TUF-FLEX®
DIAMOND PATTERN COATED THIN INSULATION

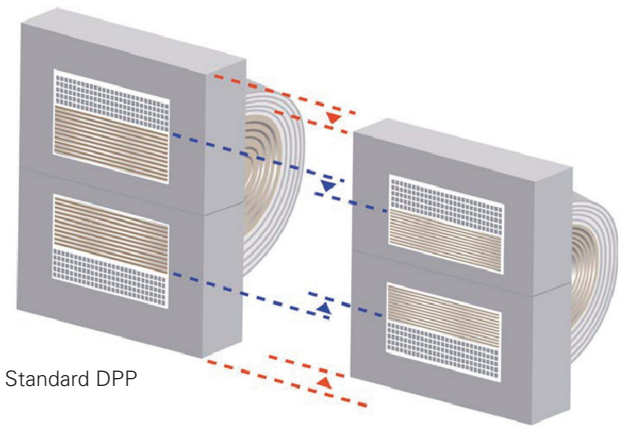
TUF-Flex® is a thin diamond pattern coated insulation paper with 20 % MD elongation that provides the highest level of mechanical performance for layer insulation in distribution transformers. Developed by Weidmann engineers specifically for use as LV foil winding layer insulation, TUF-Flex® allows the distribution transformer design engineer to replace thicker LV insulation papers with thin TUF-Flex®, which in turn results in a smaller, lighter, and less expensive coil with lower losses and increased efficiency.

CHALLENGES FOR DISTRIBUTION TRANSFORMER MANUFACTURERS

- High and Fluctuating Prices of Active Materials: Copper, Aluminum, and Core Steel
- Competitive Pressures Driving Down Transformer Prices
- Constant Need to Reduce Costs
- Growing Requirements to Increase Transformer Efficiency

PRODUCT APPLICATION

TUF-Flex® is designed to be used in applications where mechanical constraints force the use of thicker insulation. Its superior mechanical properties allow thicker or multi-layer conventional papers to be replaced with thinner, stronger TUF-Flex®. A typical application is as layer insulation in the Low Voltage (LV) windings of distribution transformers.



HOW IT WORKS

- **TUF-Flex® Makes a Smaller Coil**
  Thinner LV winding layer insulation reduces coil radial build - without any design changes. A smaller coil radial build shrinks the Mean Turn Length (MTL) of the coil, therefore reducing the amount of conductor and paper required, and ultimately saving money. In addition, a smaller MTL also means lower load losses, which contributes to better transformer efficiency.

- **TUF-Flex® Enables a Better-Shaped and More Accurate Coil**
  TUF-Flex® can handle a high amount of tension during winding. Thinner sheet conductors wound at a high amount of tension conform better to the shape of the winding mandrel. TUF-Flex®, when wound together with thinner sheet conductors at a high amount of tension, will yield a better-shaped, more accurate coil with lower dimensional tolerances, enabling further optimization and cost savings.

- **TUF-Flex® Enables a Smaller Core**
  Shrinking the coil, with thinner LV winding layer insulation and lower dimensional tolerances, creates extra clearance in the core window. A simple redesign to narrow the core window allows the core to be made smaller. The amount of core steel is reduced, saving the OEM even more money. In addition, less core steel also means lower no-load losses, further improving transformer efficiency.

- **TUF-Flex® Enables a Smaller Tank and Less Oil**
  With a smaller core and coil, tank size and oil volume can also be reduced, maximizing the savings possibilities with thin, strong TUF-Flex®.

- **TUF-Flex® Improves Coil Cooling**
  As cellulose paper is a thermal barrier, thinner TUF-Flex® enables better heat transfer. This allows coils to cool more efficiently, and reduces coil operating temperatures.

- **TUF-Flex® Dries and Impregnates More Quickly**
  With less mass of cellulose and corresponding less mass of water at ambient conditions before processing, thinner TUF-Flex® has been found to enable coils to dry and oil impregnate more quickly, increasing productivity.

WEIDMANN

TYPICAL VALUES (metric)

Thickness	inch mm	0.002 0.051	0.003 0.076	Standard
Basis Weight	g / m^2	63	86	ASTM D202 (ASTM D646)
Apparent Density	g / cm^3	0.95 - 1.15		Calculated
Moisture Content	%	4-7		ASTM D202 (ASTM D644)
pH Water Extract	-	6 - 8		TAPPI T435 (ASTM E70)
Ash Content	% max	1		ASTM D202 (ASTM D586)
Nitrogen Content	% by weight	1.3 - 2.6		ASTM D982
Elongation (MD)	% min	15		ASTM D202
Tensile Strength (MD)	kN / m	7	10	(ASTM D76)
TEA (MD)	kJ / m^2	0.7	1.0	
Conformability *	Nmm	270	340	Weidmann
Bond Strength**	N / cm^2, min	28		Weidmann
Breakdown Strength AC (oil)	kV / mm	75	72	ASTM D202 (ASTM D149)

All data shown in Table represents Typical Values only unless specifically stated differently.

* Conformability Test - Special Test by Weidmann.

** Bond Strength Test - Special Quality Test by Weidmann.

BENEFITS

By replacing thicker or multi-layer conventional papers with thinner, stronger TUF-Flex®, distribution transformer manufacturers have observed the following benefits:

- Material Savings (Conductor, Core Steel, Tank, and Oil)
- Overall Unit Size and Weight Reduction
- Reduced Losses and Increased Transformer Efficiency
- Lower Total Owning Costs (Bid More Competitively)
- Better-Shaped, More Accurate Coils
- Coil Temperature Reduction
- Faster Dry-out and Oil Impregnation (Increased Productivity)

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