

INTRODUCTION

Process Engineering, Inc. inspected the customer's Q set evaporators during the mill outage during the week of April 5, 2020. The inspection was performed to find loose or broken internal elements and excessive corrosion activity. All vapor heads, and steam chests and lower liquor boxes were inspected. Major findings were provided to the mill at the time of the inspection. This report includes the major findings and other details of our inspection.

Vessels were inspected as indicated in the table below:

EFFECT		"Q" SET EVAPORATOR
F1 EFFECT	Vapor Head	YES
	Liquor Box	YES
	Chest	YES
F2 EFFECT	Vapor Head	YES
	Liquor Box	YES
	Chest	NO ⁽¹⁾
FIRST EFFECT	Vapor Head	YES
	Liquor Box	YES
	Chest	NO ⁽¹⁾
SECOND EFFECT	Vapor Head	YES
	Liquor Box	YES
	Chest	YES
THIRD EFFECT	Vapor Head	YES
	Liquor Box	YES
	Chest	YES
FOURTH EFFECT	Vapor Head	YES
	Liquor Box	YES
	Chest	YES
FIFTH EFFECT	Vapor Head	YES
	Liquor Box	YES
	Chest	YES
SIXTH EFFECT	Vapor Head	YES
	Liquor Box	YES
	Chest	YES
PRIMARY SURFACE CONDENSER	Water Boxes	YES ⁽²⁾
	Shell	NO ⁽¹⁾
SECONDARY SURFACE CONDENSER	Water Boxes	NO ⁽¹⁾
	Shell	NO ⁽¹⁾

NOTES: 1. Not opened
2. Top water box only

RECOMMENDATIONS (*Recommendations provide a valuable road map to avoiding future failures and unscheduled downtime.*)

- SAFETY – E6: Install hand rungs or equivalent for the full length of the internal vapor sidewall on E6. Existing hand rungs only go part way down the lower cone.
- SAFETY – E5 & E6: Install handrail at upper level grating in way of vapor dome manholes. Personnel could slip between vapor head and grating between vapor head and grating.
- C1: Remove calcium carbonate scale from vapor dome walls and seal pots. Large sections of this scale could break off and block the liquor down leg or clog the suction of C1's discharge pump.
- C1: Test weak liquor and boil out water for calcium. Levels above 0.065 ppm can cause calcium scaling. High steam temperature may also contribute to the formation of calcium scale. Liquor temperature above 274°f can also contribute to the formation of calcium scale.
- C1: Repair umbrella. Reinstall section of missing umbrella as a removable bolt on attachment. Repair damaged support for this section. This missing section contributes to liquor carryover and excessive calcium carbonate scale on the seal pots and vapor dome walls.
- C1 & C2: Collapsed tube sleeves located in top tube sheet should be removed. Many of these sleeves are restricting flow of the liquor (see photo section)
- Q1: Remove liquor box covers for the preheat – falling film section located on the west side of the tube sheet, both top and bottom of the tube sheet. Discontinue use of the angle iron distribution system. Implementing these changes will convert this section to a single pass rising film evaporator and should reduce the number of liquor plugged tubes. Consider permanently removing liquor boxes after next year's inspection.
- Q3: Repair 2~3 bent vanes on mist eliminator. Long term decay of these bent vanes will likely result in additional liquor carryover
- Q5: Repair bent North seal pot in the vapor dome.
- Q5, Q6: Substantial corrosion of carbon steel supports of the umbrella baffles are noted. No action is required at this time; however, the condition of these supports should be monitored in future inspections.
- Q6: Replace one missing stud and tighten remaining in top internal heater cover.
- Soap Skimmer: Monitor soap carryover from desoaping system. We found two long sections of congealed soap in the Q3 liquor box. This is a likely indication of soap carryover and intermittent pluggage of tubes due to excessive soap
- Unsecured tube inserts have been installed in the top of tubes in several bodies. These inserts have begun to collapse restricting flow in tubes. It is recommended that these inserts be removed. If inserts are to be used, secure the inserts so liquor cannot get behind them.

- C1, C2, Q2, Q4 & Q6: The umbrella baffle hold down bolts were loose due to too long bolts. The connection between umbrella leg and heating element lug should be tight to prevent umbrella movement.

