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Sustainable and Cleaner production in the manufacturing industries of Pakistan



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PROGRAMME

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*Sustainable and  
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Manufacturing Industries of Pakistan



# Caustic Recovery Plant at Kamal Limited

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# Caustic Recovery Plant at Kamal Limited: Project Summary

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- 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.



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# Caustic Recovery Plant at Kamal Limited: Saving & Payback Calculations

## Caustic Recovery Plant Annual Sheet

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

# Caustic Recovery Plant at Kamal Limited: Project Cash Flows

Year	1	2	3	4	5	6	7	8	9	10	11
<b>Cash Flows from operating Activities:</b>											
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
Depreciation		(225,000)	(225,000)	(225,000)	(225,000)	(225,000)	(225,000)	(225,000)	(225,000)	(225,000)	(225,000)
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)
<b>Cash Flow</b>	<b>(4,500,000)</b>	<b>13,784,006</b>	<b>13,784,006</b>	<b>13,784,006</b>	<b>13,784,006</b>	<b>13,784,006</b>	<b>13,784,006</b>	<b>13,784,006</b>	<b>13,784,006</b>	<b>13,784,006</b>	<b>13,784,006</b>
NPV @15% Discount Rate	<b>69,178,739</b>										
IRR	<b>306%</b>										

## Project Timeline

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
Milestone 1	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																				█



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# Waste Heat Recovery at Nimra Textile Limited

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# Waste Heat Recovery at Nimra Textile Limited: Project Summary

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- Installation and operation of Waste Heat Recovery Boiler (WHRB) at Nimra Textile Limited, Faisalabad is one of the pilot projects under SCI-Pak project.
- Nimra Textile Limited has installed Waste Heat Recovery Boiler (WHRB) at its facility to produce steam by utilizing waste energy of the flue gases of its Power House Generators.
- The steam generated from waste heat is being used in the process. This project has results in fuel savings and reduction in green house gases emissions.



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# Waste Heat Recovery at Nimra Textile Limited: Saving & Payback Calculations

Capacity of WHB (Designed)	1.5 t/hr
Quantity of water used per day	13 ton
Blow down per day	0.39 ton (@3% of total steam produced)
Steam produced per day	12.61 ton
Steam produced per hour	0.52 ton
Enthalpy at 100 psig	2761177 j/kg (@110psia)
Steam energy per day	0.52 x 1000 x 2761177
	1,435,812,378 j/hr
Gas consumed to produce this much energy	1,435,812,378/35,359,380
	40.60 m <sup>3</sup> /hr (100% efficiency) or 50.75 m <sup>3</sup> /hr (80% efficiency) where calorific value of natural gas is 35,359,380 j/m <sup>3</sup>
Or 50.75 x 24 x 300 x 12.50 <sup>1</sup>	Rs. 4,568,205/year
<b>Capital cost of Pilot Plant</b>	<b>5,300,000 Rs</b>
<b>O &amp; M Cost</b>	3,200 per day
	960,000 Rs/year
<b>Net profit</b>	Steam saving – O&M cost
	4,568,205 – 960,000
	<b>3,608,205 Rs/year</b>
<b>Pay back</b>	(Capital cost / Net profit) x 12
	(5,300,000 / 3,608,205) x 12
	<b>17.60 month</b>



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# Waste Heat Recovery at Nimra Textile Limited: Project Cash Flows

Year	1	2	3	4	5	6	7	8	9	10	11
<b>Cash Flows from operating Activities:</b>											
Capital Expenditure	(5,300,000)										
Revenue from Savings	4,568,205	4,568,205	4,568,205	4,568,205	4,568,205	4,568,205	4,568,205	4,568,205	4,568,205	4,568,205	4,568,205
Depreciation	(265,000)	(265,000)	(265,000)	(265,000)	(265,000)	(265,000)	(265,000)	(265,000)	(265,000)	(265,000)	(265,000)
Recurring Cost	(960,000)	(960,000)	(960,000)	(960,000)	(960,000)	(960,000)	(960,000)	(960,000)	(960,000)	(960,000)	(960,000)
<b>Cash Flow</b>	<b>(5,300,000)</b>	<b>3,343,205</b>	<b>3,343,205</b>	<b>3,343,205</b>	<b>3,343,205</b>	<b>3,343,205</b>	<b>3,343,205</b>	<b>3,343,205</b>	<b>3,343,205</b>	<b>3,343,205</b>	<b>3,343,205</b>
NPV @15% Discount Rate	<b>16,778,772</b>										
IRR	<b>63%</b>										

