8th Chemical Process Safety Sharing (CPSS)

Caustic Stress Corrosion Cracking in Olefin Plant

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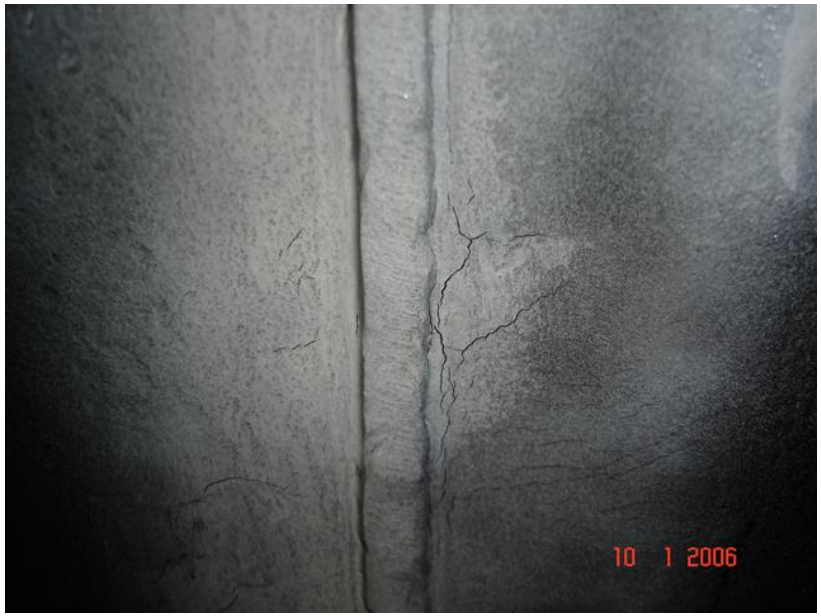
Contents

