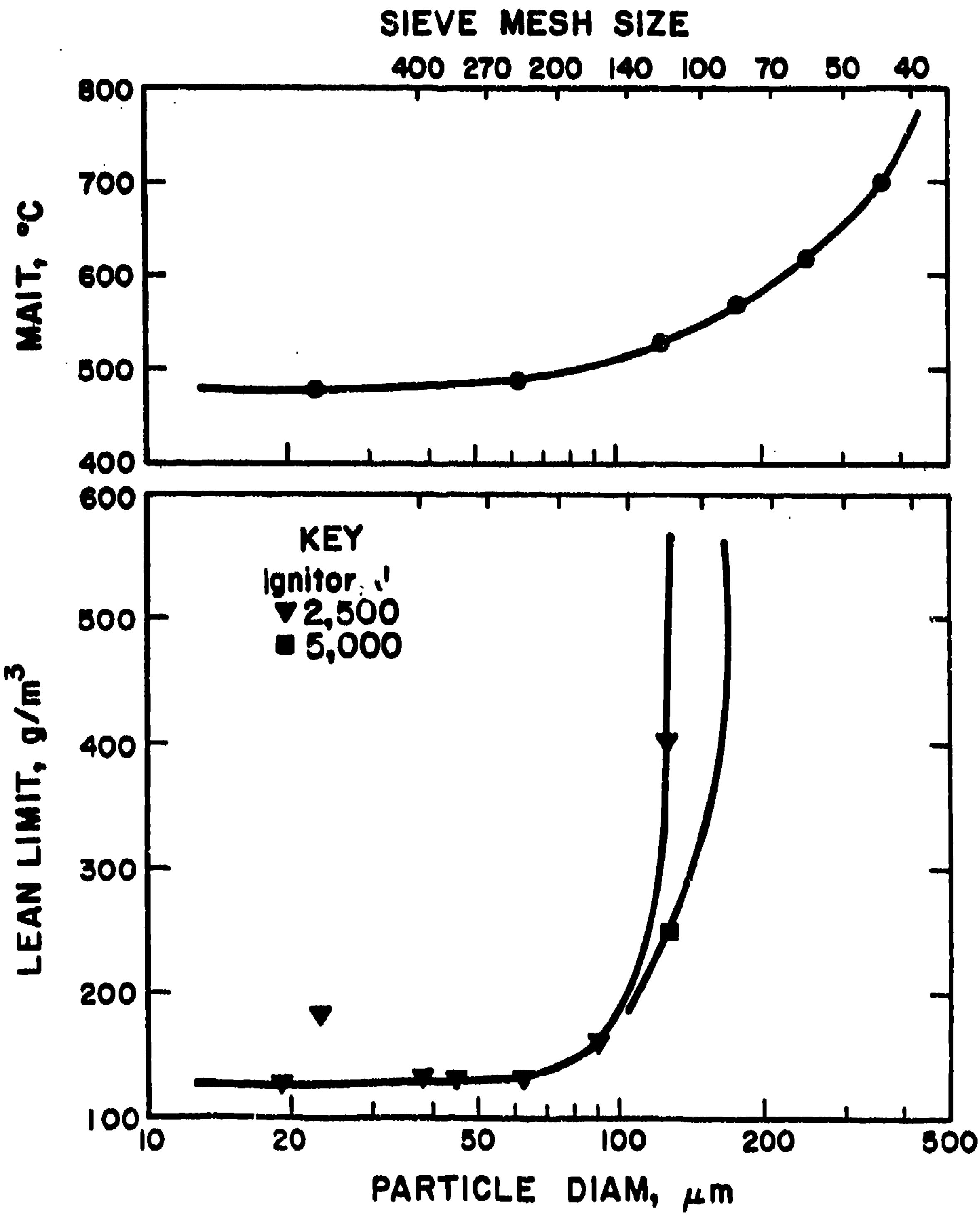

FIGURE 9. - Effect of particle size on explosibility and ignitability for Polyplus.

