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MATERIALS - UNCLAD 202C ALUMINUM ALLOY
CORROSION PROTECTIVE SURFACE TREATMENT FOR -
DETERMINATION OF

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Published and Distributed Under
Contract Number AF33(657)-7248

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TEST DATA MEMORANDUM

F-TDM NO. 2124
MODEL R-58
TEST NO. F-7589

TEST: MATERIALS - UNCLAD 2020 ALUMINUM ALLOY, CORROSION PROTECTIVE SURFACE TREATMENT FOR - DETERMINATION OF

OBJECT: To evaluate Type I and Type II Anodic Coatings and Alodine 1200 Chemical Film Treatment for corrosion protection of unclad 2020 aluminum alloy.

TEST SPECIMENS AND PROCEDURE:

Sixty-four (64) Panels, 5 x 1 x .064 inch, of unclad 2020-T6 aluminum alloy were prepared, treated and tested in accordance with Table I.

RESULTS: See Tables I through V and Figures 1, 2 and 3.

DISCUSSION: Visually the Type II Sulfuric Acid Anodic Coating exhibited satisfactory corrosion resistance to all types exposure (Ref. Figures 1, 2 and 3). The only obvious change in appearance of the coating was a bleaching effect obtained in three phase immersion and salt spray exposure. No pitting was observed. Tensile tests also indicate that least physical damage was suffered with this coating (Ref. Summary Table I).

The Alodine 1200 Chemical Film exhibited slight attack in salt spray and three phase immersion tests (Ref. Figures 1 and 3). With the exception of a 42% reduction in elongation obtained on the specimens exposed to humidity, the tensile test results on Alodine 1200 were almost equal to Type II Anodic Coating.

Type I Chromic Acid Anodic Coating showed more pronounced pitting in salt spray and three phase immersion (Ref. Figures 1 and 3). Tensile test results were consistently lower than those of either the Type II Anodic Coating or the Alodine 1200 Chemical Film. A 31% reduction in elongation after salt spray exposure indicates the failure of the coating per Mil-A-8625A.

Variations in appearance of control panels in Figures 2 and 3 are the result of uneven lighting in the photographs, not dissimilarity in the specimens.

CONCLUSION: Various protective coatings for unclad 2020 aluminum alloy were evaluated. The results of this evaluation lead to the following conclusions:

- (1) Type II Sulfuric Acid Anodic Coating imparts satisfactory corrosion resistance to unclad 2020 aluminum alloy.
- (2) Alodine 1200 Chemical Film Treatment provides adequate protection to salt spray environment in accordance with Mil-C-5541. However, the treatment does not prevent a considerable reduction in % elongation after humidity exposure.
- (3) Type I Chromic Acid Anodic Coating on unclad 2020 aluminum alloy fails to meet the requirements of Mil-A-8625A.

Test Dates: 8-29-58 to 11-13-58.

WITNESS: *[Signature]*

DATE: 24 November 1958

BY *J. D. Reynolds*

CHECKED *C. E. Miller*

APPROVED *K. E. [Signature]*
A. C. Wilson

TABLE I

SUMMARY OF TEST PROCEDURES AND RESULTS

SURFACE TREATMENT*	CORROSION TEST**	AVE. YIELD POINT (PSI)	AVE. ULTIMATE (PSI)	AVE. ELONGATION (% IN 2")
A	I	82,016	84,839	5.63
A	II	76,150	78,450	6.0
A	III	75,150	76,550	3.0
A	IV	75,875	78,350	6.5
A	V	76,575	79,125	6.5
B	I	77,900	80,900	6.5
B	II	75,375	77,700	4.5
B	IV	76,275	78,750	7.0
B	V	79,450	82,350	5.75
C	I	79,125	82,400	5.5
C	II	79,250	81,950	5.25
C	IV	79,450	82,300	5.75
C	V	79,600	82,950	5.25
D	I	80,200	83,375	6.0
D	III	78,225	81,200	6.0
D	IV	77,400	79,200	3.5
D	V	79,625	83,075	5.75

*Treatment:

- A. Control - No treatment
- B. Type I Anodic Coating - Chromic Acid (Mil-A-8625A)
- C. Type II Anodic Coating - Sulphuric Acid (Mil-A-8625A)
- D. Alodine 1200 Chemical Film (Mil-C-5541) Per P.S. 71.04F

** Corrosion Test:

- I. Control - No corrosion test
- II. 240 hr. salt spray @6° from vertical (Mil-A-8625A) by FTMS 151, Method 811
- III. 168 hr. salt spray @15° from vertical (Mil-C-5541) by FTMS 151, Method 811
- IV. 360 hr. humidity chamber (95% R.H., 120°F)
- V. 24 hr. 3 phase immersion (JP-4 vapor, JP-4, 3% NaCl Solution @140°F)

