INDUSTRIAL WASTE CHARACTERIZATION
STATE-OF-THE-ART REVIEW

by

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The utilization of industrial waste for recovery of heat is rarely practiced today. It is therefore necessary to derive a new set of characterization techniques for classifying industrial wastes relative to their suitability for particular applications. It is reasonable to expect that the ultimate characterization methodologies which are evolved for industrial waste materials would be derived from those used currently in determining the incineration or thermal destruction characteristics of these materials. In this regard, there are five characteristics which are important to under standing the behavior of industrial wastes in a thermal environment:

1. Physical form
2. Temperature range required for destruction
3. Off gases
4. Ash
5. Heating value

In the following, each of these five characteristics will be discussed as they apply to physical wastes. Physical form, which is important to determining the method of importing, storing, and feeding wastes to a thermal unit, is classed for industrial waste in five categories:

1. Gas
2. Liquid
3. Slurry
4. Sludge
5. Solid

These terms are somewhat general in nature, and mean different things to different people. However, they are useful in indicating general equipment requirements. For example, if a material is a slurry, some equipment must be provided to assure that the solid which is suspended in the liquid remains suspended through the storage process and the feeding process.

The temperature required for destruction is normally put into four categories:

1. Greater than 1366°K (2000°F)
2. 1033-1366°K (1400-2000°F)
3. 644-1033°K (700-1400°F)
4. Less than 644°K (700°F)

These data are important for two reasons: first, they determine the minumum requirement for operating thermal equipment which is intended to alleviate any potential hazards associated with the industrial waste, and second,it indicates to the designer the type of material which is required for injection plate materials, boiler tubes, or other types of combustion or heat recovery subsystems.

Off gases must be examined in terms of air pollution potential which effects the materials of construction of the thermal unit. These are presently classified into five categories:

1. Primarily oxides of carbon, hydrogen or nitrogen
2. Halogens
3. Sulfur oxides
4. Phosphorous
5. Volatile metal species

Materials such as phosphorous oxides must be examined separately since present experience with such materials has taught that special equip- must be added to the stack to remove phosphorous oxides generated in a combustion process. Halogens, of course, when combusted in an environment containing sufficient hydrogen, form the hologen acid anhydrides, such as hydrogen chloride gas, which have well known and characterized effects on materials of construction.

Ash is put into three categories:

1. Non-fusible
2. Fusible
3. Metallic

These characteristics are somewhat important to the design of the feeding, combustion and ash collection equipment.

The heating value of an industrial waste is important both for systems designed primarily to destroy industrial wastes and systems designed to recover the heat contained in such materials. Wastes currently are characterized as:

1. Greater than 23,260 KJ/kg (10,000 Btu/lb)
2. 11,630-23,260 KJ/kg (5,000-10,000 Btu/lb)
3. Less than 11630 KJ/kg (5,000 Btu/lb)

For certain types of thermal equipment, the heating value greater than 23,260 Kilo-Joules per kilogram (10,000 Btu per pound) may require that a diluent be added to the industrial waste to keep the temperature below that which might cause critical damage. When the heating value drops below 11,630 Kilo-Joules per kilogram (5,000 Btu per pound), the operator must consider adding a supplementary fuel since often the flame cannot be sustained with this low heating value.

Figure 1 summarizes the characteristics just discussed above on the side against various types of thermal destruction equipment listed across the top. An "X" indicates that a particular type of thermal unit may be used to destroy or recover heat from an industrial waste which has a particular property. An "O" indicates that the particular piece of equipment heading the column is not applicable to a waste having that property. For example, a halogen-containing sludge which must be incinerated at 1144°K (1600°F) or higher and which produces no ash can be incinerated in a multiple hearth, rotary kiln, molten salt, or fluidized-bed system.

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	LIQUID INJECTION	MULTIPLE HEARTH	ROTARY KILN	CATALYTIC & THERMAL	MOLTEN SALT	PYROLYSIS	FLUIDIZED BED	WET AIR OXIDATION
GAS	X	0	X	X	X	0	X	0
LIQUID								
LOW VISCOSITY	X	0	X	X	X	0	X	X
HIGH VISCOSITY	0	0	X	0	X	0	X	X
SLURRY								
LOW VISCOSITY	X	0	X	0	X	0	X	X
HIGH VISCOSITY	0	0	X	0	X	0	X	X
SLUDGE	0	X	X	0	X	X	X	0
SOLID								
FRIABLE POWDER	0	X	X	0	X	X	X	0
TARRY	0	0	X	0	X	X	0	0
TEMPERATURE RANGE (F)*								
>2000	X	0	X	0	0	X	X	0
1400 - 2000	X	X	X	0	X	X	X	0
700 - 1400	0	0	0	X	X	0	0	0
<700	0	0	0	0	0	0	0	X
OFF GASES								
OXIDES OF H, C, N	X	X	X	X	X	X	X	X
HALOGEN, SULFUR, ETC.	X	X	X	X	X	0	X	X
ASH								
NON-FUSIBLE	X	X	X	0	X	X	X	X
FUSIBLE	X	0	X	0	X	X	0	X
METALLIC	X	0	X	0	X	X	X	X

FIGURE 1 WASTE CHARACTERISTICS VERSUS THERMAL UNIT TYPES

*Conversion Factors: $^{o}K = \frac{5}{9} (^{o}F - 32) + 273.15$