Revised: 2/01/2007

Plastic Combination Tubes for Electric Motors

Bulletin #S-19

The primary function of plastic combination tubes in electric motors is to provide the necessary electrical, mechanical, thermal, and environmental insulation for the electrical connections. This is accomplished through tube physical construction, materials, or combinations of materials required providing adequate insulation during the manufacture and operation of the motor.

A. Types of plastic combination shrink tubes engineered by Stone Industrial include:

1. NS (no shrink) Polyester outside/ HS (heat shrink) Polyester inside - HS Polyester inside shrinks around the splice protecting the connection with an air pocket.
2. NS Polyester outside/ Nomex® and HS Polyester inside - Thermal upgrade (155°C), plus cut through protection.
3. HS polyester outside/ extruded Polyethylene tube inside - Designed as a lower cost alternative to a heavy wall (.012") all HS tube.
4. HS Polyester outside/ extruded Zytel® (Nylon) inside - Provides superior cut through protection.

B. Wire Splice or Connection Insulation:

Any connection of two or more wires in an electric motor must be insulated. There are connections in an average motor between the field coils, (coil to coil); between the field coils and the insulated lead wires; and between the field coils and the lead wires of devices inserted in the current, such as motor thermal cutoff protectors. The number of splice connections in a motor varies from two, three, or four in a single speed motor such as those in the compressor of a refrigerator or air conditioner, to more than twelve in a multi-speed, integral fan motor. Tubing products for splice insulation include sonic-seal caps, short cut tubes, Tac-Line™ (pinch-seal/ encapsulation), and Cap Line™ (encapsulation) tubing.

The normal mechanical requirements for combination plastic tubes are its ability to resist cut through at splice connections and to resist wear from abrasion due to vibration on crossover and lead wire insulation. Usually the most severe mechanical stress is found at the splice connections.

There are two types of splice connections, mechanical and welded. A mechanical splice is one, which is made by crimping a plated brass connector to the wires being spliced. A welded connection effected by welding, (melting the wire ends together). Brazing, and in some instances soldering wires together are two other methods generally included in the term welded splices. Welded splices is the more common method used by motor manufacturers. Although the use of mechanical crimped connections is gaining wide usage, primarily by the increasing use of aluminum wire, which cannot be welded, brazed, or soldered by current methods.

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The mechanical connectors have a burr on them. The splice insulation must not be punctured by the burr. Welded connections often have sharp points on them formed by the welding process. The splice insulation must not be punctured by these points. The puncture problem is greater when the field coils are blocked, (pressed down to size and shape by large hydraulic pressers), thereby pressing the burr or sharp point against the inside wall of the insulating tube, often with considerable force. The reason for the development of the polyethylene lined caps, 12 mil all polyester tube and heavy wall HS Poly/ Zytel tubing is to resist and prevent cut through. The initial dielectric strength of these heavy wall tubes is much higher than needed. However, after blocking the burr or sharp point cuts into the wall, its effective thickness is reduced thereby providing less dielectric strength.

The cut through resistance of plastic tubes is generally determined by measuring its dielectric strength after application in the motor. This is called a surge test, whereby high voltage is surged through the coils. Cut-through shows up in this surge test by breaking through the wall of the tube. A failure can be seen as a pinhole with burned edges. The motor industry surge tests in voltages ranging from 1,500 to 6,000 volts.

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