

Flammable Solids & Dusts

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FRICITIONAL IGNITION PROPERTIES OF STAINLESS STEEL

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Summary

This Discipline Information Note summarises research by HSL which compared 4 types of stainless steel in a rig which tests the ability of different materials rubbing together to ignite gas air mixtures.

Background

A large database of research carried out by HSL into the frictional igniting potential of different materials is available from DST E5 or ignition control section in Buxton. It is known that many factors influence the probability of ignition. These include surface hardness, rubbing speed and the force between the rubbing surfaces. The fuel gas present makes a very large difference to the risk of ignition, but for a given fuel, differences between types of surfaces in rubbing contact can have practical significance.

Although much process equipment in the chemical and food industries is made of stainless steel, little data was previously available on its igniting properties. The project started in response to a specific query but was later extended to examine a range of stainless steels. The materials tested were grades 18/8, 18/9, 2205 and 254 SMO, from Avesta Sheffield Ltd. selected after discussion with British Steel. The results expected from a typical mild steel were known from previous work. The variables studied were rotational speed, and forces between the surfaces, with 4 fuel gases - hydrogen, ethylene, propane and methane.

In the test rig, a fixed block is pressed against a second circular piece of the same metal which rotates at a controlled speed. The rubbing load between the test pieces can be varied from 240 to 3000 Newtons. The rubbing surfaces are enclosed by a box containing the selected flammable atmosphere. Rubbing is continued until ignition or for a maximum of 4 minutes.

Conclusions

- Mild steel and 18/8 stainless steel were similar in igniting potential. The other 3 materials ignited each of the fuel gases more readily than mild steel.
- The igniting potential for each of the steels was little influenced by the rubbing speed, when tested at 5 m/s and 20 m/s.
- Hydrogen ignited quickly with each sample, even at the lowest load that the test rig can apply to the test pieces.

In practice the load between rubbing parts is rarely known, but the maximum power that could be dissipated may be known, perhaps because the driving motor is of limited size. Using estimates of the coefficient of friction, igniting powers on the test rig varied from 1.8

kW for hydrogen at a low rubbing speed to more than 35 kW for methane at a high rubbing speed.

High speed photography shows that in most cases ignition starts at the hot surface close to the point of rubbing contact. Sparks of burning metal are usually not an effective ignition source. Methane resists ignition by large showers of sparks, and the point of rubbing may reach red heat before ignition occurs. In contrast, hydrogen ignites rapidly at low loads, before the test pieces become obviously hot or much material has worn away. The size of the hot surface influences ignition as much as the actual temperature. Figure 1 from earlier work on different materials demonstrates this.

Further work on frictional ignition has been carried out. It compared a range of common solvents for ease of ignition, and also dust clouds kept continuously in suspension while exposed to friction sparks and hot surfaces of small area.