



Caustic Recovery Plant at Kamal Ltd

1 Executive Summary

Caustic Recovery Plant at Kamal Limited is one of the pilot projects under SCI-Pak project. Kamal Limited has installed Caustic Recovery Plant (CRP) at its facility to recover caustic soda from the wastewater generated from the mercerization process.

Kamal has installed CRP to recover this caustic soda to conserve resource and also to reduce wastewater pollution. The project resulted in recovery of a valuable resource which would have otherwise been purchased and also resulted in reduction of pollution load at waste water treatment plant and hence consumption of acid for the effluent treatment.

The technology is locally manufactured. The project has resulted in 3 direct employment opportunities.



2 Project purpose

The purpose of Caustic Recovery Plant at Kamal Limited is to recover 300 ton of caustic soda per year by installation of 3 stage multi effect evaporator system. The plant will result in net benefit of Rs. 14,009,006 per year. The life of the project is 10 years. The simple payback of investment is 4 months.



3 Previous Process

A large quantity of caustic soda is used in different processes of textile processing industry, most notably in mercerization process. The purpose of mercerization is to give strength, improve luster and increase absorption of the fabric for dyes in the subsequent processes for cotton fabric.

In this process, fabric is treated with caustic soda (NaOH) solution. Caustic soda reacts with the cellulose, swells it and imparts above properties. After treatment, fabric is washed with water to remove un-reacted caustic soda from the fabric. This wash water contains substantial amount of caustic soda which is not only the resource loss but also it generates pollution in the wastewater (higher COD, TSS, alkalinity etc).



Picture 1: Mercerization Machine at Kamal Limited

Similar was the case of Kamal Limited. Weak lye (waste wash water of caustic soda solution) of about seven degree Baume (7 °Bé) or 5% concentration was being wasted from the mercerization process.

It is estimated that Kamal was draining 300 ton of Caustic Soda every year.



Picture 2: Wash Boxes after Mercerization at Kamal Limited



4 Improved Process



Kamal Limited decided to install CRP in 2010.

The purpose of the CRP was to convert this 7 °Bé into 24 °Bé or 20% concentration, called strong lye. This strong lye is then used again in the mercerization process as a fresh caustic soda.

Weak lye, from the mercerization machine, is transferred into the **underground storage tank** of 50 m³ capacity from where it is pumped and passed through **lye filter** (mesh screen type) where suspended particles are removed from it. A **sludge pump** has been installed to remove the solid impurities settled in underground storage tank. Filtered lye is then fed into the shell and tube type **pre-heater** where its temperature is increased up to 70 °C with indirect contact of steam. This preheated weak lye is passed through the **first evaporator** (working temperature 120°C, 450 mm of Hg) where water is evaporated and solution is allowed to concentrate by the application of steam taken from boiler. Steam required is 400~500 tons per hour. Vapors and intermediate concentrated lye are separated out in the **vapor liquid separator**. Vapors and lye are transferred to the **second evaporator** (at temperature 95°C, pressure 250 mm of Hg). Vapors act as heating medium for the second evaporator where as lye is further concentrated. Similarly the vapors from the second evaporator are passed to the **third evaporator** (at 80°C, 100 mm of Hg) and act as heating medium and intermediate lye is further concentrated. A **vacuum pump** is used to maintain the vacuum in evaporators. A **circulation pump** is used at the third evaporator to circulate the lye in the third evaporator until it gets the required concentration i.e. 24 °Bé or 20%. After getting the required concentration, the strong lye is then pumped into the **settling tank** (of capacity 5m³) where the settled impurities are drained out manually and final product is stored in the storage tank (10 m³ capacity). This caustic soda (strong lye) is again used in the mercerization process. Vapors from the last evaporator are condensed in the **condenser**. Steam condensate from all the three evaporators, pre-heater and condenser is collected in the storage tank and used as boiler feed water.

Analog type flow meter has been installed to measure the flow of incoming weak lye. Steam being used in the first evaporator is being measured with digital steam flow meter. Temperature sensors have been installed at outgoing streams of pre-heater, all three evaporators and condenser. Vacuum meter has also been installed at the three evaporators. All measurements are being displayed at LCD display.

