

Incinerator Refuse-Residue and Fly Ash Materials Handling

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ABSTRACT

Handling of refuse and residue presents one of the greatest challenges in the design of incinerator plants. Owing to the extreme diversity in size, shape and weight of both refuse and residue, advances have been slow in developing. Nevertheless improvements in details and application of time-proven devices have been made which the authors describe in the paper.

INTRODUCTION

The subject matter of this paper will be considered under three major categories: (a) refuse handling into the furnace; (b) residue handling from the grates; and (c) fly ash handling from the settling chambers and dust collectors, which matter is assuming ever greater importance. The many points where materials handling occur are shown in Fig. 1.

REFUSE HANDLING

Refuse handling will be divided basically into the two charging methods, direct charging or crane and bin charging. The choice between these methods is determined mainly by the burning capacity of the plant.

Direct charging of the furnace may be accomplished by conveyors, skip hoists, charging rams, or the so-called floor dump using manual labor or bull-

dozers. Conveyors have been used infrequently in municipal incinerator plants because their first cost plus operating-labor costs have not shown enough savings to offset the flexibility of operation using cranes. Where salvage operations require hand picking and sorting, conveyors have been used to advantage.

In industrial plants, the control of refuse pickups can be more readily adapted to conveyor charging. Thus in these plants conveyors are coming into greater use. The Merck, Sharp & Dohme plant at West Point, Pa., incorporates an apron conveyor to charge the furnace. All types of material from cartons of outdated literature to laboratory waste and filtered sewage sludge are conveyed at this installation. The only labor required is that of unloading trucks and placing containers on the conveyor.

A plant in California uses an apron conveyor. Trucks dump directly into a hopper over an apron conveyor. The refuse is then conveyed up an incline and dumped into the incinerator. With this arrangement hoppers must be kept shallow to allow some mixing of refuse. Since it is very difficult to do any mixing once refuse is on the conveyor, the horizontal run must be kept rather long. This allows trucks to be spotted at various points depending on the type of refuse collected by each truck.

For small industrial incinerator plants skip hoists have been used. Fig. 3 shows a recent development which not only lifts material but automatically discharges the skip. Manual loading is normally used.

