

MOLTEN SULPHUR LININGS

2006 update

BY

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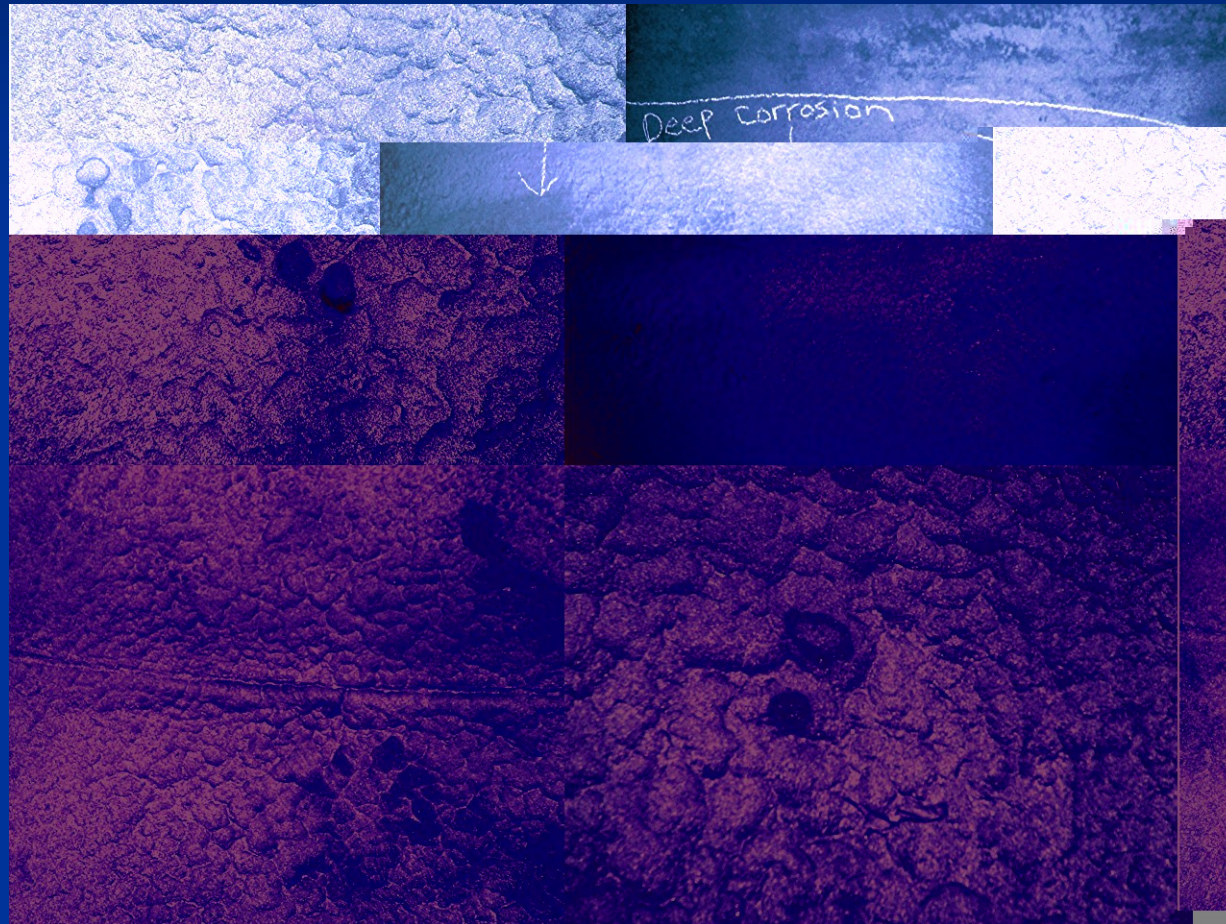
BILL HANNEMANN

JIM MOLNAR

Corrosion from Sulphur Service



Molten Sulphur Corrosion Damage



WHAT HAPPENED ?

