

# THE DESIGN AND OPERATION OF AN ASH TREATMENT SYSTEM AT THE COMMERCE REFUSE TO ENERGY FACILITY

ED WHELESS  
Whittier, California

STAN THALENBERG  
Commerce, California

## ABSTRACT

The Commerce Refuse to Energy Facility (CREF) is a nominal 370 tpd mass fired facility located in Commerce, California. After extensive testing of the ash, over 4 years of plant operation, a treatment system was developed and pilot tested which utilizes Portland cement to control the leaching of heavy metals.

This paper describes the design and operation of the full scale ash treatment system which collects and screens the ash, combines the ash and Portland cement, and produces a material which is being tested as a road sub-base material.

## INTRODUCTION

The Commerce Refuse to Energy Facility (CREF) is located in Commerce, California and has been in commercial operation since May 1987. The mass burn facility combusts a nominal 370 ton/day (tpd) and generates 10 MWe (net) of electricity. The process typically reduces the incoming refuse volume by 90% and produces approximately 100 tons of ash per day. The ash is transferred to a non hazardous waste landfill.

In 1984, prior to construction of the facility, the County Sanitation Districts of Los Angeles County (the Districts) conducted laboratory analysis of ash samples created by the combustion of refuse expected to be

typical for the facility. Based on the results of this analysis, the California State Department of Health Services classified the ash from the proposed Commerce facility as nonhazardous.

After construction and start-up of the facility, the Districts as facility operators conducted routine periodic tests of the ash generated. It was shown that the actual ash residue from the facility was higher in soluble lead and cadmium than the preconstruction laboratory analysis had predicted. The Los Angeles Regional Water Quality Control Board, which regulates nonhazardous landfills, and the Districts, agreed that all ash transferred to the landfill be treated to meet applicable water quality objectives.

As a result, the Districts embarked on a research and pilot plant study in 1990. These studies indicated that ash treated with silicates, as in Portland cement, greatly reduce the potential leaching of metals in the landfill environment. At the pilot plant stage, it was demonstrated that the ash could be successfully treated, with soluble lead reduced to below regulatory limits and cadmium reduced to nondetectable levels.

This paper describes the design and operation of the full scale ash treatment system which collects and screens the ash, combines the ash and cement, and produces a material which is being tested as a road sub-base material at District's owned Puente Hills landfill.