This plant needs one full time operator to maintain it and keep the record of measurements.





Picture 3: Caustic Recovery Plant at Kamal Limited



5 Project Financing

- Project Cost: Rs. 4.5 Million
- The project was financed by Kamal Limited from its internal equity. No bank financing was obtained.



6 Project Vendor

The project was executed by:

Sitara Engineers

Nishatabad Bridge

Shiekupura Road, Faisalabad Pakistan.

Phone: +92-41-8752683-4

Contact Person: Engr. Nawaz-ul-Haq





7 Saving Calculations



Caustic Recovery Plant	Annual Sheet
Annual Working days=	300 days
Degree Baume of weak lye=	7 Be
Degree Baume of strong lye=	24 Be
Running hours of machine per day=	10 hr
Cost of steam=	1,100 Rs/ton
Flow rate of weak lye=	2 m ³ /hr
Flow rate of strong lye=	1 m ³ /hr
Fresh water consumption in condensor=	18 m ³ /hr
Steam used per year=	1,365 t/yr
Calrific value of natural gas=	35,359,380 j
Condensate temperature=	90 °C
Ambiant temperature=	30 °C
Hot water temperature obtained from condensor=	70 °C
Cost of gas=	13 Rs/m ³
Pumping cost=	2 Rs/m ³
Cost of caustic 100%	40 Rs/kg
Electricity cost (approximately)=	3,000 Rs/d
Labor cost=	27,600 Rs/m
Capital cost of CRP=	4,500,000 Rs
Percentage of Caustic Soda in the weak lye=	5.07 %
Percentage of Caustic Soda in the strong lye=	19.83 %
Flow rate of weak lye=	6,000.00 m ³ /yr
Water in weak lye=	5,695.65 m ³ /yr
Caustic in weak lye=	304.35 m ³ /yr
Flow rate of strong lye=	1,500 m ³ /yr
Caustic in strong lye=	297.52 m ³ /yr
Water in strong lye=	1,202.48 m ³ /yr
Water evaporated from lye=	4,493.17 m ³ /yr
This water is obtained as condensate	4,493.17 m ³ /yr
Steam used is also converted into condensate=	1,365 m ³ /yr
Total steam condensate obtained=	5,858.17 m ³ /yr
Saving steam condensate=	
Gas saving in condensate=	51,988.88 m ³ /yr
Total Saving steam condensate=	687,571.81 Rs/yr
Hot water saving	
Gas Saving in hot water=	319,485.24 m ³ /yr
Total saving in hot water=	4,261,308.12 Rs/yr
Chemical Saving	11,900,826.45 Rs/yr
Total savings =	16,849,706 Rs/yr
O & M Cost =	
Steam cost=	1,501,500 Rs/yr
Water pumping cost=	108,000 Rs/yr
Electricity cost=	900,000 Rs/yr
Labor cost=	331,200 Rs/yr
Total O& M Cost=	2,840,700 Rs/yr
Net Profit=	14,009,006 Rs/yr
Pay Back=	3.85 Months



8 Financial Performance of Project

Year	1	2	3	4	5	6	7	8	9	10	11
Cash Flows from operating Activities:											
Capital Expenditure	(4,500,000)										
Revenue from Savings		16,849,706	16,849,706	16,849,706	16,849,706	16,849,706	16,849,706	16,849,706	16,849,706	16,849,706	16,849,706
Recurring Cost		(2,840,700)	(2,840,700)	(2,840,700)	(2,840,700)	(2,840,700)	(2,840,700)	(2,840,700)	(2,840,700)	(2,840,700)	(2,840,700)
Cash Flow	(4,500,000)	14,009,006									
NPV @15% Discount Rate	70,307,962										
IRR	311%										



9 Project Time Line

Timeline of Project		Project Duration																			
		Month 1				Month 2				Month 3				Month 4				Month 5			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Milestone1	Feasibility Study for CRP	█	█																		
Milestone 2	Fabrication of CRP			█	█	█	█	█	█	█	█	█	█								
Milestone 3	Erection of CRP (Civil, Mechanical and Electrical Works)											█	█	█	█						
Milestone 4	Commissioning														█	█	█				
Milestone 5	Start of Caustic Recovery																			█	





10 System Schematic

