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Report No. 8926-097

Materials - Laminates - Fiberglass - Polyester Resin
(CFR 474-MA, U. S. Polymetric Chemicals Co.)

Qualification Tests (Mil-P-8013C, Type I)

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Abstract

Fiberglass-polyester resin laminates consisting of twelve plies of No. 181 Volan A fiberglass fabric impregnated with United States Polymeric Chemicals Co., Stamford, Connecticut, CFR 474-MA polyester resin were fabricated by vacuum bag curing under 24 inches of mercury at 275°F for 1 hour. The results of the several tests made with this material are as follows:

1. Room Temperature Conditions

Specific Gravity - 1.98

Resin Content - 34.3%

Barcol Hardness - 70.0

Flexural Flatwise Ultimate Strength, ksi - 67.0

Flexural Initial Modulus of Elasticity, $\text{psi} \times 10^6$ - 3.0

Compression Ultimate Strength, Edgewise, ksi - 47.9

Tensile Ultimate Strength, ksi - 59.5

2. Wet Conditions

Flexural Flatwise Ultimate Strength, ksi - 60.1

Flexural Initial Modulus of Elasticity, $\text{psi} \times 10^6$ - 2.9

Compression Ultimate Strength, Edgewise, ksi - 46.3

Tensile Ultimate Strength, ksi - 56.0

Reference: Gardner, G. E., Jr., Bergstedt, P. W., Turner, H. C.,
"Qualification Test of Laminates of Fiberglass Cloth
No. 181 Volan A With U. S. Polymeric CFR 474-MA Resin,"
Mil-P-8013C, Type I. (Reference attached).

ANALYSIS

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OBJECT:

The qualification to Specification MIL-P-8013C, Type I, of laminates of Fiberglas Cloth No. 181 (CVAC 1000-5) impregnated with U.S. Polymeric CFR 474-MA Resin, manufactured at Convair - San Diego.

CONCLUSION:

Laminates of Fiberglas Cloth No. 181 (CVAC 1000-5) and U.S. Polymeric CFR 474-MA Resin, fabricated by Dept. 129, Convair-San Diego, satisfactorily conformed to minimum mechanical property requirements of Military Specification MIL-P-8013C, Type I.

TEST PANEL:

One panel, 0.125 inch in thickness by 15 inches square, was submitted to the Materials and Processes Laboratory on March 25, 1959, by the fabricator, the Production Plastics Manufacturing Dept. No. 129 of Convair-San Diego.

This laminate was submitted as a wet lay-up, nominally two feet square, consisting of twelve (12) plies of No. 181 glass fabric impregnated with U.S. Polymeric CFR 474-MA Resin.

The laminate was cured by employing the flat vacuum-bag process. Contact pressure was maintained for one hour at 24 inches of mercury; curing temperature was held at $275^{\circ}\text{F} \pm 10^{\circ}\text{F}$. Laminating and curing procedures followed the resin manufacturer's process recommendations.

TEST SPECIMENS:

Ten flexural, ten compression, and ten tensile specimens were machined from the submitted panel with the long direction parallel to the warp direction of the laminate. Prior to testing, five specimens of each type were placed in boiling distilled water for two hours. The second set of five specimens of each type was tested in the standard condition.

PROCEDURE:

The length of each flexural specimen was equal to the span length plus two inches, and the width was three-fourths of an inch. The span length had a constant length/thickness ratio of 16-18 to 1. The specimens were center loaded, and load-deflection data were taken until failure. The speed of testing was regulated to produce a unit rate of outer-fiber strain of 0.010 inch per inch per minute.

Tensile tests were performed in a Tinius Olsen Tensile Machine, and a uniform crosshead travel of 0.05 inch per minute was applied until failure.

Compression specimens were loaded in a compression jig at a speed of 0.05 inch per minute crosshead travel until failure.

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PROCEDURE: (Continued)

The examination for percent of resin content (Method 7061) and specific gravity (5011) and tests of flexural (1031), compression (1021), and tension (1011) properties were in accordance with Federal Specification LP-406B.

Barcol hardness was determined by direct reading with a Barcol Impressor.

RESULTS:

The results of tension, compression, and flexural tests in the standard condition are shown in Table I. The results of tension, compression, and flexural tests on specimens subjected to two hours in boiling distilled water (wet condition) are shown in Table II. The results of observations made on the submitted panel for specific gravity, resin content, and Barcol hardness are shown in Table I.

ANALYSIS

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TABLE I

**QUALIFICATION TEST FOR LAMINATED (1-1)
 GLASS FABRIC MADE WITH U.S. POLYMERIC 774-MA**

BEST OF SEVERAL STANDARD SPECIFICATIONS

SPECIFIC GRAVITY ----- 1.98
ANGLE OF FIBER ----- 34.7
STRENGTH (LONGITUDINAL) ----- 100,000

TYPE OF TEST	SPEC. NO.	MIN. REQUIREMENT	TEST RESULTS
FLEXURAL FLATWISE ULTIMATE STRENGTH, PSI.	1	50,000	61,600
	2		67,400
	3		61,100
	4		62,500
	5		65,000
	AVERAGE		67,600
FLEXURAL INITIAL MODULUS OF ELASTICITY, PSI.	1	2.7 X 10 ⁶	3.1 X 10 ⁶
	2		3.0 X 10 ⁶
	3		2.1 X 10 ⁶
	4		2.9 X 10 ⁶
	5		3.1 X 10 ⁶
	AVERAGE		3.0 X 10 ⁶
COMPRESSION ULTIMATE STRENGTH, EDGewise, PSI.	1	50,000	55,300
	2		42,300
	3		52,000
	4		40,500
	5		47,400
	AVERAGE		47,500
TENSILE ULTIMATE STRENGTH, PSI	1	40,000	59,000
	2		50,200
	3		59,500
	4		60,600
	5		55,000
	AVERAGE		57,500

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TABLE II

QUALIFICATION TEST FOR LAMINATED (121)
 GLASS FABRIC MADE WITH U.S. POLYMERIS 474-MA

TESTED UNDER WET CONDITION

TYPE OF TEST	SPECIM. NO.	MIN. REQUIREMENTS	TEST RESULTS
FLEXURAL FLATWISE ULTIMATE STRENGTH, PSI.	1	45,000	61,800
	2		56,300
	3		63,400
	4		57,600
	5		61,600
	AVERAGE	60,100	
FLEXURAL INITIAL MODULUS OF ELASTICITY, PSI.	1	2.9×10^6	3.0×10^6
	2		2.7×10^6
	3		2.9×10^6
	4		3.0×10^6
	5		3.0×10^6
	AVERAGE	2.8×10^6	
COMPRESSION ULTIMATE STRENGTH EDGewise, PSI.	1	30,000	52,000
	2		43,600
	3		47,100
	4		47,600
	5		39,700
	AVERAGE	46,200	
TENSILE ULTIMATE STRENGTH, PSI.	1	30,000	55,800
	2		54,000
	3		54,500
	4		57,100
	5		53,700
	AVERAGE	56,000	

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