

**3M**

**Scotchkote™**

**134 Fusion Bonded Epoxy Coating**

Information, Properties and Test Results

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# 3M™ Scotchkote™ 134 Fusion Bonded Epoxy Coating

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## 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<sub>2</sub>O, CO<sub>2</sub> and CH<sub>4</sub>, 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 throughout 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 powdered 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 <sup>2</sup> /lb/mil 0.66 m <sup>2</sup> /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

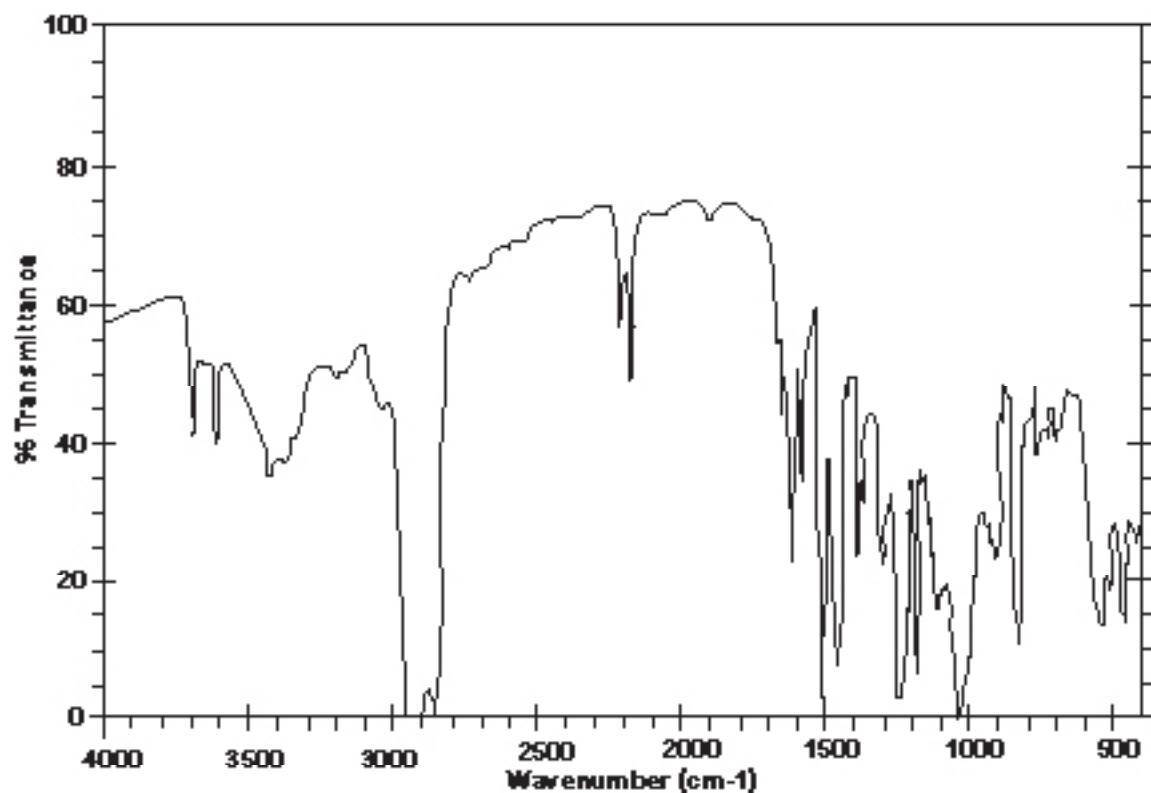
All tests have been conducted at 73°F (23°C) on unprimed surfaces unless otherwise noted.

