C00-94

THE DOW CHEMICAL COMPANY

REPORT

C00-94

TENTH QUARTERLY REPORT
(MARCH 1, 1952 - MAY 31, 1952)
U. S. ATOMIC ENERGY COMMISSION
CONTRACT NO. AT(11-1)60

PREPARATION OF HIGH PURITY MAGNESIUM
AND A STUDY OF THE EFFECT OF
NON-METALLIC AND ALKALI METAL
IMPURITIES ON THE CORROSION
CHARACTERISTICS OF PURE MAGNESIUM

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OF PURE MAGNESIUM

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OF THE EFFECT OF NON-METALLIC AND ALKALI METAL
IMPURITIES ON THE CORROSION CHARACTERISTICS
OF PURE MAGNESIUM

ABSTRACT:

Continued studies of Mg-Fe alloys have substantiated the existence of an iron tolerance limit at 60 ppm Fe for the slowly cooled alloys. Further studies of this alloy system revealed that thermal history can have a considerable effect (25% variation) upon the spectrographic analysis of iron.

Investigation of the Mg-Fe-non-metallic ternary systems indicates that silicon is detrimental to the corrosion properties of alloys containing iron below the tolerance limit and beneficial in alloys containing iron above the tolerance limit. Sulfur has no effect on the salt water corrosion resistance of pure magnesium or Mg-Fe alloys. Both carbon and chlorides yielded erratic corrosion results in Mg-Fe alloys.

The physical state of high purity magnesium (machined, annealed, or etched) has no significant effect upon the corrosion properties.

INTRODUCTION:

The purpose of this investigation is to prepare high purity magnesium and to study the effect of non-metallic and alkali metal impurities on the corrosion characteristics of high purity magnesium. The earlier portion of the contract period was devoted primarily to a detailed study of purification by sublimation and a study of the effect of various non-metallic and alkali metal additions on the corrosion characteristics of pure binary magnesium alloys. In the ninth quarter the contamination studies were broadened to include the Mg-Fe system and the Mg-Fe-C and Mg-Fe-Si systems. Studies of these ternary systems have continued in the tenth quarter. The work has also been extended to include the Mg-S, Mg-Fe-S and the Mg-Fe-Cl systems.

SUMMARY OF EXPERIMENTAL RESULTS:

Mg-Fe Alloys

Corrosion tests on slow cooled Mg-Fe alloys confirmed the general shape of the curve of Figure 1 in the Ninth Quarterly Report (C00-88), but showed a more sharply defined tolerance limit at 60 ppm Fe. (cf Fig. 1 of this report). Similarly, the new solution potential measurements defined a curve with the same characteristics as previously reported (Fig. 22, 8th Quarterly Report C00-85) and the greater number of measurements permitted better definition near the 60 ppm Fe (tolerance limit).

Effect of Thermal History on Spectrographic Iron Analyses

Quadruplicate spectrographic iron analyses on seven 150 gm ingots indicated a pronounced influence of thermal history on this type of iron analyses. An ingot cast at 800C into a split graphite mold and cooled at a rate of 2000F/min. gave an apparent average iron analysis of 325 ppm while one treated similarly but cast at 700C showed 312 ppm Fe. Three of the ingots, air cooled from 800C, gave the following averages: 285, 244, and 265 for a cumulative average of 265 ppm Fe. Two ingots which were air cooled to 625C and 600C and subsequently water quenched gave 295 and 272 ppm Fe, respectively. See Fig. 3.

Mg-Fe-Si Alloys

The 3-hour and 1-day alternate immersion corrosion data show increasing corrosion rates with increasing concentrations of silicon up to ~150 ppm if iron is present to the extent of 43 ppm. With further Si increases, the corrosion rates drops sharply to a minimum at approximately 500 ppm and then increases rapidly again. See Fig. 3 and 4.

Mg-Fe-Cl Alloys

The corrosion rates of sublimed magnesium containing 37 ppm and mixed chlorides (#230 flux) up to 45 ppm show erratic corrosion behavior as illustrated by Fig. 7.

