Successful storage

Jaap P.J. Ruijgrok, ESI Eurosilo® BV, The Netherlands, discusses the benefits of storing coal in silo's.

Coal is now and will continue to be an important fuel for power generation, despite the current debate on renewable energy, CO_2 reduction etc. This means that retrofits, rehabilitations and new power plant projects using coal as a fuel will form a significant part of the power generation projects to come.

Due to deregulation and privatization more outside investment will be involved and consequently increased competition and a more precise evaluation of economic data will be introduced.

Coal handling and storage, which have often been overlooked in the past, will also become a subject for reconsideration and closer examination. The projects described below shows the increasing importance of new alternatives for storing coal beside the more traditional methods.

Silo storage, a short introduction

The main criteria in deciding whether to use silo storage are:

- *Space and capacity considerations.*

  Particularly for restricted areas, the volume-to area storage factor is of major importance. Silos are the most compact form compared to covered storage piles, whether circular or rectangular.

- *Environmental considerations.*

  Dust emission, water percolation etc. have become decisive factors in obtaining permits.

- *Safety and fire considerations.*

  Silo storage, by its configuration, minimizes the intrusion of oxygen in the stored coal mass; the tight packing reduces the potential for possible fires. In a situation where self-heating is discovered by CO-detection at an early stage, effective measures can be taken; if necessary, it is even possible to make the silo fully inert by nitrogen purging.

- *High degree of automation.*

  Storage silos with a mechanical filling and reclaim system can be remotely controlled. An online blending facility can also be included through controlled reclaiming from two or more silos simultaneously.

First-in first-out vs. first-in last-out.

The first coal silos built were used for loading unit trains (approx. 10,000 tons), typically these silos range in diameter from 10 – 15 meters and storage heights from 50 –70 meters. These mass-flow silos are equipped with a hopper underneath and, through gravity, a high-speed loading process of the trains travelling beneath can be achieved.

However, in cases where the operational stock of power stations has to be stored, storage capacities of 50,000 tons per unit are quite common. Creating a mass flow storage system for these sizes will result in a multiple silo system. Therefore these bigger units can be built more efficiently as a flat bottom wide-body silo structure with a filling and reclaiming system inside. The silo structure and the foundation are straight-forward constructions that can usually be erected by local construction companies. The total building height is notably less because the large outlet hoppers can be omitted.

Fig. 1. The Tiefstack Power Plant in Hamburg featuring two 50,000 m3 Eurosilos®

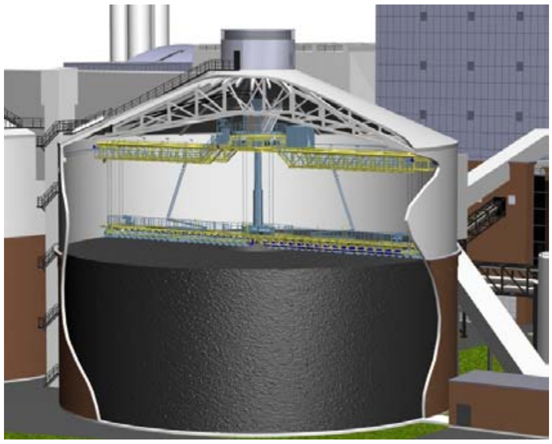


Fig. 2. Inside view of the Tiefstack silos

System Operation

The Eurosilo® system for coal storage consists of a slip-formed concrete silo shell, ranging from 30 up to 55 meters in diameter, with a storage height of 30 to 50 meters. The silo is mounted on a concrete foundation including a concrete reclaim tunnel and is covered by a structural steel roof, which supports the infeed conveyor which discharges the coal into the silo. In case of a multiple silo system the coal can be transferred to an adjacent silo by installing a two-way diverting gate.

Each silo receives the coal via a telescopic chute supported by the upper structural ring bearing. The upper slewing bridge is supported by a silo ridge mounted circumferential crane track. This bridge also contains pressurized electrical equipment, the slip-ring assembly with its electrical and air connection, the slewing drive wheel assemblies and the winches that support and operate the auger frame.

The auger frame is suspended from the upper bridge by steel wire ropes and contains the main twin screw system and the lower section of the telescopic chute. The frame is accessed by a motorized cable-suspended personnel cage.

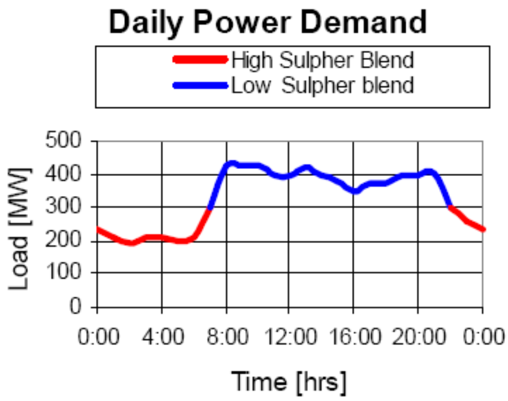
The coal is fed via the infeed conveyor into the telescopic chute and reaches the auger frame on the coal-pile surface. The two main parallel screw conveyors, when operating in stacking mode, convey and radially distribute the material over the entire area of the silo. The lower frame is guided along the silo wall by horizontally and vertically mounted wheels. After each complete rotation, the auger frame is raised by the winches to fill the silo layer by layer until the coal reaches its maximum level or when reclaiming commences.

