+1.888-416-9513 main
+1.419.281.4087 fax

740 E 9th Street
Ashland, OH 44805
United States
www.pentair.com

WHITE PAPER

Oil-Filled VS. Air-Filled Premium Efficient Motors

Introduction

If one debate over a specific design feature stands out amongst all the others in the submersible wastewater pump field, it must be "Which is better, air-filled or oil-filled motors"? With the introduction of premium efficient motors by several manufacturers, this topic has come to the forefront once again. Each design has specific advantages. However, the advantages of an oil-filled design out-weigh those of an air-filled design.

Cooling

The NEMA MG-1 Standard specifies that a submersible totally enclosed non-ventilated motor (TENV) with IP68 rating is cooled by its surrounding pumped media (NEMA MG1 5.2, 6.2.5 and 6.2.6). For the heat generated by the motor windings to get to the cooling medium, it must pass from the inner working parts of the motor to the outer shell. Both air-filled and oil-filled motors rely to a great extent upon convection to transfer heat from the rotor core, motor windings and laminations to the outer shell. The heat convection process uses oil as the transfer media in an oil-filled motor and air as the transfer media in an air-filled motor.

Since oil has from 5 to 7 times the thermal conductivity of air, it follows that oil-filled motors pass internal thermal energy to the cooling medium much more efficiently than do air-filled motors.

Additionally, in higher efficiency motors, since a greater portion of the input energy is converted to work, rather than waste heat, a premium efficient motor CAN be designed to operate at cooler temperatures.

Traditionally, the benefits of oil-cooled motors have taken a back seat to efficiency, since it was a commonly held belief that an oil-filled motor could not be designed to meet premium efficiency standards. Hydromatic has been able to overcome the design hurdles to introduce their new HPE series of premium efficient submersible motors.

For each 10 degrees C that a motor operates below its maximum design operating temperature, life expectancy is approximately doubled. Conversely, for each 10 degrees C a motor is operated beyond its designed operating temperature, its life expectancy is cut in half. Hydromatic's oil-filled motor design operates at temperatures significantly cooler than their designed maximum operating temperature. This translates into greatly extended motor life expectancy. For example: Hydromatic's HPE Series premium efficient submersible oil-filled motors are equipped with Class H (180 C) insulation systems. These motors actually operate in the Class A temperature range (less than 105 C) at about 68 C. Most air-filled submersible motors are also equipped with Class F or H insulation systems. These motors generally operate at or near their winding design temperature, (155 to 180 C). Because of cooler operating temperatures, Hydromatic's Premium Efficient oil-filled motors design life expectancy is many times that of a similar motor operating in air. Hydromatic's Premium Efficient greater motor life expectancy translates into lower overall costs to the user.

Lubrication

Another advantage that oil-filled motors offer over air-filled motors is their inherent self-lubrication. The oil used as a cooling medium also lubricates the bearings and seals. Air-filled motors utilize sealed or shielded bearings which

require periodic re-packing of their lubricating grease. Oil-filled motors do not require periodic replacement of the cooling oil. It should only be necessary to replace the oil if water enters the motor via a faulty seal or some other repairs are required. This translates into lower overall costs to the user.

Perceived Disadvantage

Many air-filled submersible motor manufacturers proclaim their motors are inherently more efficient than their oil-filled motor counterparts. Their reasoning is that oil-filled motors have additional viscous losses due to the motor rotor running in oil. While it is true that in equal sized motors, viscous losses due to running in oil can range from 1 to 1.5 percent, however, what is more important is total motor efficiency. Hydromatic's HPE premium efficient submersible motors meet or exceed NEMA MG-1 and IEC 60034-30 level IE3 requirements for premium efficiency. Since oil-filled motors run much cooler than air-filled motors, with all other factors remaining the same, oil-filled motors can be designed to run at better peak efficiencies than air filled motors. One only has to compare motor electrical data between air-filled and oil-filled designs to be convinced of this fact.

Conclusion

Hydromatic's Premium Efficient oil-filled motors offer cooler operation, continuous lubrication and better overall efficiencies than similar air-filled motors. The end user benefits from lower operating and maintenance costs over the useful life of the motor.

For more information, contact your authorized Hydromatic distributor, or Kevin Clemons, Senior System Applications Engineer, Pentair Flow Technologies LLC at 419.281.9200 or kevin.clemons@pentair.com.