Safety and Environmental Protection
for Modern Spray Drying Plants
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VISION AND COMMITMENT

SPX’s Flow Technology segment designs, manufactures and markets process engineering and automation solutions to the dairy, food, beverage, marine, pharmaceutical and personal care industries through its global operations.

We are committed to helping our customers all over the world to improve the performance and profitability of their manufacturing plant and processes. We achieve this by offering a wide range of products and solutions from engineered components to design of complete process plants supported by world-leading applications and development expertise.

We continue to help our customers optimize the performance and profitability of their plant throughout its service life with support services tailored to their individual needs through a coordinated customer service and spare parts network.

CUSTOMER FOCUS

SPX Flow Technology Danmark A/S is an international engineering company with a consistent goal to provide our customers with the optimal processing technology and the highest plant performance standards. We have specialized in supplying the optimal design and engineering with respect to production performance, flexibility, energy efficiency and environmental protection. SPX offers a wide range of Anhydro drying and evaporation technologies for handling numerous applications that give high-quality end products in the most efficient and economical way.
There are a number of major safety issues to be addressed in modern spray drying plants and each plant needs to be specifically designed for its particular purpose and conditions. The supplier, customer and local authorities need to work together to evaluate and ensure all safety requirements are met to protect personnel, equipment and the environment.

There are several areas of legislation which apply to spray dryer plant manufacturers:


- ATEX Directive 94/9/EC Annex 1 describes equipment safety classification zones and all products supplied within the EU into potentially explosive atmospheres must comply with this Directive. For dust these zones are 20, 21 and 22 with 20 being the highest risk of an explosive atmosphere. Each area of the spray dryer is classified to determine where there is most risk of explosion.

- VDI 2263 (re-issued in December 2011) and the corresponding EN 14.491 describe the safety evaluation required when constructing a spray dryer and the ATEX zones in the various parts of the plant. The latest version of VDI 2263 brings more clarification to the regulation and deals with defining the correct zones within the spray dryer. The rules combine equipment design pressure and corresponding relief area or suppression by injection of inert material for each explosion class (defined by the rate of pressure rise or Kst figure) of powder and maximum pressure (Pmax). Powders with Kst less than 200 bar m/s are defined as Class 1, between 200 and 300 bar m/s Class 2 and Class 3 is for greater than 300 bar m/s.

Based on the assessment of materials, process and application each spray dryer is individually designed to resist the required maximum pressure and provide adequate explosion suppression or relief areas to safe zones with rupture discs on the drying chamber.
**RISK OF ORGANIC POWDER DUST EXPLOSION**

An organic powder may explode if there is an ignition source (oxygen and a spark) within the plant. Each organic product needs to be tested and its explosive properties ascertained. The system needs to be designed to resist a given pressure and provide an adequate relief area or suppress an explosion by injecting an inert substance. Suppression may be advantageous on fluid beds, powder ducts and cyclones.

Particularly explosive powders are often found in the manufacture of synthetic flavourings, used as food additives. The flavours are volatile and, as they contain vegetable oil, it is important that the feed material is well homogenised before the drying process takes place.

The following example used high-risk powders and Kst figures measured were up to 290 bar m/s, which corresponds to dust class 2, and the system was designed for a Pmax of 0.5 bar. Sufficient area for pressure relief is provided based on calculations using EN 14491. The fluid bed, powder ducts and cyclone are protected by a suppression system, which has quick responding detectors and suppression bottles for inert powder injection. The system immediately suppresses an explosion before it can develop. Plants utilising organic powders always have automatically controlled fire extinguishing nozzles for additional protection.

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*Figure 1: Spray drying plant for synthetic flavourings*
**RISK OF SOLVENT VAPOUR EXPLOSION**

Some products are dried in organic solvents such as acetone or ethanol and, if there is an ignition source and sufficient oxygen present in the drying chamber, the released vapours present an explosion risk. In such an application normal air is replaced as the drying medium with an inert gas such as nitrogen which does not support ignition. Continuous monitoring and control of oxygen levels to keep them low ensures safe plant operation and eliminates the explosion risk.

The system shown in Figure 2 is a spray drying plant for drying hard metals, such as tungsten carbides. Used to make cutting or mining tools, the powders are suspended in the organic solvent and milled before drying. The plant is designed as a closed system to protect the environment from emissions of both solvents and metal powders. The evaporated solvent is condensed out in a condensing unit and the nitrogen is recirculated to the inlet of the dryer. The plant is maintained at a slight overpressure to avoid ambient air being sucked into the system. Advanced automatic plant control is utilised and safety aspects of the operation of such a plant a key issue.

Figure 2: Spray drying plant for hard metals
PROTECTION AGAINST HAZARDOUS OR TOXIC PRODUCTS

There are many products in the chemical industry that present health or environmental risks. The design of plants to dry such products has to ensure that they do not come into contact with operators or are released to the atmosphere. The systems are, therefore, implemented as completely closed cycle systems.

Herbicides and weed killers are still widely used in the agricultural sector throughout the world and are manufactured under very strict safety control. Figure 3 shows the design for a herbicide drying plant. If exhausted from the plant the product presents a hazard to plant operators and the environment. The system is completely closed and uses air as a drying medium.

As with the solvent based system described above, the plant is provided with a condenser to condensate and capture evaporated water and air is recirculated to the dryer inlet.

Emissions from the plant are very low and filtered through an absolute filter. Constant monitoring and control are in place to avoid pollution from the plant. Once dry, the powder leaves the system in sealed containers to avoid any risk of dust in the discharge area. Personnel may also be provided with protective clothing and a clean oxygen supply as additional safety measures.

Figure 3: Spray drying plant for herbicides
PLANTS DRYING PRODUCTS WITH A RISK OF SELF-IGNITION

Organic powders used to make dyestuffs and pigments have a risk of self-ignition if there are high oxygen levels in the drying plant. In this application the plant is designed to be low oxygen with self-inertizing conditions. A direct-fired heater uses inert, recycled drying gas consisting of flue gases from a directly gas-fired air heater and only sufficient ambient air to support combustion. In this way the oxygen level will be reduced below 5% and the risk of self-ignition by oxidation is prevented.

Drying temperatures are carefully selected to ensure the powder temperature is kept below a certain level. The system architecture shown in Figure 4 is a spray drying plant for drying a mixture of iron oxides and metallic iron. The powder temperature is kept below 130°C.

Figure 4: Spray drying plant for pigments

SUMMARY

Safety considerations for spray dryers where there is a potential for an explosion have been further developed. Instead of just classifying a whole operation as a particular zone the design now looks separately at different parts of the plant and areas inside the spray dryer to assess risks and safety requirements. On-going new directives from ATEX and the Machine Directive continue to push up standards and improve safety for personnel.

Ultimately the spray dryer supplier designs a customised solution based on the specific customer requirements and Hazop procedures. A dedicated team will focus on safety issues to ensure the safety of every spray dryer produced. Whatever the application, the customer and the local authorities must be convinced that it is safe to operate the plant and it complies with all the safety regulations.
ABOUT SPX
Based in Charlotte, North Carolina, SPX Corporation (NYSE: SPW) is a global Fortune 500 multi-industry manufacturing leader.
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ISSUED 02/2013  GB
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