HEAT TRACE

TYPE HB HEATING MODULE SYSTEMS

AN INTRODUCTION TO THE APPLICATION AND REQUIRMENTS FOR THE HEATING OF FLYASH COLLECTION HOPPERS ON ELECTROSTATIC PRECIPITATORS AND FABRIC FILTERS

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HEAT TRACE

HOPPER HEAT TRACING

A short overview of the Problem, the Results and the Solution

General

The inclusion of high performance air pollution control equipment is a mandatory consideration in the design of new fossil-fired power plants or the upgrading and retrofitting of existing fossil-fired power plants. Identical considerations are also mandatory for most industrial boiler installations that burn fossil fuels. The two major Air Pollution Control equipment choices are:

- The Electrostatic Precipitator
- The Baghouse or Fabric Filter

The following discourse centers around the Electrostatic Precipitator. The problem and solution, however, are applicable to Baghouses, Fabric Filters and other forms of Air Pollution Control Equipment.

The Problem

The hot flue gases from the boiler enter the Precipitator at temperatures ranging from 250 to 400° F. The hot flue gases are carrying particles of dust known as flyash, which are the remains of burning fossil fuels. The flyash-laden gases are directed by mechanical veins over a series of electrically charged collecting plates. The electrical charge causes the flyash to adhere to the collecting plates.

The cleaned gases exit the Precipitator and enter the plant stack for eventual release into the atmosphere.

Thermal profiles from the top to the bottom of several Precipitator casings were measured and each thermal profile showed a reducing temperature gradient. This is caused by:

- *Natural Convection* - hot gases are naturally carried upwards within the Precipitator casing.
- *Induced Convection* - resulting from the hot gases being redirected by baffles and veins away from the collection hoppers and upwards into the Precipitator casing.

The net effect of the natural and induced convection creates a stagnant gas condition within the flyash collection hoppers

The application of thermal insulation to the exterior of the flyash collection hoppers cannot prevent the stagnant gases from cooling. As the gas temperature falls the "dew point" is reached and condensation begins to form on the flyash collection hopper walls. Continued cooling of the flue gases may also result in the temperature falling to the "moisture dew point" which results in increased levels of condensation. Typical flue gas dew point temperatures range from 250 to 350°F with coal fired boilers and 300 to 400°F with oil fired boilers. Moisture dew points vary between 100 to 180°F.

Once condensation has taken place, two problems exist:

- The condensate is usually a mild sulfuric acid resulting in corrosion and pitting of the collection hoppers.
- The flyash falling into the collection hoppers is a very hygroscopic material and as it mixes with the condensate, it quickly changes from a free-flowing, dry dust into a thick, immobile mud.

The second problem listed is by far the most serious, expensive and far-reaching for plant operators.

When the flyash agglomerates, it quickly builds up in the lower areas of the collection hopper and quickly blocks the hopper outlet (throat). This blockage must be immediately removed because continued build up of flyash can cause:

- Structural damage to the Precipitator due to increased and unanticipated weight factors (*hoppers have been torn from casings).*
- Arcing and shorting of the high voltage electrode system, resulting in reduced operating efficiencies, fires within the Precipitator and significant and expensive repairs *(several Precipitators have been completely destroyed by hopper fires*).

It is, therefore, imperative that collection hoppers always remain clear, essentially acting as a funnel to carry the collected flyash directly into the flyash conveying system.

The obvious solution to this overall problem is to *eliminate the condensation.* If this is achieved, the flyash remains in a dry, free-flowing state and can be easily evacuated from the hoppers and moved through the ash conveying system.

The elimination of condensation cannot be achieved by merely insulating the collection hoppers. The answer is very basic - **HEAT THE HOPPERS**.

Before any type of heater can be selected, there is one major consideration to be made: How much heat is required to prevent the condensation?

Computerized heat loss programs have been developed and used by HTD for over twenty years. These programs include allowances for hopper manways, strike plates, vibrators and other forms of protuberances that are directly attached to the hopper surfaces. Empirically established data also allows for hopper preheating prior to start up of the Precipitator.

HTD Heat Trace, Inc. offers free consultancy, design and engineering services on all flyash hopper heating applications. Please consult HTD to determine the correct kW load for your hopper heating application.

The Product.

Over the last 40 years there have been four major styles of heating equipment used on flyash hopper heating applications. These are:

- Mineral Insulated (MI) Heating Cable.
- Rod or Hairpin style heaters.
- Strip Heaters and rigid metal heating modules.
- Flexible faced heating modules.

The Mineral Insulated or MI Heating Cable is a semi rigid, metal sheathed cable with a single or dual, round resistance wire element that is packed in magnesium oxide. It is suitable for the application temperatures, it can be purchased in fixed circuit lengths to suit various system designs and it can be applied to the hopper surfaces such that all heating cable circuits can be routed to terminate at one point on the hopper.

Experience has shown that MI Heating Cables are not the ideal type of heater for use on flyash hopper heating applications. The heating cable is round, and at best, only offers tangential point contact with the hopper surface. Lack of surface contact results in overheating and hot spots on the cable. MI Heating Cables are also very difficult to install on flat hopper surfaces and fixing clips are required every 6 to 12 inches. The crossing of hopper stiffeners is a particularly acute problem and heater failure due to stress or overheating is common when the cable does not have intimate contact with a highly conductive metal heat sink.

