Operations - Keynote to Successful Incineration

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ABSTRACT
This paper emphasizes the extreme importance of establishing proper operating procedures to obtain good overall efficiency of an incinerator. It pinpoints six major factors affecting operation, shows how some severe operating problems were solved in a particular installation, and emphasizes the importance of close cooperation between consulting engineers, manufacturers, and operators.

INTRODUCTION
Central incineration of municipal refuse has been in use in the United States since the latter part of the 19th Century. Over the years, much has been learned and written about incinerator design and construction, furnace types, air-pollution control, refractories, and a host of other details relating to engineering design criteria. Yet, even today, with the most modern concepts of design, construction, and architectural treatment, municipal incinerators are looked on by the average layman as dirty, odorous, albeit necessary, nuisances. Most of this feeling, in the opinion of the author, is due not to inefficient design but to inadequate attention to the prime function of operations. The author can find little mention of operating methods in current or past literature. Therefore, this paper attempts to point out some of the most important points that should be considered essential to insure that good operating practices are followed, not only on a daily basis but also as a long-range program. If these points are followed carefully, incineration should become accepted as a satisfactory means for the reduction of municipal refuse without offending the environmental and aesthetic feelings of the community.

The ensuing comments are based on 13 years of incinerator operation by the Public Works Department of Alexandria, Virginia. From 1956 to 1966, we operated a batch-type, 200-ton/day incinerator without special air-pollution-control devices. In 1966, a new, 300-ton/day, continuous-flow type incinerator with wetted baffles was put into operation, and the batch-type plant was closed. The department is now completing modifications on the older plant, providing wetted-baffle fly-ash control and expects to put this plant back on line about January 1970. The renewed use of this plant has become necessary due to population increases and an apparent increase in the per capita generation of combustible refuse.

The experience of the past 13 years and the general acceptance of our incinerators by the community has isolated six essential factors that must be integrated into a successful operating procedure. Not necessarily in order of importance, these factors are

1. personnel selection and training,
2. preventive maintenance,
3. plant modification,
4. general maintenance and cleanliness,
5. plant safety program, and
6. plant records' keeping.

This paper will attempt to explain the department's procedures in each of these six areas and show how, taken as a whole, they have resulted in
what, in the author’s opinion, has been an eminently successful incineration program.

**PERSONNEL SELECTION AND TRAINING**

One of the most essential factors in achieving successful operation is careful selection and training of personnel. Mechanical ability, good work habits such as punctuality and attendance, flexibility in accepting new methods and adapting to changing conditions, and real desire to perform a badly needed municipal service are points that should be considered in selection of employees for this type of work. Foremen and maintenance men should be able to keep legible records of operations and to interpret them as they may apply to operating procedures and changes. Although not essential, knowledge of similar operations is desirable, such as previous experience in boiler or furnace operations.

Specifications for construction of the furnaces should require that the furnace contractor furnish the services of a fully qualified incinerator operator during the break-in period to train employees in proper operation procedures. On our first incinerator (200-ton batch type, 1956), the department was fortunate in having such service; break-in problems were minimized, and personnel received training and experience that enabled them to cope with new problems as they arose. This procedure did not work satisfactorily in the case of the new (1966), 300-ton, continuous-flow plant.

Continuous on-the-job training is extremely important. The department has attempted to train most of its personnel to fill more than one job at the plant. All foremen and maintenance men are trained as shift bosses, crane operators, and maintenance mechanics; stoker men may operate as tipping-floor or charging floor men or as drivers in an emergency. Personnel from other activities have also been used from time to time to fill vacancies, and these men also receive training.

**PREVENTIVE MAINTENANCE**

A second very important ingredient in assuring good and continuous operation is a planned program of preventive maintenance. Each incinerator will have its own special problems in this field; the more the operation is mechanized, the greater the need for a maintenance plan. Inspection, lubrication, and testing of some equipment may have to be performed on a daily basis; some, such as cleaning furnaces, cleaning spray nozzles, etc., on a weekly basis; and some, such as refractory repair and replacement, on an as-needed basis.

We have found that the weekly program cannot normally be done until Monday morning. For this program, we use the regular 7 a.m. to 3 p.m. shift augmented as needed by part of the 11 p.m. to 7 a.m. shift. Four to five hours are usually needed to complete such work, including cleanup.

