

Incident Summary #II-977639-2020 (#16571) (FINAL)

SUPPORTING INFORMATION	Incident Date	February 9, 2020	
	Location	Prince George	
	Regulated industry sector	Boilers, PV & refrigeration - Boiler and pressure vessel system	
	Impact	Qty injuries	0
		Injury description	NA
		Injury rating	None
	Damage	Damage description	Kraft paper pulping, strong black liquor was sprayed onto buildings and equipment.
		Damage rating	None / Insignificant / Minor / Moderate / Major / Severe – See Guidance
	Incident rating	Minor	
Incident overview	Erosion of a stainless steel pressure piping elbow located on top of a black liquor storage tank resulted in strong black liquor being sprayed onto buildings, equipment and the and surrounding area.		
INVESTIGATION CONCLUSIONS	Site, system and components	Black liquor is the by-product from the Kraft pulping process when digesting pulpwood into paper pulp removing lignin's and other extractives from the wood to free the cellulose fibers. The organic matter in the black liquor is made up of water/alkali soluble degradation components from the wood. Black liquor is corrosive and exposure may be through inhalation, ingestion, eye or skin contact. During the Kraft process, strong black liquor (75 percent solids) is fed from a concentrator vessel to a liquor storage tank which is several stories high. The black liquor is pumped to the top of the tank at 145 deg. C and under pressure. The process is normally contained in the vessels and stainless steel pressure piping.	
	Failure scenario(s)	Black liquor traveling through a 6" - 90 degree piping elbow into a liquor storage tank eroded the grade SAE 304 stainless steel (SS) causing thinning of the piping wall. The thinned piping then ruptured resulting in a release of 125-145 degrees Celsius black liquor which flowed from the top of the storage vessel for approximately 1 hour until the process was stopped by pulped mill staff.	
	Facts and evidence	Inspection of the failed piping elbow found a large hole indicating a complete rupture had occurred. Inspection of the pipe wall verified thinning of the metal had occurred at the sweep of the elbow and was localized to that area of the piping. Inspection of the thinning determined that the primary damage mechanism was erosion/corrosion. An initial failure analysis determined why this elbow failed and not others. Upstream of the elbow a pressure and temperature drop through a control valve causes the black liquor to flash from a liquid to two phase (steam and liquid), this creates a higher velocity in the elbow increasing the rate of erosion/corrosion. Investigation determined that similar failures have happened at other facilities. An engineering solution has been to replace the SAE 304 SS with SAE 316 SS for improved erosion/corrosion resistance.	
	Causes and contributing factors	It is highly likely that erosion/corrosion caused thinning of the pressure piping elbow resulting in an eventual rupture of the pressure boundary. Flashing of the liquid to two phase (steam and liquid) just upstream of the elbow created a higher velocity in the elbow contributing to the rate of erosion/corrosion.	

Ruptured Stainless Steel Elbow



Black Liquor storage vessel and contamination after initial clean up

