How to Choose the Right Electric Motor for the Chemical Process Industry – Part 5 of 5

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Operating an electric motor in a hazardous location poses risks that range from production downtime to injury and death. In this series of articles, learn how to select the appropriate motor for your operating environment in the chemical process industry.

Inverter-Duty Motors: An Overview

In this final article in this series, we will look at how inverter-duty electric motors are used to counteract the heating effects of variable-frequency drive controllers in hazardous environments.

In some hazardous environments, an AC induction motor's load may vary. This creates a new set of variables to consider when purchasing an electric motor to work in this environment. In order to deal with these kinds of loads, variable-frequency drive (VFD) controllers are often employed. A VFD controls the rotational speed of a motor by changing the fixed frequency of the supplied voltage to a variable frequency. The use of VFD motors improves efficiency and allows for better process control. However, VFDs cause additional heating of the motor, which

must be taken into consideration if the VFD motor is to be operated in an area classified as hazardous.

One way in which VFDs cause excessive motor heating is through harmonic currents. A VFD distorts the sinusoidal voltage and current waveform of the input, producing higher frequency harmonics. These harmonic currents cause an increase in the overall current draw of the motor (without creating any useful torque at the shaft), and this causes an increase in the amount of heat generated by the motor.

Changing the rotational speed of the motor is the purpose of a VFD, as it allows, for example, a change in the speed of a mixer or a pump's flow rate. However, slowing the rotation of the motor shaft can also cause additional heating. When the speed of the rotating shaft is reduced, less air flows over the motor, decreasing the air's ability to cool the motor. Therefore, a VFD-controlled motor will tend to run at a higher temperature as its speed drops.

There are electric motors that are designed for use at variable speeds with VFDs. These are called inverter-duty motors. Inverter-duty motors can withstand signal distortions and low rotational speeds without overheating. However, selection of an inverter-duty motor for use in a hazardous location is not simply a matter of choosing one suitable for Class I or Class II areas. The hazardous location approval and T-code on a motor's nameplate apply only when the motor is used in a constant-speed application (for more about these classifications see the previous articles in this series). For variable-speed operation, inverter-duty motor and VFD combinations require a hazardous location approval of their own. And, as Figure 1 shows, the hazardous locations for

Figure 1. Inverter-duty motor nameplate for Class I, Division 2, Group B, C, and D.

which the motor is approved when used with a VFD must be shown separately (typically on an auxiliary nameplate). Even with this added classification information, however, it is up to the operator to recognize the variations within group classifications and adjust accordingly.

Consider a motor whose main nameplate shows that the motor is approved by the CSA for use in Class I, Division 2, Groups B, C, and D hazardous locations, and it has a T-code rating of T3A. A rating of T3A tells the operator that the motor will develop a maximum surface temperature of 180°C when used in a constant-speed application. The same motor is also approved for inverter duty. The auxiliary nameplate indicates that when the motor is controlled by a pulse-width-modulated (PWM) VFD, it is approved for Class I, Division 2, Groups B, C and D, with a T-code rating of T2A. A rating of T2A tells the operator that the motor will develop a maximum surface temperature of 280°C when used in a variable-speed application.

What these nameplates cannot do is tell the operator what material in Group B, C, or D will be used. The operator must look up the AIT ratings of any materials in use, as the autoignition points have quite a significant range. If this area contained the Group D material gasoline, for instance, the motor could only be operated safely *without* the VFD (i.e., in a constant-speed application), as its 180°C surface temperature would not be sufficient to cause spontaneous ignition. If the motor were run *with* the VFD, the motor's higher surface temperature (280°C) would be hotter than the AIT of gasoline (246–280°C). In fact, it would be hot enough to cause an explosion of the gasoline.

While there have been significant advancements in the efficiency of inverter-duty motors with VFDs, and NEC/CEC classifications of use are listed on the motor itself, it is important to remind the operator that they must do their own research on the AIT of the material in the working environment. Within Group D alone, for example, there is an AIT range from 246°C for gasoline to 651°C for ammonia. Clearly, no one motor will work for every scenario, but choosing the best fit is not only cost efficient but is the safest route in the long run.

In Conclusion

As discussed in this series of articles, selecting a motor for use in a hazardous location requires careful consideration of a variety of factors. Here are some quick tips to guide you in this process.

• ***Classify hazardous area.*** When an electric motor is to be operated in a location that contains hazardous materials, it is the responsibility of the end-user to determine the applicable class, division, and group — not an easy task.

• ***Plan ahead.*** Just because a hazardous location can be described in terms of class, division, and group, does not mean that a motor is readily available that meets requirements. Group A explosion-proof motors, for example, cannot be easily obtained because applications necessitating their use are relatively rare. In such a case, you must work with the authority having jurisdiction in your area to find a motor that is suitable.

• ***Do not overdesign.*** Avoid the temptation to select an explosion-proof motor for all Class I environments. Explosion-proof motors exceed the minimum requirements for Class I, Division 2 and can be significantly more expensive.

• ***Safety first.*** Safety should be a primary concern when choosing a motor for use in a hazardous environment. It is important to understand the implications that different classifications have on the design requirements of a motor. This knowledge will allow you to provide adequate specifications to the manufacturer and ensure that you select a motor that poses minimal risk of a dangerous explosion.