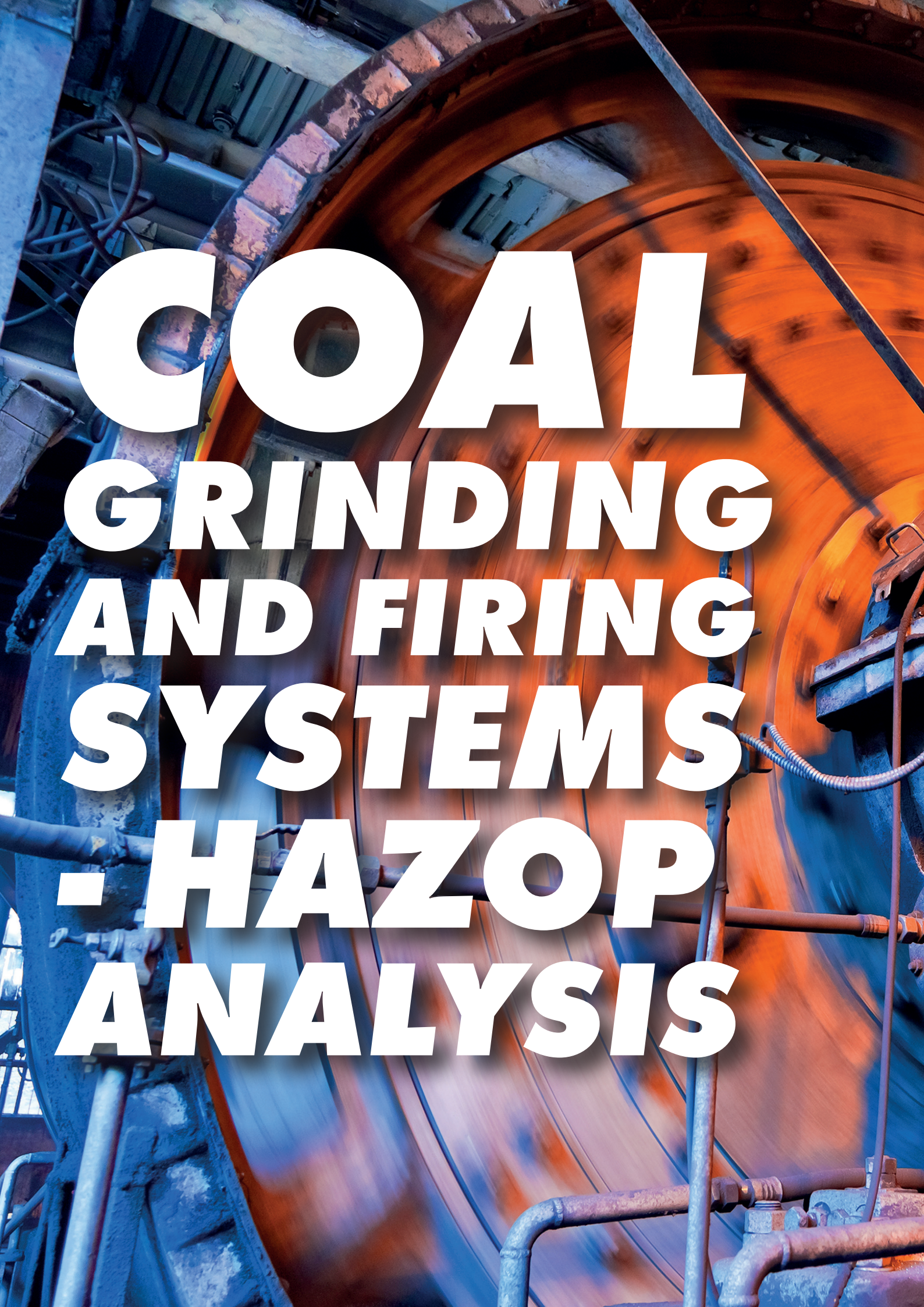


COAL GRINDING AND FIRING SYSTEMS - HAZOP ANALYSIS

JAGRUT UPADHYAY, PEC CONSULTING GROUP LLC, US, OUTLINES AND EXPLAINS THE USE OF THE HAZOP STUDY WITHIN COAL GRINDING AND FIRING SYSTEMS.

A Process Hazard Analysis (PHA) is a key element of a Process Safety Management (PSM) programme. It analyses potential risks to personnel operating in an industrial environment.