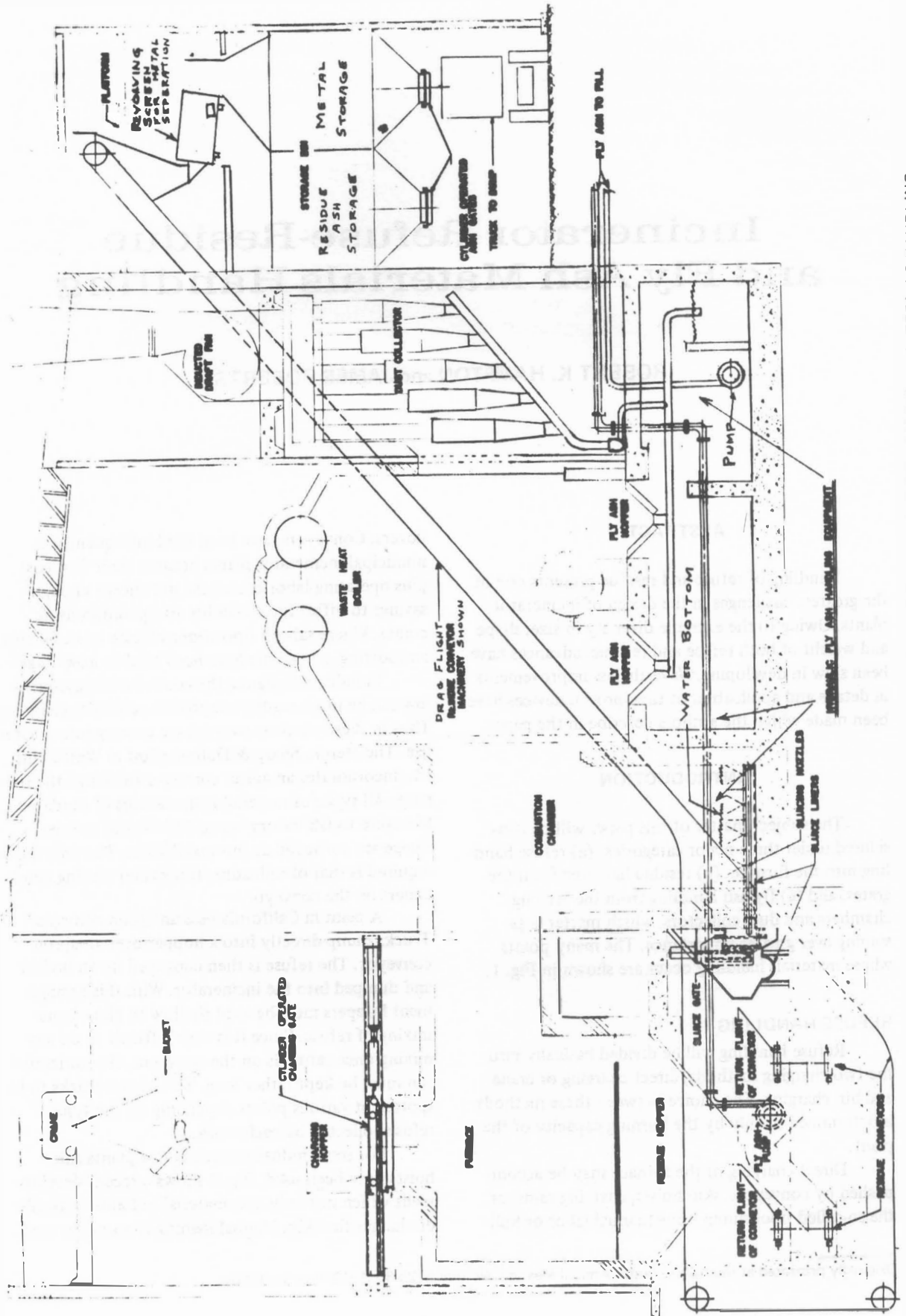


FIG. 1 LAYOUT OF TYPICAL MUNICIPAL INCINERATOR SHOWING MANY POINTS REQUIRING MATERIALS HANDLING.

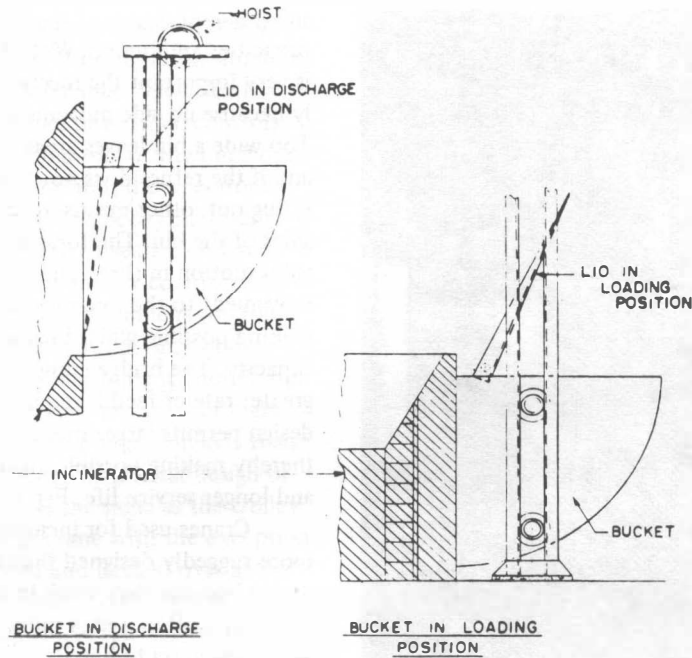


FIG. 3 SKIP BUCKET FOR LOADING AND CHARGING REFUSE INTO AN INDUSTRIAL INCINERATOR.