The Rod or Hairpin style heater is essentially an MI Heating Cable in a rigid form. These heaters are available in lengths from 12 to 60 inches with various kW ratings and voltage options. The Rod or Hairpin style heater can meet the temperature requirements for flyash hopper heating applications.

The major drawback with the Rod or Hairpin style heater is it must be installed in the air cavity between the hopper surfaces and the inner face of the hopper insulation. The thermal design concept is convective, and the Rod or Hairpin heater is used to create an oven, with air being convected across and around the exterior of the hopper. Energy consumption and operating costs are extremely high and heat is continually being convected away from the lower areas of the hopper where condensation and pluggage are most likely to occur. To compensate for this inefficiency, the heating system operates continually, resulting in frequent heater burnouts and replacements

The Strip Heater and the rigid metal heating module are basically resistance alloy heating elements contained within a rigid metal enclosure. Both heater styles are suitable for the application temperature and conditions and they are available in varying lengths, widths, ratings and voltages to suit individual applications.

The major problem with this style of heater is the rigid construction only permits effective surface contact when the installation surface is completely flat. Flyash hopper surfaces are never completely flat. Plate distortions and weld seams are common examples of the surface irregularities found on flyash hoppers. The installation of Strip Heaters and rigid metal modules on conventional Precipitator, Baghouse and Fabric Filter hoppers will always involve locations where air gaps between heater and hopper exist. The thermal design concept of the Strip Heater and rigid metal heating module is conduction and any lack of contact between the heater and the hopper will result in reduced efficiency, increased heater operating temperatures, hot spots and potential heater failures.

The flexible faced heating module, exclusively known as the **Type HB Heating Module** was developed by the Heat Tracing Division of Cooperheat, Inc. in 1976. The product and system were specifically engineered and developed to address and eliminate the known problems identified with the four other styles of hopper heaters described previously.

The HB Heating Module System has now been successfully used on many hundreds of major power and industrial flyash hopper heating projects around the world. Many of our earlier installations have over 20 years of satisfactory, trouble free operation.

The HB Heating Module and System

The heat source of the HB Heating Module is a flat foil, low watt density heating element. The flat foils are sewn into a multi-layer construction of high temperature glass cloth to form a heating blanket. The heating blanket is combined with thermal insulation and aluminum mounting pan to form one, easily installed modular unit.

The right image shows the aluminum back surface of the HB Heating Module, complete with a letter designation to identify heater location within the system.

The left image shows the flexible heater face that is unique to the HB Heating Module.

The ***flexible, cushion-like heater face*** completely eliminates the single point contact problem inherent with the use of MI Heating Cable and the air gap problems consistently found with the use of Strip Heaters and rigid metal heating modules. The ability of the flexible heater face to conform to the uneven hopper surface guarantees continual and intimate contact between heater and hopper surface. ***Heat conduction is maximized*** over the entire heater area and the HB Heating Module operates at optimum efficiency, eliminating the high energy consumption and operating costs associated with the Rod or Hairpin style heaters.

The thermal design concept of the heater and system is based exclusively on conduction. ***Each HB Heating Module is customized to cover the maximum hopper plate area between stiffeners.*** Optimum levels of conduction are achieved throughout the entire heating system and the potential for cold spots and condensation in the lower areas of the hopper is eliminated.

The use of standard sized heating modules is not recommended on flyash hopper heating applications. Failure to provide maximum levels of direct heater coverage in the lower areas of the hopper will result in cold spots and the potential for condensation in the area of the hopper most prone to "bridging and pluggage"

The reliability and life expectancy of hopper heaters is directly related to their power density.

An (externally) insulated hopper that is (internally) full of flyash, basically creates a totally insulated and sealed operating environment for the hopper heater. Flyash has a K factor that is comparable to many types of low grade insulation material, therefore, the hopper heater is basically sandwiched between layers of thermal insulation.

Conventional heaters quickly fail under these unique and severe operating conditions. Normal heater power densities must be reduced to a level that will permit safe heater operation even when conduction through the hopper skin is severely limited. (i.e. when the hopper is full or partially full of flyash).

The HB Heating Module has a maximum design power density of 2.5 w/sq.in. for all flyash hopper heating applications. Extensive testing in 1976 established that this level of power is not harmful to the construction or materials of the HB Heating Module ***even when the heater is operating under completely uncontrolled conditions***.

The HB Heating Module is an ULTRA LOW WATT DENSITY heating product and system that is specifically rated for safe reliable operation on EMPTY, PARTIALLY FULL OR FULL flyash collection hoppers.

The Heat Tracing Division of Cooperheat, Inc was purchased in 1995, as part of a management buyout program. Type HB Heating Module Systems are now designed and manufactured *exclusively* in the USA by HTD Heat Trace, Inc at our Whitehouse, NJ headquarters. All design and manufacturing is conducted in complete accordance with IEEE Standard 1069-1991 and the HB Heating Module was retested, certified and approved by Factory Mutual in 2003 to this current industry standard . The HB Heating Module is also CSA approved to the current Canadian standards.

The problem of hopper pluggage due to flue gas condensation is recognized as one of biggest maintenance expenditures associated with the operation of Precipitators, Baghouses and Fabric Filters at fossil fired power and industrial plants.

HTD Heat Trace, Inc and the HB Heating Module System can help you eliminate such problems and expenditures.

Please contact us for further details, information and engineering support.

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