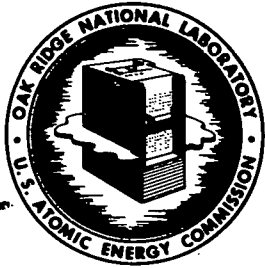


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SUBJECT: Examination of Corrosion Specimens from Slurry Blanket
Mockup Run SM-5

TO: E. G. Bohlmann

FROM: S. A. Reed and E. L. Compere

SUMMARY

Generally low attack rates were displayed by specimens of type 347 stainless steel, titanium RC-55 and Zircaloy-2 which were exposed for 1096.5 hr in slurry blanket mockup run SM-5. The leading coupon of type 347 stainless steel suffered more severe attack due to erosive action by the slurry. Specimens of SA-212-B carbon steel displayed attack rates of 230 to 300 mpy.

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In conjunction with the program in the Systems Development Section on the slurry blanket mockup, the Reactor Materials Research Section prepared a set of coupon-corrosion specimens for field exposure in the experimental mockup equipment during run SM-5.

The results of the examination of similar specimens which were exposed in runs SM-3 and SM-4 have been reported previously.^{1,2}

A set of sixteen coupon-type corrosion specimens, placed in the main line of the mockup loop, were exposed for a total period of 1096.5 hr (645 hr in slurry) during run SM-5.

The coupons, contained in a type 347 stainless steel holder, were not insulated. The coupon array consisted of four specimens each of type 347 stainless steel, SA-212-B boiler plate (carbon steel), titanium RC-55, and Zircaloy-2. Each specimen was machined to the dimensions 2.35 x 1.0 x 0.20 in. from special 1/4-in. plate stock from the controlled materials stores of the Reactor Materials Research Section.¹

The flow velocity across the specimens varied from an estimated 20 fps to 13 fps as a result of varying flow rates in the system while the pump was operated from a variable frequency generator.

A brief operating summary for run SM-5 is presented in Table I. A detailed description of the run is being prepared³ by the Systems Development Section.

The slurry charged to run SM-5 consisted of a composite of batches of LO-series, 800°C-calcined thoria to which was added approximately 3500 ppm sulfate, based on thorium, as sulfuric acid. The thoria had been circulated previously in mockup run SM-4.

Slurry pH values during the test varied between 5.8 and 6.0. Loop temperatures during run SM-5 ranged from 140 to 203°C.

No oxygen was added to the mockup. Gas analyses of samples withdrawn from the system during the run indicated build-up of the hydrogen in the mockup as a result of corrosion (primarily of the carbon steel blanket vessel). Hydrogen values ranged from 2 to 4 ppm.

As shown in Table II, corrosion-erosion rates, except for SA-212-B carbon steel, were low. The upstream coupon of the array, of type 347 stainless steel, displayed a higher rate (about twenty-fold) than specimens of the same alloy in the downstream positions of the array. The higher rate of that specimen was attributed to increased erosive attack by impinging slurry and by other entrance effects. The pattern of attack of the specimens may be seen in Figures 1 through 3.

Attack of type 347 stainless steel ranged from 0 to 0.32 mpy on three of the coupons; the fourth, the coupon at the entrance of the array, showed 1.5 mpy. All specimens of titanium RC-55 displayed weight gains. Zircaloy-2 attack rates ranged from 0.03 to 0.11 mpy. The average attack rate for SA-212-B carbon steel specimens was 257 mpy.

The attack rates are in close agreement with those rates observed in the two previous runs in the mockup equipment.

A sharper increase in corrosion product (Fe, Cr, Ni) build-up was noted during run SM-5 than in the previous two runs; however, no evidence of severe localized corrosion was found when the mockup was inspected after shutdown.

An interesting pattern of attack was noted on both top and bottom surfaces of each of the carbon steel specimens. The downstream portions of the surfaces of these specimens were covered with a dark-brown-to-black adherent corrosion film. The upstream surfaces were covered with a loose, voluminous rust-colored deposit.