Mg-Fe-C Alloys

The maximum carbon contamination which could be obtained by adding powdered spectrographically pure graphite to molten magnesium was 53 ppm. Unfortunately, only a small range (10 ppm) of carbon

content was obtained. Although the carbon content of these alloys was quite low, they still showed erratic corrosion behavior on 1-day exposure to 3% NaCl. See Fig. 8.

Mg-S and Mg-Fe-S Alloys

In spite of attempts to make high sulfur content alloys, only 52 ppm S could be obtained in either the sublimed magnesium or the sublimed Mg containing 42 ppm iron. The corrosion results on these alloys demonstrated excellent reproducibility and showed no effects as a result of the sulfur contamination. See Fig. 9 & 10.

Corrosion

Corrosion rates were determined for high-purity magnesium samples in the machined, annealed, and deep-etched states. No significant differences were observed.

CONCLUSIONS:

Mg-Fe Alloys

Additional corrosion data on Mg-Fe alloys substantiates the existence of 60 ppm Fe as the tolerance limit in the slowly cooled (50-2000F/min.) alloys. Thermal history directly affects the spectrographic analyses of Mg-Fe alloys. In general, air cooled alloys containing ~300 ppm Fe give analyses which are lower by 53 ppm Fe than those which are cooled more rapidly by casting into split graphite molds.

Mg-Fe-Si Alloys

Certain critical amounts of silicon are detrimental to the corrosion properties of magnesium containing Fe below the tolerance limit (60 ppm). On the other hand, Si is beneficial in alloys containing Fe above the tolerance limit. See Fig. 6. These changes in corrosion behavior appear to be a function of the number of phases present in the alloys. That is, alloys in the single phase region (compositions below the solid solubility limit for iron) would have the lowest corrosion rates. Alloys of the two phase regions (compositions exceeding the solid solubility limit for iron) would have the poorest corrosion rates, while alloys of the three phase region would have an intermediate corrosion rate. Metallographic examination will be necessary to substantiate this hypothesis.

Mg-Fe-Cl and Mg-Fe-C Alloys

The erratic corrosion behavior of these alloys (Fig. 7 and Fig. 8) suggests that a critical concentration of carbon or chlorides may result from segregation giving higher corrosion rates. Because of the poor miscibility of carbon or chlorides with magnesium, numerous attempts to define the effect of C and Cl on the corrosion properties have been unsuccessful. No further studies of these contaminants will be made until better alloying and sampling techniques are developed.

Mg-S and Mg-Fe-S Alloys

Sulfur contents up to 52 ppm have no effect on the salt water corrosion resistance of pure Mg or Mg-Fe alloys. Since 52 ppm was the maximum amount of S which could be introduced into the melts, no further work on these systems is warranted if the humidity tests also demonstrate negative results.

Corrosion

Cold working during sample preparation has a negligible effect on the corrosion rate of high-purity magnesium.

RESULTS AND DISCUSSION:

Mg-Fe Alloys

A group of Mg-Fe alloys (#70869-70875) was made to obtain better definition of the corrosion characteristics and solution potential values in the region of the tolerance limit. These alloys were 150 gm melts cast into split graphite molds and cooled at a rate of ~2000F/min. The 3-hour alternate immersion 3% NaCl corrosion data have been plotted with the older data to give a more sharply defined tolerance limit at 60 ppm Fe. See Fig. 1. Similarly the new solution potential measurements have been plotted with the data previously reported to give the curve shown in Fig. 2.

Effect of Thermal History on Spectrographic Iron Analyses

Because of the results reported in the 9th Quarterly Report (COO-88) (Fig. 22), the effect of thermal history on spectrographic iron analysis was investigated further. A series of 150 gram melts having different thermal histories were made from a Mg-Fe master alloy (#67515). The results of these experiments are summarized

in Fig. 3. These data show that casting at 800C (cooling rate $\sim 2000^\circ\text{F}/\text{min.}$) gives the highest iron analyses, while casting at 700C gives the next highest results. (See alloy #71018 and 71019 respectively). This type of treatment appears to give the most consistent analytical response. The analytical results were quite erratic when the alloys were either air cooled or air cooled to a temperature below the freezing point and cold water quenched. See alloys #71020-71024. This would indicate that air cooling is incapable of furnishing reproducible thermal histories, thus affecting the distribution of the iron bearing second phase and the spectrographic iron analyses. The average iron analyses of air cooled plus water quenched alloys are lower than those of the cast alloys but higher than for the straight air cooled alloys.

