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Waste Materials in Construction: Putting Theory into Practice

MAASVLAKTE FLY ASH PROCESSING PLANT

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Abstract

In 1995 Vliegasunie put the Maasvlakte Fly Ash Processing Plant in Rotterdam, The Netherlands, in operation. With a capacity of 250.000 tonnes per annum, this installation has an important role in maintaining a record of 100% use of Dutch fly ash by continuing to meet the customer's need for fly ash of constant quality and quantity. The main objectives of the installation are storage and upgrading of fly ash.

The fully computer controlled installation is located adjacent to the site of EZH's Maasvlakte Power Plant in Rotterdam. The Plant consist of an intake silo, an upgrading plant and an end-product silo. In the upgrading plant the carbon content of the fly ash is reduced to less than 5% and the fineness is improved to over 70% less than 45 µm. The Plant has a blending installation in order to produce a desired constant product quality. The total storage capacity for incoming fly ash is 9.000 tonnes and for end-product is 32.000 tonnes. Most of the fly ash the Plant receives from the adjacent Maasvlakte Power Plant by pipeline. The rest of the fly ash is transported to the Plan both by bulk truck and by barge. The upgraded product is transported to the customers both by bulk trucks and by barges.

For internal transport airslides are installed for horizontal transport and a pneumatic transport system for vertical transport. To meet with strict environmental regulations, all air used for transporting fly ash is filtered in order to reduce the possible dust emissions to 10 mg dust per m^3 max.

The first year of production shows that the installation is functioning as expected.

Introduction

In the spring of 1995, construction of Vliegasunie's Maasvlakte Fly Ash Processing Plant in Rotterdam, The Netherlands was completed. In the course of 1995, an extensive programme of testing and alignment took place as this plant is the first in the world to upgrade fly ash produced by coal fired power plants on such large scale. With a capacity of 250.000 tonnes per annum, this plant is intended for the upgrading of approximately 40% of the total production of fly ash of the Dutch power generating companies and represents a major investment in the future on the part of Vliegasunie and its shareholders. Only through such continued investment does Vliegasunie expect to maintain its record of 100% use of its by-products by continuing to meet the customer's needs for a fly ash of constant quality and quantity.

Objectives of the installation

As known, the quality of fly ash depends on several factors. The main factors are the type of coal that is used for power generation, the completeness of the coal combustion, the type of furnace and the type of flue gas scrubbers. In 1988, Vliegasunie foresaw that the quality of the fly ash produced by the Dutch power generating companies would diminish and the demand for high quality fly ash for the cement industry and as a filler and binding agent in concrete would increase.

One of the major factors for the diminishing quality of fly ash is the agreement between the Dutch government and the combined power generating corporations to reduce NO_x and CO_2 emissions. For this reason, the coal fired power plants installed LowNOX installations. These installations have a negative effect on the quality of fly ash.

Another problem Vliegasunie foresaw was how to match production and demand. In the winter when production of fly ash is high demand is low; in the summer demand for fly ash is high while production is low.

These two problems resulted in the design of the Maasvlakte Fly Ash Processing Plant. The plant has two objectives: (dry) storage and upgrading of fly ash. The storage facility allows matching of production and demand; the upgrading guarantees a constant high quality to our customers who need a high and constant quality of fly ash: the cement and concrete industries. Through sieving and blending of different qualities of fly ash, a constant quality can be guaranteed.

Table 1 shows the quality of the fly ash produced in this plant.

Table 1

Quality parameters

Code	description	unit	minimum	maximum
SiO_2	Silicon oxide	%	50	60
Al_2O_3	Aluminium oxide	%	20	30
Al/Si		-	0.45	
Fe_2O_3	Iron oxide	%	0	10
CaO	Calcium oxide	%	0	5
MgO	Magnesium oxide	%	0	4
C*	Loss on ignition	%	3	4.5
pH		-	10	14
45µm	% less than 45 µm	%	75	90

After completing several studies, engineering and obtaining the necessary permits, Vliegasunie commenced construction of the installation at the end of 1993.