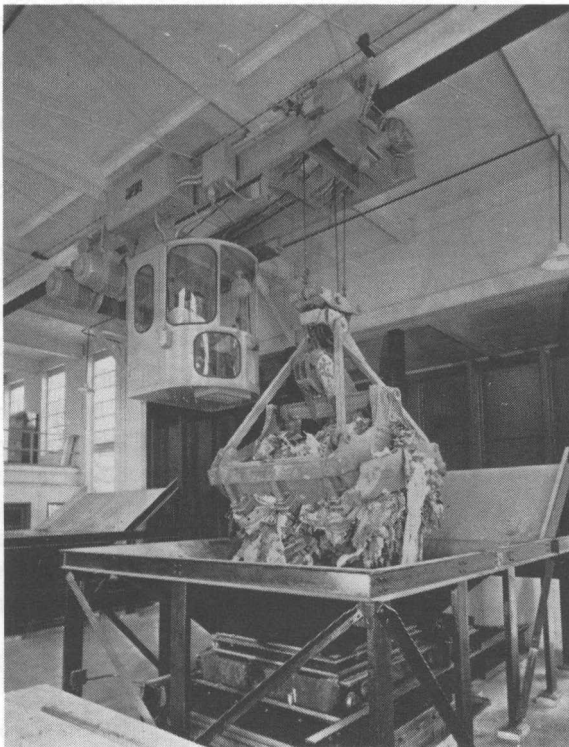


FIG. 4 MONORAIL CRANE WITH OPERATOR IN FLOOR-MOUNTED PULPIT FOR SMALL INCINERATORS

In recent years a charging ram has been used in several plants, such as Winchester, Ky., and Whitmarsh, Pa. This device has possibilities in conjunction with some of the newer type furnace designs utilizing continuous burning stokers and semi-continuous charging.

Vibrating-pan conveyors have also been used in some installations, the largest being Whitmarsh, Pa. Here again it is difficult to mix the refuse once it is discharged onto the conveyor. Their high first cost also requires considerable economic study.

Bulldozers have largely replaced manual handling on so-called floor dump plants. High rates of pay of operators in many cases coupled with lack of space for large dumping areas limits the application of floor-dump plants.

In plants where storage in a bin or pit is required, a traveling bucket crane must be used for charging the furnace. Two basic types of cranes are used in incinerator plants. One is the underhung monorail type and the other is the top-running bridge crane.

The monorail type provides longitudinal motion only along a line under the rail and the raising and lowering of the bucket. It can be remotely, (Fig. 4) or by cab, (Fig. 5) controlled. The monorail type of crane is used for smaller capacity plants and offers lower cost operation and greater safety than floor-dump operation. Because of the underhung arrangement



FIG. 5 MONORAIL CRANE WITH OPERATOR RIDING IN CAB WITH BUCKET FOR SMALL MUNICIPAL AND INDUSTRIAL INCINERATORS.

and inherent design of the unit, speeds and/or bucket capacities are limited. With the monorail-type unit, it is very important the receiving bin be designed properly because no side movement of the bucket is possible. Too wide a bin leaves areas inaccessible to the crane and if the refuse does not flow or fill in as the center is dug out, other means must be found to clear the sides of the bin. The top-running bridge crane provides motion in three directions; that is, adds a lateral movement to the two motions of the monorail type, making possible wider bins with greater storage capacity. The bridge crane is usually used where greater rate of feed is required, as its more flexible design permits larger motors, gear cases and drums, thereby making possible higher speeds, bigger buckets and longer service life, Fig. 6.

Cranes used for incinerator service must be far more ruggedly designed than standard hook-service cranes because they work in an extremely dusty atmosphere, often with a minimum of maintenance and are called upon to handle capacity loads continuously day in and day out. In other words, they are hard-worked production cranes, and should be designed and equipped for full-time rugged service.

There are many elements to be considered in crane design for this service, and crane builders have made improvements on many of these elements. The

