

# Morpholine Poisoning of Claus Catalyst in Sulphur Recovery Units

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# CASE HISTORY

## What is Morpholine?

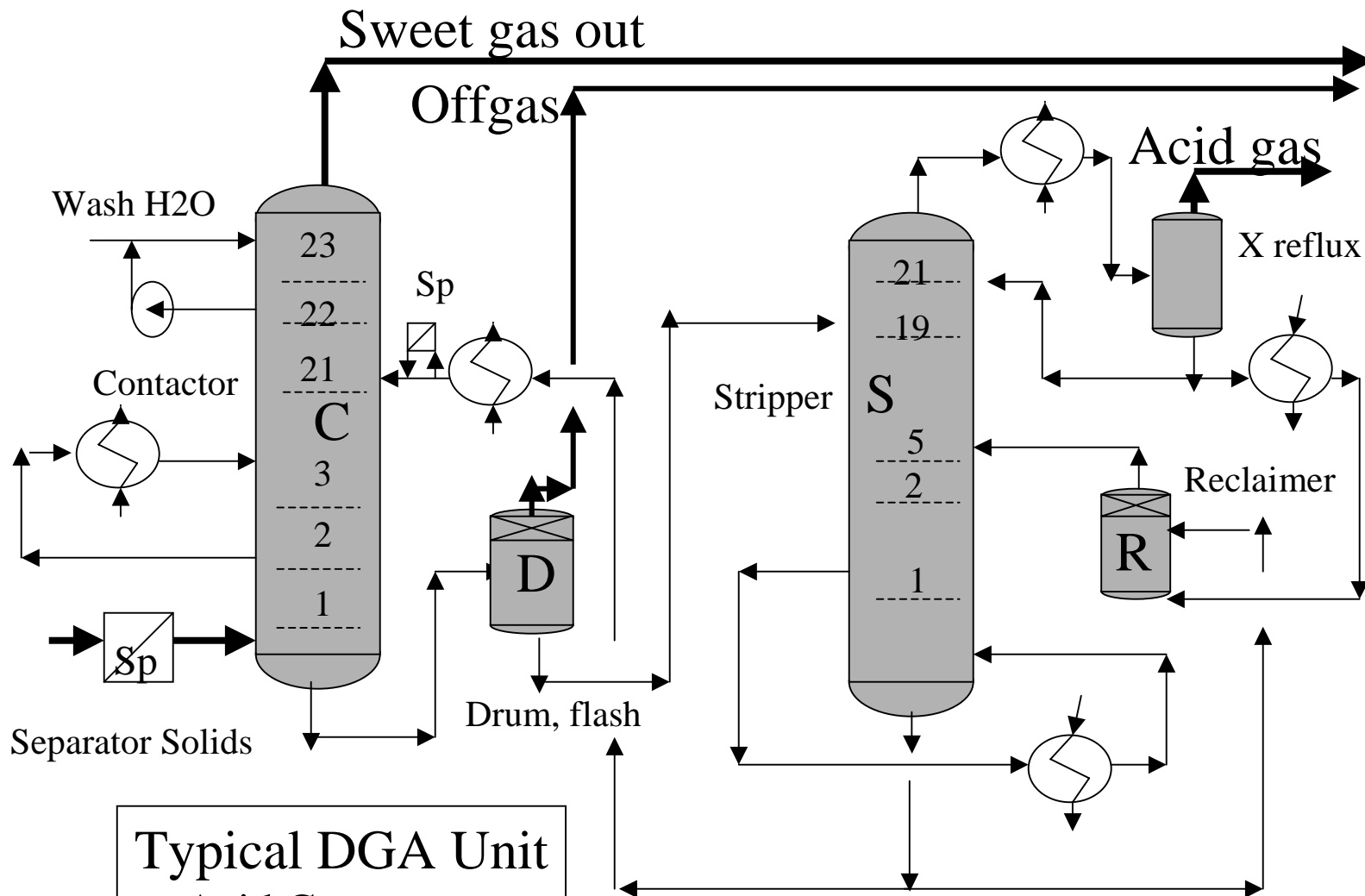
degradation product of BHEEU conversion to DGA, always present in small amounts in DGA type Amine Units, minimize by keeping correct reclaimer Temperature

## What are impacts on Sulfur Plant Operations?

Morpholine Carryover is typically slow & continuous w/ little impact on operation of sulfur plant

## What happened?

A DGA reclaimer tube leak dumped superheated steam into the reclaimer & increased Morpholine production with a drastic decrease in SRU recovery and increased DGA makeup



Typical DGA Unit  
 Acid Gas goes to  
 SRU Gas Scrubber

Table 1 shows vapor pressure of Morpholine, which is about 1/2 that of water. Thus where water goes, Morpholine goes. DGA has only 1/100 of water and very little is lost in well rectified units.

