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Submersible Motor Megger Testing

Meggers, or Megohmeters, are often used by service personnel or sophisticated end users as an immediate trouble shooting device. Unfortunately, Megger results are not appropriate for use as a pass/fail determination due to the many variables and judgments involved. Some of the variables to be aware of are: length of cable, size of conductors, ambient temperature and humidity, status of the motor (new, submerged, previously submerged), with or without cap attached and even coiled cable vs laid out cable. Consideration for all these variables should be made when using a Megger reading to evaluate the condition of a submersible motor.

Meggers are best used as a trend analysis tool. To accomplish this, a test procedure should be established and used consistently over time. The above variables should be controlled as much as possible to promote accurate insulation resistance measurement data. After a benchmark is established, periodic measurements should be taken and recorded along with notation of temperature, humidity and duration of the Megger test. This procedure must be continued for subsequent tests to accurately determine if the rate of insulation breakdown is occurring at an abnormal rate. This determination is also very subjective and should be based on sound judgment and experience.

The reason why the term "subjective" is used above, is that often electrical equipment manufacturers and industry standards give vague information and/or general rules of thumb that do not necessarily apply to submersible electric motors where the cable actually becomes an integral part of the motor. These guide lines normally have large plus or minus tolerances which makes trend analysis the only logical approach for the use of Megohmeters readings.

There are two characteristics that make submersible motors substantially different from standard electrical motors or other electrical devices that can be Meggered. The first is that the electrical cable for a submersible motor is an integral part of the motor as a whole. Most other electrical apparatus is measured exclusive of a cable. The other big difference is that the motor and a portion of the cable is normally submerged in water or wastewater and is subject to ambient moisture. Both of these conditions greatly affect Megohm readings. Both conditions must be given allowances for lower Megger readings when compared with other electrical equipment or when using standard guidelines for motors or equipment that is operated "in-air" or are not subject to the above factors.

The cap & cable assemblies of a submersible pump motor are generally 25-50 feet long and of a relatively large diameter because the contain both power and control wires. These larger cables provide a large surface area that is exposed to wastewater and ambient moisture. Because they are also submerged in an extreme environment, they are more susceptible to damage. This unique environment and operating conditions contribute to two physical phenomena: 1. changes to the outside insulation resistance by exposure of a greater surface area compared to standard in-air cable and 2. increased dielectric effect expands overall capacitance. The following is an explanation of the effects that these two phenomena have on producing a lower Megger reading.

A. While the cable jacket is a very good insulator, it is not perfect. There are no perfect insulators. A good conductor requires less surface area for electrical contact to conduct more amperage with minimal loss. Conversely, a poor conductor requires more surface area to conduct the same amperage when compared to a good conductor. When a cable is submerged in wastewater, there is a great amount of its outside surface area in contact with water. Water is a good conductor when compared to air. This overall coverage of water on the jacket of the cable acts like hundreds of resistors connected in parallel, reducing the total resistance as demonstrated by Ohms Law (4), where Multiple Resistors in Parallel in Ohms = $(1/ ((1/R_1) + (1/R_2).....+ (1/R_N)$ a division of resistance. This overall reduced resistance will be manifested in a lower Meg Ohm reading. This lower reading does not necessarily mean the cable insulation has electrically broken down or that there is moisture inside the cable or motor.

B. The motor and cable act as a large capacitor. When the motor and part of the cable are submerged, the water acts as an additional dielectric component to increase the electrical potential as a capacitor. When a Megger or a multi meter is connected to take readings, a voltage is actually being supplied. At initial contact, a low resistance reading will be observed. When the meter is connected for a duration, it will gradually and continually exhibit increasing Ohm readings. What is actually happening is the "charging up" of the effective capacitor. Resistance times a capacitance constant is involved. It may take six to eight hours before a full charge is achieved and a "true" reading is obtained.

Megger testing is not an exact science, and should not be used as an immediate conclusion of whether a motor is good or no good. It is a useful tool if it is used to measure against a benchmark in an effort to analyze the quality of insulation over time.

The Submersible Wastewater Pump Association (www.SWPA.org) has published an excellent manual on the selection, installation, operation and maintenance of submersible pumps. This book includes some valuable reference data such as a guide to Insulation Resistance Readings. This data is restated below:

Condition of Motor & Leads	Ohm Value	Megohm Value
Motor out of wet well (without cap/cable attached)		
A new motor	20,000,000 or more	> 20.0
A used motor which can be reinstalled in wet well	10,000,000 or more	> 10.0
Motor installed in wet well (cap/cable installed)		
A new motor	2,000,000 or more	> 2.0
A used motor which can be reinstalled in wet well	500,000 or more	> 0.5
A motor which may have been damaged by lightening or may have damaged leads (Motor still ok to operate)	20,000 or more	> 0.02
A motor which has been damaged by lightning or has damaged cable Motor may be operational, but should be pulled for repair	10,000 or more	> 0.01
A motor that has failed or has severely damaged insulation.	Less Than 10,000	< 0.01

Yeomans Chicago Corporation manufactures and markets submersible pumps under the Yeomans Pump and Chicago Pump Company product brands. We also manufacture submersible motors on an OEM basis. Submersible motor sizes range from fractional to 200 HP and are available in a variety of speeds and voltages. Motor frame sizes use standard mounting flange sizes ranging from 140TY to 360TY. For more information, please contact Yeomans Chicago Corporation or visit our website at www.YCCPUMP.com

Revised 11/08/00