NOTE: Unclad 2020 Aluminum Alloy from Aluminum Company of America
301 Thomas Bldg.
Dallas, Texas

TABLE II

RESULTS OF TENSILE TESTS* ON 2020-T6 ALUMINUM ALLOY
PROTECTED WITH TYPE II ANODIC COATING (MIL-A-8625A)

CORROSION TEST & SPECIMEN NO.	YIELD POINT (PSI)	ULTIMATE (PSI)	ELONGATION (% IN 2")
Control - No Corrosion Test			
1	78,900	82,000	5.0
2	79,100	82,400	6.0
3	79,100	82,500	5.0
4	79,400	82,700	6.0
Max.	79,400	82,700	6.0
Min.	78,900	82,000	5.0
Ave.	79,125	82,400	5.5
240 Hr. Salt Spray (Mil-A-8625A)			
1	79,400	82,300	6.0
2	79,400	81,900	5.0
3	79,000	81,800	5.0
4	79,200	81,800	5.0
Max.	79,400	82,300	6.0
Min.	79,000	81,800	5.0
Ave.	79,250	81,950	5.25
360 Hr. Humidity (95% R.H. @120°F)			
1	79,700	82,300	6.0
2	79,000	81,900	5.0
3	78,900	81,800	6.0
4	80,200	83,200	6.0
Max.	80,200	83,200	6.0
Min.	78,900	81,800	5.0
Ave.	79,450	82,300	5.75
24 Hr. 3 Phase Immersion @140°F			
1	80,100	83,000	6.0
2	78,700	83,000	5.0
3	79,800	82,900	5.0
4	79,800	82,900	5.0
Max.	80,100	83,000	6.0
Min.	78,700	82,900	5.0
Ave.	79,600	82,950	5.25

*Tensile tests were conducted in accordance with FTMS 151, Method 211.

TABLE III

RESULTS OF TENSILE TESTS* ON 2020-T6 ALUMINUM ALLOY
 PROTECTED WITH ALODINE 1200 CHEMICAL FILM (MIL-C-5541) PER P.S. 71.04F

CORROSION TEST & SPECIMEN NO.	YIELD POINT (PSI)	ULTIMATE (PSI)	ELONGATION (% IN 2")
Control - N₂ Corrosion Test			
1	80,000	83,200	6.0
2	80,300	83,400	6.0
3	80,000	83,200	6.0
4	80,500	83,700	6.0
Max.	80,500	83,700	6.0
Min.	80,000	83,200	6.0
Ave.	80,200	83,375	6.0
168 Hr. Salt Spray (Mil-C-5541)			
1	79,200	82,300	6.0
2	78,200	81,100	7.0
3	78,700	81,600	6.0
4	76,800	79,800	5.0
Max.	79,200	82,300	7.0
Min.	76,800	79,800	5.0
Ave.	78,225	81,200	6.0
360 Hr. Humidity (95% R.H. @120°F)			
1	77,700	80,300	3.0
2	No Record	77,000	1.0
3	77,000	79,700	5.0
4	77,500	79,800	5.0
Max.	77,700	80,300	5.0
Min.	77,000	77,000	1.0
Ave.	77,400	79,200	3.5
24 Hr. 3 Phase Immersion @140°F			
1	79,800	83,100	6.0
2	80,400	83,500	5.0
3	79,800	83,200	6.0
4	79,400	82,500	6.0
Max.	80,400	83,500	6.0
Min.	79,400	82,500	5.0
Ave.	79,850	83,075	5.75

*Tensile tests were conducted in accordance with FTMS 151, Method 211.

TABLE IV

RESULTS OF TENSILE TESTS* ON 2020-T6 ALUMINUM
 ALLOY PROTECTED WITH TYPE I ANODIC COATING (MIL-A-8625A)

CORROSION TEST & SPECIMEN NO.	YIELD POINT (PSI)	ULTIMATE (PSI)	ELONGATION (% IN 2")
Control - No Corrosion Test			
1	78,300	81,200	6.0
2	77,800	80,900	7.0
3	77,800	80,900	6.0
4	77,700	80,600	7.0
Max.	78,300	81,200	7.0
Min.	77,700	80,600	6.0
Ave.	77,900	80,900	6.5
240 Hr. Salt Spray (Mil-A-8625A)			
1	75,600	78,200	6.0
2	74,400	76,600	4.0
3	75,500	77,900	4.0
4	76,000	78,100	4.0
Max.	76,000	78,200	6.0
Min.	74,400	76,600	4.0
Ave.	75,375	77,700	4.5
360 Hr. Humidity (95% R.H. @120°F)			
1	76,800	79,200	7.0
2	76,200	78,700	8.0
3	75,200	77,900	7.0
4	76,900	79,200	6.0
Max.	76,900	79,200	8.0
Min.	75,200	77,900	6.0
Ave.	76,275	78,750	7.0
24 Hr. 3 Phase Immersion @140°F			
1	79,700	82,700	5.0
2	79,100	81,900	6.0
3	80,200	83,200	6.0
4	78,800	81,600	6.0
Max.	80,200	83,200	6.0
Min.	78,800	81,600	5.0
Ave.	79,450	82,350	5.75

*Tensile tests were conducted in accordance with FTMS 151, Method 211.