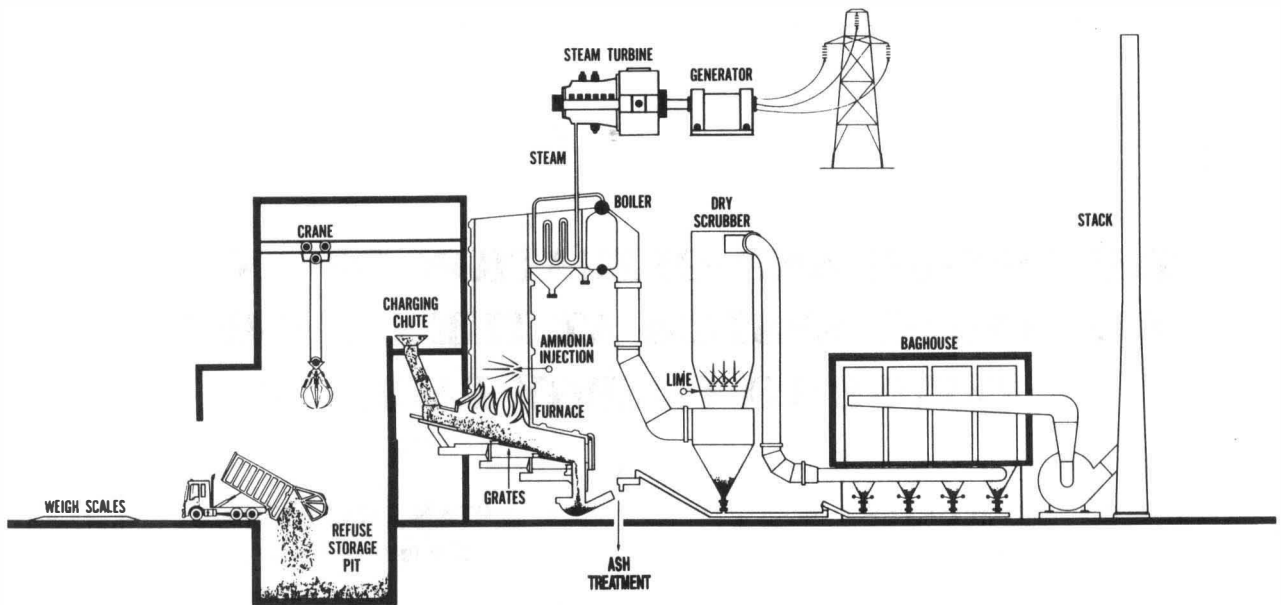


FIG. 1 COMMERCE REFUSE-TO-ENERGY

## PLANT DESCRIPTION

### Facility Description

The Commerce Refuse to Energy Facility was created through a Joint Powers Agreement between the City of Commerce and the Districts. The Facility is owned by the Commerce Refuse To Energy Authority and is operated by the Districts.

The facility primarily serves the needs of the City of Commerce. The City has a large commercial industrial base with only 12,000 residents which contribute approximately 5% of the City's waste stream. The high commercial industrial component of the refuse results in a fairly consistent fuel with a heating value of 5400 Btu/lb.

### Power Plant & Refuse Processing System

The plant is a single boiler/furnace arrangement (Fig. 1) designed for mass burn operation. The water-wall furnace is equipped with a three-section reciprocating grate system, with vertical drops between the sections to improve refuse mixing. The boiler furnace arrangement operates normally at full load fired by refuse alone. No supplemental fuel is needed. There is a natural gas burner which is used during start-up and shutdown.

The boiler is a natural circulation top supported unit. It is coupled to an 11.5 MWe steam turbine generator with three steam extractions, in a conventional Rankine cycle. Turbine inlet conditions are 750°F and 615 psia.

Refuse is brought to the facility, 5 days a week, by private haulers, licensed through the City of Commerce. The licensing maintains control of the incoming refuse in that only licensed haulers may use the facility, and any violation of the facility's regulations regarding unacceptable materials being dumped is grounds for license revocation. Materials not accepted at the facility include liquid and hazardous wastes.

The haulers are weighed in by the weighmaster and directed to the tipping floor of the refuse receiving building. There the haulers discharge their loads into an 80 ft × 45 ft × 35 ft deep refuse pit.

Above the pit is installed a bridge crane with an orange peel grapple. The crane is manually operated from a local enclosed crane operator cab. The crane operator sifts the refuse to attain as homogeneous a mixture as practical. He also can then pick out oversized objects, such as white goods or furniture, and loads them out into transfer trucks.

On a continuous basis, the crane operator collects a grapple of refuse and delivers it to the charging chute. Material falls down the water cooled chute onto the first grate section. The reciprocating grates move the now burning material along, until at the end of the third grate, the material falls off the end of the grate system into a water quench ash extractor.

### Ash Generation

The ash extractor provides a means for water quenching the furnace noncombustibles and ash, and

maintaining a water seal for the boiler. The extractor discharges the ash by way of a submerged hydraulic ram, which pushes the ash out of the extractor onto a vibratory conveyor (Fig. 2). This conveyor delivers the ash to the ash handling and treatment system described below.

Flue gas from the boiler passes over conventional economiser tubes and enters the air pollution control system. The flue gas travels on to a dry scrubber, where it is reacted with lime slurry to control acid gases. The dried residue and other particulates are collected in a baghouse as fly ash. This fly ash is conveyed further through the process using drag conveyors and a dense phase pneumatic transfer system.

The fly ash along with the bottom ash from the furnace had previously been mixed together at the ash extractor and discharged as combined ash. This material was disposed of at a landfill. Currently these two ash fractions are collected separately and are treated in the Ash Handling and Treatment System.

Note that siftings, which are fines that fall through the grates in the furnace, are collected and conveyed into the ash extractor, along with the bottom ash. Slag from boiler tubes, on the other hand, are ground up using in line grinders, and this material is conveyed, by way of a screw conveyor, to the fly ash collecting system.

## ASH TREATMENT SYSTEM DESCRIPTION

### Process Flow

The treatment process decided upon is a simple concrete batch plant process (Fig. 2). Ash, cement and water are combined to form a concrete in equipment typically found in concrete plants. After a 24-hr cure the concrete material is transferred to the landfill, where it is stockpiled for use during winter as a road sub-base. This ash based concrete has approximately 300 psi strength after 7 days and 700 psi strength after 28 days, using 10% cement. More cement results in a higher strength and higher cost.

