TECHNICAL ARTICLE

CORTEM™ GROUP
To be sure to be safe.

February, 2013

THE FLAME PATHS

The most critical part of an 'Ex d' flameproof enclosure is the flame path.

In order to understand what a flame path is and how it works we need to review briefly the principle on which is based the security of the 'Ex d' (flame proof) method of protection. This is the oldest method of protection that exists, the first used and still one of the safest because it is based on a very simple technology and, therefore, hardly fallible.

This method, designed for protection in systems where may be an explosive atmosphere in form of gas, is based on the assumption that it's impossible to prevent a gas to penetrate everywhere. No gasket will ever be able to prevent the entry of a gas in an enclosure. Therefore, if an explosive atmosphere penetrates into an enclosure producing a trigger, for example a spark between two electrical contacts, the explosion occurs, but it remains confined within the enclosure and does not allow the spread of flame to the surrounding atmosphere, thus causing a devastating explosion.

To ensure this, enclosures must be constructed with a mechanical strength such as to contain the overpressure caused by the explosion and to allow the escape of flue gases. This is the mission of the flame path which is the interface between two parts of an enclosure, for example the body and the lid. It allows the gases to exit the enclosure and to cool down during the passage, so that they are no longer able to trigger the outside atmosphere. For this reason, the flame path must be sufficiently long and with an interstice enough narrow to guarantee the cooling of the flue gases.

There are, depending on the gas and the enclosure volume, precise rules to be observed, which are specified in EN 60079-1 standard.

1. Roughness

One of the common rules to all flame paths is the maximum acceptable roughness limit after machining of their surface. This value may not exceed 6.3 µm measured according to ISO 468 standard. Today the flame path surfaces, thanks to machining carried out by modern machine tools with numerical control, reach degrees of roughness enormously lower and, therefore, more safe.

2. Flame path length and interstice

The length of the flame path and the maximum value of the interstice residue after the complete closure of the housing are two important elements. Once experimentally determined and defined in the certificates issued by testing laboratories, they must be respected by manufacturers in order to ensure the complete cooling of the flue gas. Just think about what could be the consequences if a flue gas, produced by an explosion inside a enclosure, would not be rolled because the screws holding a cover are loosen and the interstice is thus wider than the necessary.

The result would be that the flue gases still hot should ignite the explosive atmosphere outside the enclosure, causing an explosion. On the other hand, a flame path cannot even be completely

closed and sealed, because if it were, at the time of the explosion the enclosure would not be able to withstand the shock without flame paths which allow a quick exit of the flue gases. In the absence of flame paths, the enclosure would become a real dangerous bomb.

3. Types of flame paths

3.1 Non-threaded flame paths

Within this category there are different types of flame paths. The main ones are cylindrical and plan. The cylindrical flame paths are universal, usable for any type of application and with gas of any group. Normally, they are difficult to find in equipment on the market due to their complexity of production which is reflected in a higher cost. The plan flame paths, on the contrary, are the most common, but they can't be used anywhere; in fact, they are prohibited in applications where there's presence of acetylene (gas group II C).

3.2 Threaded flame paths

They are divided into two groups, cylindrical and tapered. With regards to the cylindrical threaded flame paths you will need to use threads that meet the tolerances of ISO 956-1 standard with a pitch greater than or equal to 0.7 mm. For pitches of more than 2 mm, manufacturers should take necessary measures to ensure that the enclosures pass the test of non-transmission of the flame. Threads must be more than 5 for enclosure with volume up to 100 cm^3 and more than 8 for enclosures with a volume greater than 100 cm^3. For tapered flame paths, threads are manufactured in accordance with ISO 7/1 standard in Italy, while according to standard NPT ANSI/ASME B1.20.1 in Europe.

4. Flame paths on rotating machines

On 'Ex d' rotating electrical machines, it's necessary to provide a flame path on the propeller shaft. Flame paths positioned in such places must not be subject to wear. They must be completely free and independent from the other structures that support the propeller shaft allowing the rotation. Any bearings, seals, lubrication channels, etc. must be outside of the length of the flame path and it must not be interrupt.

5. Obstruction of a flame path

To ensure the safety of an enclosure, you should check that the flame paths are not blocked and not closed to solid objects such as pipes, walls, trellises or other enclosures which may obstruct the proper release of flue gases. It's a good practice respect the minimum distances between an enclosure and the surrounding objects as required by EN 60079-14 standard, Paragraph 10.2.