Lay out

The installation is located adjacent to the site of EZH's Maasvlakte power plant at Rotterdam, next to the existing fly ash silo bins belonging to the power plant. Figure 1 shows an overview of the plant.

Figure 1

Overview of the Maasvlakte Fly Ash Processing Plant

ince the costs of transportation of fly ash from the production site to the client form a considerable part of total costs, the logistical costs of supply and delivery need to be minimised. Aspects of cost minimisation which led to the choice of this location are:

- the availability of a site next to a power plant to allow direct transport to the installation;
- a power plant that produces enough fly ash of a quality that can be upgraded;
- a location with excellent hinterland connections both by barge and bulk truck.

The Maasvlakte Fly Ash Processing Plant consists of an intake silo, an upgrading plant and an end-product silo.

The square intake silo consists of 9 slip-formed concrete bins of 1,000 tonnes content each. The fly ash content of the concrete used for the silo is up to 70 kg/m^3 . All intake of fly ash by bulk trucks, barges or from the existing EZH fly ash silos, is via this intake silo. Underneath the bins of the intake silo, a blending installation is located. Up to three different flows of fly ash can be blended in a continuous product flow. Figure 2 shows part of the transport system underneath the bins.

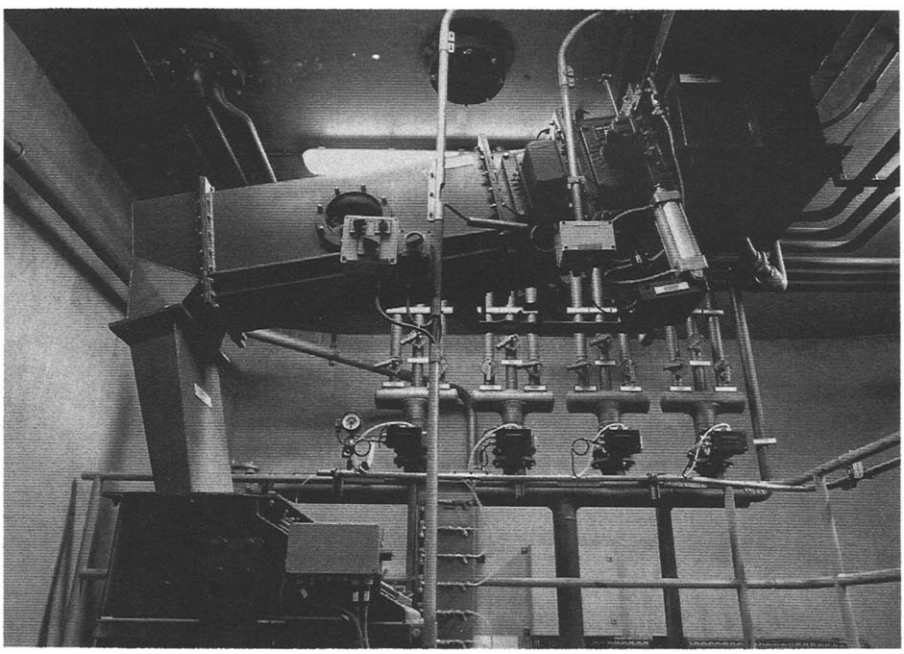


Figure 2

Transport installation underneath intake silo bins

Also underneath the bins, the control room is located. From this control room all operations (intake, outtake, internal transport, blending and sieving) are controlled. For this purpose, the installation has a fully computerised control system that can be operated by using a mouse-controlled computer screen. All transport routes are shown on a mimic panel.

