COAL GRINDING SYSTEMS
SAFETY CONSIDERATIONS

Most rotary kilns use solid fuels as the main heat source to produce cement clinker.

A training program should be developed and extensive training for coal mill system operators provided on a regular basis. Safety considerations, such as the prevention of fire or explosion are of utmost importance as is the knowledge of how to proceed under normal conditions. The training program should include the development of an operating manual which should be updated with new procedures as situations occur.

SAFETY ASPECTS

Solid Coal Unloading, Storage, and Reclaiming Areas

A major hazard associated with coal handling facilities is the possible formation of an explosive atmosphere originating from accumulation of methane and coal dust especially in enclosed areas or tunnels such as rail unloading facilities. Walls should be washed down frequently to prevent dust accumulation, and welding or electrical repair work should **not** be conducted in an enclosed area during unloading operations or if methane or coal dust is present. Smoking, open flames, and other potential ignition sources should be prohibited in any areas in which coal is being handled or processed.

Fires that start around the edges of coal storage piles should be removed with a front end loader, spread in a location away from the coal storage area, and allowed to cool. Water should NOT be sprayed on a smoldering coal pile. The degree of wetness in a coal storage pile is known to influence spontaneous heating.

Belt magnets and metal detectors on coal belts must always be operating properly. Pieces of metal can cause sparks or become overheated which can ignite a fire or initiate an explosion. Scrap metal in a coal mill is particularly dangerous during mill shut down or start up.

Coal Mill Operation

Fires or explosions most likely occur during startup and shutdown of a coal mill system.
If a small amount of coal remains in the mill after it is shut down, it slowly increases in temperature. If the pulverized coal undergoes spontaneous heating and the coal mill is restarted with hot embers present, an explosion or fire is possible. Although this does not happen often, the chances increase when a coal mill is frequently shut down and then restarted.

A coal mill system that goes down, particularly under load, must be treated with extreme caution. In several cases, fires or explosions have occurred when an employee opened an inspection door. Air admitted to the system allows oxygen to reach a smoldering pile of

pulverized coal that then ignites explosively. Also, an inrush of air may create a pulverized coal dust cloud that explodes.

Accumulations of Pulverized Coal Dust

All leaks, spills, and any accumulations of coal or coke dust must be cleaned up promptly around coal mill grinding and firing systems because of the potential for spontaneous combustion. Small piles or layers of coal or coke dust may spontaneously heat and start a fire.

Coal dust spills or leaks must be cleaned up or repaired as soon as it can be safely done. A potentially serious problem exists if coal dust is allowed to accumulate inside a building or enclosure, for example around an unloading facility or because of a leaking coal conveying line. If large accumulations of dust exist and a small explosion occurs, the dust build-up can be dispersed into the air as a result of the relatively minor first explosion and then produce a very large secondary explosion.

When coal is freshly pulverized, volatile gases such as methane can be released and the result is no longer a coal dust/air mixture but what is termed a hybrid mixture.

Coal Mill Temperatures

Coal mill hot air inlet temperatures should never be more than 600□F and the outlet temperature should not exceed 200°F on Raymond coal mills. If the flow of raw coal to the coal mill is interrupted for any reason (for example: plugging, failure of the coal feeder, etc.), the outlet temperature of the coal mill can quickly climb to dangerous levels. The risk of explosions or fires can be extreme when the coal mill inlet temperature increases to more than 600°F or the outlet temperature is more than 200°F.

Velocity in Ducts and Burner Pipes

Fuel efficiency would tend to dictate that the airflow should be varied as the coal feed rate varies. However, velocities in ducts or conveying lines must be at least 5000 fpm (25 meters per second), which has the practical effect of limiting how much the airflow can be varied without reducing the velocity below safe levels.

Burner pipes must be designed to maintain a minimum tip velocity of 8500 fpm (45 meters per second). Velocities less than 8500 fpm substantially increase the risk of the coal flame propagating into the burner pipe and potentially through the conveying lines to the coal mill causing substantial damage to the equipment.