## Project Timeline

Timeline of Project		Project Duration																							
		Month 1				Month 2				Month 3				Month 4				Month 5				Month 6			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Milestone1	Feasibility Study for WHRB																								
Milestone 2	Fabrication of WHRB																								
Milestone 3	Commissioning																								
Milestone 5	Start of Steam Generation from WHRB																								



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# Biomass Boiler at Crescent Textile Mills

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# Biomass Boiler at Crescent Textile Mills: Project Summary

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- Installation and operation of Rice Husk Boiler (RHB) at Crescent Textile Mills (Faisalabad City) is one of the pilot projects under SCI-Pak project.
- To overcome the steam requirement of the textile processing, the pilot industry installed 10 ton per hour rice husk fired boiler to replaced carbon intensive furnace oil with carbon neutral biomass.
- Cost of generating steam comes out to be 72% less than furnace oil resulting in payback of a month.



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# Biomass Boiler at Crescent Textile Mills: Saving & Payback Calculations

Parameters	Rice Husk	Furnace Oil+ Natural Gas
Net Calorific Value (NCV)	13.44 MJ/kg	42.60 MJ/kg+ 850 BTU/lb
Quantity of fuel used	240kg/ton of steam	72.80kg/ton of steam+ 80m <sup>3</sup> /ton of Steam
Quantity of steam produced (ton/hr)	7.75	7.75
Cost of fuel	7.0 Rs/kg	69.0 Rs/kg of Furnace Oil 12.5 Rs./ m <sup>3</sup> of Natural Gas
Boiler efficiency (%)	77	80
Cost of steam per ton (Rs)	1,680	Rs. 5,023 (for Furnace Oil) Rs. 1,000 (for Natural Gas)
Cost of steam per year-Rs (300 days/year, 1 day =24hr) (90 Day Operation on Furnace Oil& 210 Day Operation on Natural Gas)	93,744,000	123,145,020
Tube replacement cost (Rs/yr) (30% of the capital investment after each two years)	2,100,000	-
Capital cost of the RHB (Rs)	14,000,000	-
Savings/yr (in comparison of furnace oil boiler) (Rs. 123,145,020 – Rs. 93,744,000)	29,401,020	
Pay Back (Months)	6.2	-



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# Biomass Boiler at Crescent Textile Mills: Project Cash Flows

Year	1	2	3	4	5	6	7	8	9	10	11
<b>Cash Flows from operating Activities:</b>											
Capital Expenditure	(14,000,000)										
Revenue from Savings	29,401,020	29,401,020	29,401,020	29,401,020	29,401,020	29,401,020	29,401,020	29,401,020	29,401,020	29,401,020	29,401,020
Depreciation	(700,000)	(700,000)	(700,000)	(700,000)	(700,000)	(700,000)	(700,000)	(700,000)	(700,000)	(700,000)	(700,000)
Recurring Cost	(2,100,000)	(2,100,000)	(2,100,000)	(2,100,000)	(2,100,000)	(2,100,000)	(2,100,000)	(2,100,000)	(2,100,000)	(2,100,000)	(2,100,000)
<b>Cash Flow</b>	<b>(14,000,000)</b>	<b>26,601,020</b>	<b>26,601,020</b>	<b>26,601,020</b>	<b>26,601,020</b>	<b>26,601,020</b>	<b>26,601,020</b>	<b>26,601,020</b>	<b>26,601,020</b>	<b>26,601,020</b>	<b>26,601,020</b>
NPV @15% Discount Rate	<b>133,504,365</b>										
IRR	<b>190%</b>										

## Project Timeline

Timeline of Project		Project Duration																											
		Month 1				Month 2				Month 3				Month 4				Month 5				Month 6				Month 7			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24				
Milestone 1	Feasibility Study for RH Boiler	█	█	█	█																								
Milestone 2	Fabrication of RH Boiler					█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█				
Milestone 3	Civil Works/ Foundation													█	█	█	█	█	█	█	█	█	█	█	█				
Milestone 4	Erection																									█	█	█	
Milestone 5	Commissioning																												█
Milestone 6	Start of Steam Generation from RH Boiler																												█



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# Chrome Recycling at Muhammad Hussain (MH) Tannery

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# Chrome Recycling at (MH) Tannery: Project Summary

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- MH Tannery is one of the pilot projects under SCI-Pak project.
- MH Tannery has installed Chrome Recycling Plant (CrRP) at its facility to reuse the basic chromium sulfate  $\text{Cr}(\text{OH})\text{SO}_4$ , discharged as waste in the spent liquor of the tanning process.
- Objective of CrRP is to conserve the resource (Chemical) and reduce wastewater pollution due to chrome discharge in the effluent.