TABLE V

RESULTS OF TENSILE TESTS*ON 2020-T6 ALUMINUM
ALLOY CONTROL SPECIMENS

CORROSION TEST & SPECIMEN NO.	YIELD POINT (PSI)	ULTIMATE (PSI)	ELONGATION (% IN 2")
Control - No Corrosion Test			
1	82,258	85,000	6.0
2	81,774	84,677	6.0
3	82,258	85,000	6.0
4	80,484	83,548	5.5
5	81,936	84,355	4.5
6	82,903	85,645	5.5
7	82,258	85,161	5.5
8	82,258	85,323	6.0
Max.	82,903	85,645	6.0
Min.	80,484	83,548	4.5
Ave.	82,016	84,839	5.63
240 Hr. Salt Spray (Mil-A-8625A requirement)			
1	75,800	78,200	6.0
2	76,500	78,700	6.0
Ave.	76,150	78,450	6.0
168 Hr. Salt Spray (Mil-C-5541 requirement)			
3	74,200	75,000	2.0
4	76,100	78,100	4.0
Ave.	75,150	76,550	3.0
360 Hr. Humidity (95% R.H. @120°F)			
1	75,200	77,600	7.0
2	76,500	78,700	7.0
3	76,600	79,400	6.0
4	75,200	77,700	6.0
Max.	76,600	79,400	7.0
Min.	75,200	77,600	6.0
Ave.	75,875	78,350	6.5

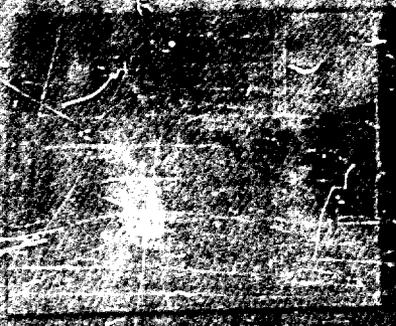
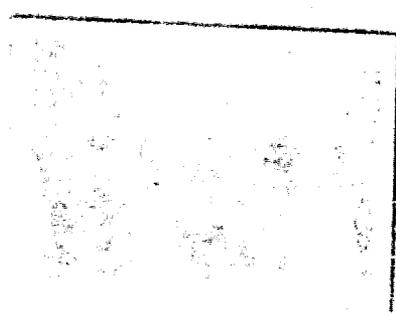
*Tensile tests were conducted in accordance with FTMS 151, Method 211.

TABLE V (Continued)

CORROSION TEST & SPECIMEN NO.	YIELD POINT (PSI)	ULTIMATE (PSI)	ELONGATION (% IN 2")
24 Hr. 3 Phase Immersion @ 140°F			
1	76,600	78,900	7.0
2	76,300	78,400	6.0
3	76,300	79,200	6.0
4	77,100	80,000	7.0
Max.	77,100	80,000	7.0
Min.	76,300	78,400	6.0
Ave.	76,575	79,125	6.5

SALT SPRAY EXPOSURE

240 HRS PER MIL-A-8625A



CONTROL - NO TREATMENT

TYPE 1 ANODIC COATING
MIL-A-8625 A

TYPE 2 ANODIC COATING
MIL-A-8625 A

Microscopic view of a surface showing a granular texture, likely a control or untreated sample.

HUMANITY CHAMBER TEST
MIL-STD-883C, 207

TYPE 2 ANODIC COATING
MIL-STD-883C, 207

TYPE 1 ANODIC COATING
MIL-STD-883C, 207

CONTROL - NO TREATMENT

PHOTOGRAPHIC COPY

TYPE 1 ANODIC COATING
MIL-STD-883C, 207

THREE PHASE SYSTEM
IMMERSION
24 HRS AT 140°F

ALCONE 200 CHEMICAL FILM
MIL-C-554; PER PS-7104F

CONTROL - NO TREATMENT

TYPE 1 ANODIC COATING
MIL-A-8625 A

TYPE 2 ANODIC COATING
MIL-A-8625 A

THREE PHASE SYSTEM
IMMERSION
24 HRS AT 140°F



ALODINE 200 CHEMICAL FILM
MIL-C-5541 PER PS 7104F

CONTROL - NO TREATMENT

TYPE 1 ANODIC COATING
MIL-A-8625 A

TYPE 2 ANODIC COATING
MIL-A-8625 A