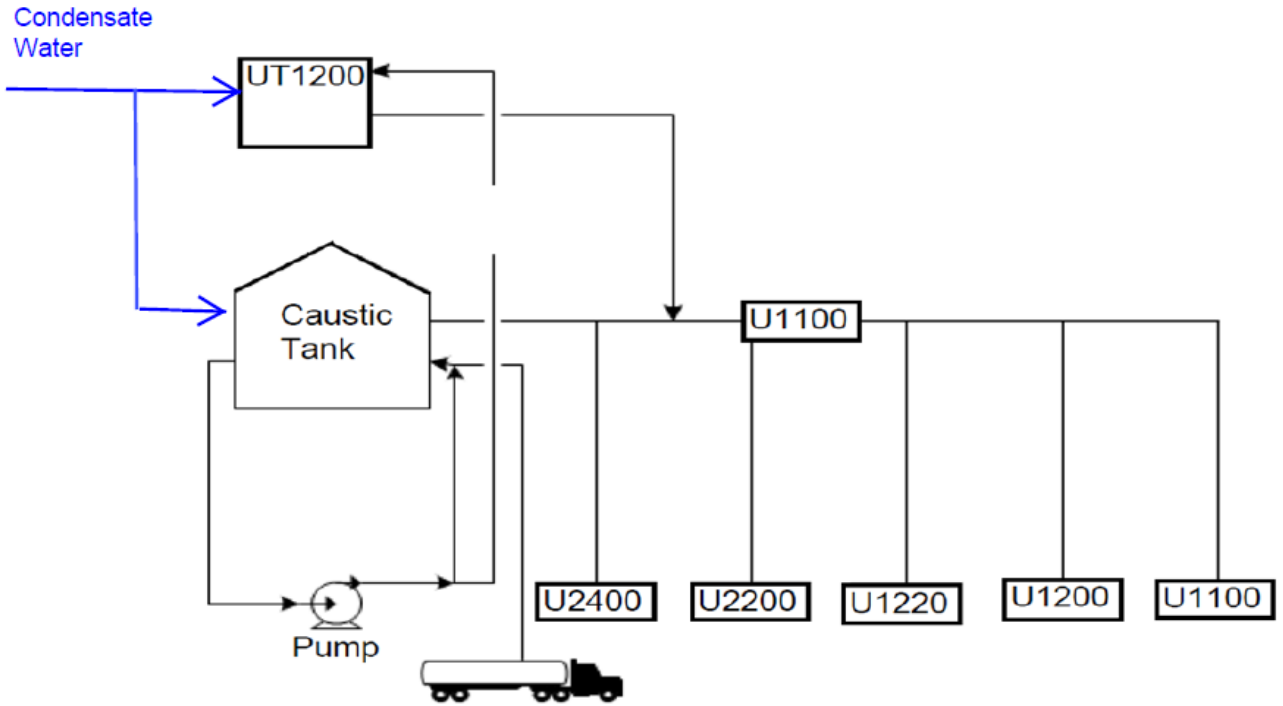
Background

- Olefins Plant had a caustic leakage incident of 30% caustic Tank in Jan. 10, 2006.
- This tank contains caustic solution which dilutes 50% caustic to 30% caustic by condensate water.



Process Description

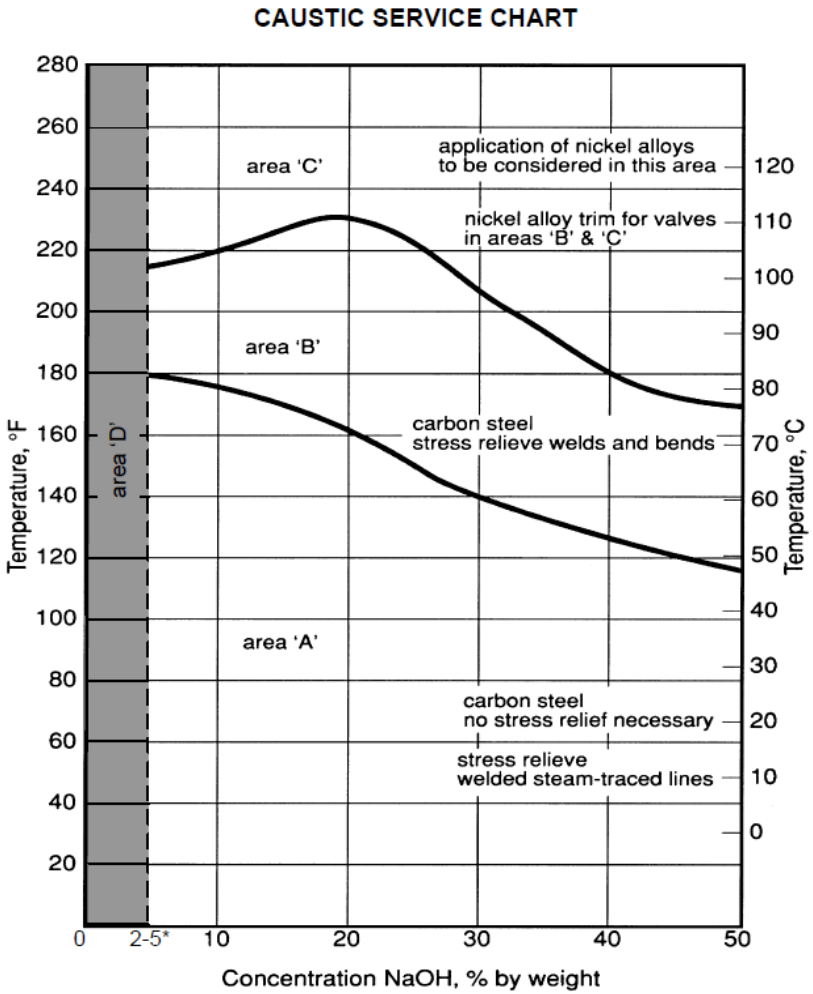
- Caustic soda 50 wt% supply from outsource to Caustic Tank via truck loading then feed to Caustic Tank and diluted with condensate water to desert value at Caustic soda 30 wt%. Then feed This Caustic Soda 30 wt% to all users in Olefins Plant.



Caustic Stress Corrosion Cracking (Caustic-SCC)