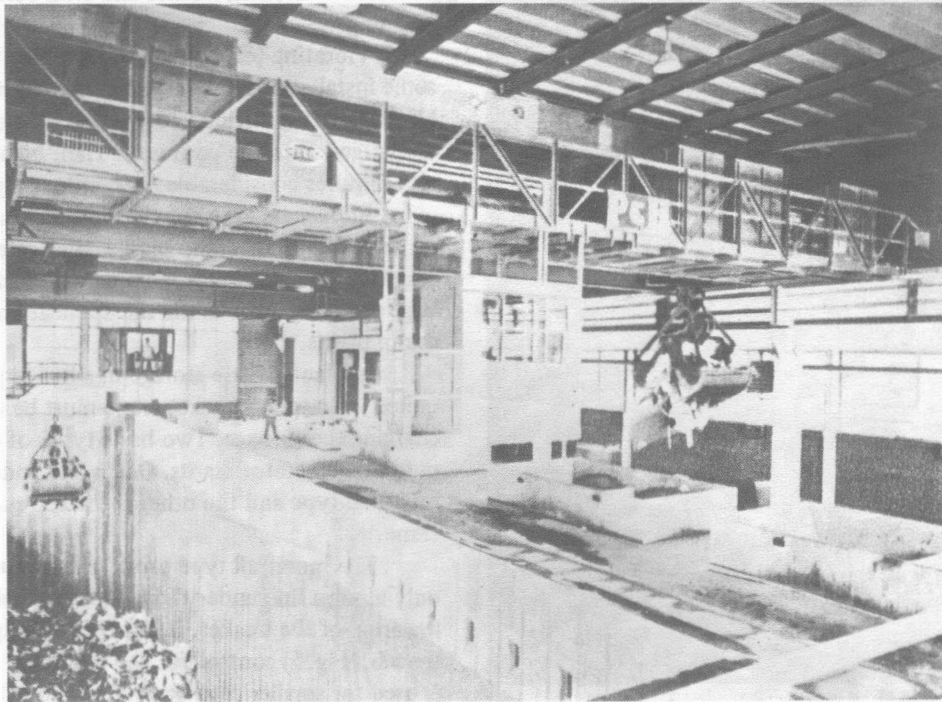


FIG. 6 TRAVELING BRIDGE CRANE AT LARGE MUNICIPAL INCINERATOR.

selection of speed of hoist and travel should follow a careful analysis of duty cycle. Consideration should be given to quick and easy maintenance. Specifications should call for improved design of motors, controls, brakes, bearings, foot-walks, lighting of the bin from the crane, and the like. In addition, the operator's comfort should be considered by specifying totally enclosed all-steel cabs, upholstered seats, full vision from a sitting position, heaters and air conditioners.

A modification of the bridge crane is the top-running trolley unit which operates in only one vertical plane, similar to the underhung monorail, but is of a top-running design and can be built for higher speeds, greater service life and/or larger buckets than the underhung monorail type. The general design of the top-running trolley unit is the same as the trolley unit on a top-running bridge crane with the exception that a trailing cab is supplied and decked over at the elevation of the rails to provide mounting space for control cabinets, resistors, etc. A few installations have been made utilizing a fixed-position, rotating-boom-type crane. However, too little experience has been gained at this point to evaluate this application of standard construction equipment type of machinery to incinerator service, or to know what modifications will be necessary for satisfactory performance. It is expected that operation costs will be higher and service life considerably less. However, the initial investment may be lower, which could partially offset the other higher costs. Choosing the type crane, the proper speeds, the correct size and type of bucket for incinerator service requires a careful analysis of many factors. Some of these factors are:

Rate of feed, hours of operation, possibility of future expansion, distances traveled by each motion of crane, bin design, rehandling of refuse in bin, type of refuse, peak days and even whether the furnaces are of the batch or continuously fed type.

Whether a bucket or a tine-type grapple is used will depend on the type of refuse to be handled as well as on the plant operator's preference. The tine grapple digs better and, accordingly, works well for compacted material or refuse containing a large percentage of garbage. The enclosed clamshell bucket with teeth works well in loose material and also is far superior for clean-up in the bottom of the bin.

RESIDUE HANDLING

Residue handling is a vital part of incinerator design and should be considered in the initial design stages.

The ash tunnel with ash hoppers and gates is well adapted to batch-type operation. Even in medium-

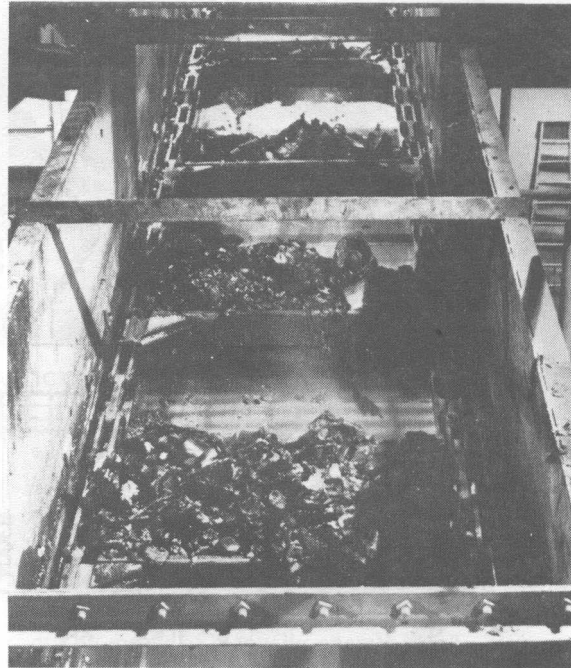


FIG. 7 TYPICAL RESIDUE FROM A MUNICIPAL INCINERATOR

size plants the traffic problem can be handled with a minimum of confusion. In small plants this is an economical and efficient method for handling residue.

