

Improving Coal Pulverizer Performance and Reliability

Introduction

Power generation industry studies have shown that coal pulverizers are an area where improved equipment reliability is badly needed. The Electric Research Institute (EPRI) has determined that 1% of plant availability is lost on average due to pulverizer-related problems.¹ EPRI also identified oil contamination and excessive leakage as two areas where pulverizer drive train failures account for 53% of pulverizer problems.

Description

Pulverization is currently the favored method of preparing coal for burning. Mechanically pulverizing coal into a fine powder enables it to be burned like a gas, thus allowing more efficient combustion. Transported by an air or an air/gas mixture, pulverized coal can be introduced directly into the boiler for combustion.

There are several pieces of equipment involved in processing coal to be burned in this fashion. Figure 1 is a simplified diagram detailing this equipment in a direct-fired coal burning system.

Combustion Engineering, Babcock & Wilcox, and Riley Stoker Corp. are major manufacturers of coal pulverizing equipment. The four most common types of coal pulverizers are:

Ball-Tube Mills

This type of mill consists of a rotating tube filled with cast alloy balls. Coal is introduced through two hollow trunnions on each side of the tube. As the tube rotates, the balls tumble onto the coal, crushing and pulverizing it.

Impact Mills

Grinding Action is carried out by a series of hinged or fixed hammers revolving in an

¹ EPRI study on large coal fired utility boilers (greater than 600MW) using pulverizers with capacities greater than 50 tons per hour

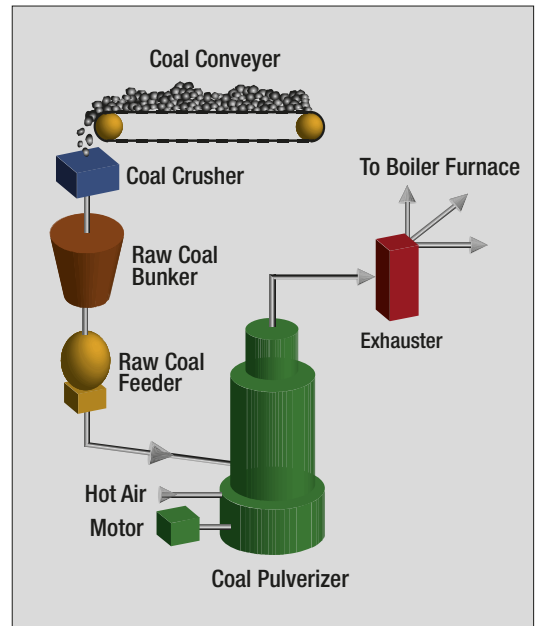


Figure 1: Simplified diagram detailing a direct-fired coal burning system.



Combustion Engineering 783RP Bowl-Mill Coal Pulverizer.

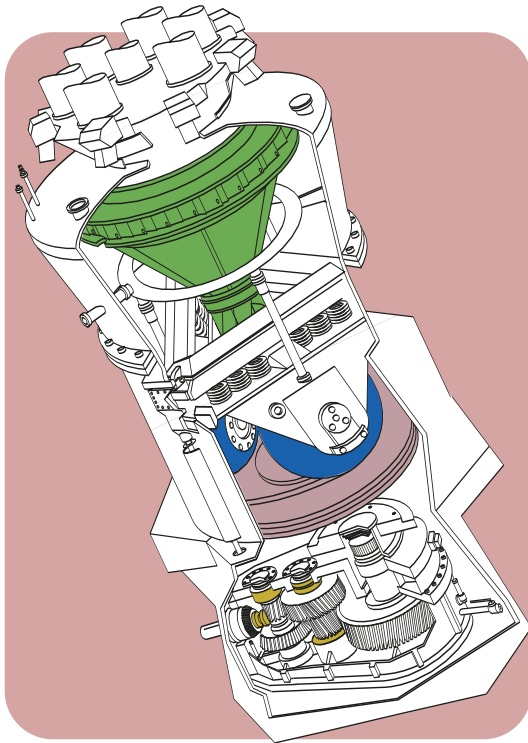


Figure 2. Babcock and Wilcox MPS cutaway view.

enclosed chamber with wear resistant plates. The hammers impact on the coal, crushing it against the plates. Further pulverization is achieved as the smaller coal particles are ground through attrition against each other and the grinding face.

Vertical Roller Mills

This mill uses hydraulically loaded vertical rollers resembling large tires to pulverize raw coal fed down onto a rotating table. As the table rotates, the raw coal is pulverized as it passes underneath the rollers. Hot air forced through the bottom of the pulverizing chamber removes unwanted moisture and transports the pulverized coal dust up through the top of the pulverizer and out the exhaust pipes directly to the burner. The more recent coal pulverizer designs are Vertical Roller Mills. Figure 2 shows a cutaway view of a Babcock and Wilcox MPS Pulverizer.

Ring-Roll and Ball-Race Mills

A ball or roller between two races or rings provides the grinding surfaces on which pulverization occurs. One or both of the races may rotate against a ball or roll (in a Ring-Roll Mill the rolls may rotate while the ring is stationary). Ring-Roll (Bowl-Mill) and Ball-Race Mills comprise the majority of coal pulverizers currently in service at power generating facilities.

