3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating

Information, Properties and Test Results

3M

Table of Contents

3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating

1 - Introduction

The cost of the coating is only a small fraction of the cost of a tubing string, yet the coating is the major means of assuring extended operation by preventing deterioration and service disruption due to corrosion loss. 3M™ Scotchkote™ Fusion Bonded Epoxy Coatings represent a significant improvement in internal coating technology for the oil, gas and water industries.

2 - Description

Scotchkote 134 fusion bonded epoxy coating is a one - part, heat curable, thermosetting epoxy coating designed for corrosion protection of metal. The epoxy is applied to preheated steel as a dry powder which melts and cures to a uniform, coating thickness. This bonding process provides excellent adhesion and coverage on applications such as valves, pumps, pipe drains, hydrants and porous castings. Scotchkote 134 FBEC assistant to waste water, corrosive soils, hydrocarbons, harsh chemicals and sea water. Powder properties allow easy manual or automatic application by electrostatic or air - spray equipment. When applied over a suitable primer, it is appropriate for operation at moderate temperatures and pressures in the presence of H_2O, CO_2 and CH_4, crude oil and brine.

Scotchkote 134 FBEC consists of a blend of epoxy resin and curing agent additives, pigments, catalysts, leveling and flow control agents. Possible combinations of raw materials are extensive; hence careful selection has been made by 3M so that the resultant coating will serve in the environment encountered. Scotchkote 134 FBEC has been designed to allow trouble - free, consistent production application at the coating plant. Selection of the chemical elements for the fusion bonded epoxy coating is very important. The molecular structure of the epoxy resin, the type and reactivity of the hardener, catalyst and additives all play an important role in the ultimate coatability and performance of the fusion bonded epoxy.

3M Company maintains a divisional laboratory group dedicated to the research and development of fusion bonded epoxy coating. The group's personnel have many years of experience in the formulation and evaluation of epoxy coatings. This effort is assisted by 3M staff laboratories with broad - based expertise in scientific disciplines applicable to coating and surface technology. In addition, 3M synthesizes and manufactures specialized epoxy resins, hardeners, catalysts and additives used to formulate Scotchkote FBE coatings to meet unusual performance and operational requirements.

3 - History

Scotchkote 134 FBEC has been used extensively in the oil and gas industry to coat the exterior and interior of line pipe. Over 40,000 miles (65,000 km) of Scotchkote coated pipe have been installed thoughout the world. This technology has been expanded through 3M research to develop chemically stable, high temperature/pressure resistant internal linings for use in drill pipe, primary and secondary recovery tubing, and pipe for oil, gas and water transportation. Coating properties have been proven by rigorous 3M autoclave testing, and the results verified by independent laboratory and customer investigation.

4 - Manufacturing

All Scotchkote fusion bonded epoxy coating powders are made using the fusion blend process developed by 3M. Ingredients are first pulverized, properly proportioned and homogeneously dry mixed. Next, the blended materials are carefully and thoroughly mixed in the molten state using a continuous melt mixer. The fused blend is cooled and then pulverized into the final powered form. Particle size distribution is carefully monitored to meet optimum application standards required by the various coating plants. The fusion blend process assures that each particle of the coating powder contains all active ingredients, thus eliminating changes in reactivity due to separation or stratification of ingredients during transportation and application.

5 - Process and Quality Control

Process control is essential to the quality of the finished product. 3M maintains rigid incoming quality inspection of raw materials, precise measurement and metering of critical components, controlled environmental conditions and processing temperatures for the chemical constituents, and a discerning outgoing inspection of the finished coating powder to assure uniformity of product application and performance. Among the quality control tests performed on 3M powder coatings are: gel time, cure, flow, fluidization, particle distribution, adhesion, impact, appearance and moisture content.

6 - Packaging, Storage and Shipping

Scotchkote 134 FBEC is packaged in a heavy duty, polyethylene bag in a stout, easy open, fiberboard carton which is clearly labeled with product number and manufacturing identification. This package protects the coating powder from humidity and contamination during shipment and storage. The net weight is 65 U.S. lbs. (29.5 kilos). The sealed cartons are palletized on wooden pallets with net weight of 1170 lbs. (530 kilos) and securely banded for shipment. The packaged product must be shipped and stored at temperatures not exceeding 80˚F (27˚C).

