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Soil Burial Tests:

Effect of Soil Burial Exposure on the Properties of Electrical Grade Reinforced Plastic Laminates

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Twenty-three types of unclad laminates based on phenolic, melamine, silicone, epoxy, and polyester resins were examined after exposure in alkaline soil at Roswell, New Mexico, and in acid soil at Bainbridge, Georgia. The laminates have initial insulation resistance values ranging from 1.4 × 10^6 to less than 30 megohms. Each suffers a large decrease in insulation resistance upon exposure. The percentage decrease can be in excess of 90 percent after four years underground exposure in New Mexico or Georgia. Moderate decreases in flexural strengths also were observed.

I. INTRODUCTION

Twenty-three types of unclad laminates based on phenolic, melamine, silicone, epoxy, and polyester resins were examined after exposure in alkaline soil at Roswell, New Mexico, and in acid soil at Bainbridge, Georgia.[1-3] The laminate thickness was 1/16 inch nominal in all cases. Tests were made of insulation resistance, flexural strength, and flexural modulus.

The properties evaluated included:

(*i*) Insulation resistance after conditioning four days at 90 percent relative humidity and 95°F, using a tapered pin method in accordance with ASTM D257. Five replicates for each below-ground exposure condition were tested, each of which provided three readings to give fifteen readings for averaging. Two replicates were measured for each of the shelf-aging specimens, to give six readings for averaging.

(*ii*) Flexural strength and modulus of elasticity in flexure in accordance with ASTM D790. Five replicates for each exposure condition were tested.

(*iii*) The exposed samples were examined visually for deterioration, color change, staining, and overall physical appearance.

II. RESULTS AND DISCUSSION

2.1 *Insulation Resistance*

The laminates included in this study have initial insulation resistance values ranging from 1.4×10^6 megohms to less than 30 megohms. Each suffers a large decrease in insulation resistance upon exposure and the trend of change is similar for all laminates. For this reason, only eight laminates with initial insulation resistance of greater than 1000 megohms are listed in Table I. The laminates possessing high initial IR values still maintain their *numerical* superiority after exposure, although the percentage decrease can be in excess of 90 percent after four years underground exposure in New Mexico or Georgia. The alkaline soil environment is somewhat more detrimental than the acid soil environment. The depth of burial does not appear to be a significant influence on the IR values.

2.2 *Flexural Strength and Flexural Modulus*

Moderate decreases in flexural strengths, about 20 to 30 percent, and in flexural moduli, about 10 to 28 percent, were observed.

2.3 *Biological Attack*

Paper-base phenolic laminates having low resin contents (not listed in Table I) exhibited noticeable biological attack of the core material

TABLE I—AVERAGE PERCENT DECREASE IN INSULATION RESISTANCE

Material	Type	Initial IR, Megohms	4 Years Exposure in Roswell, N.M.		4 Years Exposure in Bainbridge, Ga.	
			6 in	12 in	6 in	12 in
Phenolic-Paper	XXP	11,300	−99	−99	−58	−22
	XXX	8,350	−92	−91	−87	−84
	XXXPC	390,000	−98	−98	−98	−97
	XXXP	212,000	−96	−95	−95	−95
Melamine-Glass	G-5	4,380	−96	−96	−98	−97
Silicone-Glass	G-7	1,510,000	−83	−80	−99	−98
Epoxy-Glass	G-10	616,000	−86	−86	−80	−79
Phenolic-Nylon	N-1	1,720,000	−99	−99	−99	−98

on burial. Many laminates, aged above ground at both locations for the purpose of comparison, showed fungus growth.

REFERENCES

1. Pape, N. R., and Schlabach, T. D., unpublished work.
2. Schlabach, T. D., and Pape, N. R., unpublished work.
3. Pape, N. R., unpublished work.