Table 1

	vap	press	mmHg
T, F	Morph	H2O	DGA
90.00	20.00	36.00	0.35
120.00	40.00	88.00	0.61
212.00	310.00	750.00	2.30

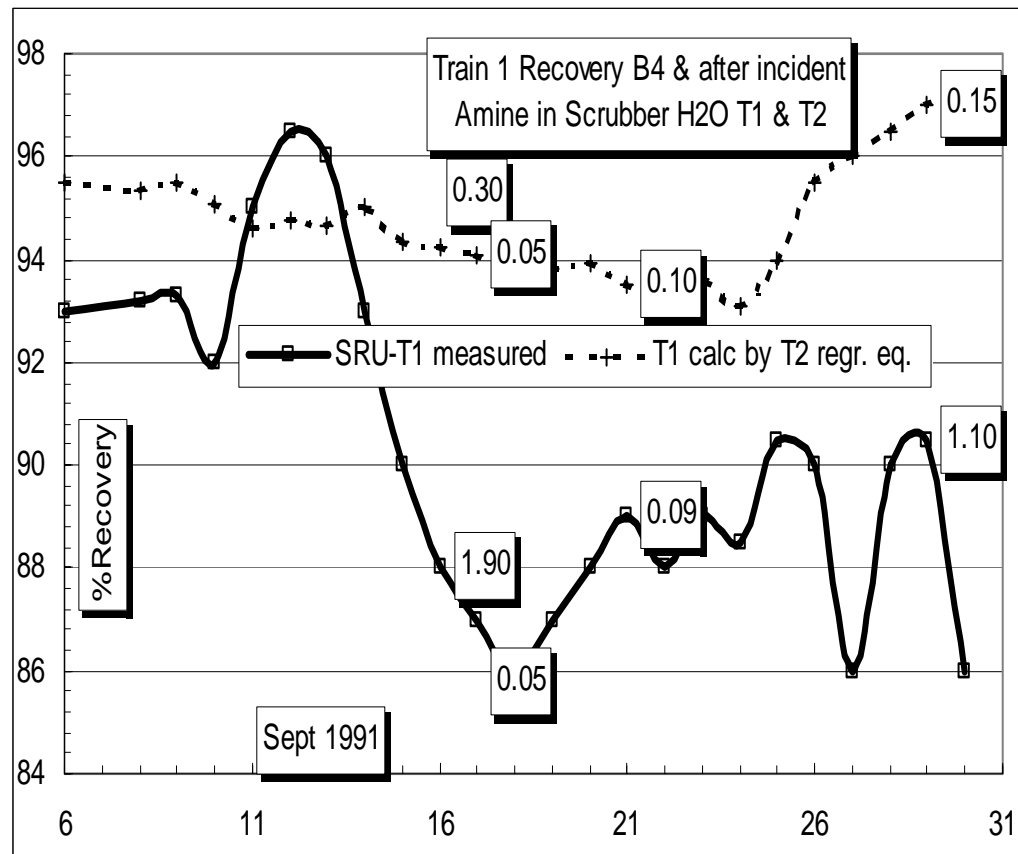
The normal concentration of amine in the acid gas scrubber is typically less than 0.20% by weight. During this incident, the concentration was 10-20 times normal levels in SRU-1, which is adjacent to the GT unit which developed reclaimer tube leak

Table 2

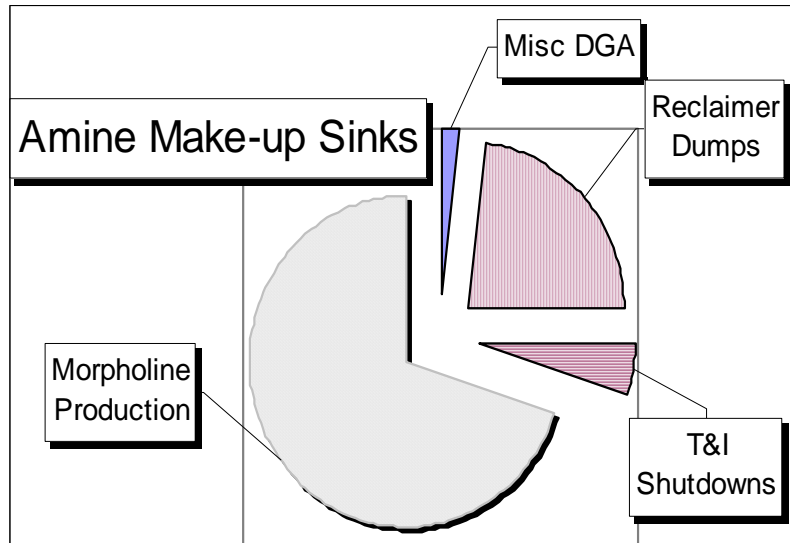
Total Amine in Acid Gas Scrubber %			
Date	Train 1	Train 2	Train 3
16-Sep	1.90	0.30	0.30
17-Sep	0.05	0.07	0.05
21-Sep	<0.10	0.10	<0.10
29-Sep	1.10	0.15	<0.10
6-Oct	0.02	0.04	0.04

