ABSTRACT

In the past a poor quality residue was frequently excused and accepted when incoming refuse had a high moisture content. This is no longer permissible. Means of coping with the wet refuse problem are summarized, based on reports from operators of 15 municipal incinerators of various types, sizes and ages. The author's comments and conclusions are included.

INTRODUCTION

Until relatively recently, it was generally conceded that the average municipal incinerator plant could not be expected to produce good results when burning refuse with a high moisture content. Low temperatures, the frequently accompanying smoke and odors, and a poor quality residue with a large proportion of unburned material were accepted when the refuse was wet from heavy or protracted rain or contained large quantities of lawn and garden refuse. Today, when residue quality is an important and necessary criterion of incinerator plant performance, a poor quality residue cannot be accepted except under emergency conditions, and objectionable smoke and odors can not be tolerated.

Recognizing the fact that many older plants, in particular, still have trouble with wet refuse, operators of about 30 plants were canvased for information on their experience in burning such material. Replies were received covering 15 plants, based on operating experience ranging from one and one-half years at Montgomery County, Ohio, to about 19 years at Waterbury Connecticut. Capacity of reporting plants was from 200 to 1000 tons/day with furnaces from 100 ton/day batch feed units operating one shift a day to 250-ton units operating continuously 24 h/day, six and seven days a week.

THE CAUSES

Wet refuse problems stem, not surprisingly, from three primary causes:

1. Extended periods of rainy weather;
2. High proportion of lawn and garden waste, particularly grass, in the refuse; and
3. Extinguishing pit fires.

GENERAL APPROACH

Regardless of the source of the moisture, operators are nearly unanimous in agreement that wet refuse will reduce burning capacity and that best results can only be accomplished by mixing fresh, dry refuse with the wet, or by the use of auxiliary fuel. Plants which receive a large proportion of commercial and industrial refuse appear to survive better than others inasmuch
as this material tends to be dryer than that picked up on the normal municipal route. At East Hartford, Connecticut for example, about one third of the total refuse delivered to the plant is from commercial and industrial sources and can be depended upon to be dry regardless of the weather or other circumstances. This dry material is fed into the furnaces in alternate charges with the wet and as a general rule a minimum temperature of 1400 °F can be achieved. At other plants, dry and wet refuse are mixed in the storage pits before charging to the furnaces. Some operators report maintaining a stock of rubber tires or other waste rubber for addition to the refuse during wet weather.

Most operators concede the necessity for slowing down stoker operation when handling wet refuse. The Superintendent of one traveling grate plant stated it is necessary to maintain a thin fire bed and manual stoking may be required. Little was said about combustion air except that the underfire air supply must be increased. One Superintendent attributed the absence of serious problems with wet refuse to the automatic control of underfire and overfire air provided in his plant.

Plants operating continuously, 24 h/day, appear to have less trouble with wet refuse than plants that are operated one or two shifts a day. Both Delaware County, Pennsylvania and Montgomery County, Ohio report much better results since they went to seven days a week continuous operation.

Years ago, auxiliary oil or gas-fired burners were integral parts of all incinerator plants, but subsequently they were omitted from most installations. Now, however, they are being provided again and appear to produce good results. The East Side plant in New Orleans had burners in the original installation and is reported to have good results burning refuse despite a high lawn and garden waste content. At the Central Wayne County Sanitation Authority Plant in Michigan, it was impossible to raise temperatures above 900 °F in heavy rainy periods or during the heavy grass season. The burning capacity fell off as much as 35 percent and frequent complaints of odors were received from nearby residents. Two 13 mm Btu/h auxiliary gas burners were installed in each 250 ton/day furnace, and it is reported that with their use, adequate temperatures can be maintained, the odor problem has been eliminated and the furnaces operate at design capacity at all times and under all conditions.

