COOLING TECHNOLOGY INSTITUTE

CTI CODE TOWER
Standard Specifications

Thermoplastic Materials Used for Film Fill, Splash Fill, Louvers And Drift Eliminators

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This guideline document summarizes the best current state of knowledge regarding the specific subject. This document represents a consensus of those individual members who have reviewed this document, its scope and provisions. It is intended to aid all users or potential users of cooling towers.

Approved by the CTI Executive Board

This document has been reviewed and approved as part of CTI's Five Year Review Cycle. This Document is again subject to review in 2015.

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CTI Standard Specification for Thermoplastic Materials Used for Film Fill, Splash Fill, Louvers And Drift Eliminators

1.0 SCOPE

1.1 This specification covers the most common thermoplastics used in the manufacture of film fills, splash fills, louvers, drift eliminators, nozzles and other small components for use in standard cooling tower application and the physical properties, burning properties and recommended testing procedures employed to determine the defined values, whether processed from virgin or reground material.

1.2 Materials covered by this standard are polyvinyl chloride; hereafter called PVC; chlorinated polyvinyl chloride hereafter called CPVC; heat elevated PVC hereafter called HPVC; Polypropylene hereafter called PP; and high density polyethylene hereafter called HDPE.

1.2.1 PVC – used in the manufacture of film fill, splash fill, inlet louvers, and drift eliminators. PVC by its nature has a low flammability risk, is low cost, easily thermoformed and extruded into complex shapes, and is rigid with minimal creep characteristics. PVC is not easily used for injection molded products. PVC has been the overwhelming material of choice for the aforementioned cooling tower components.

1.2.2 CPVC – used in the manufacture of film fill and drift eliminators. CPVC will add about 30°F (16.67C) the heat distortion temperature of PVC so is it used for high temperature applications. CPVC is self-extinguishing and can be thermoformed. CPVC is much more expensive than PVC and can have embrittlement problems. CPVC and blends of CPVC are more susceptible to U.V. degradation and once exposed to U.V. will continue to degrade and lose impact resistance. Only select these products when PVC, HPVC, are absolutely unsuitable, and expect a material with much lower impact resistance and therefore a shorter useful life.

1.2.3 HPVC – used in the manufacture of film fills and drift eliminators, HPVC has a higher heat distortion temperature than PVC but lower than CPVC. HPVC is self-extinguishing and can be thermoformed. HPVC does not have the embrittlement problems of CPVC and will add about 15°F (8.33C) to the heat distortion to the heat distortion temperature of PVC.

1.2.4 PP – used in the manufacture of injection-molded products such as splash grids and thermoformed film fills. It is also used in other smaller components, such as nozzles. Due to its highly flammable properties caution should be used in applying this material in large quantities in application such as fill. PP material can be formulated to reduce flammability and in some cases designed to meet an E84 flame spread rating of 25 or less. Refer to section 2.1. The use of PP may require the cooling tower be designed with a sprinkler system due to its flammability. PP can not be solvent or adhesively bonded so for products requiring assembly; the design must include an alternate means to assemble. PP has a higher heat deflection than PVC and can add 15°F (8.33C) to the distortion temperature if properly formulated to include fillers to add stiffness. PP inherently is softer and more susceptible to creep factors when loaded. Copolymers are much tougher and will impart better impact resistance to the part. PP has a density approximately 35% less than PVC and should be supplied in a thickness that allows the same overall part strength. However, the product shape or geometry also imparts physical attributes that may add strength to the product and must be taken into consideration as well as how thickness affects weather ability.

1.2.5 HDPE – used in the manufacture of injection-molded products extruded splash fill products. Due to its highly flammable properties caution should be used in applying this material in large quantities in applications such as fill. HDPE material can be formulated to reduce flammability and in some cases designed to meet an E84 flame spread rating of 25 or less. Refer to section 2.1. The use of HDPE may require the cooling tower to be designed with a sprinkler system due to its flammability.

1.3 Plastic film thickness is intrinsic to the weather ability and durability of the finished product, but not the only indicator of the suitability of the product. Material formulation, product configuration geometry and other properties all have an engineering value in determining the strength of the product. A standardized method for specifying and measuring film thickness is described.

2.0 Physical Properties of Plastics used for Cooling Tower Applications.

Listed below are properties and values for materials to be used to manufacture film fills, louvers, splash fill and drift eliminators.