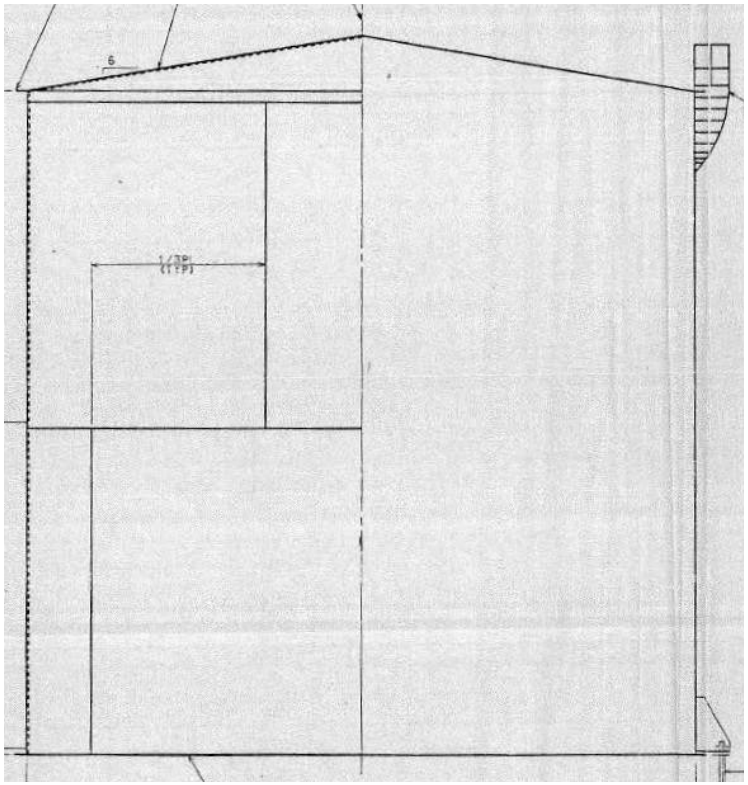
Description of Damage

- Caustic-SCC of carbon steel (CS) can occur in a caustic solution with a concentration of 5%wt or greater and is not anticipated at temperature less than 46°C. Cracking susceptibility is a function of caustic concentration, stress, temperature and type of material. Residual stress can accumulate in CS from fabrication such as welding, cold work. The majority of Caustic-SCC incidents in non-stress-relieved CS fitting and piping have been associated with welds. CS-PWHT or stress-relieved CS resists Caustic-SCC at higher temperature than CS-No PWHT and non-stress-relieved CS.



Caustic Stress Corrosion Cracking (Caustic-SCC)

- Tank design data
(Since July 31, 1988)



DESIGN CONDITION

CODE & SPEC: API650 7TH EDIT. APPENDIX A
SERVICE: 20% CAUSTIC SOLUTION
SPECIFIC GRAVITY: 1.2
CAPACITY: 66.9 M3
CORROSION ALLOWANCE: SHELL 3.0 MM
ROOF 0.0 MM
BOTTOM 3.0 MM
PRESSURE DESIGN/OPER.: ATMOS.
TEMPERATURE DESIGN: 70 DEG. C
DESIGN METAL TEMPERATURE: 70 DEG. C
EARTHQUAKE: NONE
WIND: 38 M/S
RAIN FALL: 135 MM/HR
SNOW LOAD: NONE
FILLING RATE: ——
EMPTYING RATE: ——
HYDROSTATIC TEST: FULL WATER

