FCI® TECH BRIEF No. TB001

Understanding Instrumentation T-Ratings

To ensure that instrumentation will operate safely in hazardous locations requires a thorough understanding of the circumstances that create the hazardous environment as well as the safety pedigree of the instrumentation that will be used within this environment. Hazardous location safety standards have been established by most industrialized countries and a number of certification laboratories analyze designs and perform testing to validate that a manufacturer's product is qualified for hazardous location use. These certification laboratories are typically called approval agencies and UL, FM, CSA, BASEEFA, PTB and LCIE are some of the better known safety testing organizations.

Gases or vapors that are present in a hazardous location environment can be ignited by an arc or spark of energy. From a safety standpoint, in addition to being concerned about the prevention or containment of arcs and sparks, it is also necessary to understand that these same hazardous location gases and vapors can be ignited if they come into contact with a surface that is hot enough to heat the gas or vapor about its **ignition temperature.** Therefore, knowledge of the maximum, worst-case temperature of any exposed instrument surface can help prevent hazardous location explosions and fires due to a gas or vapor exceeding its ignition temperature.

North American and European hazardous location safety standards (NEC, CEC and IEC) contain a surface temperature rating system that is based upon a 40°C (104°F) still air reference condition -- see Table 1. An instrument that is tested by a certification laboratory will be tested per the appropriate standard and a maximum surface temperature code or classification, commonly called a **T-rating,** will be assigned based upon the measurement result -- see Table 2 for a summary of the T-ratings of FCI's products. The North American standards require that the surface temperature measurement be made during a single, **worst-case fault of the instrument**; this is why the FM and CSA T-ratings of the FLT93 (with selectable heater power) and AF Series products are different than the corresponding CENELEC ratings.

The hottest exposed surface of an FCI thermal dispersion instrument is the heated, or active, thermowell of the sensing element. Depending on the instrument model and part number, FCI sensing elements can operate in process conditions at temperatures up to 450°C (850°F). The large difference between the certification laboratory reference condition (40°C) and the actual sensing element operating condition (any temperature up to 450°C) appears to limit the practical application of T-ratings with thermal dispersion instruments. However, it is possible to estimate the hazardous location suitability of FCI's products by calculating the **maximum temperature surface rise and ignition temperature safety factor** -- see Table 3. Note that the maximum sensing element operating temperature of each FCI product has been used as if it was the maximum fluid temperature in all of the sample calculations.

Maximum Surface Temperature		North American Code	European Classification
degree C	degree F		
450	842	T1	T1
300	572	T2	T2
280	536	T2A	
260	500	T2B	
230	446	T2C	
215	419	T2D	
200	392	T3	T3
180	356	T3A	
165	329	T3B	
160	320	T3C	
135	275	T4	T4
120	248	T4A	
100	212	T5	T5
85	185	T6	T6

Table 1: Surface T-Ratings

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Product	FM or CSA	CENELEC
12-64B or 8-66B	T4	T4
FLT93 (fixed heater power)	T4	T4
ST-Series	T4	T4
GF-Series	T4	T4
MT86	T4	T4
FLT93 (selectable htr. pwr.)	T3A	T4
AF-Series	T2B	T4

Table 2: FCI Product T-Ratings

Gas or vapor ignition temperatures can be found in many technical references. Instrument specification sheets should list the maximum fluid temperature of an application. Knowing the T-rating of an instrument and following the outline of the examples shown in Table 3 makes it possible to estimate the ignition temperature safety factor of an instrument. To make this calculation even easier, **FCI now indicates an instrument's maximum surface temperature rise on its agency approval label.** Adding the maximum surface temperature rise value that is indicated on the label of the instru-ment to the application's maximum fluid temperature will yield an estimate of the in-service maximum surface temperature.

Some of the thermal dispersion instrumentation manufacturers and many of the certification laboratories recognize the limitation of the current surface temperature test and identification method. The concerned parties have asked the safety standard organizations to incorporate a means of accommodating product operation at temperatures that are higher than a 40°C reference condition into the surface temperature classification method. Although progress has been slow, the requests have at least gained an acknowledgment from the standards organizations that the structure of the T-rating system should be revisited.

Validating the existence of an instrument's T-rating can provide a measure of safe operation assurance. Many manufacturers, by placing their products in an agency approved enclosure, hope to imply that their instrument is agency approved. This is not the case. **If an instrument does not have a T-rating, it has not been submitted to and tested by a certification laboratory, and consequently, that same instrument should not be considered for any hazardous location application.**

	Example 1 (Germany)	Example 2 (Canada)	Example 3 (USA)
Hazardous Location Application	**12-64B monitors ethylene transfers**	**FLT93F detects hydrogen gas blanket**	**AF88 measures methane flow rate**
T-rating of the product	T4	T3A	T2B
Estimated maximum surface temperature rise (T-rating temp.) - (ref temp.)	95°C (135°C - 40°C)	140°C (180°C - 40°C)	396°F (500°F - 104°F)
Maximum fluid temperature	177°C	260°C	250°F
Estimated maximum surface temperature (est. rise) + (max. fluid temp.)	272°C (95°C + 177°C)	400°C (140°C + 260°C)	646°F (396°F + 250°F)
Ignition temperature of the application gas	450°C	520°C	999°F
Ignition temperature safety factor (ignition temp.) / (est. max. surface temp.)	1.6 (450°C / 272°C)	1.3 (520°C / 400°C)	1.5 (999°F / 646°F)

Table 3: Sample Temperature Rise and Ignition Temperature Safety Factor Calculations