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Application Note

Corrosion of Ash-Handling Systems

Ash handling is a major problem for utilities and industrial owners using as a primary fuel. The firing concept used, that is, cyclone, pulverized coal, or fluidized bed firing, determines the type and characteristics of ash. Waste fly ash (fly ash and bottom ash) is generated in large volumes and must be disposed off in an environmentally acceptable manner. Fly ash comprises of small dust like particles (100μm or less in diameter); bottom ash consists of much larger slag particles removed from furnace bottoms.

Conventional ash-handling systems collect, convey and dispose waste ash by methods that depend on site-specific considerations, regulations of Pollution Control Board (local, state and national) requirements, and economic considerations. Generally, the ash will be handled wet or dry, but handling system may include combinations of wet and dry conveying. Fly ash is collected dry and generally conveyed dry to storage or disposal. Wet conveying and storage of fly ash has become environmentally more difficult, and regulations are likely to favour dry conveying systems. Bottom ash is collected in a water bath and is almost handled wet. Most ash-handling systems convey bottom ash and fly ash separately to storage or disposal, but conveyance in the same pipeline is also acceptable.

Typical operating problems associated with conventional fly ash/bottom ash handling systems may be grouped into two categories:

Corrosion and erosion (material deterioration)

Scaling and plugging (material buildup)

The above problem areas must be addressed by designers of ash-handling systems and plant operators, who would consider such factor as equipment selection, material applications, maintenance policy, and system concept. The handling system concepts for fly ash/bottom ash are dry/dry, dry/wet, wet/dry or wet/wet. Corrosion and corrosion related problems are more prevalent in wet systems than in dry systems. Corrosion-related problems by system concept are reviewed below.

Fly Ash Systems

Dry Fly Ash Systems. The pneumatic conveying of coal ash particles can produce plugging of conveying lines, sticking of the ash to chutes, and hoppers, and erosion of internal parts of ash handling equipment. Corrosion of internal components is normally small to non-existent. Only the introduction of unwanted moisture will create an environment that will produce corrosion severe enough to cause system outages or to require frequent maintenance. Wet chlorine or other halides present in even trace (ppm) levels can create such a situation.

Wet Fly Ash Systems. The transport of fly ash with water as the conveying medium is normally achieved by using a slurry comprising of 10-15% ash by weight. The introduction of conveying water sets up an array water chemistry situations that can lead to scaling and /or corrosion. Chemistry of water used to obtain a slurry, significantly effects corrosion, based on its contents of carbonates, bi-carbonates, salts and suspended impurities or metallics. Salinity, brakishness, or hardness levels of water/underground water used in wet fly ash systems affects type of corrosion. The tendency for scaling and corrosion depends in part on the chemical characteristics of the ash sluice water and in part on the composition of coal ash.

The soluble ash contents of such elements as iron, calcium, sodium, magnesium and a variety of trace elements will produce a wide range of pH levels in the ash slurry. For example, a dramatic change in coal supply can result in changes of 1-2 pH units. The dominant alkaline constituents are Fe_2O_3, CaO, MgO, Na_2O, and K_2O; the acid constituents of are SiO_2, Al_2O_3 and TiO_2. This interaction of water and ash is the cause of most corrosion problems.

Scale formation on equipment internals and pipeline walls is always a frequent maintenance problem. A characterization of typical scale indicates that compounds of calcium, magnesium, sodium and silica go into solution, concentrate, and precipitate out on internal surfaces. The reduction of pipe diameter by heavy scale buildup, pump and valve scaling (reduction in internal clearances), and plugging of small control lines will require dismantling and descaling, or replacement. Most corrosion or erosion related failures are complicated by scale formation.

Wet Bottom Ash Systems

Hot ash (clinkers or agglomerated slag) deposits of varying sizes are quenched and collected for conveying in the bottom ash system. As noted above, bottom ash systems are generally conveyed wet from collection to final disposal. However, some systems incorporate dewatering equipment and haul the ash by mobile equipment or belt conveyors to suitable disposable sites. The pumping and pipeline conveying of bottom ash slurries (normally 15-20% ash by weight) generally results in a highly abrasive but only moderately corrosive condition. Agglomerated granular (fused) bottom ash, with its irregular shape and large size, gives the slurry its abrasive nature. As compared to fly ash, it is inert and insoluble, therefore, chemical reaction interaction between bottom ash and conveying water is less worrisome.

Current environmental regulations have resulted in the development of the zero discharge (closed-loop) system. The reuse of conveying water in either bottom ash or fly ash systems will concentrate soluble salts and will usually result in a more corrosive water chemistry. Therefore, most failures result from erosion, scaling, or plugging, but corrosion may become a problem if soluble salts are allowed to accumulate too long in closed-loop systems.

Inference

It is not possible to recommend a single approach or a material of construction that will work for every ash-handling application.

Corrosion problems are reduced, mitigated and equipment lifetime is extended by good case-by-case material selection, the existence of adequate quality control, operational simplicity and the use of inspection/maintenance practices.

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