7 - Properties of the Powder

3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating

Property	Test Method	Value
Classification	ASTM D 1763	Type 1, Grade 2
Color	–	Forest Green
Gloss	Gardener 60˚ gloss meter, 350˚ (177˚C) application temperature	34 average
Specific Gravity (Powder)	Air Pycnometer	1.51
Coverage	Calculated from air pycnometer specific gravity of powder	125 ft^2/lb/mil 0.66 m^2/kg/mm
Gel time at 400˚F (204˚C)	Hot plate	120 sec average
Glass Plate Pill Flow	3M glass slide 300˚F (149˚C) 12 mm diameter, 0,85 gram pill, 1 min horizontal, 15 min. at 63˚ angle	75 - 100 mm average flow
Moisture Content at time of manufacture	Carl Fischer	<0.3%
Particle size	Alpine sieve analysis	>177 µm 1% <44 µm 45 - 55%
Heat of Polymerization	Differential Scanning Calorimeter	70 J/gm typical
Glass Transition Temperature of Cured Coating	Differential Scanning Calorimeter (midpoint)	107˚C (225˚F) typical

8 - Properties of the Coating

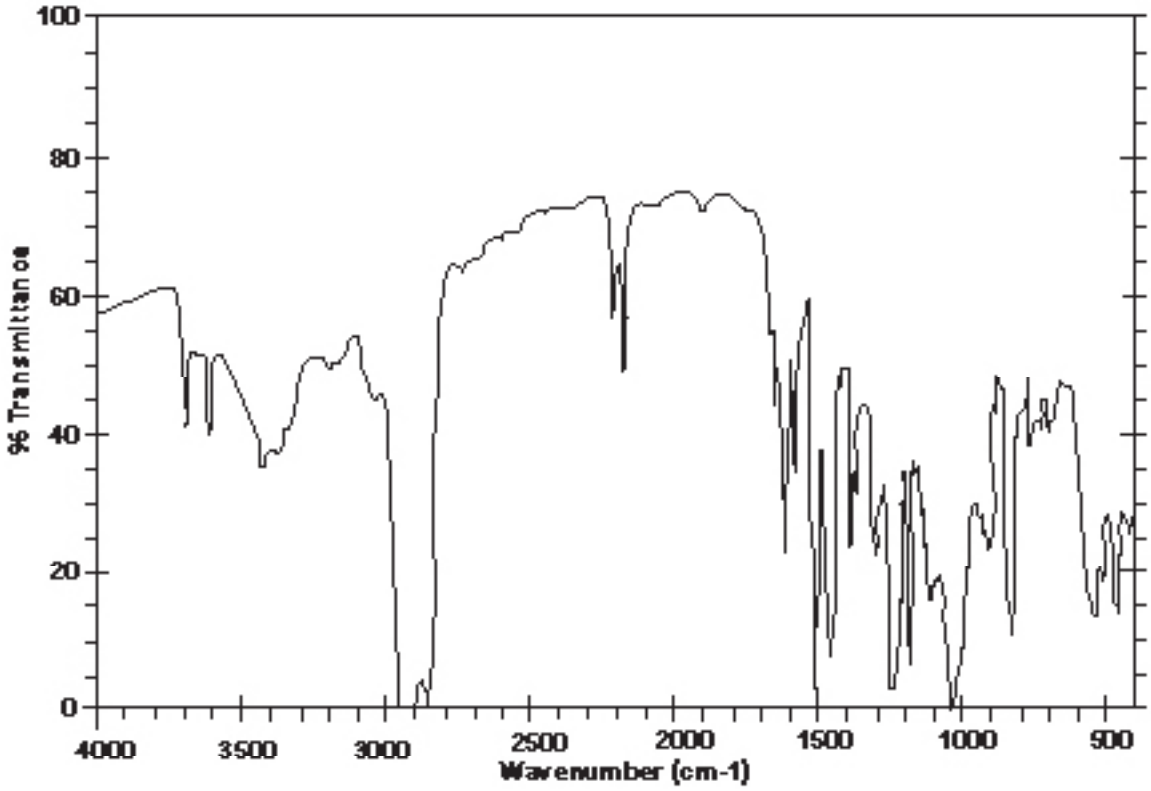
All tests have been conducted at 73˚F (23˚C) on unprimed surfaces unless otherwise noted.