## Claus Unit 1 Recovery B4 & after amine carryover.

The rapid decline in recovery after 13<sup>Sept.</sup> triggered this study. A regression analysis was made to determine if operating parameters can explain the decrease in %Rec. But only 20% of the changes in recovery could be explained by operating parameters. The main external effect was amine in scrubber water.



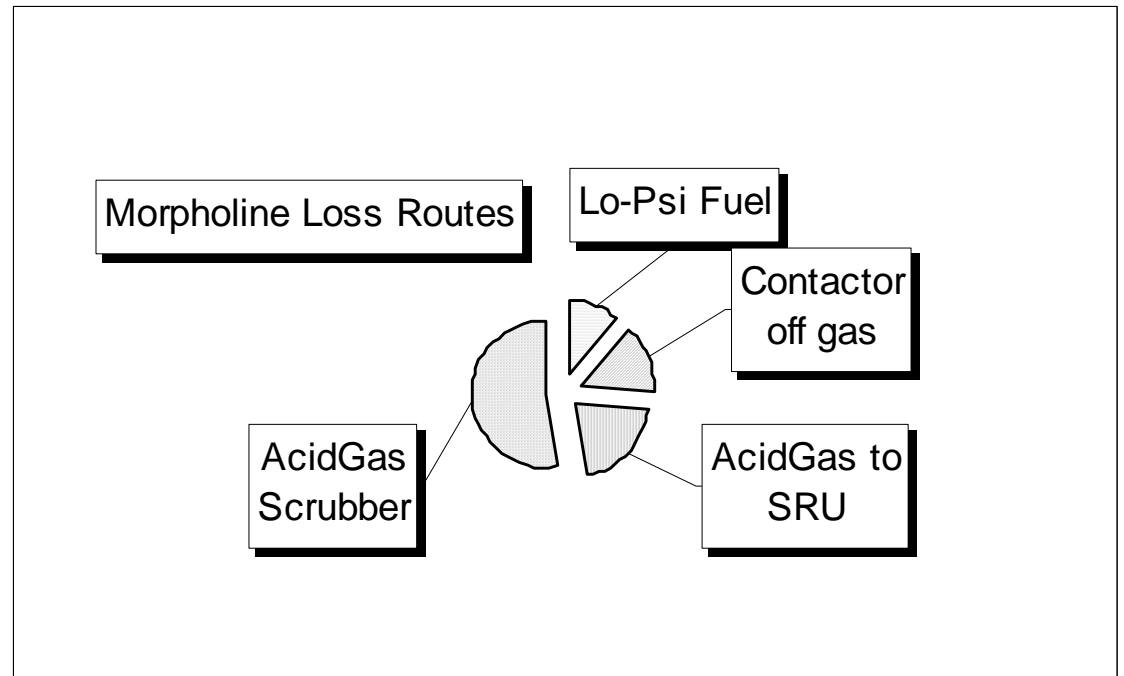
The primary increase of amine in scrubber water is thought to be Morpholine, due to the high vapor pressure of Morpholine.



The main source of Amine Loss is Morpholine in a DGA unit 70%

The main egress of Morph. is to the SRU Process, 73%

2/3 of egress is removed in amine scrubber H<sub>2</sub>O, for normal operation  
 upsets send more to SRU  
 Acid Gas Scrubber



# Process Study Results

- Morpholine Lost is DGA Lost
- Morpholine losses go mainly to the SRU
- Morpholine deactivates Alumina catalyst

# Conclusions

Abnormal Conditions Cause Excessive Morpholine Carryover, such as:

- excess generation in reclaimer
- stripper overhead condenser failure
- boilouts during unit shutdowns

Deactivation is thought to be from 2 effects

1. Temporary deactivation of active site by ammonia
2. Longer Term deactivation by coke formation
3. Normal Morpholine carryover is acceptable



# Recommendations

1. Minimize Morpholine Production in reclaimer
2. Monitor Amine in Acid Gas Scrubber of SRU
3. Use Temperature Alarms on Amine Reclaimer

Appreciation is given to Saudi Arabian  
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for permission to publish this work