Mg-Fe-Si Alloys

A series of Mg-Fe-Si alloys containing 43 ppm Fe were made and corrosion tested to supplement the data obtained in the previous quarter. This new data (Fig. 4 and 5) plus that previously reported allowed the construction of a corrosion model (Fig. 6) for the Mg-Fe-Si system in the region of the iron tolerance limit. These data indicate that the tolerance limit for iron is reduced from 60 ppm Fe to 9 ppm Fe by 2600 ppm silicon. Similarly ~ 300 ppm Si reduce the tolerance limit to 22 ppm and 150 ppm Si reduce it to 43 ppm. This decrease in the tolerance limit for iron may be associated with a decrease in the solid solubility of Fe. The sharp decrease in corrosion rate between 150 and 400 ppm Si in the 43 ppm Fe alloy could possibly be associated with a transition from a 2 to a 3-phase field. These hypotheses, however, will require a thorough metallographic examination of the Mg-Fe-Si system for confirmation.

Mg-Fe-Cl Alloys

A series of alloys containing 37 ppm Fe and varying chloride content (20-45 ppm) were made by adding #230 flux to a Mg-Fe master alloy and casting without the usual settling period. The erratic corrosion behavior of these alloys (Fig. 7) suggests the existence of a critical chloride content which can be obtained by segregation to give high corrosion rates.

Mg-Fe-C

Spectrographically pure graphite powder was added to pure magnesium containing 42 ppm iron. Although 12 to 18% carbon by weight was added, the highest residual carbon content was 53 ppm. The slight amounts of chlorides in these alloys (#71222-71126) are not believed to be responsible for the erratic behavior encountered, since a plot of the chloride contents against the corrosion rates also showed slightly erratic results.

Mg-S and Mg-Fe-S

Additions of 5.5-9% S and 4-30% S were added in the elemental form to sublimed Mg and Mg-42 ppm Fe alloys respectively. In either case, the highest sulfur content obtained in the metal was 52 ppm. No further corrosion studies of these systems are planned, since sulfur apparently has no effect on the salt water corrosion properties of magnesium. Fig. 9 and 10.

Effect of Cold Working on the Corrosion Rate of High-Purity Magnesium

Since a correlation of corrosion rate with impurity content of high-purity magnesium specimens was unsuccessful, it was postulated that certain physical factors other than impurity content may result in a minimum corrosion rate, and that only by removing these factors can lower corrosion rates be obtained. (See 9th Quarterly Report, this project). It has been observed that salt water corrosion patterns on high purity magnesium samples follow the direction of machining in many instances. Therefore, to determine the effect of cold working on the corrosion rate of machined, high-purity samples, the following experiments were designed.

Corrosion specimens were prepared from Alloy No. 67535 in the machined, machined and annealed (2 hours at 400F), and annealed and machined condition. Each of these conditions was given three different surface preparations: (1) Rinsing in a series of baths¹ to remove hydroxide and grease surface films (surfaces prepared in this way have no detectable hydroxide film as determined by electron diffraction). (2) Grinding with 150 grit aloxite paper and rinsing

1. Rinse baths: 5% HCl in absolute ethanol, 1% formic acid in 50-50 methanol-acetone, 50-50 methanol-acetone, benzene.

as above. (3) Deep etch-polishing (or pickling) in 50% hydrochloric acid and rinsing as above. After the final rinse, samples were handled with ivory tipped tongs and stored in a desiccator to insure clean surfaces at the beginning of the corrosion test.

