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Report of

Test of Alsimag Ceramic Insulation  
Nos. 35 and 196.

FR-1351

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## AUTHORIZATION

1. The work herein reported was authorized by Bureau of Engineering letter, reference (a). Other pertinent correspondence is given as references (b) to (f).

Reference: (a) BuEng.let. S67/61/L5(2-12-W8) of 3 Mar. 1937.  
(b) Specifications RE 13A 317F.  
(c) NRL let. S67/61 of 12 Feb. 1936.  
(d) NRL Report No. R-1245.  
(e) American Lava Corp. let. of 16 Feb. 1937 to BuEng.  
(f) NRL Report No. R-1117.

## OBJECT OF TEST

2. The object of the test was to determine if Alsimag ceramic insulation Nos. 35 and 196, manufactured by the American Lava Corporation, comply with specifications, reference (b), for grades F or G insulation, and are suitable for Naval use.

## ABSTRACT OF TEST

3. The loss factor of a number of samples of Alsimag 35 and 196 was determined both before and after the samples had been immersed in water for 96 hours.

4. The moisture absorption of samples of both materials was determined by accurately weighing samples of each, both before and after soaking them in distilled water for 100 hours.

## Conclusions

The following conclusions are arrived at from the test of the subject samples, and they supersede the conclusions stated in references (c) and (d).

- (a) Alsimag 35 and 196 both comply with specification requirements for grade F insulation on the basis of loss factor and moisture absorption by weight.
- (b) The materials represented by these samples are considered suitable for Naval use as grade F insulation.
- (c) Alsimag 196 with wax impregnation complies with specification requirements for grade G insulation.
- (d) Alsimag 196 has an unusually low loss factor when dry; Alsimag 35, when dry, has quite a low loss factor.

Recommendations

- (a) It is recommended that Alsimag 35 and 196 be approved for Naval use as grade F ceramic insulation.
- (b) If it is the policy of the Bureau to grade wax impregnated ceramic insulation, it is recommended that Alsimag 196 when impregnated with Ceresin wax be approved as grade G insulation.

## DESCRIPTION OF MATERIAL UNDER TEST

5. The material under test consisted of discs of Alsimag 35 and 196 manufactured by the American Lava Corporation. The discs are three inches in diameter and 1/8 inch thick. Besides five untreated samples of each of these materials, two additional samples of each grade which had been impregnated with Ceresin wax to improve the water-proofing properties of the material were also tested.

## METHOD OF TEST

6. In the loss factor test the discs were placed between metal plates of the same diameter as the discs, and the power factor and dielectric constant of the condenser thus formed was measured by the method of parallel substitution as described in detail in reference (f). The loss factor which is the quantity desired is the product of the power factor and dielectric constant. This test was performed on three unimpregnated and two Ceresin wax impregnated samples of Alsimag 35 and 196 at a frequency of approximately 500 kilocycles. These measurements were made twice on each sample; once while dry and again after it had been immersed for 96 hours in distilled water and the surface carefully wiped with a clean, dry cloth, without any time allowed for air drying. Only the latter or wet measurement is required by specifications, reference (b), paragraph 6-1, but the dry measurement was made to determine the change in loss factor due to immersion in water.

7. The gain in weight due to immersion in distilled water for 100 hours was determined on two samples each of Alsimag 35 and 196 which had not been subjected to the loss factor test. These samples were accurately weighed after having been dried out in an oven at a temperature of 120°C. for 24 hours and again after they had been immersed in distilled water for 100 hours and the surfaces wiped dry. These samples were unglazed and unimpregnated. They were not broken up to secure newly fractured surfaces (see reference (b), paragraph 6-2) since the weight of the whole discs was that required for this test, between 30 and 50 grams. However, since the discs are unglazed and unimpregnated and have such a large surface area, it is believed that the intent of these specifications is fully met. During the 100 hour immersion, the water was boiled for one hour on four occasions, as required by reference (b). The specimens were weighed approximately five minutes after removal from the water bath.

## DATA RECORDED DURING TEST

8. The data recorded during the test, or values computed therefrom, are given in Tables 1 and 2 appended.

## DISCUSSION OF PROBABLE ERRORS

9. The error in the determination of the loss factor is less than + 10%. The error in the determination of the weight of the samples in the moisture absorption test is not greater than + 0.002 grams.

## RESULTS OF TEST

10. The results of the loss factor test are summarized in Table 1 and the results of the moisture absorption test are given in Table 2. In regard to the loss factor requirements of specifications, reference (b), only the values in the column of Table 1 in which the wet loss factor is given need be considered, but the other values are given as a matter of information and interest. It will be noted that the loss factor (wet) of Alsimag 35 lies between 1.09 and 2.76 per cent. for the three unimpregnated samples, and that for the two impregnated samples it averages 1.1 per cent. This material therefore qualifies, as to loss factor, as a grade F insulation (loss factor between 1 and 7 per cent).