After defilming, the surfaces of the specimens under the rust-colored films were markedly more attacked than the downstream surfaces. Similar patterns were seen on all specimens (see Figures 2 and 3). The upstream areas of the coupons were attacked 60 to 80 mils deeper on those surfaces covered by the rust-like films.

- 1) ORNL CF-57-10-5
- 2) ORNL CF-58-6-59
- 3) To be issued by L. F. Parsly, et al, of the Systems Development Section

TABLE I

Operating Summary, Slurry Blanket Mockup Run SM-5^a

<u>Circulation Hours</u>	<u>Loop Temperature, °C</u>	<u>Frequency, cps</u>	<u>Slurry Concentration, g Th/kg H₂O</u>
0 - 254.4	Rm temp, 200	60	
451.5	150	60	Loading to 169
570.4	150	60	Loading to 238
594.4	152	60	Loading to 350
618.4	157	60	349
738.4	153	60	344
762.4	175	60	355
785.4	170	60	359
806.4	188	60	358
830.4	148	Pump Off	
902.4	203	60	366
926.4	200	50	366
950.4	202	43	374
974.4	170	43	358
998.4	172	50	363
1070.4	150	50	354
1094.4	150	43	350
1096.5	Dumped Slurry		

451.5 hr on water
645.0 hr on slurry

a) Furnished by L. F. Parsly, et al, of the Systems Development Section.

TABLE II

In-Line Coupon Corrosion Rates in Slurry Blanket Mockup Run SM-5

Material Type	Position in Holder	Weight Change, mg		Weight Loss (mg/cm ²) ^b	Corrosion Rate, mpy Defilmed
		Scrubbed	Defilmed		
347 Stainless Steel	1 ^a	- 80.4	- 82.2	2.3	1.5
	5	+ 27.8	+ 1.7	WG	-
	9	+ 25.2	- 3.6	0.10	0.07
	16	- 15.1	- 17.4	0.48	0.32
Zircaloy-2	2	- 4.6	- 4.6	0.13	0.11
	6	- 1.5	- 1.8	0.05	0.04
	10	- 0.9	- 1.1	0.03	0.03
	15	- 0.8	- 1.3	0.04	0.03
Titanium RC-55	3	+ 52.7	+ 25.2	WG	-
	7	+ 42.7	+ 10.1	WG	-
	12	+ 47.8	+ 1.5	WG	-
	14	+ 54.3	+ 3.5	WG	-
SA-212 Grade B Boiler Plate ^c	4	-15,104	-15,872	436	296
	8	-12,914	-13,647	377	256
	11	-11,465	-12,299	340	231
	13	-12,272	-13,090	361	245

