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Avoiding pitfalls

Atex compliant gear pump design

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For over two years now, mechanical equipment intended for use in potentially explosive atmospheres has also required certification. Despite this, there still seems to be some confusion about the correct choice of components for Atex applications. The aim of this article is therefore to help readers avoid potential pitfalls and to clear the general fog that seems to be surrounding the design and selection of gear pumps for applications in Ex-areas.

The general aim of the Atex directives is to prevent the creation of potentially explosive atmospheres or, if that is not possible, to ensure that any equipment which is used in these zones does not have any ignition sources. The avoidance of potentially explosive atmospheres and the definition of Atex areas is under the responsibility of the plant operator. The operator must perform a risk assessment of the plant in accordance with Atex 137 and divide it into zones and temperature classes according to the gases or dusts which can occur. By contrast, it is the responsibility of the supplier to ensure that any of his products used in these zones and temperature classes are free of ignition sources. In accordance with Atex 95, suppliers must avoid all possible types of ignition source, including those arising for example due to excessively high surface temperatures, sparks, electrostatic discharge etc.

Selection of the temperature class

One important design aspect which is frequently misinterpreted is the selection of the required temperature class. The plant operator defines the zone and the temperature class on the basis of the risks present in the plant. In the process, the gases and dusts are classified in temperature classes ranging from T1 (ignition temperature >450 °C) to T6 (ignition temperature >85 °C). The higher the temperature class, the lower the ignition temperature of the media present in the zone - i.e. in a higher temperature class the maximum permitted surface temperature of the components used is lower. This means higher temperature classes also have more stringent requirements.

Practical implementation

Imagine the following example: in an Atex area a plant operator uses ethylene, which has an ignition temperature of 425 °C. According to the definitions, this plant therefore needs to be operated with equipment which complies with temperature class T2 (ignition temperatures >300 °C). If the operator operates a three-phase AC motor in the same zone which is rated for temperature class T4 (ignition temperatures >135 °C), the pump he orders will often also be designed for the same temperature class (T4) - along the lines of "if is right for the motor then it must be OK for the pump". In principle, this is of course correct, as equipment designed for a higher class can always be used in lower temperature class applications. For example, three-phase AC motors are often certified for temperature class T4 as - providing a correct design is used - the maximum permitted surface temperature for temperature class T4 is never reached. Of course, this makes life easier for manufacturers and operators, as it allows a standard product to be used for all temperature classes from T1 to T4.
Unfortunately however, in the case of a pump the situation is slightly more complicated. The permitted temperature class of a gear pump depends very much on the temperature of the material being pumped. If in the above example the temperature of the material being pumped is 120 °C, this means

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that the pump is already no longer suitable for temperature class T4, as the maximum permitted temperature defined for this temperature class of 108 °C (zone 1, gases, continuous operation) is already exceeded by the material being pumped. This does not even take into account any additional temperature increases arising in and around the pump during operation. It is therefore not recommended that you base your decision about the temperature class requirements in a zone on the temperature classes of other existing components. The components used in the zone are usually only marked with the maximum permitted temperature class, but not with the minimum required temperature class. Ultimately, the decision about the required temperature class should only be based on the gases and dusts which may be present in a zone.

Temperature of the material being pumped

Gear pumps for Atex applications are generally designed according to the equation below:

$$T_{fluid} + \Delta T_{pump} = T_{max} \leq T_{max.perm.} = T_{ignition} - \Delta T_{safety}$$

whereby T_{fluid} is the fluid temperature on entry into the pump, T_{pump} is the temperature increase in and around the pump (safety allowance), T_{max} is the maximum surface temperature which can occur on the pump, $T_{max.perm.}$ is the maximum permissible surface temperature of the pump, $T_{ignition}$ is the minimum ignition temperature for the defined temperature class and T_{safety} is the safety margin (in accordance with the directive) depending on the zone, length of operation and type of potentially explosive atmosphere (gas, dust).

Due to the inclusion of safety margins and the expected temperature increases, the maximum permitted temperature of the material being pumped may be significantly below the effective ignition temperature of the atmosphere. Let us again consider the example of ethylene with an ignition temperature of 425 °C. As the minimum required ignition temperature for class T1 is 450 °C, the next higher temperature class T2 (> 300 °C) needs to be chosen for ethylene. According to the definitions, the maximum surface temperature for temperature class T2 is 240 °C (zone 1, gases, continuous operation). If a gear pump with a magnetic coupling is ordered for this temperature class without any further details being specified, the maximum temperature for the material being pumped is approximately 160 °C, as temperature increases of up to 80 °C can arise within the magnetic coupling. This temperature increase value is a maximum value which does not make allowances for application data like pressures, speeds or the viscosity of the material being pumped. Ultimately, this means that the permissible temperature for the material being pumped is 265 K below the effective ignition temperature of the surroundings. Of course, among operators there is often a lack of understanding for the magnitude of this value. The reason for this large temperature difference lies in the way the temperature classes are handled and the standardised safety factors which enable fast configuration and planning for non-critical applications.

Carefully adapted

If the initial design - like the one described in the example above - is unsatisfactory and all of the relevant operating data are available then the maximum permitted temperature of the material being pumped can be increased with the following measures:

Instead of the fixed classification using the temperature classes, the pump can also be certified for a defined temperature (e.g. 3G T = 400 °C).

Through careful choice of dimensions, materials and components (e.g. magnetic clutches with a double containment shell), it is possible to minimise the potential temperature increases in and around the pump, and this in turn means that the required safety allowances can be minimised.

In the case of our example above, this means that the maximum permitted temperature of the material being pumped could potentially be increased to around 300 °C. However, this type of optimisation is only possible if the operator of the plant and the manufacturer of the pump sit down together to discuss the effective process data and the technical possibilities in detail.

The corrosion-resistant cinox gear pump is also suitable for use in areas with a potentially explosive atmosphere.