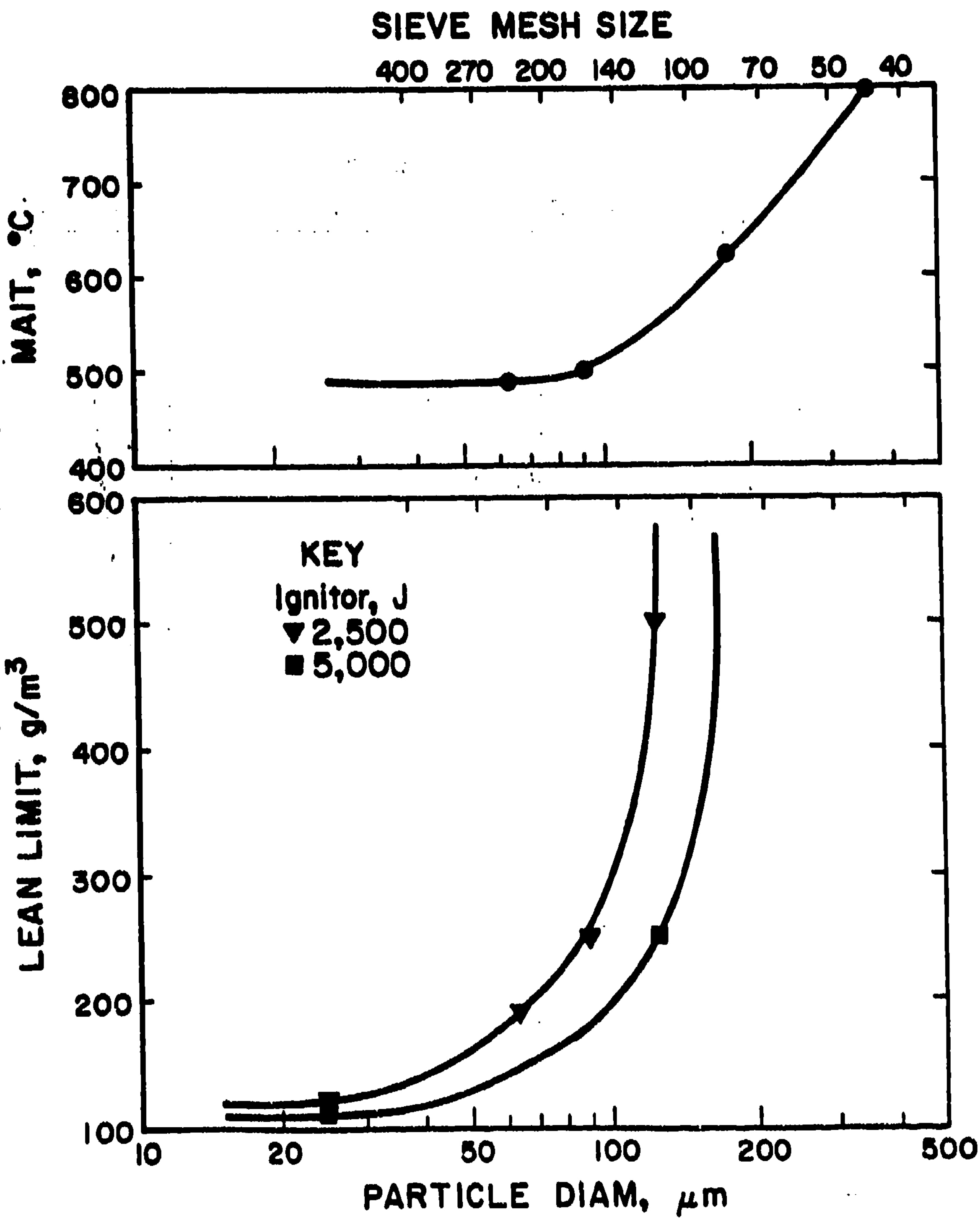

FIGURE 10. - Effect of particle size on explosibility and ignitability for Type III.