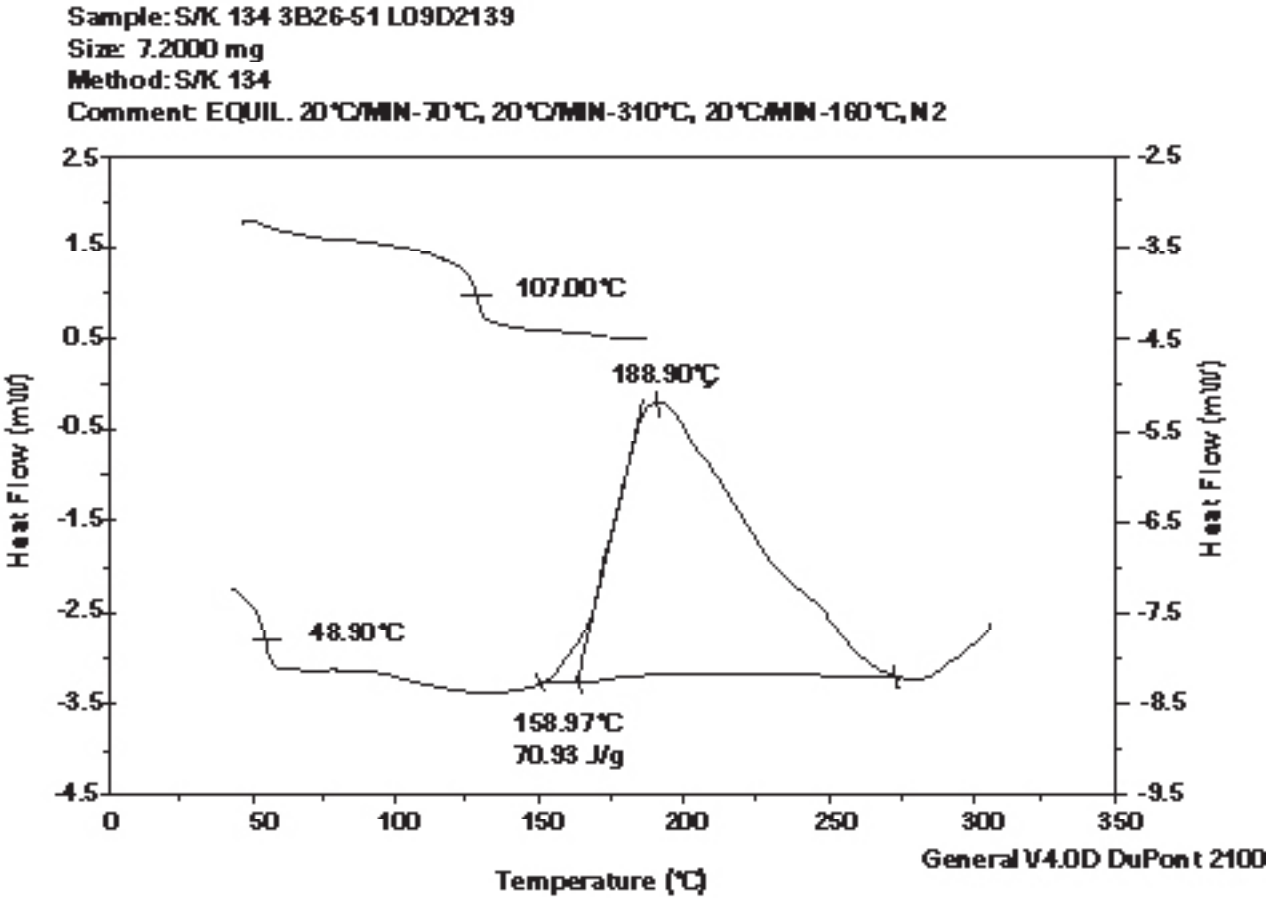
8.1 Hardness

Property	Test Method	Test Results
Hardness	Barcol, ASTM D 2583	23
	ASTM D 785	89
	Rockwell M	55

8.2 Tensile Strength

Property	Test Method	Test Results
Tensile Strength	ASTM D 2370	7300 psi
	free film	513 kg/cm2


100
80
60
40
20
0
% Transmittance
4000
3500
3000
2500
2000
1500
1000
900
Wavenumber (cm-1)


Sample: S/K 134 3B26-51 L09D2139
Size: 7.2000 mg
Method: S/K 134
Comment: EQUIL. 20°C/MIN-70°C, 20°C/MIN-310°C, 20°C/MIN-160°C, N2
2.5
1.5
0.5
-0.5
-1.5
-2.5
-3.5
-4.5
Heat Flow (mW)
-2.5
-3.5
-4.5
-5.5
-6.5
-7.5
-8.5
-9.5
Heat Flow (mW)
107.00°C
188.90°C
48.90°C
158.97°C
70.93 J/g
0
50
100
150
200
250
300
350
Temperature (°C)
General V4.0D DuPont 2100

8.3 Elongation

Property	Test Method	Test Results
Elongation	ASTM D 2370 free film	4.2%

8.4 Impact Resistance

Property	Test Method	Test Results
Impact	Gardener, 5/8 in. (16 mm) diameter tup, 0,125 in (3.2 mm) panel	160 in - lbs. 18,1 J

