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Coal & Coke

Emergency Inerting Systems

Preventing Explosions in Coal Grinding Systems

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Explosions can be prevented by lowering the oxygen concentration in an atmosphere below critical levels. This technology can be used as a safety measure for coal grinding systems and many other applications. The selection of an appropriate system depends on a number of factors, including environmental and infrastructure conditions.

The hazards caused by so-called hot spots or smouldering fires, sudden spontaneous combustion and explosions lurk everywhere in industries where combustible powders are stored and transported. On international level Atex regulations have to be considered for explosion prevention. In addition the guidelines TRBS 2152-2, CEN/TR 15281, VDI 2263-2 and BGV C15 are used.

As an effective preventive technology, systems based on inert gases are used which prohibit the creation of an explosive atmosphere. Inert gases have a low level of reactivity and reduce oxygen concentration below critical levels. The gases prevent the occurrence of critical operating conditions and consequently any resulting explosions and fires. Different effective inert gases according to VDI 2263 are:

- carbon dioxide / CO_2,
- steam,
- flue gases,
- nitrogen / N_2,
- rare gases / argon.

A limiting oxygen concentration exists for all mixtures of air and combustible dust. Below this oxygen concentration, a dust explosion is impossible independent of the concentration of combustible dust. It is, therefore, absolutely unnecessary to replace all oxygen by inert gas.

Generally, in terms of the European Directive 94/9/EG (Atex 95a) inerting systems are not seen as a protection system and hence don't have to comply with the requirements of this directive. An installation outside a dust explosion zone, according to the European Directive 99/92/EG (Zone 20, 21, 22), is thus strongly recommended. In applications, where the inerting system has to be installed within such a dust explosion zone, the systems automatically becomes subject to this directive.

Inerting systems can be used to avoid dust explosions and smouldering fires in silos, coal mills and filter equipment. In case of a CO, O_2, or temperature alarm, the inerting process is started automatically by the control system. It is, therefore, of utmost importance to ensure an uninterrupted CO, O_2 or temperature measurement and monitoring.

Coal Grinding Systems

In general, coal mill plants are constantly inerted. During normal operation, inerting is done using the exhaust gas of the rotary kiln plant or of a hot gas generator. If such exhaust gases are not available, for example, in case of an emergency shutdown, or during starting and stopping of the coal mill plant, the inert gas is injected. The goal here is to reduce the Limiting Oxygen Concentration (LOC) down to a level were explosions can not occur due to the lack of oxygen.

The Maximum Allowed Oxygen Concentration (MAOC) constitutes a safety factor of approximately 2 to 3 per cent below the limiting oxygen concentration. The limiting oxygen concentration depends on the kind of coal that is used and needs to be determined separately by experts. For lignite, for example, the limiting oxygen concentration amounts to approx. 12 per cent by volume, for hard coal it is approximately 14 per cent by volume.

In accordance with German coal dust regulation BGV C15, a sufficient inerting is guaranteed, if the geometrical volume of the individual components receives a simple rinse, i.e., in a 1:1 ratio. This assures that the oxygen concentration is kept below the limiting oxygen concentration.

To extinguish existing smoldering fires, the oxygen concentration has to be reduced to 2 to 3 per cent. In this case the inerting process has to be repeated up to 3 or 4 times, depending on the limiting oxygen concentration when inerting is started first.

The inerting method described here, is the so called blending method (in contrast to the flushing method). Here the inert gas is introduced at the highest possible speed, i.e. with a high entry impulse into different parts of the system that have to be inertized. As a result of the strong turbulence that is produced, the gas content undergoes thorough mixing and optimum inerting.

This high speed is reached through special nozzles in connection with the adjusted inert gas pressure at the valve station. The number and size of nozzles is calculated according to the geometrical volume of the aggregates which have to be protected.

General design and size of the stock amount is calculated in accordance with the following criteria, which was developed, with regard to the safety standard in coal grinding plants, in co-operation with leading cement manufacturers (e.g. Lafarge, Holcim, Cemex, Heidelberg Cement) as well as European engineering and coal grinding plant manufacturers:

- Withdrawal of the maximum required inert gas volume is possible within one hour.
- Maximally necessary inert gas volume has to be stored two- to threefold, in addition to a security reserve to be double stocked.

Fig. 1: A high pressure CO_2 tank

Basis for the calculation is the total geometrical volume of coal grinding system.