Figure 3 shows a cut-away of a Ring-Roll type coal pulverizer. In this design the grinding rolls are stationary, while the ring (or bowl, as it is sometimes called) is rotated by a worm gear drive. Powerful springs force the grinding rolls against the ring, providing the pressure required to pulverize the coal.

Raw coal enters the top of the pulverizer through the raw coal feed pipe. The raw coal is then pulverized between the roll and rotating ring. Hot air is forced in through the bottom of the pulverizing chamber to remove unwanted moisture and transport the coal dust up through the top of the pulverizer and out the exhaust pipe directly to the burner. Coal that has not been pulverized into fine enough particles cannot be blown out of the top of the unit; it falls back to the ring and roll to be further pulverized.

Contamination Ingression

The gears and bearings in the gearbox are oil lubricated. Fine coal particles and wear metals from grinding surfaces enter the lube oil through worn bearing and shaft seals, as well as being “inhaled” through reservoir vents. Historically, the design of pulverizers has been based on the expectation of few drive system problems under prescribed operation and maintenance. In practice, this has often been found not to be true.

OEM Supplied Filtration

Many coal pulverizer designs do not incorporate any filtration in their lube circuits. The pulverizers that do not incorporate filtration use coarse filtration such as 40-micron cleanable mesh or 200-micron cleanable, stacked disk filters. Such OEM-supplied filtration is often unable to keep up with the inherently high ingression rate. This results in contamination levels often exceeding ISO code 30/30, particularly on older designs. This high level of contamination can severely diminish bearing, gear, pump, and seal life, leading to premature need for replacement or rework. Coal pulverizer downtime can be a major factor in reducing overall plant availability and reliability.

Recommended Filtration Upgrade to Achieve Total Cleanliness Control

(See diagrams on back page)

The majority of pulverized coal particles are in the 4-30 μ m range, with 70% of these particles smaller than 10 μ m. Ingression rates vary with manufacturer, model, and age of

unit, with older units usually admitting contaminants faster than newer ones. Particulate contamination in the lube system can result in rapid damage to critical components.

In order to protect the coal pulverizer lube system components, Pall recommends maintaining a fluid cleanliness level of ISO 16/13 or better. This can be accomplished through the use of Ultipleat® SRT AS grade ($\beta_{12(c)} \geq 1000$) or finer filters. Ultipleat SRT filters, with their high particle removal efficiency and dirt-holding capacity, are ideally suited to cost-effectively control contamination in this high-ingression application.

When upgrading in-line filtration, a Pall Duplex Assembly is recommended so that elements can be changed out while the pulverizer is operating. Although putting filtration in-line is preferred, difficulty in getting system specifications from the OEM, combined with the typically low pump pressure associated with this application, may make kidney loop filtration a more viable alternative. Reservoir volumes typically vary from 15-300 gallons.

A 20% reservoir volume per minute flow through a kidney loop is generally sufficient to overcome the ingression rate of most applications. The high-viscosity

of gear lube oil (2,200 SUS at operating temperature) along with the inherently rapid ingression rate usually associated with these units makes it necessary in most cases to utilize at least one UR619 housing with a UE619 element ($\beta_{12(c)} \geq 1000$ or finer) for every 50 gpm of flow to provide superior filtration with long element life. Since the pulverizers come on- and off-line, it is important to size the system for the oil viscosity at the coldest possible ambient plant temperatures. Line diameters in the kidney loop should be large enough to facilitate flow of highly viscous lube oil.

Other applications where Pall high-performance filtration is useful include coal-carrying cars and conveyor belts. Many of these applications have both hydraulic and lube systems that are vulnerable to coal dust contamination. This equipment is required to transport the coal stored on-site to the coal pulverizers. Because this equipment is essential to the