8.5 Adhesive Strength

Property	Test Method	Test Results
Shear	ASTM D 1002, 10 mil (254 µm glue line)	4300 psi 302 kg/cm^2

8.6 Penetration Resistance

Property	Test Method	Test Results
Penetration	ASTM G 17 - 40˚ to 240˚F (- 40˚ to 116˚C)	0
Compression strength	ASTM D 695	12800 psi 900 kg/cm^2

8.7 Bendability

Property	Test Method	Test Results
Bend	3/8 in. (9,5 mm) primed and unprimed coupon mandrel bend	Pipe Dia.=30 Elongation (%)=17 Angle of Deflection (˚/PDL) =1.9

8.8 Coefficient of Friction

Property	Test Method	Test Results
Coefficient of Friction	API RP5L2 - 1968 Appendix 8	23˚C

8.9 Thermal - Mechanical

Property	Test Method	Test Results
Thermal Conductivity	MIL - I - 16923E	7x10 - 4 cal/sec/cm2/C˚/cm
Thermal Shock	3M, 10 cycles - 100˚ to 300˚F (- 70˚ to 150˚C)	Unaffected by thermal shock

8.10 Volume Resistivity

Property	Test Method	Test Results
Volume Resistivity	ASTM D 257	1.2×10^{15} ohm•cm

8.11 Electric Strength

Property	Test Method	Test Results
Electric Strength	ASTM D 149	1000 V/mil 40 kV/mm

8.12 Weathering Resistance

Property	Test Method	Test Results
Weathering Resistance	Weatherometer ASTM G 53, 5000 hrs. Condensation test temp. 50˚C Cycle time 4 hours UV/ Four hours condensation	Surface chalk No blistering
Salt Fog	MIL - E - 5272C	No blistering No discoloration No loss of adhesion

8.13 Cathodic Disbondment Resistance

Property	Test Method	Test Results
Cathodic Disbondment Resistance	30 day, 5 volt 5% NaCl, sand crock 230˚F (110˚C)	Disbondment radius 24 mmr average
	4 day 3 volt 3% NaCl 71˚C (160˚F)	5 mmr average

8.14 Moisture Resistance

Property	Test Method	Test Results
Water Immersion	ASTM D 570 free film, 30 day 10 mil (250 mm)	6,5 g/m 2 weight gain

Notes on Autoclave Testing

Notes: All tests conducted on coatings applied over 1 mil (25.4 µm) liquid phenol primer.

'Pass' means excellent adhesion, no blisters, no swelling in a phases, i.e.: aqueous, hydrocarbon or gas phase.
'Fail' means loss of adhesion, or blisters, or excessive swelling in any phases.

8.15 Autoclave Testing

Property	Test Method	Test Results
Pressure / Temperature Duration	1500 psi (10.3 MPa) 120˚F (49˚C) 24 hours	Excellent adhesion, no coating loss or blisters in aqueous, hydrocarbon or gas phase
Gas Phase	99.5% CO_2 0.5% H_2S	
Liquid Phase	33.0% Kerosene 33.0% Toluene 34.0% Brine Solution (5% NaCl)	
Discharge	Discharge Rapid at Test Temperature	

Autoclave Test #1

Property	Test Method	Test Results
Pressure/Temperature Duration	5 psi (0.03 MPa) 68˚F (20˚C) 72 hours	Pass
Gas Phase	100% H_2S	
Liquid Phase	Turks Island Sea Water	
Discharge	Release pressure over 5 min. @ test temperature	

Autoclave Test #2

Property	Test Method	Test Results
Pressure/Temperature Duration	60 psi (0.4 MPa) 150˚F (66˚C) 24 hours	Pass
Gas Phase	100% CO_2	
Liquid Phase	5% NaCl Brine	
Discharge	Release pressure over 1/2 hour period @ test temperature	

Autoclave Test #3

Property	Test Method	Test Results
Pressure/Temperature	450 psi (3.1 MPa)	Pass
Duration	185˚F (85˚C) 24 hours	
Gas Phase	15% CO_2 84.9% N_2 0.1% H_2S 71˚C (160˚F)	
Liquid Phase	Deionized Water Crude Oil	
Discharge	Release pressure over 5 min. @ test temperature	

Autoclave Test #4

Property	Test Method	Test Results
Pressure/Temperature	2000 psi (13.8 MPa)	Pass
Duration	200˚F (93˚C) 16 hours	
Gas Phase	5% CO_2 94.5% Methane 0.5% H_2S	
Liquid Phase	5% NaCl Brine	
Discharge	Cool for 4 hours then rapidly release pressure	