WG - Weight gain

a) Leading coupon, upstream position

b) Exposed area, 36.22 cm²

c) Carbon steel

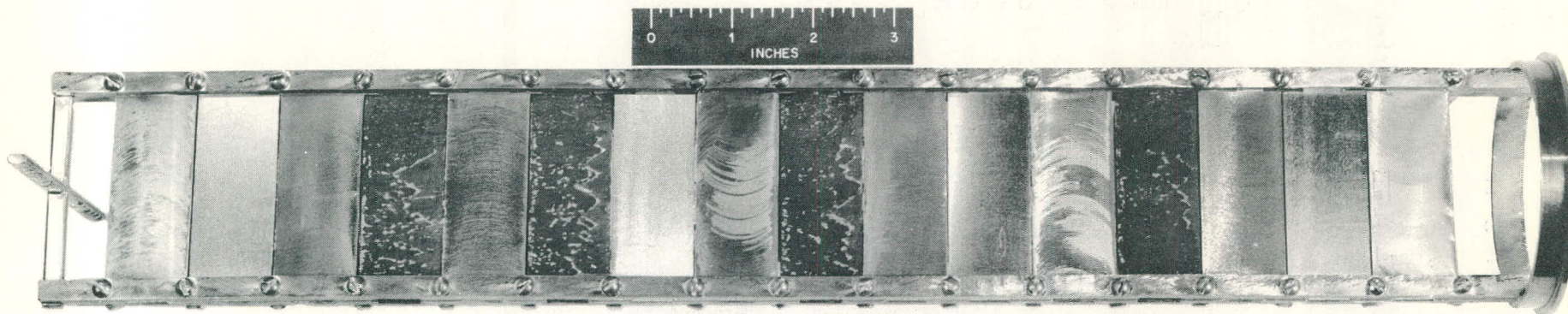


Figure 1 - In-line corrosion specimens removed from slurry blanket mockup run SM-5 (top view); slurry flow right to left.

Plate No. 31914

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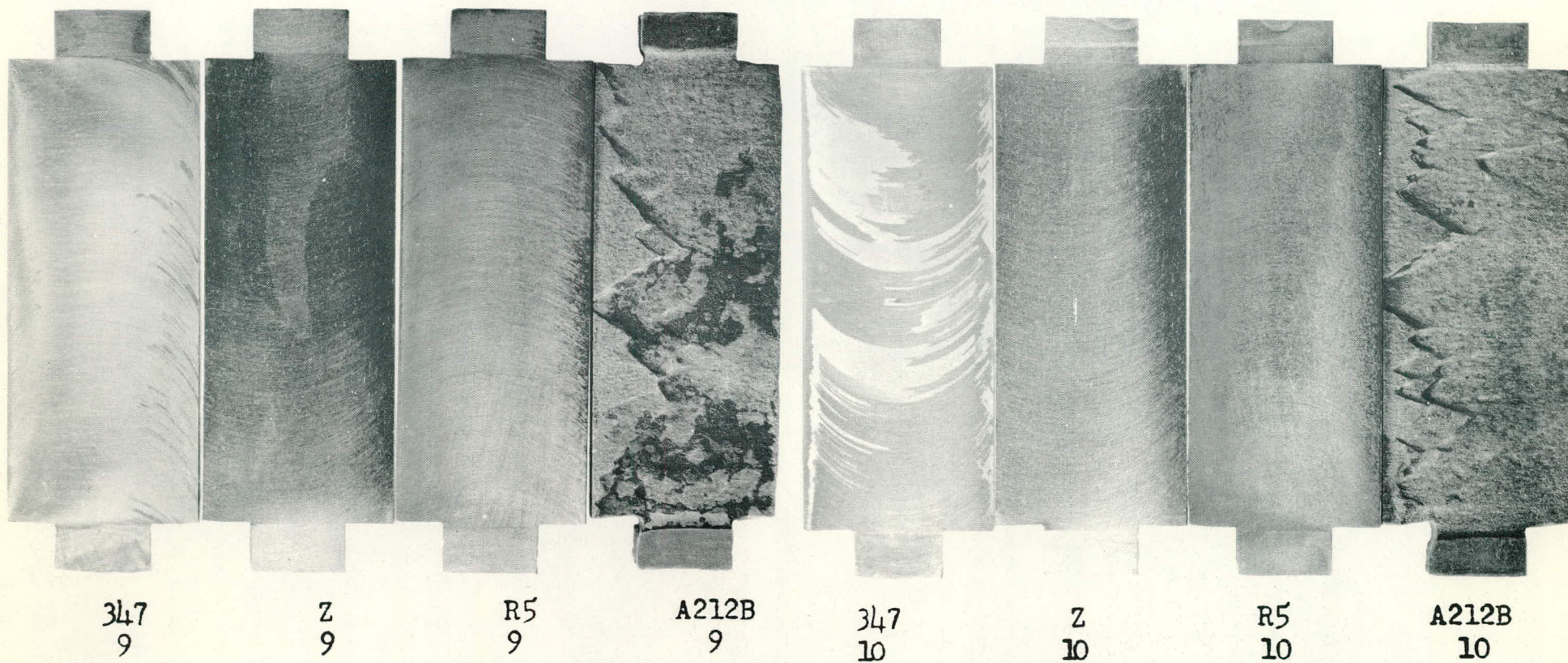