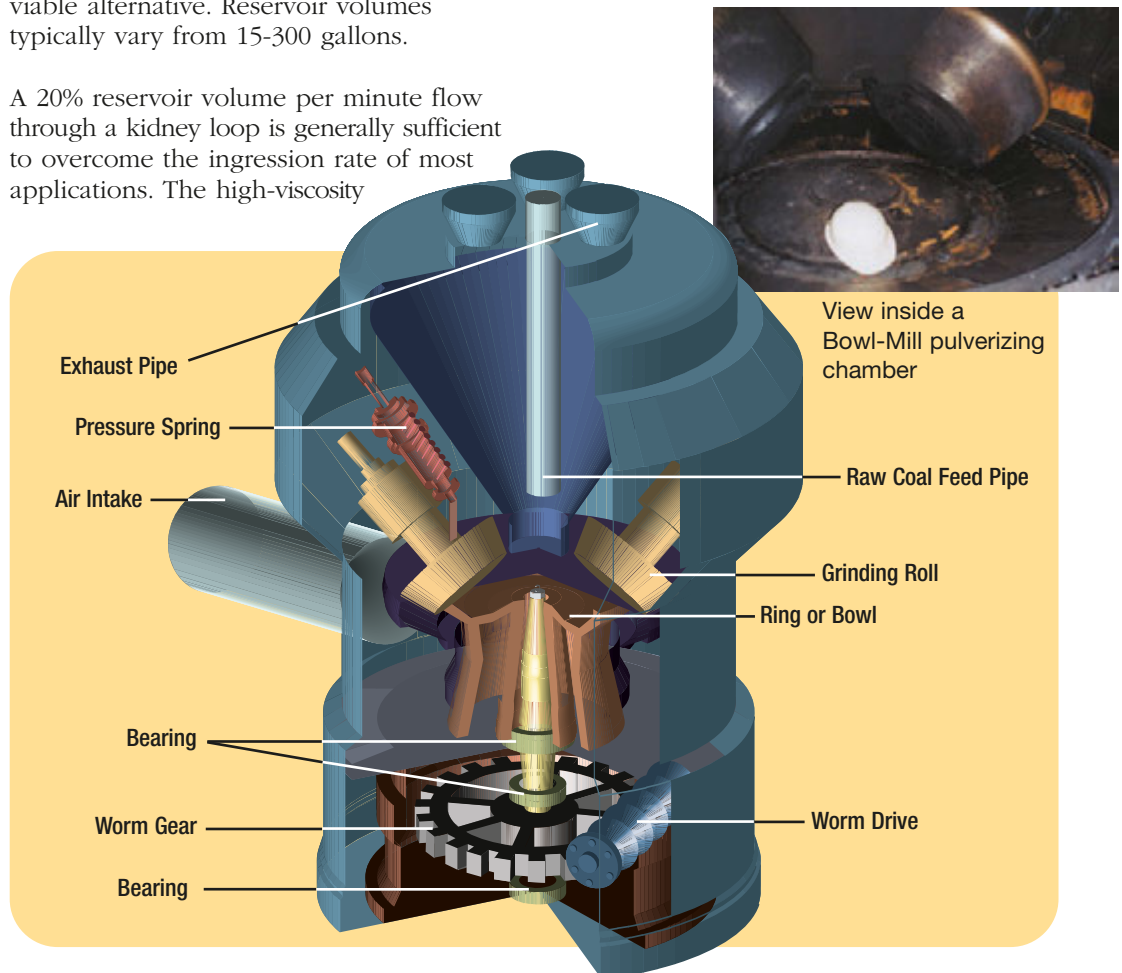


Figure 3. Ring-Roll pulverizer: cutaway view.

Filtration Upgrade Recommendations

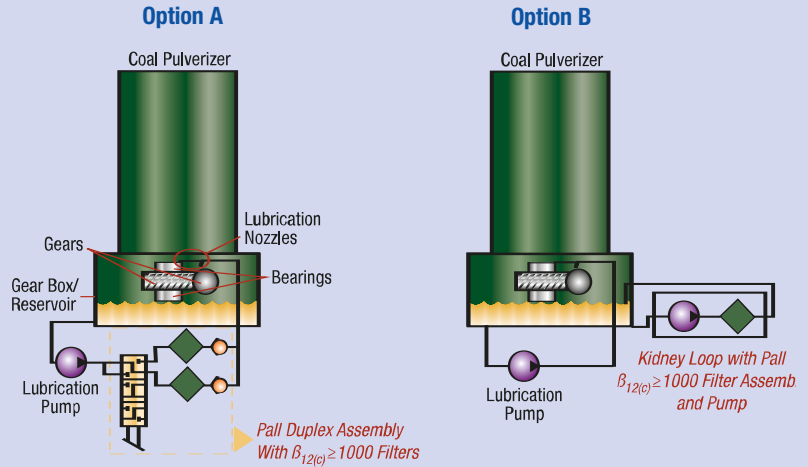
Option A (preferred)

Replace OEM supplied in-line filtration with a Pall Duplex Filter Assembly using $\beta_{12(c)} \geq 1000$ Ultipor III element.

Note: Make sure that lubrication pump pressure is sufficient to provide adequate flow to lubrication nozzles when filter element is plugged.

Option B

Install a kidney loop with Pall $\beta_{12(c)} \geq 1000$ filtration on each pulverizer. Flow through the kidney loop should be approximately 20% of the reservoir volume per minute—i.e. if reservoir volume is 250 gallons, then kidney loop flow should be 50 gpm.



operation of the power plant, it is critical that this equipment be free from contamination-related failure.

Case Study

In March 2003, a major Canadian utility derated its Unit 4 due to a failure of the B mill. The mill was expected to be out of service for about a month. With lost production of approximately 864 MWh per day, the total estimated revenue loss was around \$2,000,000. Repair costs for this outage added up to more than \$400,000 due to the severity of the damage to drive train components. An analysis concluded that there were multiple causes of this problem, including poor

predictive/preventive maintenance practices and poor oil cleanliness.

Pall provided a filter housing for a six-month trial to show that oil cleanliness could be improved to industry standards and maintained without the incurrence of substantial element costs. Oil cleanliness went from 20/19/17 to 18/16/13 in approximately 2 hours and has been maintained at this level since.

After the six-month trial, the power plant installed one assembly on each of the 30 pulverizers in its facility. The plant currently changes elements once a year.



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