The removal of cold worked surfaces is thus achieved in two ways: by annealing and by deep etching. Fourteen-day, alternate immersion rates in 3% sodium chloride were determined for the above samples and are given in Table III. Examination of the results shows that for a given surface preparation, there is little difference in the corrosion rates for the machined, machined and annealed, and annealed and machined specimens. It is also noted that, contrary to expectation, the deep-etched samples have a slightly higher average corrosion rate than the machined or aloxited samples. It is possible that deep-etching selectively dissolves away anodic areas leaving the cathodic areas exposed in a more favorable position and thus rendering them more active in the corrosion process.

From these results it is concluded that cold working during sample preparation has a negligible effect on the corrosion rate of high-purity magnesium.

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3 Tables

10 Figures

TABLE I
 NUMERICAL LISTING OF MAGNESIUM ALLOY ANALYSES (In Parts Per Million)
 AVERAGE CORROSION DATA - ALTERNATE IMMERSION IN 3% NaCl

Alloy No.	Description	Al	Cu	Fe	Mn	Ni	Pb	Si	Sn	Zn	Zr	Ba	Ca	K	Na	Sr	C	Cl	P	Miscellaneous			Average Corrosion Rate (mcd)	Exposure Time (Days)			
																				Chem.	Fe	Ave.					
<u>Mg-Fe Alloys</u>																											
70869	#67515 + #68859	2	3	100 110	4	<3	<5	<10	<10	<100											102	111	106	163.3 118.8	1/8 1		
70870	" "	<1	1	86 86	3	"	"	"	"	"											87	91	89	51.9 >210 (Destroyed)	1/8 1		
70871	" "	"	"	86 88	"	"	"	"	"	"											80	92	86	66.1 74.4	1/8 1		
70872	" "	"	2	92 92	5	"	"	"	"	"											77	113	95	80.3 >210 (Destroyed)	1/8 1		
70873	" "	"	1	70 77	3	"	"	"	"	"											60	63	62	5.47 2.67	1/8 1		
70874	" "	"	<1	58 54	"	"	"	"	"	"											48	70	59	2.9 1.58	1/8 1		
70875	" "	"	1	45 50	"	"	"	"	"	"													42		1.87 .574	1/8 1	
<u>Mg-Fe Base Melts</u>																											
71049	#67515 + #68859	<1	<1	50 49	3	<3	<5	<10	<10	<100																	
71050	" "	"	"	42 40	"	"	"	"	"	"																	
71051	" "	"	"	41 40	4	"	"	"	"	"																	
71052	" "	"	"	39 40	3	"	"	"	"	"																	
71059	" "	2	"	40 41	4	"	"	"	"	"																	
<u>Mg-Fe</u>																											
71018	T* #67515 Cast at 800C into a split graphite mold	2	1	335	7	<3	8	<10	<10	<100			<100											Ave. Fe 325			
	C*	2	6	320	"	"	6	"	"	"			"														
	C	3	4	330	"	"	9	"	"	"			"														
	B*	2	2	315	"	"	8	60	"	"			"														
71019	T' #67515 Cast at 700C into a split graphite mold	1	1	305	7	<3	6	<10	<10	<100			100											312			
	C	<1	4	305	6	"	7	"	"	"			"														
	C	2	2	320	7	"	8	"	"	"			"														
	B	2	1	320	"	"	6	"	"	"			"														
71020	T #67515 Air cooled in crucible from 800C	<1	1	285	7	<3	6	<10	<10	<100			100											285			
	C	"	10	284	8	"	"	"	"	"			"														
	C	"	3	285	7	"	"	"	"	"			"														
	B	"	<1	285	"	"	9	"	"	"			"														

*T = Top
 C = Center
 B = Bottom

[illegible]