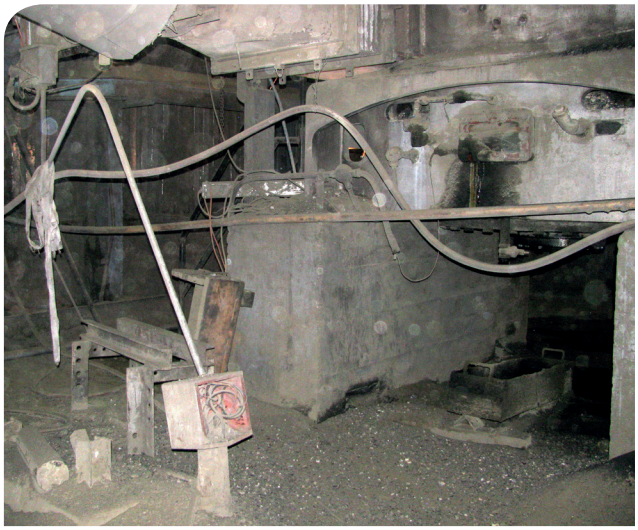
A PHA is a thorough, detailed, systematic approach to finding potential hazards in an industrial plant. It includes an analysis of the equipment, instrumentation, utilities, human actions, and external factors that could be potential hazards. In this article, we focus on potential causes and consequences of fires, explosions, release of explosive or flammable solid fuel and major spills of solid fuel – coal or petroleum coke.

One of the techniques of a PHA used to identify hazards and operability problems is the HAZOP (Hazard and Operability) study that can be performed on both a new or operating coal grinding and firing system. It is believed that the HAZOP is perhaps the most widely used methodology for identifying and mitigating hazards.

Generally in a new system, technology suppliers' cross-functional teams carry out risk analysis of their equipment and systems and incorporate preventive measures. A HAZOP study in a new system helps in evaluating the system's safety and identifying any unforeseen situations that could be hazardous.

A HAZOP study of an operating system has a different purpose. The objective is to identify potential deviations from the design intent and design operating parameters and accidental incidents that need to be subjected to a detailed and comprehensive evaluation, scrutiny and risk analysis.

Although the primary assumption when performing a HAZOP study of an operating system is that the



Spillage and unsafe conditions at coal mill.

Coal dust emission from fine coal bin.

original process design and equipment standards are probably correct, it is an opportunity to review the design, any additional technical support needed, and operational and safety requirements.

This article describes activities and elements involved in a HAZOP study of a coal grinding and firing system.

The handling, preparation, storage, conveying and firing of pulverised coal are critical processes in a typical cement or lime plant and have inherent operating risks. There are many operational difficulties in handling and transporting raw coal in locations that face extremely low or high ambient temperatures. Under such adverse conditions, establishing effective safety measures for coal handling and transportation is necessary to ensure a trouble free and smooth plant operation.

Various qualities of coal are used as fuel. Due to the combustible properties of coal in general, safe handling is important during the entire process from the point of receiving to firing through preparation and storage and conveying of ground fine coal.

Accidents are mainly caused by the unintended release of energy caused by fire and explosion. A HAZOP study identifies situations where such a release of energy may occur. It also identifies and estimates the potential severity of damage and recommends mitigation measures.

A HAZOP study of a typical operating coal grinding and firing system encompasses the following areas:

1. Fuel handling and storage – raw coal receiving, storage and handling.
2. Fuel preparation – raw coal grinding.
3. Fuel conveying – fine coal storage and conveying for an indirect firing system.
4. Fuel conveying – fine coal conveying for a direct firing system.
5. Kiln burner (firing system).

The purpose of a kiln burner is to optimise the combustion of fuels to release heat in the kiln ensuring 'complete combustion'. As the kiln burner is an important and integral component of the coal grinding and firing system, it is necessary to integrate it with the grinding facility.

A PLC (Programmable Logic Control) based BMS (Burner Management System) is an effective tool to ensure the safe operation of a kiln burner. Older fuel firing systems may not have such system incorporated.

As defined in NFPA 85, 'the BMS is a control system dedicated to combustion safety and operator assistance in the starting and stopping of fuel preparation and burning equipment and for preventing mis-operation of and damage to fuel preparation and burning equipment.'

A BMS is a safety solution for kiln burners that enables safe start, safe operation and safe shutdown in all operating conditions, including normal operating and emergency conditions, thus reducing possible errors even when the correct operating procedure is followed. It is equipped with features such as a flame detector, flame safeguard, and fail-safe mechanisms.

A BMS is a form of protection against malfunction of the fuel firing system and associated systems and against unsafe operating conditions. It performs the role of an operator's assistant by providing status information. An additional advantage of a BMS is the increase of the burner's efficiency, which reduces greenhouse gas emissions.