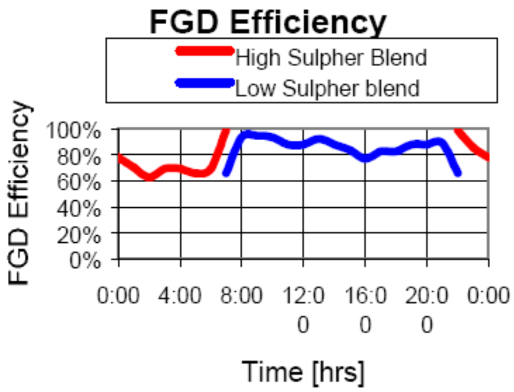
The reclaiming capacity may vary up to 1,500 tph. To ensure a continuous and uninterrupted fuel flow to the day bunkers, each silo has two (one redundant) vibrating reclaimers. The Uncoaler type reclaimers are a combination of pile activators and vibratory feeders in one machine. Electrically powered eccentric counterweights or exciters provide the necessary force to induce gravity flow in the centre and to discharge the coal onto the reclaiming conveyors. By withdrawing of the coal from the bottom of the silo, a core flow is established. At this point, the auger frame's two screws located on the surface of the coal reverse rotation, thus directing the flow of the coal toward the centre of the silo, continuously feeding the formed core. The upper bridge also rotates in the opposite direction than when loading, and with each complete revolution the auger frame is lowered.

Dynamic Coal Blending

When reclaiming two (or more) silos simultaneously, a flow of two (or more) grades of coal can be reclaimed resulting in a predetermined blend. Dynamic blending of coal is a new fuel handling approach whereby coal quality can be continuously controlled, within acceptable limits, to meet changing needs in real time. A number of power plant owners are now using dynamic coal blending at their facilities to save money and maximize revenue generating opportunities while ensuring environmental compliance.

For instance, a reason for dynamic blending of coal is to meet SO2 emission regulations and reducing the need to retrofit expensive flue gas desulphurization (FGD) systems. By changing the blending ratio during the daily load-cycle an optimal balance between fuel prices and FGD-efficiency can be achieved.





When the concept of "the right coal at the right time" is employed, its advantages become obvious. So, for example lower-priced, lower-quality coal can be burned when power demand and prices are low and in peak demand periods coal of the highest quality is made available.

The difference with the conventional "one blend for all conditions" can save 1 to 3 million Euro per year at a 1000-MW power plant.

Old arguments!

Among even experienced coal handling specialists some so conventional arguments still rule their decision-making, such as:

"You cannot pile up the coal higher than 10 meters".
The original reason behind this statement was that the risk of spontaneous combustion is increasing with the storage height. However the contrary is in fact true. The higher the coal is stored, the more compacted it will become in the lower layers which eliminates the oxygen and thus the risk of oxidation. The real reason behind this statement was that in the case of open stockpiling, which is still the most common form of storing coal, it was complicated to reach the hot spots in higher piles.

"First-in last-out is not acceptable".
Some operators still believe that coal is subject to deterioration. This phenomenon might be true for some grades of coal if it is stored in the open air where rain, wind and oxygen have free access to the coal

mass. However in completely sealed storage silos the lower layers are well conserved and all the deteriorating factors are eliminated.

"Coal silos are black bombs".
This comes from the fact that there have been a number of accidents with coal and coal dust in silos in the past. The safety can be guaranteed nowadays by installing gas detection systems through which the smallest oxidation rates can be measured and adequate precautions can be taken in an early stage.

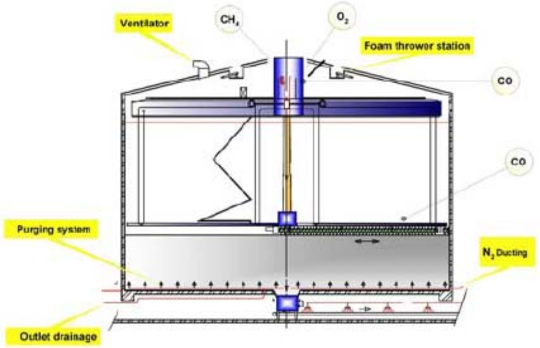


Fig. 3. Safetry Concept of the Eurosilo® coal storage

"Coal silos are too expensive".
For centuries coal has been stored outdoors, which happened as a matter of course. The scaling-up of the coal-fired units, especially in densely-populated areas, has made planners and engineers think of ways to store the coal under cover.