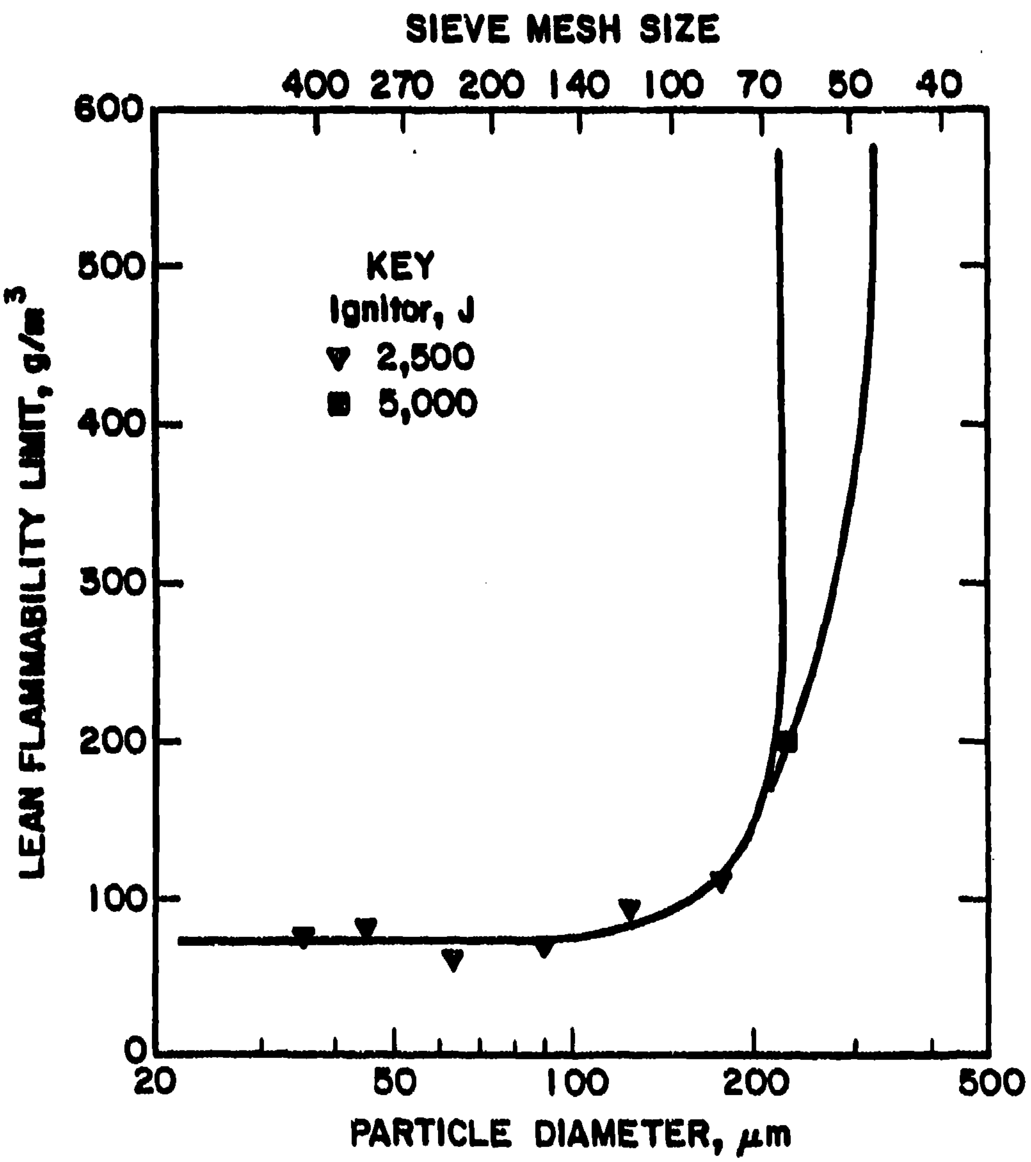

FIGURE 11. - Effect of particle size on explosibility of PMMA.