MATERIAL SPECIFICATION

SHELL: #1 THRU #2 A283C

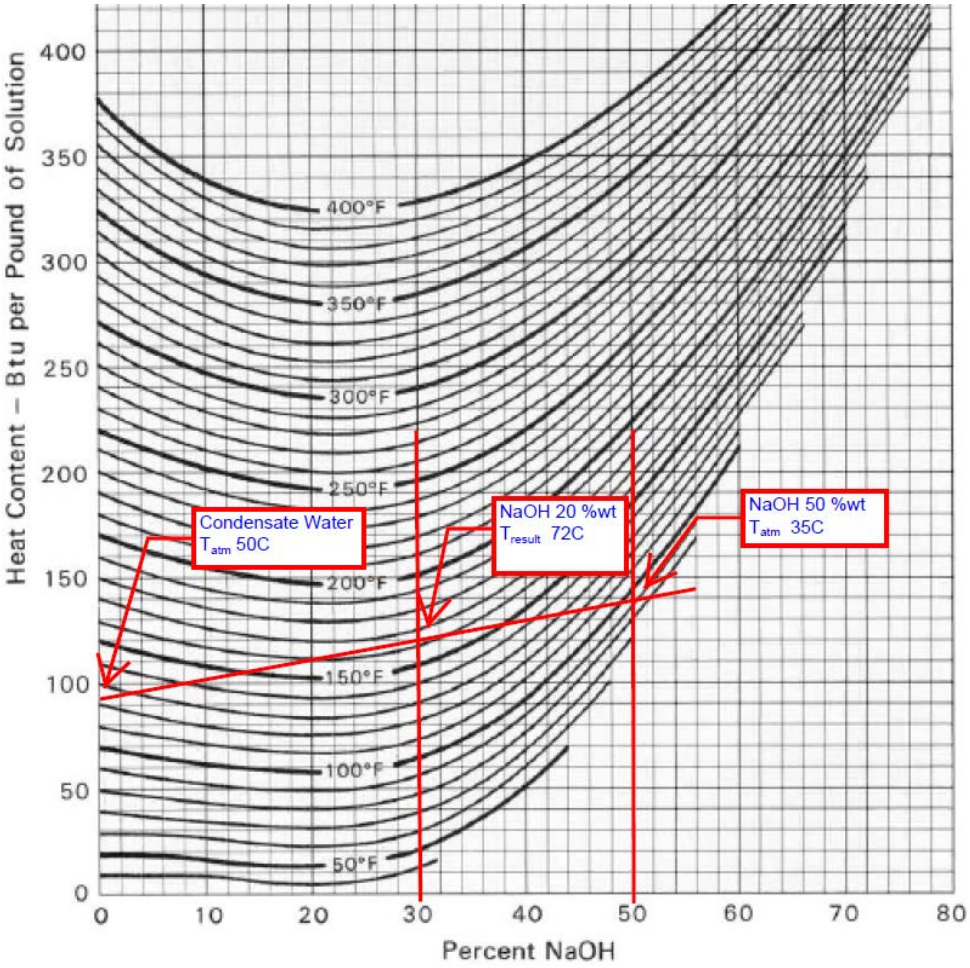
ROOF: A283C
BOTTOM: A283C
ANNULAR: NONE
COLUMN: NONE
STRUCTURAL: SS41
NOZZLE & MANHOLE:
UP TO & INCL 12" A53B
OVER 12" A283C

Caustic Stress Corrosion Cracking (Caustic-SCC)

Investigation

- There are two mechanisms concerned. **The first is effect of exothermic reaction** from caustic dilution increasing of temperature. **The second is Caustic-SCC.**
- Caustic Dilution: Caustic tank 50% caustic is diluted by condensate water at 50°C to 30% caustic. Temperature of 50% caustic is an ambient temperature (35°C). By exothermic reaction, the result of dilution when condensate water at 50°C is 30% caustic at 72°C.