### 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/cm <sup>2</sup>

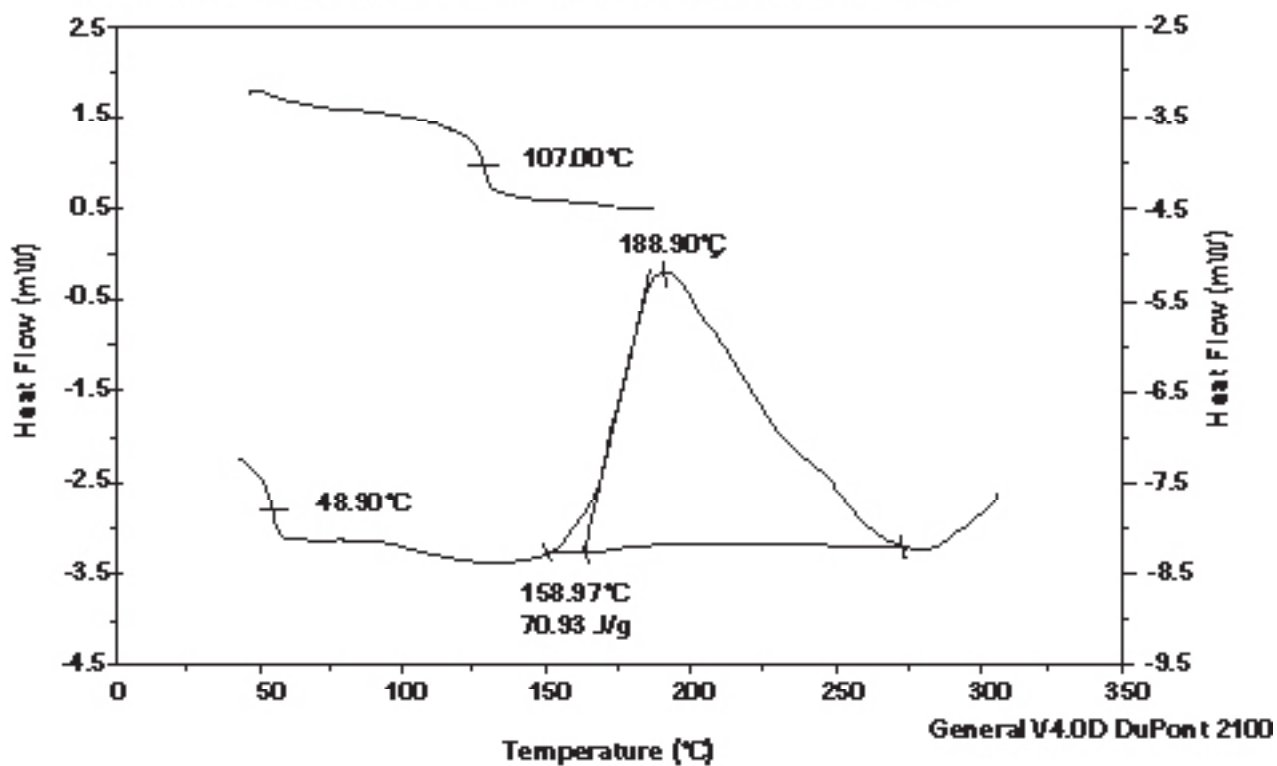


Sample: S/K 134 3B26-51 L09D2139

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



### 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 <sup>2</sup>

### 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 <sup>2</sup>

### 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	$1.2 \times 10^{15}$ 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.	Surface chalk
	Condensation test temp. 50°C Cycle time 4 hours UV/ Four hours condensation	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 10 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 <sub>2</sub> 0.5% H <sub>2</sub> S	
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 <sub>2</sub> S	
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 <sub>2</sub>	
Liquid Phase	5% NaCl Brine	
Discharge	Release pressure over 1/2 hour period @ test temperature	

**Autoclave Test #3**

<b>Property</b>	<b>Test Method</b>	<b>Test Results</b>
Pressure/Temperature	450 psi (3.1 MPa)	Pass
Duration	185°F (85°C) 24 hours	
Gas Phase	15% CO <sub>2</sub> 84.9% N <sub>2</sub> 0.1% H <sub>2</sub> S 71°C (160°F)	
Liquid Phase	Deionized Water Crude Oil	
Discharge	Release pressure over 5 min. @ test temperature	

**Autoclave Test #4**

<b>Property</b>	<b>Test Method</b>	<b>Test Results</b>
Pressure/Temperature	2000 psi (13.8 MPa)	Pass
Duration	200°F (93°C) 16 hours	
Gas Phase	5% CO <sub>2</sub> 94.5% Methane 0.5% H <sub>2</sub> S	
Liquid Phase	5% NaCl Brine	
Discharge	Cool for 4 hours then rapidly release pressure	

**Autoclave Test #5**

<b>Property</b>	<b>Test Method</b>	<b>Test Results</b>
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 <sub>2</sub> 86% Methane 6% H <sub>2</sub> S	
Discharge	Cool overnight to ambient release pressure over 1/2 hr. period	

**Autoclave Test #6**

<b>Property</b>	<b>Test Method</b>	<b>Test Results</b>
Pressure/Temperature	2500 psi (17.2 MPa)	Pass
Duration	200°F (93°C) 24 hours	
Gas Phase	10% CO <sub>2</sub> 90% N <sub>2</sub>	
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 <sub>2</sub> 0.5% H <sub>2</sub> S	
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 <sub>2</sub> 80% Methane 8% H <sub>2</sub> S	
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 <sub>2</sub>	
Liquid Phase	5% NaCl Solution saturated with H <sub>2</sub> S	
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% CO <sub>2</sub> 55% H <sub>2</sub> S 10% Methane 10% N <sub>2</sub>	
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% CO <sub>2</sub> 90% Methane Trace H <sub>2</sub> S	
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
Threshold Odor Number (TON) (Ton of 10 or less is passing)	20°C 60°C	TON
		5 days      10 days
		1              1 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

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80-6111-8429-4

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