DETAILED CORROSION AND SOLUTION POTENTIAL DATA

Alloy No.	Composition (ppm)	Melt Size	Thermal History	Alternate Immersion Corrosion Rate (mcd)			Solution Potential (Volts)
				3 hour	Exposure 1 day	7 day	
<u>Mg-Fe Master Alloys</u>							
70468	~ 150 Fe	700 grams	Poured at 800C into a split graphite mold				
70469	"	"	"				
70470	"	"	"				
70471	"	"	"				
70472	"	"	"				
<u>Mg-Fe-Alloys</u>							
				<u>Spec. Anal.</u>	<u>Chem. Anal.</u>		
70869-1	#67515 + #68859	100-110 Fe	150 grams	105 ave.	106 Fe	Poured at 800C into a split graphite mold (Cooling Rate 2000F/min.)	153.6
-2	"	"					100.0
-3	"	"					236.2
-4	"	"					163.3 ave. 118.8
							1.630
							1.637
							1.623
							1.633
							1.631 ave.
70870-1	#67515 + #68859	86-86 Fe	150 grams	86 ave.	89 Fe	"	40.8
-2	"	"					35.1
-3	"	"					79.7
-4	"	"					51.9 ave. >200 (Destroyed)
							1.644
							1.644
							1.647
							1.641
							1.644 ave.
70871-1	#67515 + # 68859	86-88 Fe	150 grams	87 ave.	86 Fe	"	37.7
-2	"	"					28.4
-3	"	"					132.3
-4	"	"					66.1 ave. 74.4
							1.639
							1.643
							1.632
							1.643
							1.639 ave.
70872-1	#67515 + #68859	92-92 Fe	150 grams	92 ave.	95 Fe	"	157.4
-2	"	"					42.3
-3	"	"					41.3
-4	"	"					80.3 ave. >210 (Destroyed)
							1.643
							1.641
							1.644
							1.640
							1.642 ave.
70873-1	#67515 + #68859	70-77 Fe	150 grams	73.5 ave.	62 Fe	"	3.48
-2	"	"					12.9
-3	"	"					2.98
-4	"	"					2.67
-5	"	"					2.5
							5.47 ave
							1.649
							1.650
							1.651
							1.651
							1.652
							1.651 ave.
70874-1	#67515 + #68859	54-58 Fe	150 grams	56 ave.	59 Fe	"	2.93
-2	"	"					1.62
-3	"	"					4.1
-4	"	"					2.9 ave 1.58
							1.654
							1.654
							1.655
							1.654
							1.654 ave.
70875-1	#67515 + #68859	45-50 Fe	150 grams	48 ave.	42 Fe	"	1.93
-2	"	"					1.86
-3	"	"					1.81
-4	"	"					1.87 ave .574
							1.658
							1.658
							1.658 ave.

TABLE II (Cont. -1)

Alloy No.	Composition (ppm)			Melt Size	Thermal History	Alternate Immersion Corrcsion Rate (mcd)			Solution Potential (Volts)
						3 hour	Exposure 1 day	7 day	
<u>Mg-Fe Alloys (Effect of Thermal History on Fe Anal.)</u>									
71018	T	#67515	335 Fe	100 grams	Poured at 800C into split graphite mold (Cooling rate ~ 2000F min.)				
	C		320 Fe						
	C		330 Fe						
	B		315 Fe						
			325 ave.						
71019	T	#67515	305 Fe	100 grams	Poured at 700C into split graphite mold.				
	C		305 Fe						
	C		320 Fe						
	B		320 Fe						
			313 ave.						
71020	T	#67515	285 Fe	100 grams	Air cooled from 800C				
	C		284 Fe						
	C		285 Fe						
	B		285 Fe						
			285 ave.						
71021	T	#67515	255 Fe	100 grams	Air cooled from 810C				
	C		264 Fe						
	C		204 Fe						
	B		255 Fe						
			255 ave.						
71022	T	#67515	275 Fe	100 grams	Air cooled from 800C to 625C, cold water quenched				
	C		300 Fe						
	C		320 Fe						
	B		285 Fe						
			295 ave						
71023	T	#67515	274 Fe	100 grams	Air cooled from 818C to 600C, cold water quenched				
	C		285 Fe						
	C		244 Fe						
	B		284 Fe						
			271 ave.						
71024	T	#67515	264 Fe	100 grams	Air cooled from 818C (Cooling rate = ~ 32F/min.)				
	C		250 Fe						
	C		264 Fe						
	B		284 Fe						
			266 ave.						
71025	T	#68859	6 Fe	100 grams	Air cooled from 800C (Cooling rate = ~ 33F/min.)				
	C		5 Fe						
	C		7 Fe						
	B		4 Fe						
<u>Mg-Fe Master Alloys</u>									
71050		#67515 + 68859	41 Fe	700 grams	Poured at 800C				
71051		#67515 + 68859	41 Fe	700 grams	Poured at 800C				
71052		#67515 + 68859	40 Fe	700 grams	Poured at 815C				
71059		#67515 + 68859	41 Fe	700 grams	Poured at 810C				