Daily lubrication and inspection of residue and fly-ash conveyors are needed to minimize wear and catch potential trouble before it develops. Daily checkups are also necessary on hydraulic systems, pumps, and water quality. Fan settings, residue-conveyor chain alignment and wear, crane controls, and other matters of this kind should be put on a regular schedule and not left to chance. In this way, many potential problems can be corrected before they affect operation.

**PLANT UPKEEP**

As mentioned earlier, incinerators have a reputation for being dirty. There should be no excuse for this, if the plant operator impresses on his employees the need for cleanliness. Consultation between the operator and the designer can often eliminate possible sources of dust and dirt collection such as horizontal ledges, inaccessible corners, and other dust catchers. Use of tile walls and floors in offices, locker rooms, and lunch rooms also aids in keeping these areas clean. The tipping-floor man should be instructed to keep that area clean and should be supplied with sand or other material to soak up oil spots from truck drippings.

Storage areas should be kept orderly and clean. It takes little, if any, more time to store materials properly than it does to throw them in a pile.

Outside areas such as grass, parking areas, and driveways should be kept up and policed, particularly in summertime when a well-mowed exterior, with some shrubbery, will add immeasurably to plant appearance.

One of the tangible benefits from such a program is higher employee morale; another is greater acceptance by citizenry. The effort is well worthwhile.

**PLANT MODIFICATION**

This phase of operation calls for use of common sense, ingenuity, and perseverance. It is doubtful if any incinerator, no matter how well designed and constructed, has ever performed exactly as the designer intended or the owner expected. For one reason, incinerator fuel is far from homogenous. It
varies in heat release, moisture content, and density from day to day and from hour to hour. Refractories, grates, and air-pollution-control systems are subject to extreme variations in load and service conditions.

Excess localized heat release may cause problems in the furnace system, and the corrosive condition of the process waters may create problems with the plant piping and treatment equipment. The following discussion gives some examples of what can happen to a new incinerator and some of the remedies that have produced a satisfactorily operating plant.

In the early stages of plant operation, we were faced with the following problems:

1. grate damage,
2. clogging of residue-conveyor drains,
3. corrosion of the fly-ash spray system,
4. clogging of flushing-water system to the shifting hoppers,
5. development of leaks in the water-cooled charging chutes,
6. warping of sifting hopper plates,
7. wear on the bottom of sifting hoppers,
8. wear on the shoes of the scraper flight in the fly-ash settling basins, and
9. damage to concrete and steel frame supporting the fly-ash baffle.

How plant personnel, with some assistance from the consultant, solved the majority of those problems is given in the following discussion.

The grate damage was significantly reduced by changes in operating procedure. Overfire air was reduced to a minimum, and underfire air increased to achieve better control of grate metal temperatures. Certain overfire duct entrances were sealed off, and all underfire air to Zone 1 (feed zone) was sealed off. Additionally, the seal in the sifting-through sluice was made more airtight. This step has resulted in a minimum of grate replacement and better gas combustion in the combustion chambers.

To control the problem of clogging of the residue-conveyor drains, the plant superintendent devised a baffle of plywood with a lower section of broom steel so placed that it traps cans and other debris. As the conveyor flights pass under the baffle, the broom steel deflects, then springs back in place to prevent backflow of material to the drains.

Mixing of combustion gases with hot spray water lowered the pH of this water to 3.0 or lower, which resulted in corrosion of the fly-ash-spray header bars and pipes and severe pitting of the spray-water pump impellers. As a temporary solution, soda ash was added in the fly-ash tank, then a used chemical tank with agitator was installed at the basins. Twenty-five pounds of soda ash were added per hour, and monitoring of pH readings was instituted. Later, an automatic chemical feeder was installed in the pump room at the spray-water sump. Ten lb/h of chemical proved ample to hold the pH value to between 6.5 and 7.0. Care had to be exercised to avoid excessive plating of the pump impellers, which might have unbalanced the pumps.

The water for sluicing of siftings is recirculated from the residue-conveyor overflow. Originally, the water was conveyed to the upper end of each of the three sifting hoppers through a piping system grading from a 5-in. diameter down to a 1-in. diameter. Solids passing the circulating pumps clogged the smaller-size pipes. The resolution of the problem consisted of conveying all the sluicing water to the uppermost hopper in a 4-in. pipe. No clogging has since occurred.

Excessive heat is generated in the feed zone and lower parts of the charging chute. This condition has not yet been corrected and has resulted in replacement of supporting frames for the feed grates within 2 years of startup. The temperature is high enough in this area that it may ultimately be necessary to water-cool the supporting frames.