SUMMARY OF FINDINGS (*Findings and recommendations provide a concise summary of what we found. A year over year review can show valuable trends. The reports also provide historical insight for a new area manager.*)

- C2 effect vapor head was heavily encrusted with liquor/CaCO₃ scale. Liquor is drying and solidifying after impacting areas within the vapor head. The cause appears to be a section of the umbrella baffle that was previously removed for clearance to allow it to swing to a completely vertical position. A bolted plate was installed to replace the removed section.
- Heavy CaCO₃ scaling was found in C1, C2, Q1, AND Q2 effects. All four effects were hydro blasted and polished.
- Sleeve inserts were found in the top 6" of tubes in several effects. The sleeves are not fixed to the tube walls and liquor solids are accumulating behind the sleeves-reducing the tube cross section. These sleeves should be removed, and if sleeves are required, use whole tubing and attach sleeves to tube wall.
- Since almost all the tubes in the second pass of the Q1 effect PFR design were plugged, it was decided to remove the heater covers and convert the Q1 effect to a circulated, single pass, design. This modification was done to try to get some use from the second pass tubes that appear to be non-functional in three-pass design. Effect supplier has agreed to provide design for a new liquor distribution plate that will be less susceptible to fouling.
- Liquor heater boxes and NCG center vent tubes were not opened as part of inspection. On previous inspections, vent tubes have been found to be plugged as well tubes in internal heaters. We suggest that both areas be opened for next outage inspection.
- Loose and/or bent umbrella supports were found on effects C1, C2, Q2, Q4, and Q6. These are carryover items from 2007 inspection and should be scheduled for repair next shutdown.
- Bent and broken entrainment separator vanes were found in effects Q3 and Q4. These should be replaced next shut down.
- A significant amount of soap was found in Q3. Monitor soap skimming system on a routine basis.

“Q” SET EVAPORATOR

SAMPLE INSPECTION SHEET

*Completed inspection sheets are provided for each major vessel
(effect bodies, flash tanks, condensers ejectors, etc.)*

*With every inspection we document our findings with inspection
sheets and photos. These reports provide a valuable reference for
identifying future shutdown work items, justifying future body retubing
or replacement, and may provide insight into the cause of evaporator
operational problems.*

LTV BODY INSPECTION REPORT

CUSTOMER	LOCATION	EVAPORATOR SET	EFFECT DESIGNATION	DATE	PROJECT NUMBER
MILL XYZ	Somewhere USA	"Q" Set	C1	4/5-8/09	#

VAPOR HEAD	MATERIAL	MECHANICAL CONDITION	CORROSION	FOULING OR DEPOSITION
UMBRELLA BAFFLE	Stainless	Good	None	Residual liquor
TUBESHEET	Stainless	Good	None	
SHELL AND HEAD	Stainless	Good	None	
LIQUOR HEATER BOX	Stainless	Good	None	
RE-ENFRANT HEATER	Stainless	Good	None	
ENTRAINMENT SEPARATOR	Stainless	Good	None	

COMMENTS:

- Modified Goslin three pass design
- Umbrella broken loose at all four support welds to umbrella and displaced against wall

TUBES			NUMBER AFFECTED		TYPE	EXTENT
TUBE MATERIAL	SS	PLUGGED WITH FIBER, ETC	491	SCALE	Hard scale >1/4"	All tubes
INSPECTED FROM	TOP	X	MECHANICALLY PLUGGED	0	CORROSION	None
	BOTTOM	X	DAMAGED	0	SCALE SAMPLE	No

COMMENTS:

- Most plugged tubes in 2nd pass

LOWER LIQUOR BOX	MATERIAL	MECHANICAL CONDITION	CORROSION	FOULING OR PLUGGING
TUBESHEET	Stainless	Good	None	Residual liquor
SHELL AND HEAD	Stainless	Good	None	
LIQUOR HEATER BOX	Stainless	Good	None	

COMMENTS:

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SHELL SIDE	MATERIAL	MECHANICAL CONDITION	CORROSION	FOULING OR PLUGGING
TUBES	Stainless	Good	None	Light black scale <1/32" thick
SHELL	Carbon Steel	Good	None	

COMMENTS:

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**C1 EFFECT
LOOSE UMBRELLA HOLD DOWN BOLT**



**C1 EFFECT
PARTIALLY COLLAPSED TUBE LINERS IN
INTERNAL HEATER**



**C1 EFFECT
LIQUOR DEPOSIT UNDER UMBRELLA**



**C1 EFFECT
ENTRAINMENT SEPARATORS**



**C1 EFFECT
LIQUOR BOX**



**C1 EFFECT
OUTSIDE OF TUBES**