One operator stated that he does not attempt to burn when the refuse moisture content reaches 60 to 65 percent. Others stated that when refuse is exceptionally wet or contains unusually large quantities of lawn and garden waste, the refuse is diverted directly to the disposal area without any attempt to burn it.

One operator suggested the inclusion of shredders in all incinerator plants to permit burning branches, furniture, wood pallets, etc. under normal conditions, as well to provide a supply of this usually dry, readily combustible material for wet weather use. The operators were unanimous on one point: their rainy weather problems would be greatly reduced if householders would use plastic bags for storing refuse instead of conventional cans whose tops are frequently leaky or missing.

**WET START-UP**

As a general rule, operators delay starting fires with wet refuse until an adequate supply of dry refuse is on hand. The fires are then started with the dry material and when "adequate" temperatures are reached, the wet material is mixed in increasing proportion to permit operation as described above. Some operators report maintaining a supply of dry material at all times for this use.

Where no dry material is available for start-up, operators report mixing kerosene, fuel oil or waste motor oil with the refuse in order to start the fires.

In general, the problem with a wet start-up is one of obtaining temperatures of 1400 °F or higher. Once such temperature has been achieved, the fire can usually be maintained although a boost such as an occasional tire, or the addition of dry refuse, oil or kerosene is frequently required. One operator of a large 24 h/day plant reported that if he can get his temperatures up to 1600 °F, he does not have a wet refuse problem. Another experienced superintendent reported, "To start fires, we use tires and slowly add some material until we can get furnaces up to 1600 to 1900 °F. Then the charges can be put into fires along with some tires and after an hour of 1700 °F we can mix materials and add a tire or two to hold the heat. Also any dry materials are kept separated and fed into the fires along with the wet materials and, if needed, tires". He did not comment on whether the burning tires cause a smoke problem.

**LAWN AND GARDEN REFUSE**

The problem of burning refuse containing high proportions of lawn and garden wastes, and particularly grass, is one which still largely defies solution, and which appears to plague suburban residential areas in particular. Oyster Bay, New York, for example, reports an increase of about 30 percent in its refuse load during the growing season while Euclid, Ohio reports that
grass comprises 60 percent of its total load during the summer. Throughout their comments, operators generally referred to grass as the culprit, with wet leaves in second place.

In general, wet weather procedures are applied as necessary when burning refuse containing large quantities of grass. Some operators report they have never been able to achieve good results under these conditions, while others stated that, particularly with moderate quantities of grass well mixed with the refuse, they have no problem in maintaining adequate temperatures. All agree, however, that grass and leaves do not burn well and a substantial proportion will pass through the furnace and be discharged unburned in the residue. This has presented serious operating problems in some plants, such as jamming of conveyors or carrying excessive quantities of water into the residue trucks.

Operators generally feel that a combination of heavy rain and high grass content create the worst possible conditions. Another states that wet leaves are his worst problem. "A full grapple of wet leaves can kill a fire".

The solution preferred by many is diversion of leaves, grass and the like directly to the disposal area, rather than to the incinerator. This is possible where there are separate collections, but impossible with combined collections. Grass delivered to an incinerator plant should be mixed as uniformly as possible with the refuse in the pit. Bags of grass should be broken up and mixed. One operator reports that by this means he is able to obtain good temperatures and achieve an excellent burn-out of everything except the grass. Other operators report that grass will burn better if held in the pit a few days before charging to the furnaces; however, this may cause odor problems.

**PIT FIRES**

In the words of one experienced large plant superintendent, "Now we will go into what is the worst thing that can happen in an incinerator — a bad pit fire."

Operators are unanimous in preferring to fight pit fires with their own personnel who are aware of the wet refuse problem, and to call the fire department only in emergency because, "If the fire department is called, they think the receiving pit is a swimming pool, and must be filled with water to the edge of the tipping floor. When this happens it is impossible to burn this material."