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# Chrome Recycling at (MH) Tannery: Saving & Payback Calculations

<b>Annual Gross Saving</b>	
Weight of the batch or lot for the chrome tanning	2,500 kg
Fresh chromium sulfate salt used in the process (6%)	150 kg
Chromium sulfate salt present in the spent liquor (25%) by laboratory analysis	37.5 kg
Fresh chromium sulfate to be added in the subsequent tanning process (75%)	112.5 kg
Saving of chromium sulfate per lot	37.5 kg
*Total numbers of recycled lots per year <i>(4 drums x 12 recycled lots/4 drums-4 days x 300 days/year)</i>	900
Saving of chromium sulfate per year (37.5 x 900)	33,750 kg
Price of chromium sulfate per kg	Rs. 130
<i>Gross saving/year in monetary terms-Rs (130 x 33,750)</i>	<b>4,387,500</b>
<b>Annual O&amp;M Cost (Rs)</b>	
Labor cost (Rs. 10,000/month)	120,000
Electricity cost	6,000
Maintenance cost	110,000
Chemicals cost-Laboratory	6,000
Chemical cost-Process (Sulfuric Acid)	27,000
<i>Total Annual O&amp;M Cost</i>	<b>269,000</b>
Net Saving per Year (Rs)	<b>4,118,500</b>
Capital Cost of the Plant (Rs)	<b>660,000</b>
Payback (months)	<b>02</b>



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# Chrome Recycling at (MH) Tannery: Project Cash Flows

Year	1	2	3	4	5	6	7	8	9	10	11
<b>Cash Flows from operating Activities:</b>											
Capital Expenditure	(660,000)										
Revenue from Savings		4,387,500	4,387,500	4,387,500	4,387,500	4,387,500	4,387,500	4,387,500	4,387,500	4,387,500	4,387,500
Depreciation		(33,000)	(33,000)	(33,000)	(33,000)	(33,000)	(33,000)	(33,000)	(33,000)	(33,000)	(33,000)
Recurring Cost		(269,000)	(269,000)	(269,000)	(269,000)	(269,000)	(269,000)	(269,000)	(269,000)	(269,000)	(269,000)
<b>Cash Flow</b>	<b>(660,000)</b>	<b>4,085,500</b>	<b>4,085,500</b>	<b>4,085,500</b>	<b>4,085,500</b>	<b>4,085,500</b>	<b>4,085,500</b>	<b>4,085,500</b>	<b>4,085,500</b>	<b>4,085,500</b>	<b>4,085,500</b>
NPV @15% Discount Rate	<b>20,504,179</b>										
IRR	<b>619%</b>										

## Project Timeline

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
Milestone 1	Feasibility Study for CrR Plant	■	■	■	■																
Milestone 2	Fabrication/Erection of CrR Plant					■	■	■	■												
Milestone 3	Training									■	■	■	■								
Milestone 4	Commissioning													■	■	■	■				
Minestone 5	Start of Operation																	■			



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# Replication Potential of Pilot Projects

Intervention	Nature of E&RE	Saving Potential	Monetary Saving (in Rs.)
<b>Caustic Recovery</b>	Caustic Soda	300 T/yr ~ 388 t CO <sub>2</sub>	12,000,000
<b>Waste Heat Recovery Boiler</b>	Natural Gas	365,456.4 m <sup>3</sup> /yr~ 656 t CO <sub>2</sub>	4,568,205
<b>Chrome Recycling</b>	Chromium Sulfate	34 T/ yr	4,387,500
<b>Biomass Boiler</b>	Furnace Oil	2,673 T/yr~ 8,275 t CO <sub>2</sub>	184,437,000
<b>Boiler Automation</b>	Electricity and Natural Gas		



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# Potential Market of E&RE

Technology	Cost of Implementation (Rs.)	Approximate Payback	Number of SMEs who could implement the technology
Caustic Recovery	4.5 Million	06 Months	200
Waste Heat Recovery Below Dew Point	3.5 Million	09 Months	300
Waste Heat Recovery Boiler	5.5 Million	18 Months	300
Process Automation in Tanneries	2.5 Million		500
Compressed Air Leakage Control	1.0 Million	18 Months	500
Solar Thermal Technologies	4.0 Million	36 Months	700
Biomass Boilers	15.0 Million	11 Months	100
CO <sub>2</sub> De-Liming	1.7 Million	14 Months	100
Chrome Recycling /Recovery	1.3 Million	11 Months	700
Hot Surface Insulation	0.5 Million	03 Months	900
High Efficiency Burners	2.0 Million	18 Months	400
Oxygen Trimming System	1.5 Million	18 Months	400



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