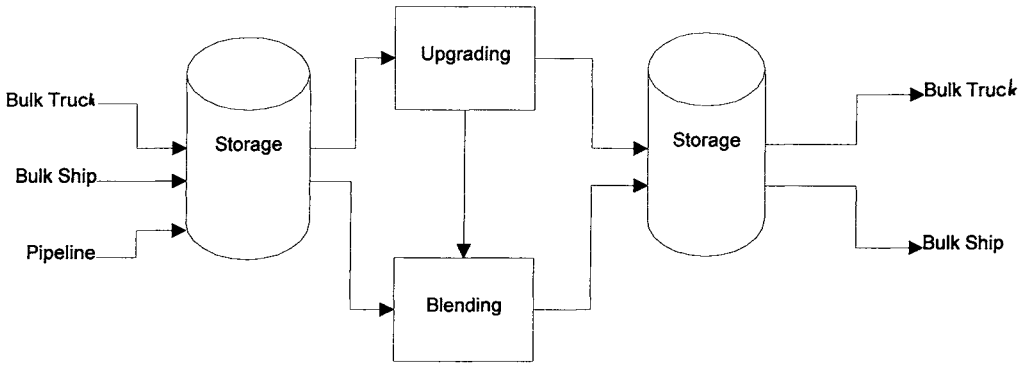
To observe loading and unloading of barges and trucks and the sieving in the adjacent upgrading installation, the operators have three video screens with cameras on various locations.
Next to the intake silo is located the upgrading plant. The upgrading plant has six sieves to reduce the carbon content of the fly ash to less than 5% and to improve the fineness to over 70% less than
45 μm. For quick analysis of fly ash samples a small laboratory is set up in the upgrading plant. More complete analyses of the samples are carried out in the laboratory of the Maasvlakte power plant.
The end product silo is located next to the intake silo. This silo consist of 4 slip-formed concrete bins of 8,000 tonnes content each. Each end-product bin has a loading spout for loading into bulk trucks. The fly ash and the fly ash residues from the upgrading process can be also loaded into bulk trucks underneath the intake silo. Barges can be loaded via the ship loading bin and two buffer bins in the intake silo using the existing barge loading installation of the Maasvlakte power plant.
Next to the end-product silo is found the weighbridge house. The complete computerised administration of ingoing and outgoing flows of fly ash is found in this building.

Operations

Intake of fly ash, into the plant, takes place in three different ways:

- from trucks (approximately 6,250 t/a = 210 trucks/a);
- from ships (approximately 56,250 t/a = 100 ships/a);
- directly from the Maasvlakte power plant (approximately 187,500 t/a).

Figure 3 shows the simplified flow chart of the processing plant.



Maasvlakte Fly Ash Processing Plant

Figure 3

Flow chart Maasvlakte Fly Ash Processing Plant

The quality characteristics of intake fly ash product are obtained from the information sent by the supplier. Random product tests are made in order to confirm these characteristics. The confirmed product characteristics are finally entered into the Fly Ash Information System. A planner then makes a planning in the Information System for the storage and internal upgrading of the fly ash, according to the demands of each customer.

Different types of weighing of the intake fly ash takes place, depending on the type of intake:

- by means of a truck weighbridge for intake from trucks;
- by means of draught survey for intake from ships;
- by means of a continuous flow-meter for intake directly from the Maasvlakte power plant.

The weighing result is entered into the Fly Ash Information System by an administrator, and is linked to the storage and/or upgrading planning for that fly ash batch.

The Maasvlakte Fly Ash Processing Plant makes use of self-unloading trucks and ships. For trucks, the unloading equipment is mounted on the trucks. Using compressed air to build up the pressure, this equipment discharges the fly ash pneumatically, through conveying pipes, to the selected storage bin. In the case of ships, a booster pump transfers the fly ash, via conveying pipes, into one of the silo bins of the intake silo. Fly ash coming directly from the Maasvlakte power plant is transported via airslides and the booster that is also used for ship unloading conveyance to the selected intake bin in the intake silo.

After weighing and unloading, the fly ash is conveyed to one of the bins in the intake silo. The exact bin chosen for storage is determined by a plant operator, who bases his decision on the planning made in the Fly Ash Information System, the type of intake and the quality characteristics of the batch.

Internal processing of fly ash takes place in one or more of three different processes:

- upgrading;
- blending;
- internal transport.