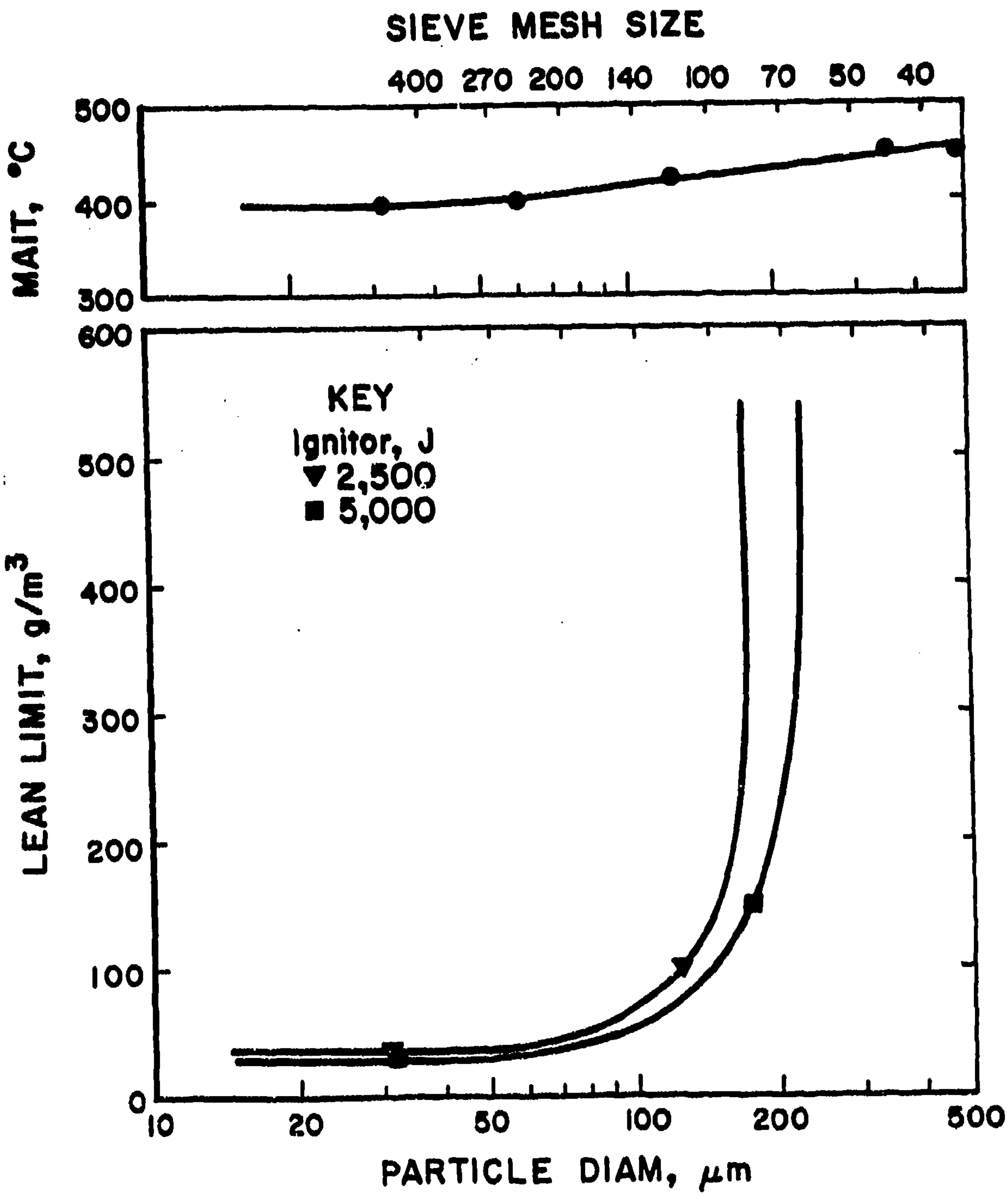

FIGURE 12. - Effect of particle size on explosibility and ignitability for polyethylene.