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COMMON CAUSES OF FIRES OR EXPLOSIONS IN COAL SYSTEMS

Combustible gases

Coal may contain trace amounts of gases such as methane. When coal is handled, it can release some of these gases. Methane concentrations in coal unloading systems, particularly in enclosed areas such as tunnels, elevator housings, and bins can accumulate to dangerous concentrations. Smoking, cutting, welding, or any source of open flame or high heat (such as a light bulb that could break and result in an electrical arc) should be strictly prohibited in coal handling areas.

Spontaneous combustion

Oxidation at the surface of a coal particle --which is most active when the coal has been freshly pulverized - and condensation of water onto the coal are reactions causing heat that can lead to spontaneous combustion.

The ease with which coal will oxidize is extremely variable. The total exposed surface area is important because, when more fresh surface is exposed, oxygen has a higher chance of uniting with the coal with the result that the total heat liberated in a given time for a given weight of coal will be substantially greater. When water condenses, it releases heat which can be a significant factor in the initial increase in temperature of a coal dust mass. However, oxidation is how the coal ultimately reaches its ignition temperature.

Spontaneous combustion is primarily oxidation occurring on a fresh surface of a coal particle. The rate of oxidation increases rapidly as the temperature increases. For some coals a temperature increase of 20°F (10□C) can double the rate of oxidation. If heating from oxidation occurs in a mass of coal dust, the ignition temperature of the coal can be reached quickly if enough oxygen is present.

When a build-up of coal dust is allowed to occur, the coal will begin to heat for reasons just explained. Therefore, it is important that all coal dust is immediately cleaned and dust is not allowed to build-up in piles.

Debris in the coal mill

Every effort must be made to prevent scrap metal and other spark producing debris to enter the coal mill system. Pieces of metal in the coal mill can also be heated to temperatures high enough to start a fire or explosion by being in the mill while it is in operation.

Solid fuel that spills over the bowl and into the area below the bowl can cause a fire since it is exposed to the hot drying air entering the coal mill. The coal mill scrapers will usually sweep the fuel pieces around to the debris chute and discharge them; however, a fire is likely to occur if a coal buildup occurs at the hot air inlet to the mill.

Hot surfaces

Hot surfaces such as hot bearings, cutting, or welding can start a coal dust fire or explosion. Any unusual temperatures must be reported immediately and steps taken to solve the problem. Cutting and welding around the coal mill system should only be done under strict supervision by qualified personnel. The system should be inerted or washed down with water prior to cutting or welding.

Coal Dust Explosions

A coal dust explosion will occur if the following three conditions exist:

1. The concentration of coal dust in the gas mixture is within the explosion limits.
2. The oxygen content in the gas mixture is sufficient for an explosion.
3. There is sufficient thermal energy to initiate an explosion.

Theoretically, the absence of one of any one of these three factors would be enough to prevent a coal dust explosion. However, it is preferable to eliminate two or, possibly, all three factors.

The thermal energy required for initiating an explosion could originate from several sources:

1. Spontaneous combustion or self-heating of the coal.
2. Overheating of the coal by hot gases used for drying that are too hot.
3. Overheated machine parts, such as hot bearings.
4. Metal entering the coal mill with the coal can cause sparks or become hot enough to start a fire or explosion.

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EMERGENCY CONSIDERATIONS

On a coal grinding and firing system, maintenance work or inspections that require opening equipment should only be performed when given specific instructions and under the direct supervision of authorized personnel. Cutting or welding around or on a coal firing system can result in fires and explosions. Opening an inspection door on a coal grinding system can provide oxygen to smoldering, powdered coal and result in fires or explosions. Use extreme caution when opening an inspection door. Do not poke or disturb any coal accumulations if there is any evidence of heat, smoke, or glowing embers. Allow the system to cool further and then check again as necessary. When you are convinced everything is OK, remove any accumulations in small amounts. Before working on or around coal firing systems, the system must be inerted or washed down with water to be sure powdered coal can not ignite.

This article was contributed by Gerald L. Young, Senior Consultant at PEC Consulting Group LLC. Jerry has authored or co-authored more than 25 papers that cover cement manufacturing and emissions control. He has conducted cement plant audits and feasibility studies for new cement plants and plant expansions. He has a BSc degree in Chemistry from Missouri University of Science and Technology, Rolla, MO, and a Master's degree in Management from the University of Redlands, CA.