Autoclave Test #5

Property	Test Method	Test Results
Pressure/Temperature	3300 psi (22.8 MPa)	Pass
Duration	200˚F (93˚C) 24 hours	
Gas Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Liquid Phase	8% CO_2 86% Methane 6% H_2S	
Discharge	Cool overnight to ambient release pressure over 1/2 hr. period	

Autoclave Test #6

Property	Test Method	Test Results
Pressure/Temperature	2500 psi (17.2 MPa)	Pass
Duration	200˚F (93˚C) 24 hours	
Gas Phase	10% CO_2 90% N_2	
Liquid Phase	Wasia Water	
Discharge	Release pressure over 1/2 hr. period @ test temperature	

Autoclave Test #7

Property	Test Method	Test Results
Pressure/Temperature	1500 psi (10.3 MPa)	Pass
Duration	120˚F (49˚C) 48 hours	
Gas Phase	95.5% CO_2 0.5% H_2S	
Liquid Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Discharge	Instant pressure release @ test temperature	

Autoclave Test #8

Property	Test Method	Test Results
Pressure/Temperature	35 psi (0.2 MPa)	Pass
Duration	200˚F (93˚C) 24 hours	
Gas Phase	Air	
Liquid Phase	15% HCl	
Discharge	Force cool to ambient release pressure over 5 min. period	

Autoclave Test #9

Property	Test Method	Test Results
Pressure/Temperature	2200 psi (15.2 MPa)	Pass
Duration	150˚F (66˚C) 24 hours	
Gas Phase	12% CO_2 80% Methane 8% H_2S	
Liquid Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Discharge	Release pressure over 1/2 hr. period @ test temperature	

Autoclave Test #10

Property	Test Method	Test Results
Pressure/Temperature	4000 psi (27.5 MPa)	Pass
Duration	225˚F (107˚C) 24 hours	
Gas Phase	100% CO_2	
Liquid Phase	5% NaCl Solution saturated with H_2S	
Discharge	Cool to ambient release pressure over 45 sec.	

Autoclave Test #11

Property	Test Method	Test Results
Pressure/Temperature	150 psi (1.0 MPa)	Pass
Duration	250˚F (121˚C) 24 hours	
Gas Phase	25% $C0_2$ 55% H_2S 10% Methane 10% N_2	
Liquid Phase	28% NaCl Solution	
Discharge	Cool for 2 hours release pressure over 15 min.	

Autoclave Test #12

Property	Test Method	Test Results
Pressure/Temperature	3000 psi (20.7 MPa)	Slight swell
Duration	300˚F (149˚C) 24 hours	
Gas Phase	10% $C0_2$ 90% Methane Trace H_2S	
Liquid Phase	34% Brine (5% NaCl) 33% Kerosene 33% Toluene	
Discharge	Cool to 104˚F (40˚C) release pressure over 1/2 hr.	

8.16 Taste and Odor Production Potential

Property	Test Method	Test Results	
		TON	
		5 days	10 days
Threshold Odor Number (TON) (Ton of 10 or less is passing)	20˚C	1	1
	60˚C	1	1
		Results: Pass Type Odor: None	

8.17 VOC Production Potential

Property	Test Method	Test Results
VOC Analysis	5 day soak cycle	Pass. Appears clean and free of significant VOC contamination

3M is a trademark of 3M Company.

Important Notice

All statements, technical information, and recommendations related to 3M's products are based on information believed to be reliable, but the accuracy or completeness is not guaranteed. Before using this product, you must evaluate it and determine if it is suitable for your intended application. You assume all risks and liability associated with such use. Any statements related to the product which are not contained in 3M's current publications, or any contrary statements contained on your purchase order shall have no force or effect unless expressly agreed upon, in writing, by an authorized officer of 3M.

Warranty; Limited Remedy; Limited Liability.

This product will be free from defects in material and manufacture for a period of one (1) year from the time of purchase. **3M MAKES NO OTHER WARRANTIES INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE**. If this product is defective within the warranty period stated above, your exclusive remedy shall be, at 3M's option, to replace or repair the 3M product or refund the purchase price of the 3M product. **Except where prohibited by law, 3M will not be liable for any indirect, special, incidental or consequential loss or damage arising from this 3M product, regardless of the legal theory asserted.**

3M

Corrosion Protection Products
6801 River Place Blvd.
Austin, TX 78726-9000
http://www.3M.com/corrosion

Please recycle. Printed in USA.

80-6111-8429-4-B