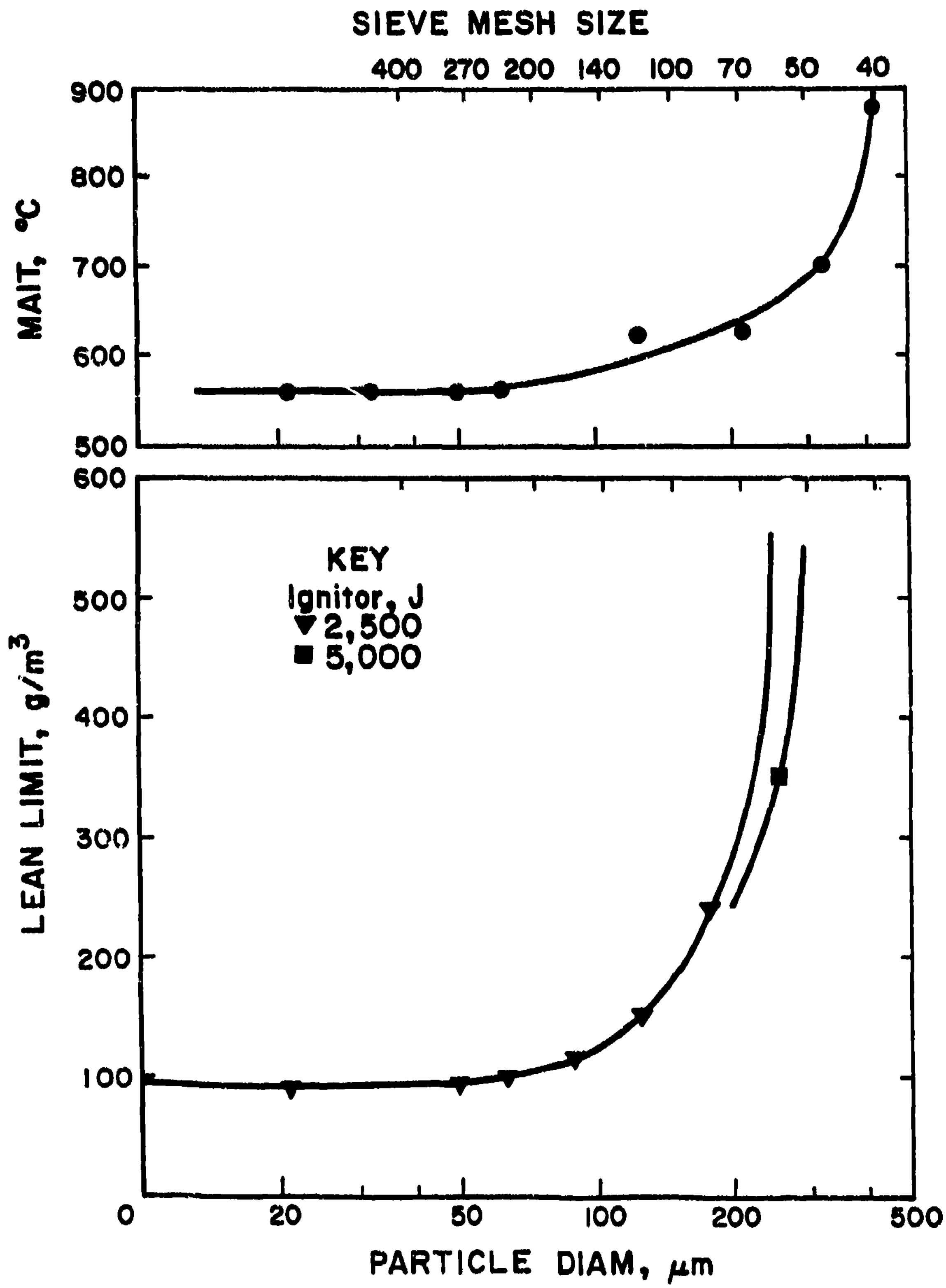

FIGURE 13. - Effect of particle size on explosibility and ignitability for Pittsburgh bituminous coal.