TABLE II (Cont. -2)

Alloy No.	Composition (ppm)			Melt Size	Thermal History	Alternate Immersion Corrosion Rate (mcd)			Solution Potential (Volts)
						3 hour	Exposure 1 day	7 day	
<u>Mg-40Fe-Si Alloys</u>									
71100-1 -2 -3 -4	#71050 + Si	56 Fe	6500 Si	135 grams	Poured at 800C into a split graphite mold.	119 54.6 86.8 ave.	159 150 155 ave.		
71101-1 -2 -3 -4	#71050 + Si	43 Fe	1420 Si	135 grams	Poured at 800C into a split graphite mold.	9.95 5.25 7.6 ave.	157 111 134 ave.		
71102-1 -2 -3 -4	#71050 + Si	40 Fe	530 Si	135 grams	Poured at 800C into a split graphite mold.	3.50 2.55 3.02 ave	9.63 9.33 9.48 ave.		
71103-1 -2 -3 -4	#71050 + Si	41 Fe	150 Si	135 grams	Poured at 800C into a split graphite mold.	38.3 30.4 34.4 ave	16.5 32.4 24.5 ave.		
71104-1 -2 -3 -4	#71050	38 Fe	<10 Si	135 grams	Poured at 810C	1.02 .94 .98 ave.	.416 .423 .420 ave.		
<u>Mg-40Fe-Cl</u>									
71105-1 -2 -3 -4	#71051 (blank)	41 Fe	21 Cl	135 grams	Poured at 800C into a split graphite mold.	1.12 1.06 1.09 ave.	.617 .531 .574 ave.		
71106-1 -2 -3 -4	#71051 + #230 flux	34 Fe	29 Cl	135 grams	Poured at 800C into a split graphite mold.	1.25 1.43 1.34 ave.	.900 .505 .703 ave.		
71107-1 -2 -3 -4	#71051 + #230 flux	34 Fe	37 Cl	135 grams	Poured at 800C into a split graphite mold.	1.43 1.18 1.21 ave.	.607 .523 .565 ave.		

TABLE II (Cont. -3)

Alloy NO.	Composition (ppm)		Melt Size	Thermal History	Alternate Immersion Corrosion Rate (mcd)			Solution Potential. (Volts)
					3 hour	Exposure 1 day	7 day	
71103-1 -2 -3 -4	#71051 + #230 flux	38 Fe	32 Cl	135 grams	Poured at 800C into a split graphite mold.	1.24 -.94 -.97 ave.	.478 .865 -.672 ave.	
71109-1 -2 -3 -4	#71051 + #230 flux	39 Fe	44 Cl	135 grams	Poured at 800C into a split graphite mold.	1.19 4.35 -2.77 ave.	.505 .730 -.618 ave.	
<u>Mg-40Fe-C</u>								
71122-1 -2 -3 -4	#71052	44 Fe	52 C	135 grams	Poured at 800C into a split graphite mold	1.00 1.37 -1.19 ave.	.513 .490 -.502 ave.	
71123-1 -2 -3 -4	#71052 + C	45 Fe	43 C	135 grams	Poured at 800C into a split graphite mold.	1.24 1.00 -1.12 ave.	.474 .535 -.505 ave.	
71124-1 -2 -3 -4	#71052 + C	41 Fe	53 C	135 grams	Poured at 800C into a split graphite mold.	1.11 .99 -1.05 ave.	1.31 .675 -.99 ave.	
71125-1 -2 -3 -4	#71052 + C	41 Fe	53 C	135 grams	Poured at 800C into a split graphite mold.	1.24 1.12 -1.18 ave.	.475 .233 -.354 ave.	
71126-1 -2 -3 -4	#71052 + C	39 Fe	45 C	135 grams	Poured at 800C into a split graphite mold.	1.00 .99 -1.00 ave.	.467 1.18 -.823 ave.	
<u>Mg-40Fe-S</u>								
71127-1 -2 -3 -4	#71059 (blank)	40 Fe	.1 S	135 grams	Poured at 800C into a split graphite mold.	1.00 1.12 -1.06 ave.	.498 .474 -.486 ave.	