Enthalpy of Caustic Soda Solution

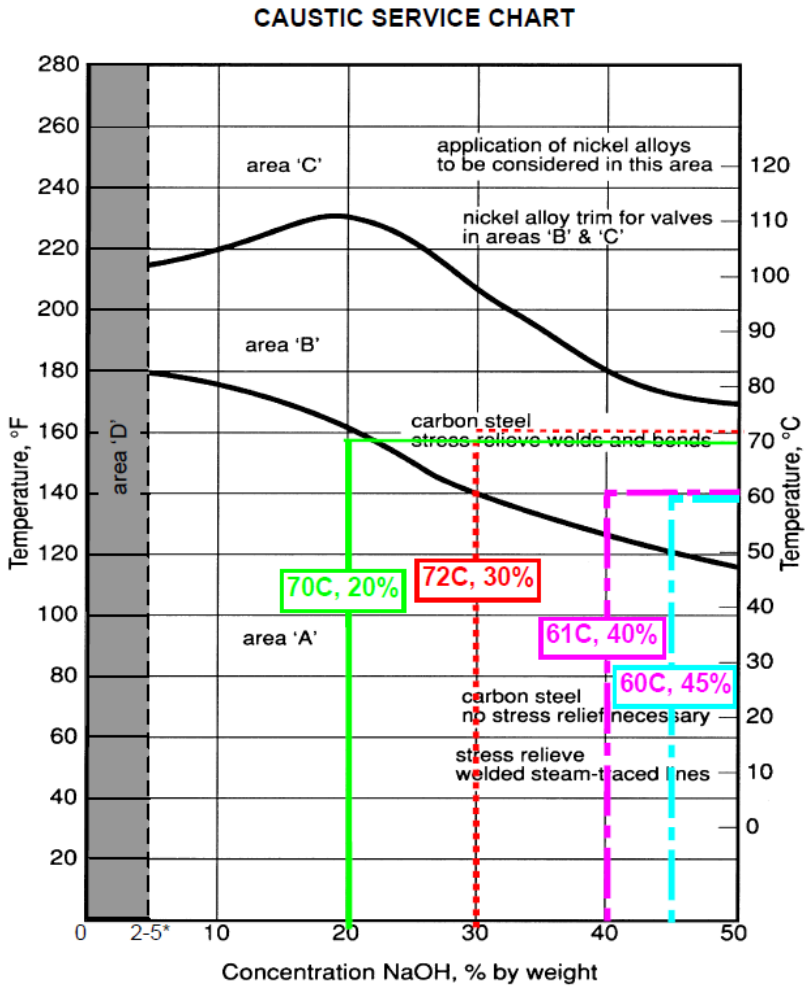


Caustic Stress Corrosion Cracking (Caustic-SCC)

Investigation

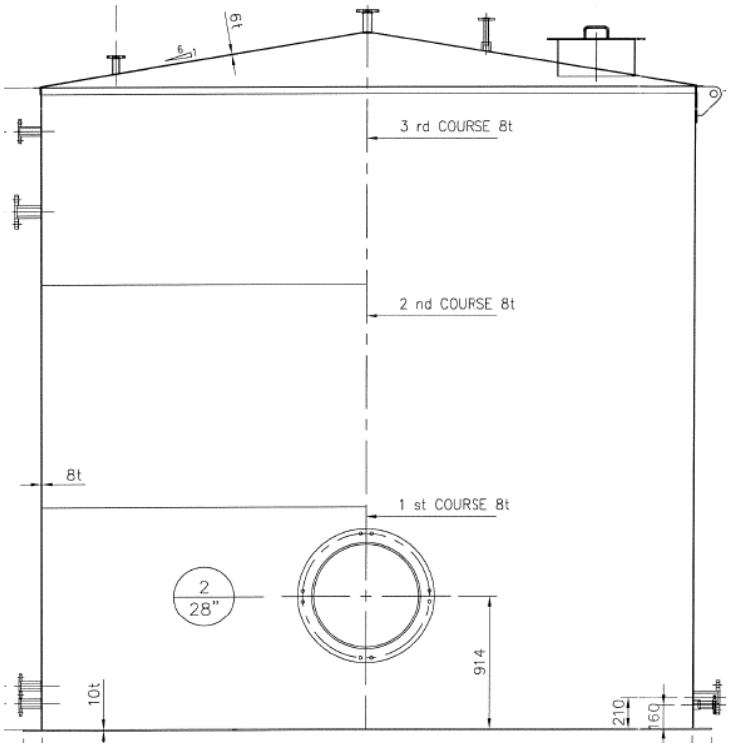
- Caustic-SCC for 30% caustic service involves two factors, tank material and limitation of temperature in 30% caustic service.

1) **Tank material for caustic service (in area "B") is required stress-relieved carbon steel, e.g. PWHT,** normalization and hot forming. The investigation of tank material, PWHT is not shown in Material Specification.
2) Limitation of cracking temperature in 30% caustic service. For non-stress-relieved carbon steel, limitation of cracking temperature is lower than 46°C.



Way forward

- **New tank of CS-PWHT** was fabricated for this service application (caustic service in area “B”) in 21/8/2006.



DESCRIPTION		SPECIFICATION
CODE : TENTH EDITION,NOVEMBER'1998		APPLIED TO API 650
SERVICES		50% CAUSTIC SOLUTION
SPECCIFIC GRAVITY		1.53
OPERATING TEMPERATURE (°C)		70 °C
DESIGN PRESSURE (KG/CM^2G)		FULL LIQUID + 150mm.H_2O
HYDRO TEST HEIGHT		4400 mm.
TEST PRESSURE	HYDRO.	FULL WATER
	PNEUM.	150 mm.H_2O
POST WELDING HEAT TREATMENT		YES
RADIOGRAPHIC EXAM		SPOT TEST
JOINT EFFICIENCY (REF.API 650)		0.85
CORROSION ALLOWANCE (MM.)	ROOF	0.0
	SHELL	3.0
	BOTTOM	3.0

Reference

- NACE SP040315 Avoiding Caustic Stress Corrosion Cracking of Refinery Equipment and Piping (21102-SG).
- Caustic Soda ©2008 PPG Industries Inc.

Thank you for your attention