Fly ash that is to be upgraded can only be extracted from one storage bin. This means that blending during the sieving operations is not possible. Upgrading of fly ash results in two fly ash types: the upgraded type which will be transhipped to one of the intake bins in order to be blended with other flows, and the residue type that is always transhipped to a determined bin for residues for temporary storage. After upgrading, every batch is sampled. The samples are tested on various product characteristics. The fly ash is stored until the test results are known and have been entered into the Fly Ash Information System. The System couples the new quality characteristics of the fly ash batch to the already existing internal planning.

Through blending, two or even three batches of fly ash with different compositions and/or varying particle sizes can be mixed together in order to produce one batch of fly ash of a desired constant product quality.

The blender is fed from several bins in the intake silo. The blended fly ash is pneumatically transported back to a bin in the intake silo. After blending, a sample is taken from every batch and the samples are tested on various product characteristics. The fly ash is stored until the test results are known and have been entered into the Fly Ash Information System. After that, the fly ash is transported to the end-product silo for outtake.

For internal transport between mutual bins and the upgrading plant, from bins to the blending installation or from bins to truck loading equipment, airslides are installed for horizontal transport and a pneumatic transport system for vertical transport. Fly ash stored in an intake or end product bin can be recirculated through the Silo complex, the starting and end bin being the same. This is done in order to guarantee the quality of the fly ash. Each internal transport is planned by the logistic planner with the help of the Fly Ash Information System.

Outtake of fly ash can take place in one of two ways:

- by truck (approximately 100,000 t/a = 3,400 trucks/a);
- by barge/ship (approximately 150,000 t/a = 250 ships/a).

Empty trucks are weighed (tare weight) when they arrive on the site. The operator selects the storage bin from which fly ash will be loaded on the basis of the information in the Fly Ash Information System. Via aspirated loading spouts the trucks are loaded. After loading, the trucks are again weighed (gross weight). The results are again entered into the Information System. For each incoming barge or ship, a draught survey is made. The operator again selects the storage bin from which fly ash is to be loaded on basis of the information in the Information System. Fly ash is transported via an aerobelt to the ship loading installation. Via an aspirated loading spout the ship is loaded. After loading, a draught survey once again takes place (gross weight). Also, the results are entered into the Information System.

To meet with strict environmental regulations, all air used for transporting fly ash is filtered in order to reduce the dust emissions 10 mg dust per m^3 maximum.

Sampling

Power plants that supply fly ash to the Maasvlakte Fly Ash Processing Plant also send information on product characteristics for that specific batch of fly ash. These are stored in the Fly Ash Information System. The plant manager occasionally authorises random sampling and laboratory testing of intake fly ash in order to confirm the fly ash quality specifications sent by the supplier. After all types of internal processing product sampling and laboratory testing takes place. Through testing, the product quality after processing and therefore the quality of stored fly ash can be determined. A sample from each outtake batch of fly ash is also laboratory tested in order to be able to determine the quality characteristics of the fly ash being shipped to a customer.

For internal processing use, the fly ash samples are tested on only max. four parameters: carbon content, fineness, colour and pH. For intake and outtake testing, up to 25 product quality characteristics are examined. Most of these samples have to be analysed in external laboratories.

These laboratories are required to have the test results ready within 16 hours after the sample was taken. All the test results are entered into and stored in the Fly ash Information System which can therefore, when requested, calculate the quantity and quality of fly ash sent to each customer on each day. In this way, invoices are easily produced, and storage and upgrading records are easily kept.

Conclusion

In the year that has installation passed since commissioning the installation, the Fly Ash Processing Plant has proven its capability of producing a constant quality of fly ash supported by the Vliegasunie Fly Ash Processing Plant Quality system. With this quality ash several tests were made to produce concrete. The outcome of these tests resulted in a Product Certificate on the fly ash, controlled by the Dutch Certification Institute Kiwa. With this product certificate Vliegasunie guarantees her customers in the concrete industry a quality of fly ash suitable to produce excellent concrete.

With this highly sophisticated installation Vliegasunie expects to be able to match production and demand, both in quality and quantity, for the coming 15 years.