Figure 2 - Relative positions of corrosion specimens from run SM-5, flow left to right
(Specimen Nos. 1 through 8)

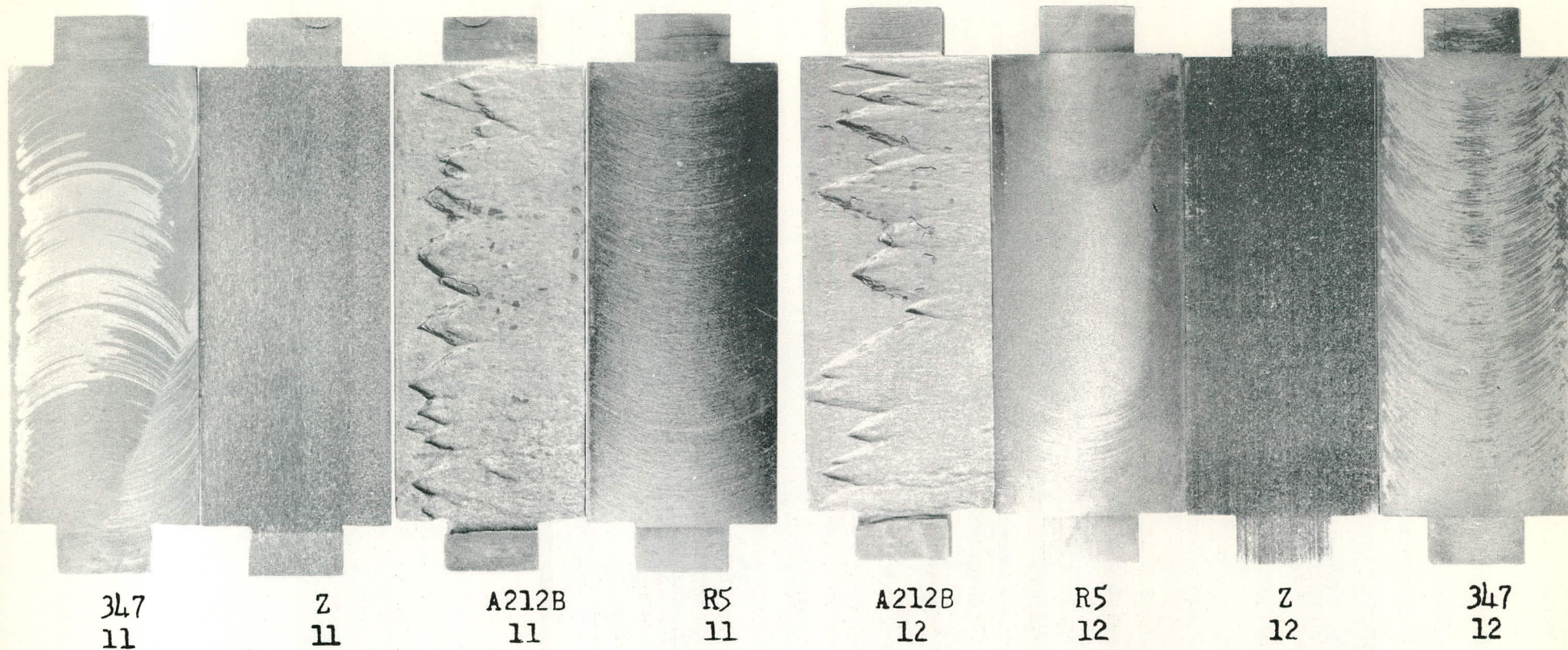


Figure 3 - Relative positions of corrosion specimens from run SM-5, flow left to right (Specimen Nos. 9 through 16)

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