However, with the trend to larger plants, larger furnaces, continuous or semi-continuous burning and fly-ash handling, conveyors have become increasingly more common.

Like many innovations, the first conveyors were adaptations of light-duty grit or drag conveyors. For some of the early incinerators and with partially burned refuse, it appeared that these light conveyors were satisfactory. However, when the residue contains such things as 20-gal drums, steel wedges, and the like, as illustrated in Fig. 7, together with intermittent dumping or operation it can be readily appreciated why ordinary conveyors did not meet the duty requirements.

One of the first of the conveyors designed and built especially for incinerator service was installed in Pittsburgh, Pa. in 1939. Except for periodical chain renewal, the basic conveyor is still in operation.

With the advent of continuous burning stokers with their much larger capacities, conveyor chain strength and wearing qualities became more important. Special chains and sprockets are now available which give from two to four times the life of standard chains formerly used.

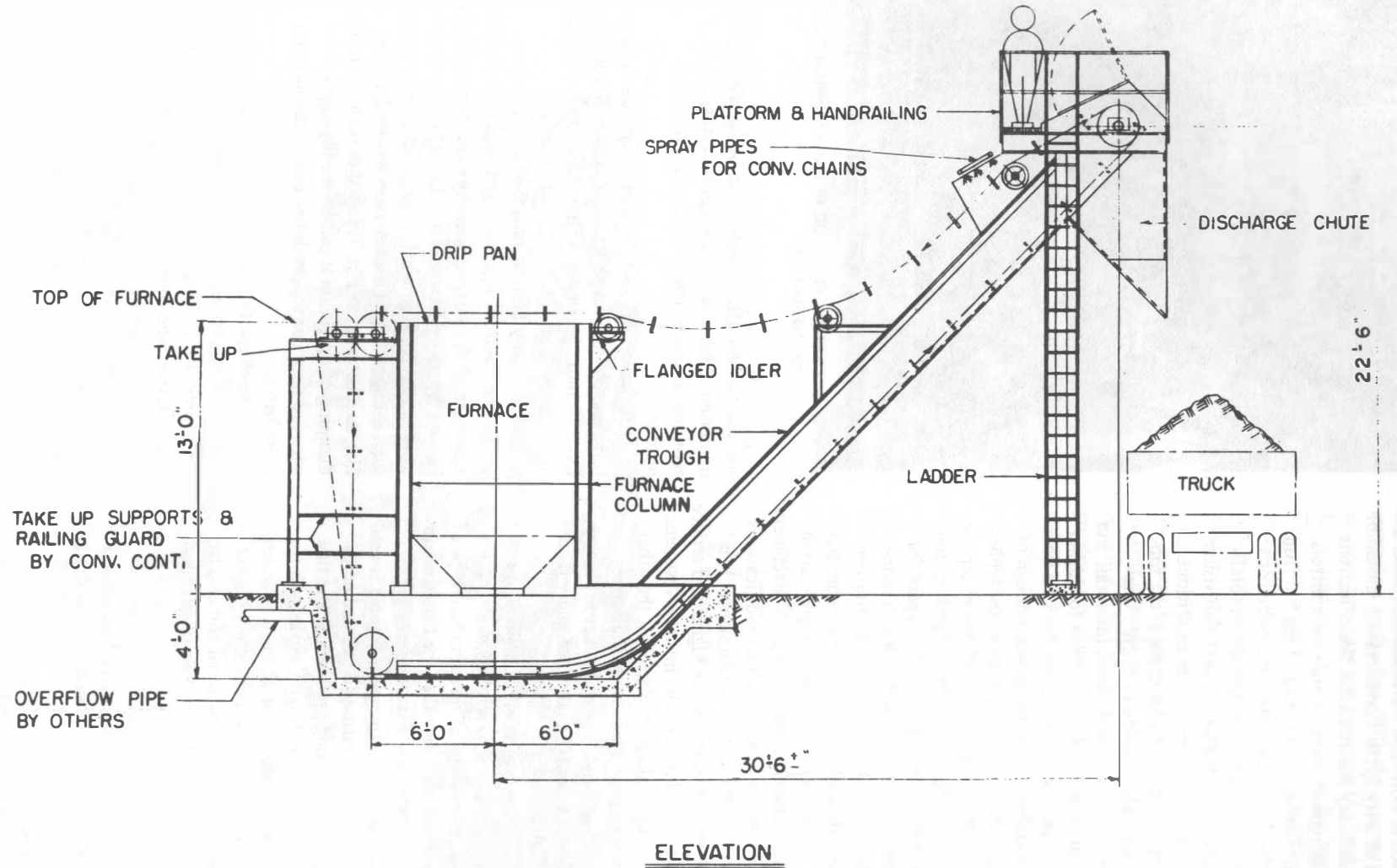


FIG. 8 RESIDUE CONVEYOR WITH SHALLOW PIT FOR SMALL INCINERATOR PLANTS.

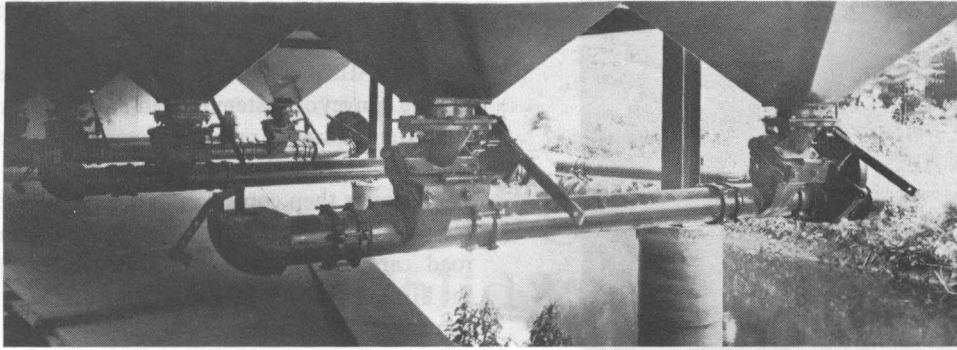


FIG. 9 DUST-COLLECTOR HOPPERS WITH PNEUMATIC CONVEYOR INTAKES AND TRANSPORT PIPING.

New steels are also available for wearing bars and flights. Formerly it was necessary to strengthen flights with structural shapes causing a carry-back problem. Today's steels make this unnecessary and much of the carry-back can be eliminated.

Conveyor arrangements have also been much improved. On smaller plants, where only one conveyor is needed, the return run can be placed over the top of the furnace, Fig. 8. This practically eliminates one whole floor in the building and reduces excavation to a minimum.

