Platinum Bursting Disc Systems

THE PROTECTION OF CLOSED EQUIPMENT AGAINST OVER-PRESSURE CONDITIONS

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The adequate protection of equipment where over-pressure conditions may occur is imperative, and is becoming the subject of more stringent regulations. The use of bursting discs for this purpose is now well known and they are extensively applied, but it is when conditions are particularly severe that the unique properties of platinum can be relied upon to prevent a disastrous situation arising.

The simple concept of a bursting disc, relying for its operation on tensile failure when the pressure in the system being protected reaches a pre-determined value, provides a "fail-safe" mechanism. The disc, which may range from only one inch to twelve inches in diameter, is fitted into a two-part holder usually made of stainless steel and having a number of features vital to the safe operation of the membrane. The fully blended radius machined to the orifice edge of the holder locates with a similar radius on the disc. The accurate blending of these two radii is of fundamental importance to the performance of the disc, ensuring that the application of pressure does not cause premature failure due to cutting by sharp orifice edges. A metal tag is attached to the disc to facilitate identification and to ease inspection after installation. The locating system of pins and holes on the inner faces of the assembly ensures that the discs cannot be installed the wrong way around. If vacuum or back pressure conditions are likely to be applied to the disc, a stainless steel support is made to fit the underside of the disc, precluding the possibility of disc distortion.

To meet the wide variety of corrosive and thermal conditions encountered, nine disc materials are used. The excellent corrosion and high temperature resistance properties of platinum are very suitable for bursting discs being used in particularly harsh environments, especially at plants involved in organic chemistry. Some examples include plants producing paints, dyes, wood pulps and sulphur drugs. Platinum discs are also used in the preparation of anti-knock compounds for petroleum, where they must withstand constant attack from tetraethyl lead at high temperatures.

Process equipment for handling such corrosive fluids can tolerate a degree of corrosion by increasing the thickness of components at the design stage. For example, a pressure vessel with a designated wall thickness of 1 inch could tolerate a corrosion rate of 0.005 inches per year if the initial wall thickness was increased to 1.0625 inches. The alternative method is to line the vessel with a resistant plastic material or glass. However, it is not possible to thicken a bursting disc as this will obviously affect the bursting pressure. Some forms of plastic coating are occasionally used on less chemically resistant materials such as nickel, but the most satisfactory solution is to rely upon the corrosion resistant properties of platinum so that a disc with a starting thickness of only 0.003 inches will not corrode during its designed lifetime. In particularly vicious situations, platinum may also be plated onto the surfaces of the holder and the back pressure support to give added protection.

Fig. 1 Each Graviner aero-engine fire extinguisher is fitted with a bursting disc for either cockpit activation of the unit or protection in case of fire engulfment. Platinum is used as the disc material because of the highly corrosive nature of BCF at elevated temperatures

The use of pure metals is generally preferred for the manufacture of bursting discs to avoid inconsistencies in performance characteristics. In the case of platinum, extremely pure foil develops a coarse grain structure when rolled so that when doming under pressure an orange peel effect tends to develop on the spherical surface. This often results in the material pinholing or splitting along the grain boundaries at pressures up to 50 per cent below the desired pressure level.

To avoid this problem, minor quantities of other noble metals are added to produce alloys which retain a fine grain structure when rolled and fully annealed. This control ensures that the pressure affects the foil uniformly, and allows the discs to burst by tearing from the crown and opening in petals to give full-bore relief.

This "fail-safe" feature has led to bursting disc usage developing from the chemical industries into other equipment markets, and bursting discs are now widely used in compressors, gas bottles, extrusion and injection moulding equipment and fire extinguishers.

Fig. 2 The platinum bursting disc is silver brazed into a housing designed to ensure correct location and provide leak-tightness

An Aerospace Application

One of the most interesting applications for platinum bursting discs is in bromochlorodifluoromethane (BCF) fire extinguishers. BCF

itself is relatively inert at room temperatures, but becomes very corrosive at elevated temperatures. It will attack many of the more commonly used bursting disc materials, such as aluminium, nickel, or Monel. Platinum, however, has an excellent resistance to BCF at high temperatures and is used by Graviner in extinguishers for fire fighting in aircraft engines, Figure 1. The extinguisher is fitted inside the engine cowling and, in the case of the Rolls Royce Olympus engine, may experience temperatures as high as 400°C.

A life of five years is expected from these discs, but the foil from which they are made is only 0.005 inches thick and the outside diameter a little more than half an inch. After manufacture, the discs are silver brazed into a retaining brass boss, which ensures no leakage or drop in pressure, Figure 2. The bursting pressure of 1200 psig is critical, and a tolerance of only ± 5 per cent is allowed. A platinum disc assembly can provide this high integrity.

A major hazard with any volume of compressed gas is its explosive potential if heated. A fire extinguisher not fitted with a bursting disc, but surrounded by flame, will eventually explode, with catastrophic results. The use of a disc on all extinguishers, and particularly in aircraft engines, is therefore a vital safety feature in case of fire engulfment.

If a fire develops in an engine, the extinguisher may be electronically activated from the flight deck. When the BCF is released it displaces oxygen from the atmosphere and smothers the fire.

Conclusion

Any closed vessel likely to experience overpressure conditions must be protected against damage to itself and its surroundings by a pressure release system, and bursting disc systems are an accepted way of achieving this. The high temperature corrosion resistant properties of platinum make it an obvious choice for bursting discs to be used in particularly harsh environments.

Homogeneous Catalysts of the Platinum Metals

The advantages of employing catalysts that are soluble in the reactant are being increasingly appreciated in the chemical and pharmaceutical industries where their high activity per unit weight of metal, high selectivity and great endurance offer important savings.

To assist those working in a research, development or production role who may be considering homogeneous catalysis as a solution to their problem a 54 page book has now been prepared by Johnson Matthey Chemicals Limited. In the first of two major sections a summary is given of the principles of homogeneous catalysis and of the advantages that it offers. This is illustrated by the success of the Joint Union Carbide—Davy McKee—Johnson Matthey low pressure rhodium catalysed hydroformylation of propylene to n-butyraldehyde that is now in large scale operation in a number of plants to the extent of over one million tons per year. The main features of homogeneous catalysis employing compounds of the platinum metals include the only possible route to some products as well as economic advantages such as high yield, lower capital and operational costs and operation at lower pressures and temperatures than those generally associated with heterogeneous catalysis.

In the second section a list is given of over 120 compounds of platinum, palladium, iridium, rhodium, ruthenium and osmium that are known to act as homogeneous catalysts, with their solubility data and with some 200 references to the relevant literature on their use in homogeneous catalysis and classified by reaction type, while advice on their safe handling is included. All are available as research samples and many in bulk for production scale use.

The commercial success of a homogeneous catalytic process can be affected by the efficiency with which the catalyst can be recovered and the metal recycled. A number of methods have been developed by Johnson Matthey Chemicals and the service offered for this operation is also summarised.

The publication is available from Johnson Matthey Chemicals Limited, Orchard Road, Royston, Hertfordshire, or from any Johnson Matthey office throughout the world.