The process proceeds as follows: furnace ash is conveyed out of the furnace through a three-section reciprocating grate system. Off the third grate, the ash falls into an ash extractor which quenches the material and discharges it out of the ash extractor. Material which falls through the grates (siftings) are conveyed also into the ash extractor via a drag conveyor.

After being quenched, the ash is moved out of the quench tank area of the ash extractor by way of the ash extractor hydraulic ram, which deposits the material onto a natural frequency 20-ft long vibratory conveyor.

This conveyor then moves the ash onto a vibratory finger screen.

### Bottom Ash Sizing

The finger screen separates out that fraction of ash which is less than 1 in., termed "unders" from the rest of the ash. The unders fraction falls through to the bottom of the screen and is conveyed to a concrete unders pit. The pit is 34 ft long  $\times$  16 ft wide and of varying depth from 10 ft below grade to a height of 23 ft above grade. The pit is designed to store 5 days of material.

The fraction which is greater than 1 in., termed "overs," is conveyed off the end of the screen into a 26-ft  $\times$  17-ft concrete pit of varying depth, similar to and located adjacent to the unders pit.

### Fly Ash

Fly ash from the spray dryer absorber and the baghouse is collected continuously. The material is conveyed through a dense phase pneumatic conveyor system to a fly ash silo capable of storing 5 days of material.

## Ash Processing & Concrete Making

Ash processing and concrete making occur on a 5 day/week, 8 hr/day basis. Ash from the combustion process, on the other hand, is generated and accumulated in the pits round the clock, 7 day/week.

### Monorail Hoist Systems

To handle the ash in the pits, two monorail hoist systems with clam shell buckets are installed, one above each pit. The hoists are manually operated from an enclosed control room located above the pits. The hoists are used to arrange the material in the pits for efficient space utilization, and for materials processing.

The overs ash hoist is equipped with an electromagnet in the palm of the grapple. This allows for the collection and separation of ferrous material from the overs ash stream. The ferrous fraction is loaded out onto trucks for delivery to an independent ferrous recovery facility. The rest of the overs are loaded out in a similar fashion and disposed of at a landfill.

### Batching Process

The batching process is a manually initiated, automatic process. The crane operator loads unders ash, now called aggregate, into a 12 cu yd weigh bin. The weight is entered into the batching computer by the operator, and the operator initiates the automatic batching process.

Fly ash from the fly ash silo is fed continuously into a cement and fly ash weigh bin. Feeding proceeds



TABLE 1 ASH COMPOSITION

Component	Fraction	Density
Fly ash	17% of total ash	density of 38 lb / cu ft
Bottom Ash	83 % of total ash	
Unders <1"	75 % of bottom ash	density of 82 #/ cu ft
Overs >1"	25 % of bottom ash	density of 28 #/ cu ft

continually until the required weight of fly ash has been added. This required weight is determined by the batching computer based on the weight of aggregate and the fly ash multiplier previously entered by the operator.

Cement from a cement silo is similarly fed into the cement and fly ash weigh bin. The operator then manually initiates the truck feeding process. The gates of the cement and fly ash weigh bin open and the weigh bin contents are delivered into a ready mix cement truck.

#### Mixing and Casting

A required amount of water, based on an aggregate water multiplier, is automatically delivered into the ready mix truck. This is followed by the feeding of aggregate. A belt conveyor starts and the clam shell doors of the aggregate weigh bin open. The aggregate weigh bin contents is conveyed and delivered to the ready mix truck. The ready mix truck mixes and blends the components of this concrete material and concludes the batching process.

The ready mix truck then travels to and discharges the load into specially constructed roll-off bins for casting. Eight bins are cast each day. The bins are 28-ft long, heavy duty bins with plastic liners designed to easily release the concrete after it has cured and hardened. Freshly poured concrete is kept on site for 24 hr to cure, and react with the ash contaminants.

At the end of the curing period, the concrete is transported to a local landfill. Here it is broken up into smaller "plates" by running a dozer over it. The concrete is then collected and stockpiled for later use. Tests are currently underway to determine how well this material will behave as sub-base material for roads at the landfill. Plans are to use this material in building the winter deck for the landfill.

#### DESIGN CRITERIA

The system was designed to handle a 109 ton/day maximum. Maximum was considered as full plant load at 100% capacity factor. Nominal ash loading of 93 ton/day was calculated at an 85% capacity factor.

Through pilot plant testing, the composition of the ash streams was determined to be as shown in Table 1.

Some design features of note of the equipment are as follows.

