Application Note

Thermal management of hazardous area enclosures

Introduction

It is important to manage the thermal status of hazardous area enclosures for many reasons.

Most critical are:

- Internal equipment is usually heat-generating and the enclosure design (well sealed) limits natural heat loss through leakage & convection..
- Internal equipment will have minimum & maximum operational temperature limits
- Internal certified equipment (such as I/O modules, IS interfaces and HMI devices) will have minimum & maximum temperatures related to certification.

Note also that the enclosure itself has a certification-related minimum & maximum temperature, and this is related to the ambient in which the enclosure is installed rather than the ambient temperature within the enclosure.

Guidance notes

While these notes refer to purged & pressurized (Ex p) panels, the general principals apply to any hazardous area panel.

Heating: This is usually quite straightforward, and there are a variety of small electrical panel heaters available, both certified and non-certified. The certified heater is best suited to a panel which is likely to be started in the hazardous location from cold – the certified heater is separately powered, itself explosion protected and thermostatically controlled independently of any purge system, and its function is to warm the entire panel to at least the minimum operational temperature before the purge cycle can be initiated. However, many panels are started and run in 'normal' ambient conditions, and the internal heater is only to cope with occasional low temperature events and for anti-condensation purposes. This unit can be uncertified – it will only be powered after the panel has been through a purge cycle.

Cooling: This is potentially more complicated, with multiple options available. Vortex Coolers are very commonly used with purged & pressurized enclosures since such panels already have compressed air supply available. These devices operate by separating a spinning air stream into hot & cold fractions, and discharging the hot fraction to the outside of the enclosure while using the cold fraction inside the enclosure. The difference between hot & cold can be quite dramatic (80-100° C) and for hazardous are use, vortex coolers are restricted so that the hot air exhaust port doesn't exceed the local T-rating. Generally speaking, Vortex Coolers are suitable for 300 – 800W of cooling and for outdoor use, as noise levels can be high.

The other main cooler type is based on heat exchanger technology, and can be simple air-air (less commonly, air-water) heat exchangers, or use refrigerant cooling with compressors & pumps. For use with purged & pressurized enclosures, the system should be selected to maintain a sealed interface between the internal enclosure and the external environment. Simple air-air heat exchangers will not get internal temperatures below external ambient conditions, so Expo recommend air conditioning . Certified systems are available in versions for both Zones and Divisions, and with ratings up to 6kW.

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Example

The amount of heating / cooling needed can be calculated from a few basic parameters: ambient temperature range, internal heat generation (assume zero for heating applications), and the enclosure size.

The target is set by the minimum & maximum equipment limits and the calculation is based on stainless steel enclosures having heat dissipation/absorption of 5.5W/sq.m K. The enclosure needs to be assessed for surfaces with exposure to the air, so free standing enclosures have 5 surfaces (4 sides plus 1 top), whereas wall mounted enclosures have 2 sides plus 1 front plus 1 top (the base is ignored since heat loss is usually convective).

A free standing enclosure of 2000 x 800 x 500 mm has heat dissipation capability based on surface area (2x0.8x2) + (2x0.5x2) + (0.8 x 0.5) = 5.6 sq.m, which, using the above heat factor, gives 30.8W per degree K delta.

If the maximum external ambient is 30 degrees and the maximum internal permitted temperature is 40 degrees, then the delta is 10 degrees from inside to outside. Hence the enclosure can dissipate 10 x 30.8 = 308W on its own before additional cooling is necessary.

If the enclosure equipment generates 500W, then the minimum cooling required is 500 – 308 = 192W.

In this case the cooling requirement is quite low and the use of a vortex cooler would be appropriate.

Expo cooling solutions

< 800 watts (2,700 BTU/hr): Certified vortex coolers

Running primarily on compressed air, vortex coolers are a perfect solution for low heat loads generated by low powered control systems such as PLC's, or where moderately high ambient temperatures are likely.

Expo offers 2 models:

Size 1 : 300W (1,023 Btu/hr)

Size 2: 800W (2,729 Btu/hr)

> 800 watts (2,700 BTU/hr): Certified air conditioning units

For larger heat loads, or locations with high ambient temperatures, air conditioning is the best solution. Expo offers a range of certified systems for ATEX, IECEx and North America, with cooling capacities up to 6kW (20,000 Btu/h)

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