Latest Projects

The Tiefstack Hamburg project (see fig 1 and 2) has resulted in the following contracts:

A twin (Euro)silo project for storing lignite at the Tractebel Red Hills Generation Plant in the state of Mississippi (USA), The concrete silos are able to store 25,000 t of lignite each and are filled at 1,800 tph and reclaimed with 2 x 750 tph. See Fig. 4.

These storage silos are in commercial operation for about five years now!

Fig. 4. Red Hills Lignite silos

A four unit **underground** Eurosilo® coal storage system at the Helsinki Energy Salmisaari Power Plant has been in operation for two years now. See Fig.5.and 6.

Each unit has a storage capacity of 50,000 t of steam coal, making a total storage capacity of 200,000 t.

The existing open coal storage depicted in figure 5, has been replaced by an underground Eurosilo® storage system for economic and environmental reasons. Since this area of Helsinki is a priority area for development, with good views on the Finnish Gulf, the freed space has been used for contemporary new offices and other real estate. The geological conditions at the power plant are solid rock formations which also house the Underground Railway nearby.

The underground Eurosilo's®, see Fig. 6 and 7, are filled by belt conveyors housed in excavated galleries. Transport to the boilers utilizes the same concept.

The excavation of the silos, see Fig. 7., have been executed through blasting. The project has been commisionded.

Fig. 5. Open coal storage Salmisaari Power Plant Helsinki

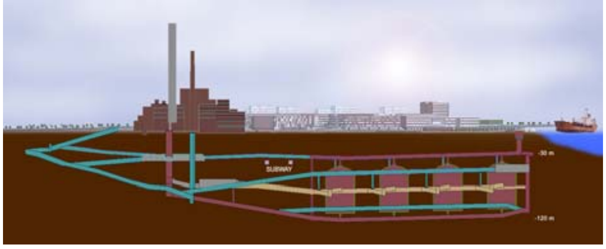


Fig. 6. Underground Eurosilo® coal storage at Salmisaari Power Plant

Fig. 7. View of the underground Eurosilo®

Cost benefits

Of utmost importance in any new venture is the need for an accurate, up-to-date assessment of costs and savings of the new system. In order to have that assessment, initial investment costs give only half the picture. The total cost of the investment must be taken over the expected life span of the project to get a true approximation of how much it is going to cost. Running costs include not only the obvious costs such as interest, energy consumption, maintenance etc., but also hidden ones, such as the cost of product loss due to dusting, and product quality loss due to self-heating. These are, in fact, the largest costs incurred over time, and cannot be ignored.

The Eurosilo® concept has been compared to both open and closed stockpile storage with respect to investment and return. Considering the advantages and drawbacks of the various systems, a comparable initial price has only been available in a few cases.

But the economical choice is shifting to the Eurosilo® system quickly, because of the increased need for environmental protection, homogenizing and drying functions, the requirement of transhipment without degradation, the avoidance of segregation, and the need for protection against fire and explosion. The aspect of land costs and space availability, especially in urban zones, can also have a great impact on the initial cost of a storage system. But the biggest difference is the running cost. The Eurosilo® has by far the lowest running costs of the four systems compared (open stockpile, A-frame storage with scraper, circular storage with scraper and Eurosilo®) meaning that the total cost is also the least. If the life expectancy is twenty years, the total price of the Eurosilo® is about 15% less than the open system, and much less than the others.

HEW power station in Hamburg recognized the importance of the running costs. A comparative study was made with respect to open coal storage versus covered storage, and the conclusion was to use two silos. On the basis of initial cost, open storage was slightly more economic, but the silos were much more versatile. The running costs were less and the automation ability was much greater. The environmental problems were negligible, and space utilization was minimised. This study resulted in the two 50,000m^3 coal storage silos built for the HEW power station in Hamburg, Germany as mentioned before.

Using coal silos brings you a range of cost savings:

Dust emissions are eliminated which can lead to coal savings of several percent depending on the average wind-force. For example, if 2.5% of the coal is blown away this can easily result in 25.000 tpa for an average 600 MW power station.

Dust emissions are often combatted with spraying water. These substantial amounts of water have to be evaporated, which decreases the calorific value of the coal mass. The same phenomenon is valid when the coal piles are subject to heavy rainfall.

Due to wind and rain, the surface of the pile can be penetrated by oxygen, so oxidation of coal cannot be avoided, even after compacting, the fines can be washed out. The deterioration of the coal after being subject to a period of oxidation should not be underestimated, coal oxidation losses may average up to 1.5% of the purchased energy content.

The automated silo machinery results in a considerable reduction in operating staff.

Finally dynamic blending enables the operators to make optimal use of the coal quality and coal prices

Conclusion

In considering the feasibility of a coal silo project an integral estimate of investment, operating and maintenance costs should be formulated, including cost savings, as discussed above!

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