Small pit fires or small areas of smouldering refuse can frequently be picked up intact by the bucket or grapple and transferred to the charging hopper. Other fires may be small enough that they can be extinguished without using an appreciable quantity of water. In case of a serious fire, however, the refuse is likely to be completely saturated whether the fire is fought by plant personnel or by the fire department.

The first step after a pit fire is to pump out or drain off any free water. If the quantity of saturated refuse remaining is small, it may be segregated at one end of the pit then mixed with dryer incoming refuse and handled in the same manner as refuse which is saturated by rain. If the quantity of refuse in the pit is too great to be handled in this manner, then it must be disposed of before normal plant operation can be resumed. Some plants have provision for transferring refuse from the pit direct to trucks for disposal using the crane and bucket. Other plants which do not have this provision must feed the saturated refuse thru the furnaces using the stoking mechanism as a conveyor. This is a time-consuming procedure frequently resulting in jamming or clogging of the residue removal equipment and is not satisfactory.

Some operators prefer to completely empty the pit after a fire and start fresh. Others find it practical to remove only as much of the saturated refuse as is absolutely necessary, thereafter handling the remainder in the same manner as in a rainy period.

**AUTHOR'S COMMENTS**

To this point, this paper has consisted primarily of quotations from, or paraphrasing of, written general comments from plant operators. They logically lead to such questions as: how much auxiliary fuel is used? what proportions of wet and dry refuse are required? and, most basically, when is refuse considered wet?

These questions were discussed subsequently with a number of operators who were unanimous in replying that the many varying factors prevent establishing hard and fast rules or operating procedures. Instead, they feel the problems must be faced on the basis of previous experience or conditions of the moment, with the furnace operators' judgment and experience being the most important consideration.

There is no problem in identifying the saturated refuse in a water filled storage pit as wet, nor in identifying a clean load of wood shavings and corrugated paper cartons as dry.

Pre-World War II refuse generally contained a high proportion of garbage and had a moisture content of 50 percent or more; most operators would consider such refuse wet today. At the same time, so-called "normal" refuse today frequently contains 20-25 percent moisture and is considered dry. It appears therefore,
that refuse becomes "wet" at a moisture content somewhere between 25 and 50 percent.

Within reasonable limits, and assuming proper operation, a continuous feed furnace with stoking grates can, because of its more uniform temperature characteristics, be expected to operate satisfactorily with a higher refuse moisture content than can a batch feed furnace with its tendency to wide temperature fluctuations. Further, any furnace can be expected to burn a higher moisture content refuse satisfactorily after it has been operating for an extended period at 1600 to 1800 F than it can at startup. It is obvious, therefore, that it is impossible to fix the moisture content at which refuse can be considered "wet", inasmuch as operating problems and conditions vary not only from plant to plant, but also in any one plant.

The use of kerosene, oil and rubber tires as auxiliary fuel is difficult to quantify primarily because the requirements vary with the conditions described above. Kerosene or oil may be sprinkled over the wet refuse in the storage bin or over the refuse in the charging hopper. Tires are generally added in the hopper; however, caution must be exercised in the use of tires or similar materials so that a new smoke problem is not introduced while the original smoke and low temperature problem is overcome.

Similarly, the proportion of dry refuse to be mixed with wet depends on the conditions of the moment. It appears that the most satisfactory practice — and the one most generally followed — is to store dry material separate from the wet, usually in different areas of the receiving bin, and feed it to the furnace as required to maintain the desired minimum temperature. A similar procedure can be followed with wet material when refuse is dry and the tendency is to excessive temperatures. Some plants use a signal system consisting of three lights visible to the crane operators. One light indicates low temperature, one indicates excessive temperature, and the third indicates furnace temperature within the desired limits. From observing these lights, the crane operator knows whether to feed wet or dry refuse or a mixture of the two.