Other types of conveyors, such as apron and belt conveyors, have been tried but so far with very little success. This is due to the necessity of quenching and then dewatering of the residue. Owing to large quantities of metal in the residue, belt conveyors were found to have a short service life.

Sluices have been used for residue handling but the problem of the proper water quantities required and cost of settling basins required for reclaiming the water for reuse has held their use to a minimum.

FLY ASH HANDLING

This is something very new in the incinerator field. Most fly ash in older plants was shoveled out manually from the combustion chambers and flues. This was done on the customary Monday morning shutdown. Very few plants had any extensive dust-collection equipment.

Today's incinerators, however, must consider fly-ash collection and handling together with air-pollution control equipment at the very outset of design.

Settling chambers with or without water sprays have been one approach to fly ash collection. Dry chambers, in most cases, still depend on manual cleaning. One notable exception is the Yonkers, N. Y., incinerator where a pneumatic system is used to clean out the hoppers, Fig. 9. With set sprays, a

wet bottom is often used and the fly ash-laden water is sluiced to a pit. A crane may be used to clean out the settled fly ash periodically. The plant at Louisville, Ky., sluices the fly ash to the residue-conveyor trough. At Hempstead, N. Y., the main combustion chambers were converted to wet bottoms. The fly ash is sluiced out by means of manually operated high-pressure water nozzles to a sump and then pumped to a lagoon. The waste water from steam condensers is used and, therefore, no extra water is required.

