From coal to petcoke grinding

When ACC decided to replace coal with petcoke as the main fuel for its kilns at the Gagal works, the vertical E-mills required a high power input as they ran for extended periods. To reduce grinding time and hence save power expenditure, the cement producer called upon Walchandnagar Industries Ltd to design, engineer, manufacture, supply and install a vertical roller mill for petcoke grinding.

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In March 2013 India-based Walchandnagar Industries Ltd (WIL) was awarded the EPC contract for a 20tph vertical roller mill (VRM) to grind petcoke at ACC's Gagal cement plant in Barmana, Himachal Pradesh, northern India. WIL was responsible for the complete design, engineering, manufacturing, supply, civil and structural work, fabrication and erection of all mechanical, electrical, instrumentation and control equipment for the plant. The cement works operates two kilns with a total clinker capacity of 9250tpd (4350 + 4950tpd) and a cement capacity of 4.4Mta.

The coal used to fire these kilns is ground in three vertical E-mills. These mills have a 19tph capacity with 22-23 per cent residue on 90µm. However, due to their low capacity, the mills ran for long hours with a high power consumption.

The decision to install a VRM to grind petcoke was taken following steps to replace coal as the main kiln fuel. The VRM is designed to enable the grinding of 20tph petcoke at ≤1% R90µm and 55tph coal at ≤15% R90µm.

All existing equipment needed to be connected with the new equipment, including raw petcoke/coal transportation up to mill feed hoppers, fine petcoke/coal conveying and feeding to kiln and calciner bins for both kilns, raw meal dust conveying to existing kiln feed bins, hot gas tapping from the kilns and the installation of a new electrical room.

Project summary

This project includes:

- raw petcoke/coal diversion from existing belt conveyor transfer tower
- raw petcoke/coal transportation up to two mill feed hoppers
- VRM for petcoke/coal grinding
- two bins for fine petcoke and fine coal storage
- fine product pneumatic conveying to the existing four fine coal storage bins for both kilns
- hot gas tapping from exhaust gas duct of preheaters.
- utilities such as compressed air distribution, water distribution, fire detection alarm, fire hydrant system, pressurisation and ventilation system for the electrical room, air conditioning for control panel room
- electrical: complete electrical power supply and distribution system from 6.6kV MV switchboard, transformer, MCC, electrical cables with cable trays etc
- instrumentation and control – all field instruments, control cables with cable trays, plant control system etc.
- civil and erection – complete civil and structural work and erection of all mechanical, electrical and instrumentation system
- no-load trails, load trails, stabilising the operation and demonstration of performance guarantee.

Walchandnagar Industries supplied a 20tph vertical roller mill to grind petcoke at ACC's Gagal works, India

Project description

Raw petcoke/coal tapping and transportation

The raw petcoke/coal is diverted using a pneumatically-operated two-way gate on the existing belt conveyor transfer tower. It is then transported to two 250t feed hoppers. These are steel structures with bolted wear resistant liners. For raw material metering, one weigh belt feeder is provided below each feed hopper and the entire hopper with weigh belt feeder is mounted on a load cell to facilitate online calibration of weigh belt feeders.

Raw petcoke/coal grinding VRM

The raw petcoke/coal is transported via a belt conveyor and fed to the mill inlet by a rotary feeder, which was designed and manufactured by WIL. The rotary feeder includes a facility to feed the hot gasses to partially dry the material before it enters the mill.

Table 1: VRM characteristics	
Make	UBE (critical parts), WIL
Petcoke grinding capacity – dry basis, 1% residue on 90µm (tph)	20
Coal grinding capacity – dry basis, 15% residue on 90µm (tph)	55
Model	26.3 (centre feed)
Main drive (kW)	810 (variable frequency)
Max speed (rpm)	980
Max table speed (rpm)	35.7
Separator type and model	Dynamic separator (UNKS50Z)
Separator drive (kW)	75 (variable frequency)
Mill vent fan (m^3/h)	210,000
Mill vent fan motor (kW)	800
Booster fan motor (kW)	315

The raw materials are extracted from hoppers and weighed using high-accuracy weigh feeders before feeding to mill.

The VRM was built by Ube Machinery Corp Ltd, a Japanese equipment manufacturer which has collaborated with WIL for 19 years and has supplied seven VRMs to Indian cement manufacturers. UBE's order list to date includes 261 coal, 138 raw, 17 cement and 52 slag mills.

The main characteristics of the VRM are shown in Table 1.

The operation of the VRM varies significantly between coal and petcoke as the physical properties of the feed and product vary. Due to its low volatility, petcoke needs to be ground very finely to increase the surface area and therefore, increase the rate of reaction. The operating parameters for coal and petcoke are shown in Table 2.

Fine petcoke/coal storage and conveying

The fine petcoke/coal is stored in two steel bins mounted on load cells. To ensure smooth extraction, both bins are cone-shaped and manufactured from stainless steel. In addition, they have explosion vents complying with the IS14491 standards.

The fine petcoke/coal is extracted using variable speed rotary air lock valves and transported further to kiln and calciner bins of both kilns using a screw pump and root blowers. The system has been designed to be completely interchangeable in terms of conveying petcoke or coal from any storage bin to either calciner bin of Kiln I and Kiln II.

Major project challenges

The main project challenge was to engineer and construct a mill building in between the two production lines at ACC's Gagal cement works with considerable space constraints on various levels. However, continuous efforts and collaboration between WIL and ACC enabled the successful engineering of the project.

One example of such space-constraints on this project was the engineering and erection of preheater hot gas ducts from Kiln I and II up to the mill inlet. The hot gases are taken from both the kilns and passed through twin cyclones to collect raw meal dust entrained in it.

The collected dust was transported pneumatically to the kiln feed bins of the production lines. As the bins were in an existing building, engineering and erection of this equipment provided an additional challenge, but this task was completed satisfactorily and the system is in operation.

A further challenge related to the pneumatic transportation of the fine coal and petcoke from the 110t storage bins to the production line, avoiding existing structures as much as possible. This was a particular issue since the calciner and kiln bins of production line I were located in different buildings a far distance from one another. The WIL team studied the feasibility of conveying the material to both lines and carried out the required engineering.

The erection of equipment at specific heights, such as baghouses, flame front equipment, raw and fine coal bins and hot gas ducts was subject to space constraints and required advanced engineering skills.

Meeting guaranteed values

Upon completion of the project, WIL achieved the performance guarantee parameters agreed in the contract – see Table 3. ■

Table 2: VRM operating parameters for coal and petcoke		
Parameter	**Coal**	**Petcoke**
Grinding capacity (tph)	55 – 15% residue on 90µm	20 – 1% residue on 90µm
Grinding pressure (MPa)	3	4.5
Separator motor speed (%)	40	85
Mill main drive motor speed (%)	90	75
Mill vent fan motor speed (%)	90	75
Dam ring height (mm)	109	115

Table 3: performance guarantees and obtained results		
Parameter	**Performance guarantee (contract)**	**Achieved guarantee values**
Mill capacity (tph)	20 (dry basis)	20.4 (dry basis)
Specific power consumption – mill main motor + mill vent fan + separator + booster fan (kWh/t)	58	Test I – 57.17 Test II – 56.51
Fine product fineness (% residue on 90µm)	≤1	Test I – 0.67 Test II – 0.8
Fine petcoke moisture (%)	max 1	Test I – 0.3 Test II – 0.5