TABLE II (Cont. -4)

Alloy No.	Composition (ppm)			Melt Size	Thermal History	Alternate Immersion Corrosion Rate (mcd)			Solution Potential (Volts)
						3 hour	Exposure 1 day	7 day	
71128-1 -2 -3 -4	#71059 + S	42 Fe	51 S	135 grams	Poured at 800C into a split graphite mold.	1.18 1.18 <u>1.18</u> ave.	.466 .503 <u>.485</u> ave.		
71129-1 -2 -3 -4	#71059 + S	45 Fe	51 S	135 grams	Poured at 800C into a split graphite mold.	1.12 1.18 <u>1.15</u> ave.	.483 .480 <u>.482</u> ave.		
71130-1 -2 -3 -4	#71059 + S	42 Fe	28 S	135 grams	Poured at 800C into a split graphite mold.	1.48 1.17 <u>1.33</u> ave.	.475 .490 <u>.483</u> ave.		
71131-1 -2 -3 -4	#71059 + S	40 Fe	31 S	135 grams	Poured at 800C into a split graphite mold.	1.12 1.18 <u>1.15</u> ave.	.475 .475 <u>.475</u> ave.		
<u>Mg-S</u>									
71134-1 -2 -3 -4	#68859 (blank)	6 Fe	18 S	135 grams	Poured at 800C into a split graphite mold.	1.12 1.19 <u>1.16</u> ave.	.485 .583 <u>.538</u> ave.		
71135-1 -2 -3 -4	#68859 + S	6 Fe	52 S	135 grams	Poured at 800C into a split graphite mold.	1.19 1.25 <u>1.22</u> ave.	.498 .470 <u>.484</u> ave.		
71136-1 -2 -3 -4	#68859 + S	5 Fe	36 S	135 grams	Poured at 800C into a split graphite mold.	1.25 1.25 <u>1.25</u> ave.	.648 .515 <u>.582</u> ave.		
71137-1 -2 -3 -4	#68859 + S	7 Fe	29 S	135 grams	Poured at 800C into a split graphite mold.	1.06 1.06 <u>1.06</u> ave.	.484 .499 <u>.492</u> ave.		
71138-1 -2 -3 -4	#68859 + S	9 Fe	16 S	135 grams	Poured at 800C into a split graphite mold.	1.31 1.17 <u>1.24</u> ave.	.575 .607 <u>.591</u> ave.		

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TABLE II (Cont. -5)

Alloy No.	Composition (ppm)	Melt Size	Thermal History	Alternate Immersion Corrosion Rate (mcd)			Solution Potential (Volts)
				3 hour	Exposure 1 day	7 day	
<u>Mg-Fe Master Alloys for Mg-Fe-Al Alloys</u>							
71185	#68859	4 Fe	700 grams	Cast at 800C into split graphite molds.			
71186	#67515 + 68859	13 Fe	700 grams				
71187	#67515 + 68859	20 Fe	700 grams				
71188	#67515 + 68859	30 Fe	700 grams				
71189	#67515 + 68859	40 Fe	700 grams				
71190	#67515 + 68859	50 Fe	700 grams				