Many plants in recent years are using dry-cyclone-type fly-ash collectors. Where collection points are few, and the amount of fly ash is small due to size of plant, direct dumping to trucks is utilized. In some cases water sprays are used to control the dust as it is discharged. However, closed containers or truck bodies should be used.

Where large quantities of fly ash are collected, pneumatic conveyors have been used to convey the fly ash to a central silo. Here a rotary-drum-type ash conditioner mounted under the silo is normally used to wet the ash when it is discharged into trucks, Fig. 10.

Two main items must be studied carefully in plant design with respect to pneumatic fly-ash handling. One is the amount of carryover of such light objects as pie plates which will clog up hopper outlets and the other is control of sprays used for cooling gases to prevent fly ash from becoming damp and even wet. Condensation as a result of long storage periods in hoppers without heat insulation must be watched carefully in design. Auxiliary heating of hopper bottoms may be money well spent in easing operations.

Where land for disposal is available adjacent to the plant, and water available, hydraulic sluicing is the best solution as it reduces manual labor to a point of merely turning on and off valves or push buttons and visually overseeing operation.

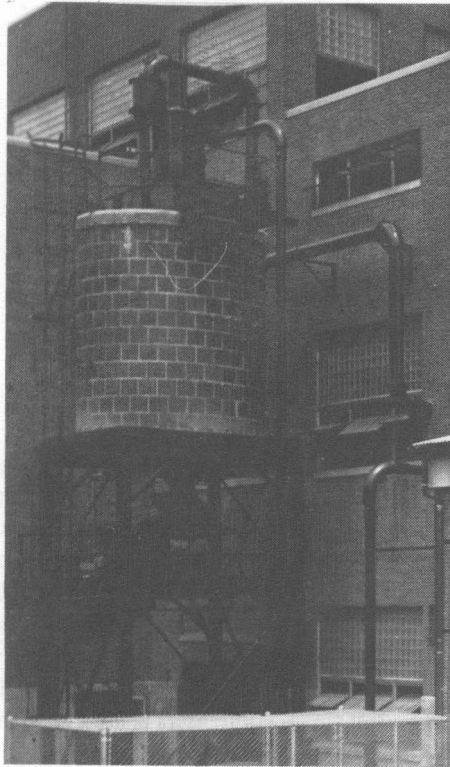


FIG. 10 FLY ASH STORAGE SILO AND UNLOADING SYSTEM.

SALVAGE

In an endeavor to reduce operating costs, some plants are salvaging metal from the residue and selling it to local steel plants. In other cases paper and cardboard have been salvaged from the refuse prior to burning.

Conveyors have been used in most salvage operations. At Trenton, N. J., the refuse was transported on flat belt conveyors. The salvagable material was picked by hand from the slow moving belts. The Trenton incinerator was a good example of a salvage operation but changing conditions have indicated that it is not economically feasible to continue salvage

operations and this system will not be incorporated in the new plant.

At Atlanta, Ga., and Louisville, Ky., an extensive conveyor system is used to salvage the metal from the residue. A revolving screen with water sprays is used to clean and wash the ashes from the metal. The metal is then conveyed to the top of a storage bin. At Atlanta the metal is dumped loose into railroad cars. At Louisville a conveyor is used to unload the bin and feed a baling machine. The bales are then conveyed to railroad cars and yard storage.

PRESENT PRACTICE SUMMARY

To sum up present day practice, for large plants the crane and bin are still the best. Medium-size plants can best be served by modified crane or monorails equipped with grab buckets. Small municipal plants will find bulldozers in conjunction with floor dumping or a charging ram fed by a hopper to be the best.

Industrial plants, where collection can be controlled, will find conveyors or skip hoists to be useful in eliminating manual labor. Large industrial plants where collections cannot be controlled will find a monorail crane and a small pit or flat concrete apron best.

For small batch charging plants, ash hoppers with gates discharging directly into trucks can handle the residue efficiently. However, on continuous burning plants of any size and all large plants, residue conveyors with water-filled troughs are the best solution for handling residue.

Careful study of local marketing conditions must be made before going into salvage operations. However, as our natural resources are depleted we will be forced to conserve more material that we now so blithely throw away.

At the present state of the art, there are no tremendous breakthroughs in sight for materials handling in incinerator plants. However, improvements in details and applications of time-proven devices hold great promise.