- LINING REQUIREMENTS ARRIVED AFTER AAR REVIEWS A CTC REPORT ON A MOLTEN SULPHUR RAIL CAR INCIDENT IN CANADA
- COATINGS WERE DEVELOPED OR ADAPTED FOR LINING TANK CARS IN MOLTEN SULPHUR SERVICE
- WORKING WITH THE AAR, THE NATIONAL ASSOCIATION OF CORROSION ENGINEERS DEVELOPED A STANDARD FOR SELECTING AND APPLYING COATINGS FOR MOLTEN SULPHUR SERVICE

NACE TASK GROUP 067 CREATED TO WRITE A SPECIFICATION

- TANK CAR BUILDERS
- TANK CAR OWNERS
- COATING MANUFACTURERS
- SHIPPERS OF MOLTEN SULPHUR
- TANK CAR REPAIR SPECIALISTS
- THE SULPHUR INSTITUTE

MATERIAL SELECTION CRITERIA

COATING SYSTEM SHALL POSSESS THE FOLLOWING PROPERTIES TO BE SUITABLE FOR TRANSPORTING MOLTEN SULFUR:

- A MINIMUM IMMERSION TEMPERATURE RATING IN MOLTEN SULFUR AT 325°F
- CHEMICAL-RESISTANT PROPERTIES TO MOLTEN SULFUR
- THE ABILITY TO WITHSTAND 10 THERMAL SHOCK CYCLES FROM -40 TO 325°F
- COATING SHALL EXHIBIT ACCEPTABLE ADHESION AND RESIST MECHANICAL DAMAGE

A TWO PART STANDARD-

PART 1:

COATING SELECTION

- CHEMICAL RESISTANCE TEST
- DRY HEAT RESISTANCE TEST
- ADHESION TEST
- IMPACT RESISTANCE TEST
- THERMAL SHOCK TEST

PART 2: APPLICATION

- CLEANING AND DECONTAMINATION OF USED TANK CARS
- SURFACE PREPARATION
- APPLICATION
- INSPECTION

PROBLEMS

- WITHIN TWO YEARS IT IS REPORTED THAT COATINGS MEETING THE NACE TEST CRITERIA MAY FAIL AFTER A SHORT TIME
- NACE GOES TO WORK DEVELOPING MORE RIGOROUS COATING MATERIAL SELECTION CRITERIA