TABLE III

EFFECT OF COLD WORKING DURING SAMPLE
PREPARATION ON THE CORROSION RATE OF
ALLOY NO. 67535

<u>Sample Preparation</u>	<u>Depth of Surface Removal, inches</u>	<u>Corrosion Rate (14 day, alt. imm.)</u>	<u>Avg. Corrosion Rate (mcd)</u>
Machined + etch- polished + rinsed	.0002	.261	
	.002	.252	
	.004	.258	
	.008	.289	
	.010	.303	
	.019	.276	
	.035	.255	
			.271
Machined + annealed (2 hrs. at 400F) + etch-polished + rinsed	.002	.235	
	.004	.263	
	.010	.272	
	.015	.277	
			.262
Annealed + machined + etch-polished + rinsed	.001	.261	
	.005	.288	
	.010	.297	
	.010	.264	
			.277
Annealed + machined + rinsed	.000	.245	
	.000	.222	
	.000	.260	
	.000	.215	
			.235
Machined + rinsed	.000	.225	
	.000	.267	
	.000	.239	
	.000	.260	
			.248
Machined + annealed + rinsed	.000	.253	
	.000	.226	
	.000	.262	
	.000	.240	
			.245
Machined + aloxited + rinsed	.001	.259	
	.001	.244	
	.001	.265	
	.001	.258	
			.256
Machined + annealed + aloxited + rinsed	.001	.264	
	.001	.239	
	.001	.250	
	.001	.264	
			.254

TABLE III (Cont. -1)

<u>Sample Preparation</u>	<u>Depth of Surface Removal, inches</u>	<u>Corrosion Rate (14 day, alt. imm.)</u>	<u>Avg. Corrosion Rate (mcd)</u>
Annealed + machined	.001	.234	
+ aloxited + rinsed	.001	.256	
	.001	.256	.249

CORROSION RATE (MCD)

1000

100

10

1

EFFECT OF IRON ON THE CORROSION RATE OF SODIUM NITROSIL
3M ALKALINE IMMERSION EXPOSURE TO 3% NaCl

IRON CONTENT (PPM)

25

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EFFECT OF THERMAL HISTORY ON THE SPECTROGRAPHIC ANALYSIS FOR IRON

SPECTROGRAPHIC IRON ANALYSES (PPM)

FIG. #3

EFFECT OF SILICON ON THE CORROSION RATE OF
SUBLIMED MAGNESIUM CONTAINING ~43 PPM IRON
(3HR ALTERNATE IMMERSION IN 3% NaCl)

FIG. # 4

ALLOY # 7100-7104
CORR. TEST # 4584

R.W.F.R. 6/18/52

FIG. 6

152A2375

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EFFECT OF CHLORIDES ON THE CORROSION RATE
OF SUBLIMED MAGNESIUM CONTAINING ~37 PPM IRON
(ALTERNATE IMMERSION IN 3% NaCl)

CORROSION RATE (MCD)

359-63 KEUFFEL & ESSER CO.
Semi-Logarithmic, 2 Cycles X 10 to the 1/2 inch,
5th lines accented.
MADE IN U.S.A.

FIG. #7

○ 1 DAY EXPOSURE
□ 3 HR "
CORR. TEST # 4589
ALLOY # 4565
7/105-7/109
R.W.F./R.6/16/52

EFFECT OF CARBON ON CORROSION RATE OF
 SUBLIMED MAGNESIUM CONTAINING 42 PPM IRON
 (ALTERNATE IMMERSION EXPOSURE TO 3% NaCl)

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EFFECT OF SULFUR ON THE CORROSION RATE
OF SUBLIMED MAGNESIUM CONTAINING 42 PPM IRON
(ALTERNATE IMMERSION EXPOSURE TO 3% NaCl)

CORROSION RATE (MCD)

KEUFFEL & ESSER CO., N. Y. NO. 389-120
Logarithmic, 3 X 3 Cycles.
MADE IN U.S.A.

EFFECT OF SULFUR ON THE CORROSION RATE OF
 SUBLIMED MAGNESIUM
 (ALTERNATE IMMERSION IN 3% NaCl)