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DATE: July 7, 1952

FROM : J. P. Termini, Process Development Branch, Production Division

SUBJECT: CORROSION RESISTANCE OF MATERIALS TO AN HF-H₂O-H₂SO₄ SYSTEM

SYMBOL : PP:JPT:js

PURPOSE

To present corrosion information on materials which can possibly be employed in the HF-H₂O-H₂SO₄ system in the extractive distillation process to be investigated at NBL.

DISCUSSIONA. Introduction

The corrosion resistance of different materials, when exposed to HF and H₂SO₄ under various conditions, will be reported in this memorandum. This corrosion information has been obtained from General Chemical, Dow Chemical, and Carbide and Carbon by phone. Since nothing is known about the control of variables affecting corrosion except for the control mentioned in the test conditions of this report, and since neither the validity nor the reliability of the corrosion results were reported to me, it is suggested that this corrosion information be used with reservation.

B. General Chemical

While no definite conclusions may be made from an examination of Table I, the following are noted:

1. Monel, as expected, appears to be resistant to high concentrations of HF.
2. Although lead is only slightly attacked by 70% HF, high concentrations of HF (95%) or H₂SO₄ (90%) will result in a very serious corrosion of lead.
3. None of the other materials, under the test conditions investigated, is significantly resistant.

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C. Dow Chemical Company

General Chemical mentioned that Dowmetal M (Mg-Mn alloy) was very resistant to HF. Dow Chemical Company stated that:

1. For HF concentrations greater than 30%, Dowmetal M had excellent corrosion resistance due to the formation of a protective fluoride film, resulting from an initial HF attack on the surface, that prevented further corrosion.
2. Dowmetal M was not suitable for an HF-H₂O-H₂SO₄ system because of the breakdown of this protective fluoride film by H₂SO₄ and water.
3. None of their alloys had satisfactory resistance to our system.

D. Carbide and Carbon

Carbide and Carbon suggested that Karbate No. 22, an impregnated graphite, was:

1. Good for all temperatures for sulfuric acid concentrations up to 96% or HF concentrations up to 48%.
2. Suitable for HF concentrations ranging from 48 to 60% at a temperature of less than 185°F.
3. Unsuitable for HF concentrations greater than 60% since the phenolic resin impregnate is attacked by the HF.

It may also be possible to line the lower section of the packed column with Karbate instead of lead. Carbide and Carbon has stated that there would be no fabrication problems in accomplishing this. The use of karbate in the lower section of the column would provide more flexibility in the column design since karbate is more resistant to HF and H₂SO₄ than lead, and a karbate-monel combination would eliminate the corrosion effect of any possible galvanic action inherent in a lead-monel contact.

Because of the high HF concentrations present, carbon, instead of karbate, Raschig rings is suggested as packing material for the column. Dr. Pinkston has told me that Catalytic is studying the possibility of using carbon bricks to line the column.

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TABLE I

CORROSION TESTS REPORTED BY GENERAL CHEMICAL

Composition (a)	Time of Test	Temperature	Material	Inches per (b) year
95% HF (L) 5% H ₂ O	24 hr.	185°F	Monel Chemical	0.04 0.6
70% HF (L) 30% H ₂ O	24 hr.	95°F	Monel Chemical Lead	0.02 0.12
95.5% HF (V) 2.0% H ₂ SO ₄ 2.5% H ₂ O	126 hr.	300°F	Chlorimet 3 Carpenter 20 Hastelloy C Chemical Lead Copper	0.1 0.18 0.4 0.5 1.1
74.0% HF (L) 1.8% Fluosilicic 1.1% H ₂ SO ₄ 23.1% H ₂ O	144 hr.	100-125°F	Chemical Lead	0.06
74.0% HF (L) 4.2% Fluosilicic 1.1% H ₂ SO ₄ 20.7% H ₂ O	144 hr.	100°F	Chemical Lead	0.04
88-91% H ₂ SO ₄ (L) 5-8% HF 3-5% H ₂ O	283 hr.	200°F	Carpenter 20 Worthite Ilium C Chemical Lead	0.03 0.04 0.1 17.8

a - (L) - material exposed to liquid phase at 0 velocity
(V) - material exposed to vapor phase at 0 velocity

b - the values are approximate

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