HDPE Leach Pad Liners & Pre-Curing of Copper Ores

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INTRODUCTION

High density polyethylene has long been the material of choice of copper leach pad construction (Smith, et al, 1996). The suitability of HDPE in a weak sulfuric acid environment has been demonstrated by conventional chemical compatibility testing, aging and testing in simulated copper PLS liquors (Smith, 1994 & 1996), and from actual field experience. However, operators have recently found that pre-curing the ore with concentrated sulfuric acid (commonly 96%) can significantly shorten leach cycle times, improving through-put from on/off pads and reducing inventory in permanent heaps. That this change may affect the design of the geomembrane protective cover and drainage gravel layers began coming under serious scrutiny in 2002 and is the subject of on-going research. A related – and potentially more serious – issue is the compatibility of HDPE liners (and, by extension, drainage pipes) with concentrated sulfuric acid.

Typical pregnant leach solution (PLS) contains less than 2% acid; however, pre-cured ore can expose the liner system to concentrated acid for brief periods. For dynamic heaps (on/off pads) this exposure is repeated with each leach cycle (albeit slightly diluted by the low concentration PLS retained in the heel layer after the first cycle). On a conventional pad (permanent heap) the peak concentration that reaches the liner significantly reduces with each additional lift.

HDPE COMPATIBILITY WITH CONCENTRATED H_2SO_4

To test the compatibility of HDPE geomembrane with concentrated sulfuric acid, a series of tensile strength-to-break tests on 25mm wide strips were performed. All samples were cut from the same virgin sheet; some were tested without acid curing to provide the initial condition. The remaining samples were immersed in acid (96% reagent grade H_2SO_4 at 21^{o}C) for periods of up to 8 days. Then they were tested for break strength and compared to the original values. Table 1 presents the results of this testing.

Concerning HDPE resin in general, a brief review of available manufacturers' data is summarized in Table 2. In addition to short-term effects, the acid may also damage the antioxidants and other compounding agents used in geomembrane formulations, leading to eventual brittle failure of the sheet (Solvay, 2001, CPChem-Solvay, 2003).

Using 60 degree reference data might, on first glance, seem conservative. However, ambient temperatures in the Chilean Atacama often reach 50 degrees. Further, one can visualize the effect of the endothermic reaction of concentrated sulfuric acid with the moisture retained in the heel layer and the ore. Thus, 60 degrees may be a reasonable design temperature for short-term exposures.

Table 1: Strength Loss versus Exposure Time
1.5mm HDPE Geomembrane – 21°C

Exposure Time in 96% H_2SO_4 (days)	Tensile Strength (% of original)
0	100%
1	98.3
4	97.4
8	97.3

Table 2: Compatibility Testing for HDPE Resin
60°C for 60 Days

Concentration of H_2SO_4	Overall Ranking	Manufacturers' Recommendations	Weight Loss	Elongation Retained
	9 = best 0 = worst	S = satisfactory O = limited U = unsatisfactory	% of original	%
<50	8 or 9	s	< 0.5	100
70	5 to 8	o	< 0.5	>85
80	2 to 8	u	< 0.5	~85
96-98	2 to 3	u	> 5.0	<50

IMPLICATIONS

Considering a dynamic heap, for the first cycle of fresh ore the liner system may be exposed to concentrated acid for a period of one to several days, depending on specific operating conditions. For subsequent cycles the overliner system (often called the "heel") will have been pre-wetted with weak PLS and thus the effect of the concentrated acid will be reduced, though the temperature may be higher due to the acid-PLS reaction. A similar effect will occur on a conventional leach pad, but the solution from subsequent lifts should be even further diluted and the effect may be negligible after the first lift.

This evaluation is far from conclusive for any purposes other than to demonstrate the need for more research. Specifically, the industry needs long-term testing to determine the ultimate reduction in physical properties for a range of acid concentrations and geomembrane thicknesses. Until such research data is available, designers should use additional care in specifying liners for leach pads where acid pre-curing is planned. Until the longer-term performance impacts are understood, it is not possible to address this issue quantitatively. However, the following guidelines are offered.

Interim Guidelines

The operators should consider pre-curing with lower concentration acid, such as 30% to 50% H_2SO_4. For a conventional pad, this "modified" pre-curing would only be necessary on the first 1 or 2 lifts of ore. If that option is not feasible, then consider ALL of the following:

- **On/Off Pads**
  - Use co-extruded HDPE with a top layer made from a resin package specifically formulated for this environment;
  - Minimum liner thickness of 2.0mm, consider 2.5mm;
  - Irrigate each new cycle aggressively for the first few hours; and,
  - Limit time that ore is allowed to "cure" on the leach pad to a few days before starting normal leaching. Irrigate "aggressively" for the first few hours to purge concentrated acid from heel.

- **Conventional Pads**
  - Use minimum of 1.5mm thick HDPE, not LLDPE unless testing verifies compatibility or it is co-extruded with HDPE;
  - Consider a thicker liner if exposure times are longer then a few days;
  - Limit cure times for the first lift to a few days;
  - Irrigate the first lift aggressively for the first few hours; and,
  - Consider co-extruding the liner with a specially formulated resin package.

References

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