Blistered Coating



Coating Failure at Nozzle



Coating Failure at Nozzle / Vapor Space



Coating Failure at Nozzle



Mudcracking of Coating



Delamination From Substrate



Vapor Zone Coating Failure



Sidewall Corrosion Failure



Liquid Line Corrosion



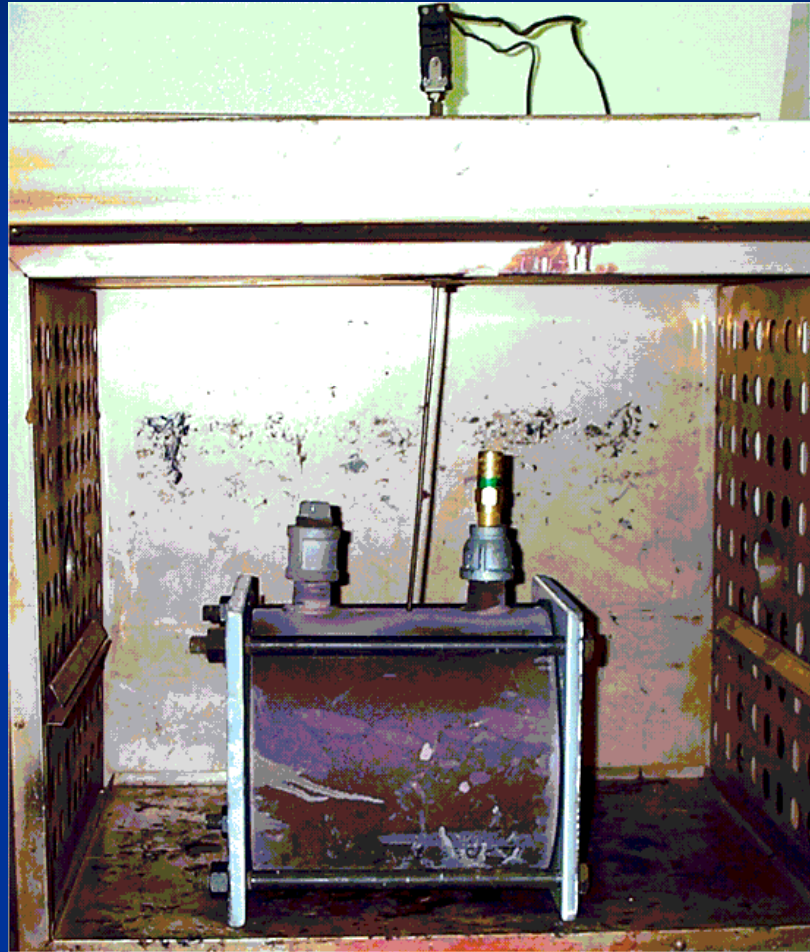
ONE MAN'S QUEST

- WORK IS DONE BY JIM MOLNAR & CO. TO DEVELOP A TEST THAT MORE ACCURATELY REPRESENTS THE VARIOUS PHENOMENA THAT HAVE BEEN OBSERVED TO TRANSPIRE IN A RAILCAR CARRING MOLTEN SULPHUR.

Cyclical Chemical Resistance Test

- The test cell should be capable of withstanding a minimum operating pressure 125 psi at an operating temperature of 340°F and be equipped with an appropriate pressure-relief device for safety.
- The test cell should be filled to one-half its capacity with an ambient temperature representative sample of sulfur typically transported in rail tank cars along with tap water equal to 1.5% by weight of the sulfur.
- The test cell with sulfur and the tap water shall be heated in an oven over a 3.5-hour ramp heating period to 325°F and soaked for three hours at a temperature of 325°F. Cool down to ambient temperature over a 5 hour period shall be allowed.
- The test cycle shall be repeated for 25 days or a minimum of 50 cycles.
- The test cell interior surface preparation, type of coating, sulfur source, and results of the test should be recorded.

ASSEMBLED TEST CELL SHOWN IN OVEN



ASSEMBLED TEST CELL SHOWN IN OVEN



VERIFICATION BY COMPARISON

- CROSS TESTING OF VARIOUS COATING MATERIALS SAMPLES HAS SHOWN RESULTS THAT MIMIC ACTUAL FAILURE MODE AS SEEN IN TANK CARS CARRYING MOLTEN SULPHUR
- CYCLICAL CHEMICAL RESISTANCE TEST ADDED TO REVISED NACE SPECIFICATION

Sample of Test Cylinder



Sample of Test Panel



WORKING ON LIFE EXTENSION

NACE TASK GROUP 067 CONTINUES TO WORK
ON MOLTEN SULPHUR CONCERNS

- MORE COMPLETE REMOVAL OF NONVISIBLE CONTAMINENTS
- USE OF AN INERT GAS BLANKET
- COATING MAINTENANCE METHODOLOGIES

COATING MAINTENANCE

- PERIODIC INSPECTION
- IF YOU FIND A PROBLEM --- START LOOKING FOR PATTERNS
 - USED CAR?
 - COATING MATERIAL
 - APPLICATION FACILITY
 - OTHER CAR WITH SAME PROBLEM FROM THAT GROUP?

COATING MAINTENANCE

(continued)

- DETERMINE OPTIMAL MACRO- AND MICRO-CONTAMINANT REMOVAL METHODS
- DETERMINE REPAIR FREQUENCY AND METHODS FOR HIGH HEAT FLUX AND OTHER AREAS
- MONITOR COATING REPAIR LONGEVITY

WHAT'S AN OWNER TO DO?

- SUBMIT COATING CANDIDATE SAMPLES TO LABORATORIES FOR EVALUATION
- COMPARE RESULTS AND MAKE THE BEST DECISION YOU CAN
- MONITOR CARS AND ASSESS ACTUAL COATING CONDITION TO WARD OFF TANK DAMAGE
- LOOK IN AS MANY CARS AS POSSIBLE
- DO TRIAL CARS WITH DIFFERENT COATINGS AND MONITOR THEM, MINIMIZING AS MANY VARIABLES AS POSSIBLE

AT THIS POINT,
SULPHUR CAR
COATING
MAINTENANCE
IS A WORK IN
PROGRESS