11. The loss factor (wet) of Alsimag 196 lies between 1.17 and 1.68 per cent for the three unimpregnated samples, and for the two impregnated samples the average value is only 0.58 per cent. It follows that the unimpregnated samples of Alsimag 196 lie in the Navy grade F and the impregnated samples qualify as grade G insulation. It is not known whether a material is to be graded on the basis of results obtained with samples impregnated with a water-proofing substance such as a wax.

12. An examination of the dry loss factor data in Table 1 shows that the average loss factor of five Alsimag 35 samples was .71 per cent, while that of the five samples of Alsimag 196 was the unusually low value of .18 per cent. Therefore, Alsimag 196 is definitely superior to Alsimag 35 when dry, although the loss in both grades of material is very low; however, the wet values indicate only a slight difference in the two grades of this material when not wax impregnated, and when the loss factor is measured immediately on wiping off the surface moisture after a 96 hour immersion. When wax impregnated, Alsimag 196 has a lower loss than Alsimag 35, as previously stated.

13. The effect of the wax impregnation employed on some of these samples is shown in the last column of Table 1, in which is given the per cent increase in loss factor of all samples wet over the corresponding dry value. From this tabulation, it will be observed that the wax impregnated specimens have the smallest increase in loss factor as a result of immersion, and that this wax impregnation has a measurable advantage in the presence of excessive humidity. (The large per cent increase in loss factor, particularly of Alsimag 196, resulting from immersion, is not serious since the actual value of loss factor when wet is very small. It indicates that the loss factor when dry is exceptionally low.) The application of the wax makes no visible change in the appearance of the material, and the minute quantity of wax present does not flow or otherwise become manifest at temperatures up to 75°C., to which these discs were heated.

14. The results of the moisture absorption test given in Table 2 indicate no appreciable gain in weight of any of the samples of either grade of Alsimag due to 100 hours immersion in water. The gain in weight noted is no greater than the probable observational error.

15. All samples of both of these materials showed excellent resistance to absorption of water. The test results given herein on seven samples of each of these grades of Alsimag are quite uniform and indicate that all of these samples are uniformly low in loss. This report supersedes references (c) and (d) in regard to test data on Alsimag 35 and 196.

## CONCLUSIONS

16. The following conclusions are arrived at from the test of the subject samples, and they supersede the conclusions stated in references (c) and (d):

- (a) Alsimag 35 and 196 both comply with specification requirements for grade F insulation on the basis of loss factor and moisture absorption by weight.
- (b) The materials represented by these samples are considered suitable for Naval use as grade F insulation.
- (c) Alsimag 196 with wax impregnation complies with specification requirements for grade G insulation.
- (d) Alsimag 196 has an unusually low loss factor when dry; Alsimag 35, when dry, has quite a low loss factor.

TABLE 1

LOSS FACTOR DATA ON ALSIMAG 35 AND 196

Sample No.	Dielectric Constant		Power Factor % of a Radian		Loss Factor		Per Cent Increase in Loss Factor (Wet vs. Dry)
	<u>Dry</u>	<u>Wet</u>	<u>Dry</u>	<u>Wet</u>	<u>Dry</u>	<u>Wet</u>	
<u>Alsimag 35</u>							
1	5.54	5.60	0.164	0.492	0.91	2.76	203
2	5.23	5.25	0.153	0.330	0.80	1.73	116
3	4.23	4.28	0.118	0.254	0.50	1.09	118
6*	5.32	5.30	0.160	0.247	0.85	1.31	54
7*	4.83	4.86	0.135	0.182	0.65	0.89	61
<u>Alsimag 196</u>							
1	4.61	4.64	0.031	0.253	0.14	1.17	736
2	4.63	4.67	0.039	0.360	0.18	1.68	834
3	4.64	4.71	0.038	0.338	0.18	1.59	784
6*	5.34	5.36	0.045	0.128	0.24	0.69	188
7*	4.47	4.47	0.035	0.106	0.16	0.47	194

\* Wax impregnated samples.

Values in next to last column indicate loss factor under conditions detailed in Specifications RE 13A 317F, paragraph 6-1.

TABLE 2

MOISTURE ABSORPTION BY WEIGHT OF ALSIMAG 35 AND 196

<u>Sample No.</u>	<u>Weight in Grams</u>		<u>Gain in Weight</u>	
	<u>After Drying</u>	<u>After Soaking</u>	<u>Grams</u>	<u>%</u>
<u>Alsimag 35</u>				
4	34.167	34.169	0.002	0.006
5	35.549	35.550	0.001	0.003
<u>Alsimag 196</u>				
4	32.833	32.836	0.003	0.009
5	33.986	33.989	0.003	0.009

Samples are whole, unimpregnated discs, diameter 3 inches, thickness 1/8 inch.

Maximum gain in weight allowed = 0.10 per cent.