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Natural vs. Forced Ventilation in Process Modules handling Flammable Fluids

Process modules handling flammable fluids must be classified according to the nature of the hazard. Process modules that are not ventilated, or have not been formally evaluated are typically designated Zone 1 (Class I, Division 1 under the Division system of classification). This impacts the certification of electrical and instrumentation equipment and the associated wiring methods as defined in the Canadian Electrical Code.

There is a preference for most process modules to be designated Zone 2 (Class I, Division 2). This permits a greater range of equipment to be used at a lower cost. To designate a process module Zone 2, a ventilation study must be performed to determine the appropriate airflow under normal operating conditions. There are two options for ventilating process modules for hazardous area classification purposes. Natural or forced ventilated. This is a key decision in the design of the building and must be made early in the design process.

Forced ventilated buildings rely on mechanical fans for ventilation purposes. Typically, there are two fan ventilation rates required. The first fan ventilation rate is for "normal" operation where the process is operating within its design parameters. The second "high rate" fan ventilation rate is for situations where a loss of containment has occurred and the flammable atmosphere is above 20% of the Lower Flammable Limit (LFL). Under such circumstances, an operator cannot enter an enclosed building in accordance with Occupational Health and Safety (OH&S) regulations.

Sizing of the "normal" operation ventilation fan is based on a release scenario where the process remains in operation. Under such circumstances, the ventilation system must have sufficient air movement velocity to dilute the release and a sufficient outside air exchange rate to control the LFL level within the building to less than 5% LFL. Typically this requires an air exchange rate of between 2 and 6 air changes per hour (ACPH). The sizing and placement of the fans and louvers are critical to ensure that sufficient air velocity is achieved throughout the enclosed area and there are no locations where flammable emissions may persist under a release scenario.

The "high rate" ventilation fan is typically sized based on reducing the LFL level from 100% to less than 20% within a 20 minute time frame after the release has stopped. 12 ACPH is a "high rate" ventilation air exchange specification common seen in many process modules.

Naturally Ventilated buildings rely on wind pressure and a stack effect to ventilate a building under "normal" operation. A natural ventilation design will typically require a ridge vent and adjustable louvers mounted low in the building to promote a stack effect. The ridge vent and ventilation louvers will be adjusted to different positions during winter and summer operation. In summer, the louvers will be fully open. In winter, they will be closed to a defined stop position to conserve building heat. The stop position ensures the minimum air exchange requirements are met in cooler ambient temperatures.

A naturally ventilated building will still require a "high rate" ventilation fan to handle a loss of containment scenario. The "high rate" fan is sized using the same criteria as with a forced ventilation design.

Which is Better – Natural or Forced Ventilated?

Natural ventilation is particularly effective in situations where there is a heat source within the building such as a compressor or process heater. The heat source drives the stack effect

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resulting in a passive ventilation design that does not rely on an external power source. A natural ventilation scheme is also very conducive to process buildings handling lighter-than-air or neutrally buoyant flammable gases such as hydrogen, natural gas or ethylene. The scheme also works very well in mild climate locations where extreme low ambient temperatures are not prevalent.

It should be noted that the natural ventilation rate will vary with the difference between the internal building temperature and the outside ambient temperature. Under certain temperature extremes, a very high rate of ventilation may result. The design of the building heating system will need to take this into account. A natural ventilation design will also require Operator's to adjust the louver position between summer and winter operation.

Forced ventilation is particularly effective in situations where heavier-than-air gas or fluid releases are expected. Under such circumstances, a process release will result in flammable vapours collecting at grade level. A forced ventilation system design will allow any emissions to be swept away. The installation of a ridge vent is not necessary. The airflow through the building can be controlled to a much tighter degree allowing the building heating system to be optimally sized. There is also the option of using the same fan assembly for both "normal" and "high rate" ventilation with application of an adjustable speed drive. The ventilation design can be fully automated thus requiring no operator intervention under normal conditions.

A forced ventilation design does require a reliable power source to ensure air movement at all times. Multiple fans may also be required to assure that all parts of the building have sufficient air movement to dilute a flammable release. Sizing of the fans is also critical to ensure the enclosed space is not "over-ventilated" resulting in increased heating costs.