Methodology

A HAZOP study is generally performed using a comprehensive and widely used 'What If' methodology in the industry. The 'What If' analysis is a creative, brainstorming methodology to identify and evaluate the process hazards. A HAZOP study is a team exercise.

A team of 3 or 4 experts usually performs the technique. By reviewing relevant documents, process knowledge and experience, the team develops 'What-If' questions around all possible deviations, upset process conditions, equipment failures and potential human errors. Potential hazards, operational problems and design faults are thus identified. The team evaluates the consequences of each deviation and, depending on what safeguards are available in the present system, decides upon recommendations or actions for preventing such occurrences.

Pulverised coal presents the highest hazard and therefore the coal grinding system is given the most intense evaluation.

In an operating coal grinding plant, it is assumed that the plant and equipment have been designed and engineered properly based on legal requirements, design/engineering codes, industry standards and good engineering practices. It is also assumed that the coal grinding and firing system is operated at least at minimum design capacity.

The HAZOP Study of coal grinding and firing systems addresses the following aspects:

1. The hazards of the coal grinding and firing process.
2. Engineering and administrative controls applicable to the hazards and their interrelationships.
3. Detection methods (Hydrocarbon detectors and gas analysers) and continuous process monitoring.
4. Consequences of failure of engineering and administrative controls.
5. Human factors affecting the operation.
6. A qualitative evaluation of safety and health effects of failure of controls on employees.
7. The identification of any previous incident that had a potential for catastrophic consequences.

Documentation

The following documents, depending on the type of the process, will be required as a basis to perform a HAZOP study:

- Lay out and G A drawings.
- Equipment lists of process areas under study.
- Process flow sheets.
- Process and instrument diagrams.
- Process control loops.
- Process and safety interlocks.
- Instrumentation and alarms.
- Gas analysers with location.
- Process variables with all limits.
- Operating procedures and work instructions for various modes of operation such as normal start-up, normal operation, normal shut down and emergency operation mode.

CO_2 warning.

- Maintenance procedures and work instructions.
- Documentation on auxiliary systems such as inertisation measures and installations and hot air generator if applicable.
- Documentation on fire hydrant system.
- Documentation on kiln burner (kiln firing system) control system.
- Raw coal analysis – including Hard Grove Index, sieve analysis, ash content, volatile content and moisture content, net calorific value.
- Fine coal analysis – residual product moisture, fineness.
- Method to control bypassing the Interlocks and alarms and record of bypassing the interlocks.
- Hazardous area classification.

Staffing

A HAZOP study is performed by a team consisting of process and maintenance engineers with specific knowledge of the operation and maintenance of coal grinding and firing processes. At least one member of the team must be knowledgeable in the specific process hazard analysis. Operation and maintenance engineers as well as coal mill operators participate in structured brainstorming to look for deviations from the design performance.

Results

A HAZOP study identifies potential deviations which had not been experienced in the coal grinding and firing system.

The ultimate aim of a HAZOP study is to achieve the following:

- Ensure that the coal grinding and firing system can be started, operated and shut down safely.

- Recommend appropriate changes to the process design or its operation that increase safety or enhance operability.
- Consider existing safety interfaces with operation software including installations such as the coal mill baghouse, fine coal storage and dosing system, fuel firing systems, inertisation systems, etc.
- Develop recommendations and actions to eliminate potential occurrences identified as risks.

A HAZOP analysis is also required whenever there have been modifications/changes to the equipment, system, operation and maintenance procedures, operating parameters, environmental conditions, and also in the case of accidents or near misses. Therefore, a HAZOP analysis also provides an opportunity to develop a system to manage changes effectively.

The HAZOP study results are used to:

- Compare basic concepts.
- Focus on important risk areas.
- Provide inputs to more comprehensive hazard analyses.

It may be noted that many plants do not have BMS incorporated in the kiln firing system as part of an original installation. Though some basic safety and operational interlocks do exist in the operating system, they are not comparable with a foolproof control system. Therefore, a HAZOP study can help in determining the need of any additional control system for an existing plant, such as BMS, to enhance the safety of the system as well as personnel.

Results of a HAZOP analysis are also beneficial in terms of enhancing equipment safety, reliability and availability and, therefore, improve the profitability of an organisation. Participants gain a thorough understanding of the coal grinding and firing system.

Report

The HAZOP Report is a key document concerning the safety of the plant, equipment and personnel. It is essential that the findings and such knowledgeable study are easily available for future reference in case there is a need to modify the equipment or its operating conditions.

The HAZOP Study Report provides comprehensive results compiled in specific formats and clearly lists the actions to be taken by the plant management.

Bibliography

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