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EXPLOSION PREVENTION

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Introduction

Laboratory testing can prevent explosions and fires in the chemical and process industries. Incident data from UK industry makes grim reading: around 30 fires per year in powder drying operations, 50 thermal runaway chemical reactions that go out of control and 40 or so industrial explosions involving dust clouds alone.

Some of these incidents cause large financial loss, injury and even fatalities. In many cases it is clear that it is lack of information on the fire and explosion properties of a company's products and intermediates that is at the root of the problem. There is a sign though, that companies are addressing this deficiency as some equip their laboratories with new specialist test equipment, and others make increased use of contract test houses to obtain the missing data. In this article we look at some of the tests and equipment that are now available to help prevent industrial explosions and fires.

The Need for Data

Fire, explosion and runaway reaction hazards in the process industries will always require some form of laboratory based investigation. Data obtained is not only fundamental in identifying the hazard, but also in defining safe operating procedures, bases of safety, specifying adequate protection measures and defining hazardous areas. From a laboratory perspective the equipment for collecting this data is often segregated into categories. That is: fire and explosion test equipment, chemical reaction hazard test equipment and perhaps a third area of tests to determine the explosive properties of compounds.

Dust, Gas & Vapour Explosions

Explosion test equipment will generally deal with the flammability properties of gases, vapours and air borne dusts. The gas/vapour flammability equipment will most likely collect flash point, auto ignition temperature and perhaps flammability limits data.

Apparatus for assessing dust explosion risk is less common. A 1 litre cylindrical vertical tube explosion chamber is central to dust explosion testing (see photograph) since apparatus like this can be used both to establish if a dust can indeed explode and, if it can, to evaluate its likelihood of ignition in terms of its minimum ignition energy. Other apparatus is then required to measure other parameters such as the minimum ignition temperature of the dust cloud, and a 20 litre spherical pressure vessel which can measure explosion pressures and can establish the levels of inert gas that would be required to render the dust non-explosible.

Powder Thermal Instability

Many materials in use in the food, chemical, and pharmaceutical industries will exhibit a degree of thermal instability when subjected to heat, as under conditions of powder drying, for example. Mild exothermic behaviour can signal loss of product quality, but in other circumstances - for example when thicker than usual powder layers are allowed to build up, if dryers are subject to build up of powder deposits, or if warm powder is accumulated in bulk (for example in a silo or big bag) - this self heating can lead to spontaneous combustion, fire and even explosion.

Thermal instability conditions of specific powders are notoriously difficult to predict in practice and small scale tests are often unsuitable for predicting thermal decomposition temperatures on a large scale. For this reason a series of test apparatus which simulate different drying conditions and which take into account variables such as sample size, sample shape and availability of air, are suggested by the IChemE [Institution of Chemical Engineers] in Prevention of Fires and Explosions in Dryers (Abbott, 1990).

Assessing Chemical Reaction Hazards

Most chemical companies will have apparatus for small-scale simulations of chemical process prior to scale up. These are likely to yield some data of use in hazard assessment work, but it is important for the safety laboratory to be able both to systematically screen reactions in small scale calorimetry apparatus and to obtain more accurate data from apparatus that can simulate large scale plant conditions. Typical screening tools include the DSC and the 10g sealed Carius tube, with better process simulation data provided by the RC-1 and SIMULAR for characterising heat flow and cooling requirements for the normal process. Essential simulation of runaway conditions can then be accurately provided by the Adiabatic Pressure Dewar Calorimeter so that vent sizing can be properly undertaken.

Screening for Explosive Properties

Few companies process detonating or deflagrating explosives, but in the fine chemicals, agrochemicals and even pharmaceutical businesses it is not unheard of for intermediates to be found to have such properties. Screening for explosive decomposition is a complex area and involves test equipment to determine impact and friction sensitivity of compounds. Another application of these types of test equipment is found in data requirements for the transport of dangerous goods.

Clearly the range of equipment required to fit out an in-company test facility to cope with all eventualities is quite large. Some companies prefer to contract out all this type of test work whereas for others it is most convenient to have at least some in-house capability.

However your company obtains its essential data on the fire and explosion properties of its materials is not the real issue. What matters is that without the proper collection and interpretation of that data, some companies will pay a high price.

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