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Standard Specification for Fluoropolymer-based Materials for Use for Encapsulation of Downhole Cable[1]

This standard is issued under the fixed designation D8436; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers thermoplastic fluoropolymer-based materials, intended for use as an encapsulation material for downhole cables used during well completion by the petroleum and natural gas industries.

1.1.1 The fluoropolymer-based materials to be used for this purpose shall be virgin materials and shall be permitted to contain up to 25 %, by weight, of reprocessed material (re-grind) of the same fluoropolymer generic material type. When reprocessed material is included, it shall be thoroughly mixed with virgin material.

1.2 The fluoropolymers covered by this specification include but are not limited to the following: ethylene tetrafluoroethylene (ETFE), polyethylene chlorotetrafluoroethylene (ECTFE), fluorinated ethylene propylene (FEP), polyvinylidene fluoride (PVDF), copolymers of PVDF, polychlorotrifluoroethylene (PCTFE), polytetrafluoroethylene (PTFE), and perfluoroalkoxy alkane (PFA).

1.3 This specification establishes common temperature ratings for the encapsulation materials and also describes requirements for alternative temperature ratings.

1.4 The applications for the encapsulation materials covered by this specification are all associated with downhole cables used during well completion. Such applications include, but are not limited to, the following: control lines (CL), tubing encased conductors (TEC), tubing encased fiber cables (TEF), and tubing encased power cables (TEPC). Other downhole cable products such as surface-controlled sub-surface safety valves (SCSSV or SSSV) and chemical injection lines/chemical injection tubes (CIL/CIT) are also covered by this specification.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents
D618 Practice for Conditioning Plastics for Testing
D638 Test Method for Tensile Properties of Plastics
D883 Terminology Relating to Plastics
D975 Specification for Diesel Fuel
D1708 Test Method for Tensile Properties of Plastics by Use of Microtensile Specimens
D1711 Terminology Relating to Electrical Insulation
D2633 Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable
D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)
D3418 Test Method for Transition Temperatures and Enthalpies of Fusion and Crystallization of Polymers by Differential Scanning Calorimetry
D3801 Test Method for Measuring the Comparative Burning Characteristics of Solid Plastics in a Vertical Position
D4591 Test Method for Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry
D6751 Specification for Biodiesel Fuel Blendstock (B100) for Middle Distillate Fuels

[1] This specification is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.07 on Electrical Insulating Materials.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

D7869 Practice for Xenon Arc Exposure Test with Enhanced Light and Water Exposure for Transportation Coatings
E176 Terminology of Fire Standards

2.2 *UL Standards:*[3]
UL 94 Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
UL 746B Standard for Polymeric Materials—Long Term Property Evaluations
UL 1581 Reference Standard for Electrical Wires, Cables, and Flexible Cords
UL 2556 Standard Wire and Cable Test Methods

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification associated with electrical and electronic insulating materials, refer to Terminology D1711. For definitions of terms used in this specification associated with plastic materials, refer to Terminology D883. For definitions of terms used in this specification associated with fire issues, refer to Terminology E176.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *encapsulation material*—protective insulation layer used to encapsulate and protect the internal components of a downhole cable.

3.2.1.1 *Discussion*—The encapsulation material layer also provides additional functions, such as component alignment and orientation, which serves to facilitate fastening to the production casing and to improve installation and management. The encapsulation material layer also aids, when needed, for future recovery of the downhole cable.

3.2.2 *internal components*—components residing within tubes contained inside the downhole cable enclosure; they are often cables providing power or communication functions.

3.2.3 *oxygen index (OI)*—the minimum concentration of oxygen, expressed as volume percent, in a mixture of oxygen and nitrogen that will just support flaming combustion of a material initially at 23 °C ± 2 °C under the conditions of this test method. **(Test Method D2863)**

3.2.4 *reprocessed material*—scrap or waste plastic material obtained following a manufacturing process.

3.2.4.1 *Discussion*—Reprocessed material can be post-industrial recycled material (PIR) or post-consumer recycled material (PCR), obtained directly from scrap produced during the manufacturing process or sourced from a plastics recycling facility.

4. Significance and Use

4.1 The materials covered by this specification are fluoropolymer-based materials intended to be used as encapsulation materials for downhole cables.

4.1.1 The fluoropolymer encapsulation materials in this specification are intended to be used for the encapsulants but not for the wires or cables contained within the encapsulants. Fig. 1 provides an illustration of the use of the materials covered by this specification.

4.1.2 The fluoropolymer-based materials to be used for this purpose shall be virgin materials and shall be permitted to contain up to 25 % by weight of reprocessed material (regrind) of the same fluoropolymer type. When reprocessed material is included, it shall be thoroughly mixed with virgin material.

4.1.3 The source of the reprocessed fluoropolymer-based material shall be either postindustrial recycled material or post-consumer recycled material.

4.2 Downhole cables are cables used during the process of injecting chemicals into a well stream in order to assist in the production of oil or gas. This is accomplished using a system of pumps, flat-packs, and valves.

4.3 Cables installed in oil or gas wells are exposed to severe mechanical and chemical conditions. Cable damage during run-in and subsequent completion processes such as hydraulic fracturing can lead to premature cable failures.

4.4 Encapsulation is the provision of a protective insulative layer that surrounds and protects the internal components of a downhole cable. In addition, encapsulation provides additional functions, which can include, but are not limited to, alignment and orientation of components, so as to facilitate fastening to the production casing. Encapsulation can also potentially improve management of the production casing as well as installation, and, when needed, future recovery.

4.5 Production casing is a large diameter pipe assembled and inserted into a recently drilled section of a borehole.

4.6 Flatpacks are assemblies of small diameter metal tubes and other components held together by an encapsulation material layer. Components of the assemblies include, but are not limited to, various types of cables, as described in Annex A1. The various components of a flatpack are normally oriented in a parallel fashion, and the encapsulation material is applied to the outer layer, typically a rectangular cable.

4.7 The specific applications of the encapsulation materials covered by this specification are described in Annex A1.

4.8 This is a specification for electrical insulating materials intended for specific applications as encapsulation materials. Processing of any material into a product, including those covered by this specification, is likely to have a significant effect on performance. Thus, additional requirements above those outlined in this specification will be potentially needed for individual applications.

5. Properties of Encapsulation Materials

5.1 The encapsulation material shall consist of a fluoropolymer-based material.

5.2 The fluoropolymer-based material shall comply with encapsulation material property requirements in Section 7. Tests shall be performed with the encapsulation material as shown below:

5.2.1 Test the unaged encapsulation material for melting point, tensile strength at break, tensile elongation at break, and flammability (7.1).

[3] Available from Underwriters Laboratories (UL), UL Headquarters, 333 Pfingsten Road, Northbrook, IL, 60062, http://www.ul.com.