More meaningful information on use of auxiliary fuel can be obtained from plants having gas or oil burners in their furnaces, although here, again, the operators point out there can be no hard or fast rules. At the Central Wayne County Sanitation Authority plant, the burners are seldom operated at more than 50 to 60 percent of capacity at startup when refuse contains a high proportion of grass. They are then manually backed off to perhaps 25-30 percent of capacity, depending on observed conditions, when the desired 1400 to 1500 F temperature has been reached. With less severe grass conditions, one burner at 25-30 percent of capacity frequently suffices to maintain the desired temperature. Studies at this plant indicate the total moisture content of dry-weather refuse during the heavy grass season may be as high as 42 to 50 percent.

It must be realized, however, that the Central Wayne burners are “overfire”. While their use unquestionably contributes to improved burnout, their primary purpose is to maintain adequate gas temperatures.

None of the operators furnished specific data on the stoker speed variation required nor on the depth of the “thin” fire bed to be maintained with wet refuse; however, it is to be expected that better results will be achieved when the refuse bed is agitated or tumbled than when there is no mixing or agitation after it is deposited on the grates.

Observation in many plants confirms the fact that a high proportion of lawn and garden waste in the refuse creates serious operation problems. Obviously, eliminating this material through separate collections and delivering it directly to a disposal area would overcome the problem; unfortunately, however, this points up a serious deficiency in current incinerator designs. It is to be hoped that future designs will assure proper burning of this material, but at present there appear to be no plants with truly satisfactory solutions to the problem.

It was surprising to receive so few comments on control of combustion air in burning wet refuse. In most cases, control of air under wet refuse and low temperature conditions is based on the operator’s judgment. No mention was made of the use of preheated air which studies by the author’s firm, confirmed by European experience, indicate to be highly desirable as an aid to overcoming high moisture problems.

Further, there were no suggestions for automation to overcome the wet refuse problem. The patented “cascading” control, wherein the proportions of overfire and underfire air are varied automatically, has proven remarkably successful in maintaining maximum furnace temperatures within plus or minus 25-50 degrees of the set point. It seems only logical, therefore, that appropriate automatic controls should be more successful than manual control in overcoming low temperature problems.

There is general agreement with the operators’ contention that a shredder for furniture, lumber, tree trunks, and the like provides a good source of readily combustible material at all times; however, such an installation is costly and its inclusion in a plant design may not be economically justifiable.
CONCLUSIONS

It appears to be the consensus of the superintendents and operators reporting that:

(1) The rainy weather problem would be greatly reduced if householders used plastic bags instead of conventional cans for storing refuse prior to collection and disposal.

(2) Continuous feed plants and plants operating 24 h/day tend to have less severe problems with wet refuse than batch feed plants and plants operating only one or two shifts a day.

(3) Auxiliary fuel in some form is usually required to start and maintain fires with excessively wet refuse.

(4) Plants with properly sized and located auxiliary burners can maintain capacity operation and adequate temperatures under all but the most extreme wet refuse conditions.

(5) Refuse containing moderate quantities of lawn and garden wastes can be burned in a satisfactory odor and nuisance free manner. With high proportions of lawn and garden wastes, auxiliary fuel, preferably supplied by burners, may be required for satisfactory operation. In either case, most of the grass can be expected to pass through the furnaces without burning.

(6) Adequate stoking is required to assure satisfactory operation with wet refuse.

(7) The amount of auxiliary fuel required and the variation in combustion air supply can not be quantified, but is dependent on refuse moisture content and furnace operating conditions.

(8) The problems in burning "wet" refuse can best be met by an experienced furnace operator continuously observing the fire and adjusting the auxiliary fuel and combustion air supply on the basis of his observations and experience.

The author is in general agreement with all the above except No. 8. It is his conclusion, based on observation and investigation, that the following are necessary for satisfactory operation, including burnout, with wet refuse, and particularly when refuse contains a high proportion of lawn and garden waste:

(1) Preheated combustion air;
(2) Automatic control of preheat, auxiliary overfire burners, and combustion air, both underfire and overfire; and
(3) Automatic control of stoker operation may also be desirable.

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