#### Fly Ash Silo

The fly ash silo was specified with a hopper to be heated and insulated. The general concern was that the fly ash exhibits hygroscopic properties and pluggage might be a chronic problem if not addressed properly.

The unit was designed with a 5-day storage capacity and equipped with a baghouse for dust collection and control.

#### Casting Bins

Roll off bins are used to cast the concrete. They are designed with tapered sides top to bottom and front to back, to facilitate unloading. In addition, a disposable plastic liner is installed in each bin. If this was not in place, the concrete would stick to the steel and be difficult to dump. Also, care is given to the construction of the floor and sides. They are made stiff enough to resist warpage or dents which would cause the block to hang up as it is being dumped.

The block is cast no more than 18-in. thick. This is done to facilitate crushing and handling of the material at the landfill.

#### Monorail Hoists

Two monorail ash hoists were selected, one for each pit. This was found to be more cost effective than a bridge crane for the duty cycle and service.

#### Unders Weighing System

The unders weighing system was designed with a 10 cu yd weigh bin with bomb bay style outlet doors. A horizontal belt conveyor feeds the ready mix truck in 3 min. The batching system is computer controlled.

#### Fly Ash and Cement Weighing System

A screw feeder is used to load the fly ash. Loading time is set at 5 min. Pneumatic gate valves are designed to load cement in 2 min, and the ready mix truck is designed to be loaded in 3 min. A dust control system is installed to control dust from the weigh bin and truck loading hopper.

#### Operation

The ash handling system is designed to operate 24 hr/day continuously, while the concrete making system is designed for 5 day/week, 8 hr/day.

Storage capacity in the overs and under pits and cement and fly ash silos were designed for a minimum of 5 days storage capacity. It is anticipated that any serious breakdown of the concrete making system, whether mechanical or administrative (i.e., breakdown

in supply of cement, etc.) could be mitigated within 5 days and not cause the shutdown of the combustion/power generation plant.

The vibratory conveyor and finger screen system convey and size separate the furnace bottom ash into the pits, on a continuous basis. Each pit is designed to allow continuous infeed of bottom ash without having to continuously operate the monorail hoists to remove the ash from its point of entry into the pits. Twice a day, a plant operator uses the hoists to move the ash away from the infeed areas.

Overs load out occurs during the concrete batching period. During this period, one operator runs both the unders and overs hoists, and operates the batch control panel. Between seven and nine batches of approximately 10 cu yd each are made and cast each batching day. This can usually be done within 5 hr. Approximately 2 hr are allocated for relocation of the ash in the pits, and the remainder of the day is for administrative purposes and problem resolution.

Operation of the concrete ready-mix truck is done on contract with an outside firm in the business of supplying traditional ready-mix concrete for construction. The driver is responsible for mixing the batches and pouring them into the roll off bins which constitute the casting system for the process. The driver is responsible, of course, for his own truck, and maintaining it in good working order. This ash-based concrete making is not considered a particularly difficult duty for the truck equipment, nor for the driver.

## ECONOMICS

Much of the economic viability of the project stems from the savings in landfill dumping fees for the ash. The concrete produced is a useful product for the land-

fill. As it is being tested and used for sub-base material for winter roads at the landfill, there is no charge (nor any revenue) stemming from the transfer of this ash-based concrete to the landfill.

Currently, there is no market for this material. In fact, it has no regulatory standing as an acceptable material outside the landfill.

The Commerce plant processes approximately 110,000 tons of refuse per year, and generates approximately 35,000 tons of ash. Prior to the installation of the ash treatment plant, ash handling costs, which included hauling and disposal, amounted to approximately \$20/ton of ash or \$6.25/ton refuse.

The Ash Handling and Treatment System resulted in a capital cost of \$2.6 million. Additional operating costs include: cement; ready mix truck and driver; concrete plant operator; and additional maintenance costs. The annual cost of operating the system, not including debt service on the capital cost, is calculated to be \$19.70/ton of ash or \$5.75/ton of refuse. Including the debt service at 10% for 20 years brings the total to \$28.43/ton of ash or \$8.53/ton of refuse.

The cost of overs disposal is not included in the additional cost. Revenues from the sale of ferrous recovered is expected to offset the cost of disposing of the remaining overs residue.

## CONCLUSION

It appears that treating ash with portland cement is an effective method of controlling leaching of heavy metals. The process, operation and equipment necessary appears to be consistent with the degree of complexity and caliber typically found at a waste to energy facility. All components in the process are generally available and common in industry, and no new equipment had to be developed to complete this system.