2.1

MINIMUM PROPERTIES	ASTM TEST METHOD	PVC, HPVC, CPVC (MIN. VALUES)	HIGH DENSITY POLYETHYLENE (HDPE) (MIN VALUES)	POLYPROPYLENE (MIN VALUES)
Tensile Strength at yield	D638/D882	5,500 psi (37.9 MPa)	4,000 psi (27.58 MPa)	3500 psi (24.1 MPa)
Flexural strength	D790	10,000 psi (68.9 MPa)	N/A	N/A
Flexural modulus	D790	350,000 psi (2413 MPa)	160,000 psi (1103 MPa)	160,000 psi (1103 MPa)
Impact resistance - Gardner	D4226 Proc. B	1.2 in-lbs/mil (5.34 j/mm)	N/A	N/A
Impact resistance - notched Izod	D256	N/A	0.5 ft-lb/in (0.27 J/cm)	0.5 ft-lb/in (0.27 J/cm)
Heat deflection temperature at 264 psi (1.82 mPa)	D648 (annealed)	160°F (71°C) PVC 175°F (79.4°C) HPVC 195°F (90.6°C) CPVC	130°F (54.4°C)	140°F (60°C)
Heat deflection temperature at 66 psi (0.455 mPa)	D648 (annealed)	N/A	176 °F (80°C)	180°F (82.2°C)
Flammability	E84	25 or less FSI Maximum value	< 25 Maximum value	< 25 Maximum value

- The ASTM E84 test is a standardized procedure for testing and measuring the relative differences in the burning characteristics of different materials. However this ASTM test procedure does not standardize the size, thickness, orientation, etc of the sample which can yield significantly different results. It is the recommendation of this committee that when testing according to ASTM E84 that it is a requirement that a standardized sample and orientation should be used, and that the sample is a single continuous unbroken 25ft (7.62m) or that the samples are overlapped by at least 4in (10.16cm), nesting or inter-weaving the sheets or part to eliminate breaks in the tunnel length direction. The samples should be oriented so that the part length is parallel to the air flow in the tunnel length, be 4in (10.16cm) tall unless the normal height is less and then the sample should be its standard height and 21in (53.34cm) wide which is the full width of the test tunnel.
- Testing of materials that melt, drip, or delaminate to such a degree that the continuity of the flame front is destroyed, results in low flame spread indices that do not relate directly to indices obtained by testing materials that remain in place. For this reason, values obtained on these materials that melt, drip, or delaminate to such an extent to destroy the flame front are not acceptable tests and values to meet the E84 requirements described in the table above.

2.2 CPVC

For cooling tower applications where either steady state or transient temperature conditions preclude the use of PVC or HPVC material, the designer may specify CPVC, which is blended with PVC. These polymers may be blended and formulated to produce materials with a continuous range of heat distortion temperatures. For the purpose of standardization, a value of 190°F (87.8°C) is specified as the minimum average temperature for the heat distortion (264 psi (1.82m Pa), D648 annealed) of a blend of CPVC and PVC. Materials formulated to this property will possess adequate elevated temperature strength for most applications that exceed the useful working range of PVC which is approximately 130°F (54.4°C) HPVC which is approximately 150°F. (66°C). The strength, stiffness, and impact resistance of the blend shall meet the minimum average values specified for PVC materials.

It is recommended that all parties concerned with the design of a tower who supply CPVC blended products assess any high temperature condition to ensure that material formulated to the standardized heat distortion temperature of 190°F is adequate.

For unusual requirements, the blend and formulation can be adjusted to yield higher heat distortion temperatures, approaching that of materials basically free of PVC.

Polypropylene and HDPE may also be formulated to provide a material with a higher heat deflection temperature equal to or greater than CPVC.

3.0 Explanation of Material Properties

3.1 Tensile Strength – The breaking strength of a material when subjected to tensile force.

3.2 Elastic Modulus – This is a measure of the ratio of stress to strain in tensile or flexural where a strained product can recover its size and shape after deformation.

3.3 Flexural strength – These properties help describe the resistance of material to deformation when the material is in a bending situation. This is most applicable to a modular fill design where weight must be supported. This is the breaking strength of a material when subjected to a bending force.

3.4 Impact Strength – This is a measure of the "toughness" of a material determined by the energy required to break a specimen in one impact.

3.5 Heat Distortion – This measures the resistance of the product deflection under specific heat and load conditions.

3.6 Flammability – Flammability refers to the comparative burning characteristics of a material under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products or assemblies under actual fire conditions.

4.0 Ultra Violet Light (UV) Resistance

Plastics will degrade over time from exposure to sunlight. The degree of degradation is a function of the climate (intensity of sun), angle and duration of exposure, material thickness, material pigmentation and the exact formulation of the plastic compound.

One effect of exposure will be increased brittleness (lower impact resistance). Plastic compounds can be specifically formulated to resist sunlight for extended periods of time. This resistance adds moderate cost. On the other hand, some sunlight resistance can be achieved relatively inexpensively through pigmentation, which screens UV radiation from destroying the plastic molecules. This type of UV resistance is probably adequate for most cooling tower applications.

5.0 Standardized Film Thickness Specification for Film Fill and Thermoformed Drift Eliminators

5.1 Specified film sheet thickness shall be based on an average and a minimum thickness after forming, as well as a raw material starting thickness before forming. All three specified thicknesses are required and will be the basis for the acceptance of the measurements as defined below.

5.2 A minimum of 50% of the measurements must be greater than or equal to the arithmetic average thickness after forming.

5.3 A minimum of 90% of the measurements must be greater than or equal to the minimum thickness after forming.

5.4 Measurements should be representative of the product and present a fair sampling of the overall geometry.



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