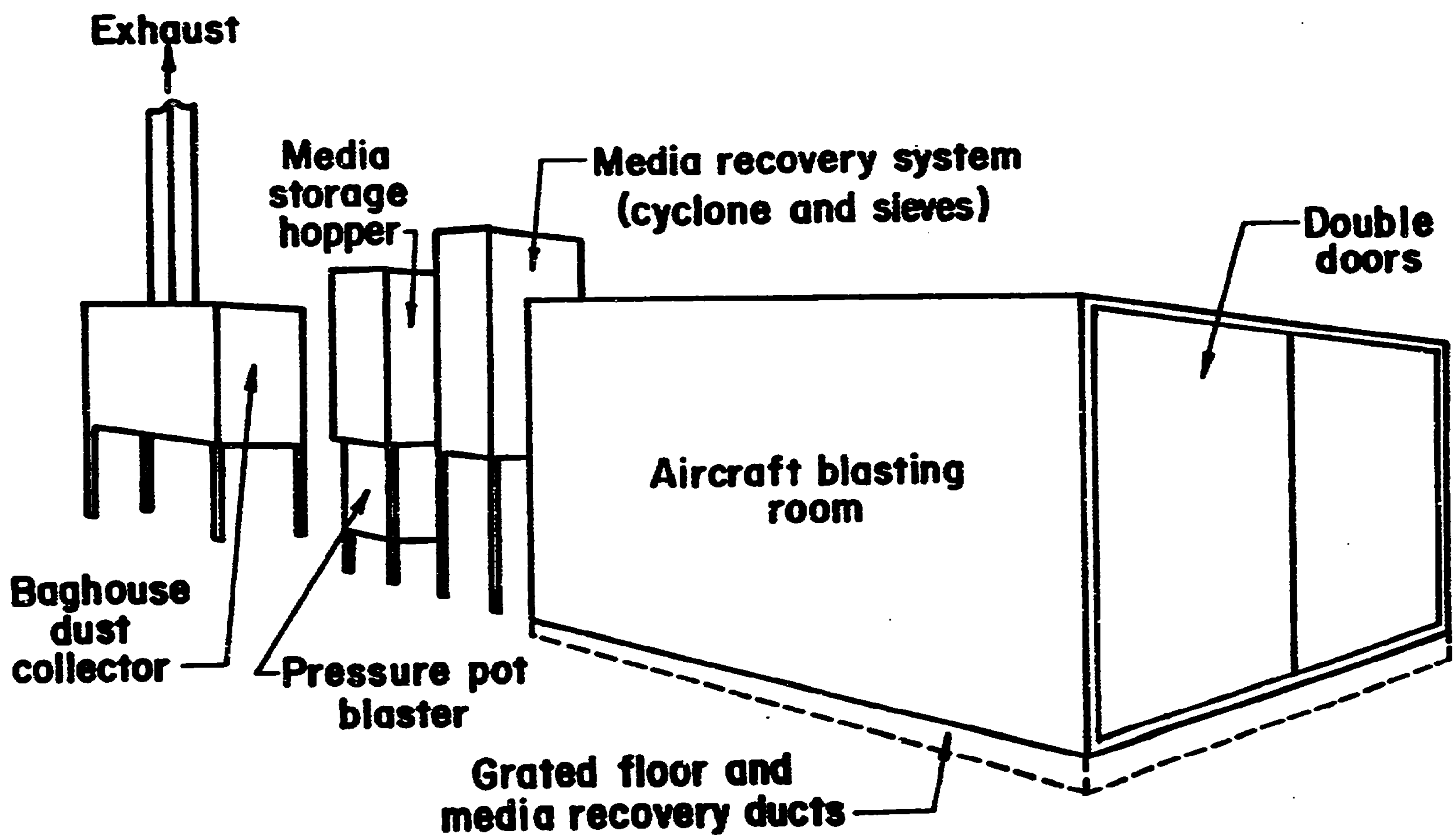

FIGURE 14. - Schematic of system for blast cleaning of aircraft with abrasive media.

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