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11236 S. Torrence Ave.
Chicago IL 60617



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Heat Exchanger Flushing

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Date: April 16, 1979

V. Beaucaire
N. H. Keyser
J. Lee

To: Al Bailey
From: C. Lin
Subject: Flushing Plate and Frame Heat Exchanger
with "Coal Tar Solvent Naphtha"
Reference: D2-001-001

Introduction

Recently, the plate and frame heat exchanger for primary cooling liquor plugged due to the deposit of tar, naphthalene, and carbon particles. Conventional way of rehabilitation -- cleaning up the plates, replacing gaskets, and reassembling the heat exchanger -- is just too expensive for us. Kopper Company suggested us to flush heat exchanger with "Coal Tar Solvent Naphtha". The purpose of this job is to find out whether gaskets could be damaged by this specific solvent, and what is the optimum operation condition.

Experimental, Results and Discussion

We divided the laboratory work into two phases:

(1) Solubility of Deposit

This is a test to find out how easy the deposit can be flushed out by "Coal Tar Solvent Naphtha".

Table 1. Solubility of Deposit

Solvent Temperature	Way of Testing (Try to dissolve a ~ 1" x 3/4" x 1/2" deposit in 100 ml solvent)	Results
Room Temperature	Occasionally stirred for the first two hours. Soaked only later on.	Less than 1/3 had been dissolved within the first 20 minutes. Less than 1/2 dissolved within the first hour. A 1/2" x 1/2" x 1/4" piece still left after 2 days. The undissolved portion was always hard to break.
134 ^o F	Occasionally stirred for the first 20 minutes.	After 20 minutes, only 1/3 left. The left-over portion was still pretty hard.
188 ^o F	Occasionally stirred for the first 20 minutes.	After 10 minutes, only a 1/2" x 1/2" x 1/4" piece left. That piece of deposit, however, was soft and easy to be broken by any external force.

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Actually, light oil can dissolve the deposit much faster than that specific solvent.

(2) Durability of Gasket

This test, here, provided the information whether and what extent gasket can get damage through flushing of "Coal Tar Solvent Naphtha".

TABLE II. Durability of Gasket

Solvent Temperature	Time Duration	Surface Remained Smooth and Un-damaged?	Gasket Remained Soft & Elastic?	Amount of * Swelling (out of 5-6 mm Original Thickness)
Room Temperature	4 Hours	Yes	Yes	1 mm
Room Temperature	40 Hours	Yes	Yes	1 mm
134°F	4 Hours	Yes	Yes	1.4 mm
134°F	40 Hours	Yes	Yes	1.5 mm
188°F	4 Hours	Yes	Yes	1.7 mm
188°F	40 Hours	Yes	Yes	1.8 mm

The amount of swelling seemed to be a function of temperature and little to do with time. The swelling shrank after the gaskets were wiped down and left in air for several days. The gasket, after 20 days in air, still had 10 to 20% swelling, and seemed softer than original. However, it is unlikely this change in gasket would hurt the function of sealing.

* Visual estimation, not accurate.

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Recommendations

In short, the writer believes that flushing with "Coal Tar Solvent Naphtha" provides us a good chance to remove the deposit from our plate and frame heat exchanger, and recommends to do so. To heat up that solvent during flushing operation would be helpful, but beware of the vapor. The toxicity of such vapor is still unknown to us. According to the "Material Safety Data", the vapors are at least irritating to eyes, nose, and throat and may cause headaches, dizziness. Two additional suggestions, here, may further improve the deposit removal operation:

- (1) Filter the Outcoming Solvent Before Recycling. Since a large portion of the deposit are insoluble carbon particles, to remove these particles before recycling would greatly increase the efficiency of this operation.
- (2) Blow Air Through the Heat Exchanger for Several Days After the Flushing Operation and Before Using Again. Air can remove the solvent soaked in gasket, help the shrinkage of gasket to its original size, and recover its original elastic strength.

C. Lin

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CL/mw