High Pressure CO_2 Tanks

A high pressure CO_2 tank inerting system with visualization at the PLC has been installed at Heidelberg Cement Akcansa's

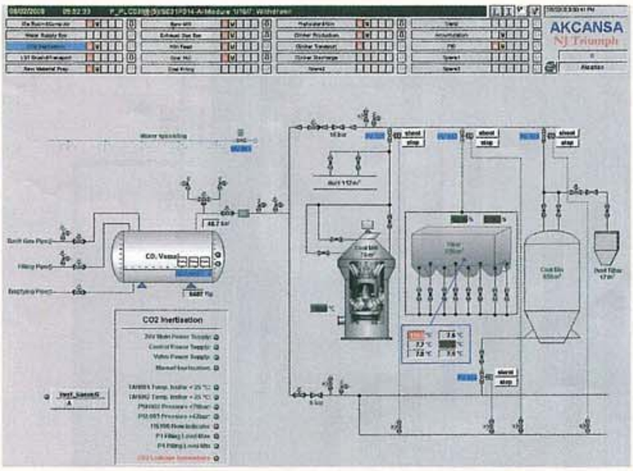

Fig. 2: Visualisation of the inerting systems

Fig. 3: Batteries of high pressure N_2 packs

Canakkale cement plant in Turkey. Carbon dioxide high pressure tanks are characterised by high inert gas capacities and compact tank dimensions, and are mainly used in countries with distinctive seasonal temperature fluctuations, i.e. warm summers and cold winters, such as Europe, Russia, Central Asia, Middle and South America.

The liquefied carbon dioxide stored in the vessels is extracted in gaseous form. The maximum operating pressure is 80 bar and the tank is operated in the range from 50 to 70 bar. To keep operation pressure in winter between 50 to 65 bar, up to three heaters with maximum heating capacity of 19 kW each are installed. At hot summer temperatures, the high pressure tank is cooled by either cooling water (maximum temperature +25 °C) or by installation in an air-conditioned room (maximum temperature +28 °C).

Several tank sizes from 3 to 15 tonnes of CO_2 storage volume are available. Inert gas capacity of high pressure tank is some 30 to 40 per cent in the first hour, depending on the tank pressure.

Monitoring of the CO_2 level and tank pressure is done by 4...20 mA signal coming from electro-mechanical weighing devices and pressure sensors.

The gas withdrawal valve of the CO_2 vessel is connected with a valve station. The valve station is a framework rack with integrated pressure reduction and individual electromechanical valves for the endangered parts of the coal grinding system that need inerting. Additionally, a control cabinet is installed and fully connected in the valve station.

During inerting, the CO_2 gas is withdrawn from the tanks and flows into the pre-selected system areas to displaces the oxygen.

Inerting is triggered by the higher-ranking control system (PLC) in the control room, which permanently monitors CO level, temperatures and oxygen concentration during the grinding process and the storage of the coal dust.

The electrical cabinet is controlling and monitoring separately CO_2 tank and valve station, it is designed according to individual customer specification. Electrical control of the tank is self-sustaining and is monitored by control circuits. At normal operation valve station and tank are controlled by PLC at control stand, additionally local control is integrated to be able to inert manually in emergency situations like power shutdown.

At present a modern state of the art control system with Profibus signal exchange is installed in the electrical cabinet for communication with central PLC at control stand and is fully integrated in higher control centers.

Low Pressure CO_2 Tanks

Low pressure CO_2 tank inerting systems with evaporizer and valve station, like the one installed at Larfarge's Bamburi cement plant in Kenya, offer the advantages of controlled storage in combination with newest technology. These inerting systems are mainly used in regions with temperatures constantly above +5 °C and higher, such as Asia, Near East, Africa, Central and South America or Australia. Inert gas capacity is mainly depending on size of evaporizer and ambient temperature.

Several tank sizes from 4 to 22 tonnes CO_2 storage volume are available, the capacities and number of ambient evaporizers is individually calculated. CO_2 is stored in the tank at deep cold with the help of an integrated refrigeration unit. For maximum inert gas discharge, the tank is equipped with a heating element to build up additional pressure. Similar to the high pressure system, the tank it is equipped with an electrical weighing device and pressure sensors for communication with the PLC system in cement plant control stand.

High Pressure N_2 Packs

High pressure N_2 packs inerting system with valve station are used for small and middle N_2 inert gas capacities or in countries with areal disadvantages in infrastructure where carbon dioxide or nitrogene is not available by road tankers. Such a system has been installed at Lafarge's Rezina cement plant in Moldova. These systems are very compact and do have similar technical equipment like tank systems with pressure sensor technology. High pressure N_2 packs are provided with standard steel cylinders for inert gas discharge and may be used in almost all countries of the world. Pressure fluctuations caused by climate conditions have no influence on the storage system, therefore, erection outside with weather protection roof is sufficient in most applications. ■

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