The problem of leakage from the water-cooled charging chutes, at least in part attributable to the excessive heat generated in the feed zone, has been practically eliminated by increasing the size of the discharge pipes leaving the water-cooled jackets and by eliminating an automatic discharge valve, allowing constant flow of water through the jackets.

Shortly after startup, severe warping of the second zone (burning zone) sifting-hopper plates occurred in addition to excessive melted metal adhering to the hopper walls. The changes instituted to reduce grate erosion have eliminated this condition, and the new plates show no further signs of warping.

Shortly after the first year of operation, leaks began to appear in the bottom of the sifting hoppers. These leaks were apparently due to abrasion caused by movement of highly abrasive metal siftings moving down the sluice. Correction was achieved by lining the lower half of the sluices with 3/8-in. half pipe welded in place.

The abrasive nature of fly ash has required frequent replacement or reinforcement of conveyor shoes on the scraper flights in the fly-ash settling basins. We have recently found a harder material, available in strips that can be welded to the conveyors to prolong shoe life and reduce frequency of replacement.
The stainless-steel and refractory fly-ash baffle was supported on carbon-steel channels resting on plain concrete supports with drain openings between to allow drainage of spray water. The extremely high initial acidity of the spray water damaged this concrete and the steel channels. The plant superintendent suggested filling the space between the damaged steel and the concrete with refractory brick and covering the entire lower support with refractory cement. This solution, together with correction of the acid condition of the spray water has prevented further deterioration of the baffle wall supports.

The foregoing examples of problems encountered and solutions found have been presented to point out that, when problems are encountered in the operation of a new plant, very often simple solutions can be found and instituted by plant personnel with a minimum of outside assistance. However, the resolution of some problems will require close collaboration between the designer, the manufacturer of equipment, and the operating personnel.

PLANT SAFETY

An incinerator plant has a number of built-in hazards: deep storage pits; moving parts of motors, fans, etc.; possible smoke hazards, particularly in forced-draft plants, if breakdown occurs in the forced-draft system; moving vehicles and various tanks, platforms and other possible sources of serious falls.

A positive, supervised plant-safety program is essential. All possible openings and moving parts should be as well guarded as possible, consistent with efficient operation. First-aid equipment and respirators should be readily available and their use insisted upon. Face masks for stokers should be a standard requirement. Particular attention should be paid to tipping-floor operation; a fall into a 30-ft pit is not to be taken lightly. Crane operation should be carefully watched together with crane maintenance; a broken cable is a dangerous weapon. Above all, the plant superintendent and shift foremen should be constantly alert for unsafe practices or physical conditions. Without their constant supervision, unnecessary accidents are going to occur, and such accidents can be costly in both personnel injury and plant downtime.

RECORDS

Record-keeping may seem to be a minor matter. It is sometimes difficult to convince upper-echelon management of the necessity for as complete records as possible. For example, the City Manager of Alexandria may not yet be convinced of the need for scales and tonnage records. Yet, without these records, our department would have had to rely on guess work in the designing of our second incinerator.

We keep a daily, weekly, and monthly record of all refuse entering the plant, together with the weight of residue and the weight of fly ash. Generally, with input in tons as a base, our residue and fly ash, completely saturated, will approximate 30 percent and 3 percent, respectively. If moisture content were to be equalized, these percentages would be very much reduced. We also keep a complete record of burning times, downtime, maintenance manhours, materials used in maintenance and upkeep, and accidents. Our input records show truck number, time of arrival, and payload. City trucks are recorded separately from private collectors; this procedure aids the collection supervisor in checking on his crews. Residue weights give a measure of efficiency of the plant in reduction of refuse. When it comes time to prepare budgets, these records give our department factual data to present to the Manager to justify our budget requests.

In view of the desirability of maintaining weight records and considering the increases that have occurred during recent years in the size and weight of refuse-collection trucks, designers of future plants should carefully consider the desirability of incorporating scales with adequate platform length and scale capacity to handle all reasonably foreseeable increases in collection-truck size and capacity.

CONCLUSION

This paper has attempted to set forth some of the operating problems faced at the author's plant and procedures established to achieve an acceptable mode of operation and degree of availability. Each installation and each municipality will have its own peculiar problems. However, this paper has attempted to show operating people that they do not necessarily have to be discouraged if all does not go well at their shiny new plant. This paper will have accomplished its purpose if it has been able to show that operation was the keynote to successful operation at our plants in Alexandria, Virginia.