PaCT
Partnership for Cleaner Textile

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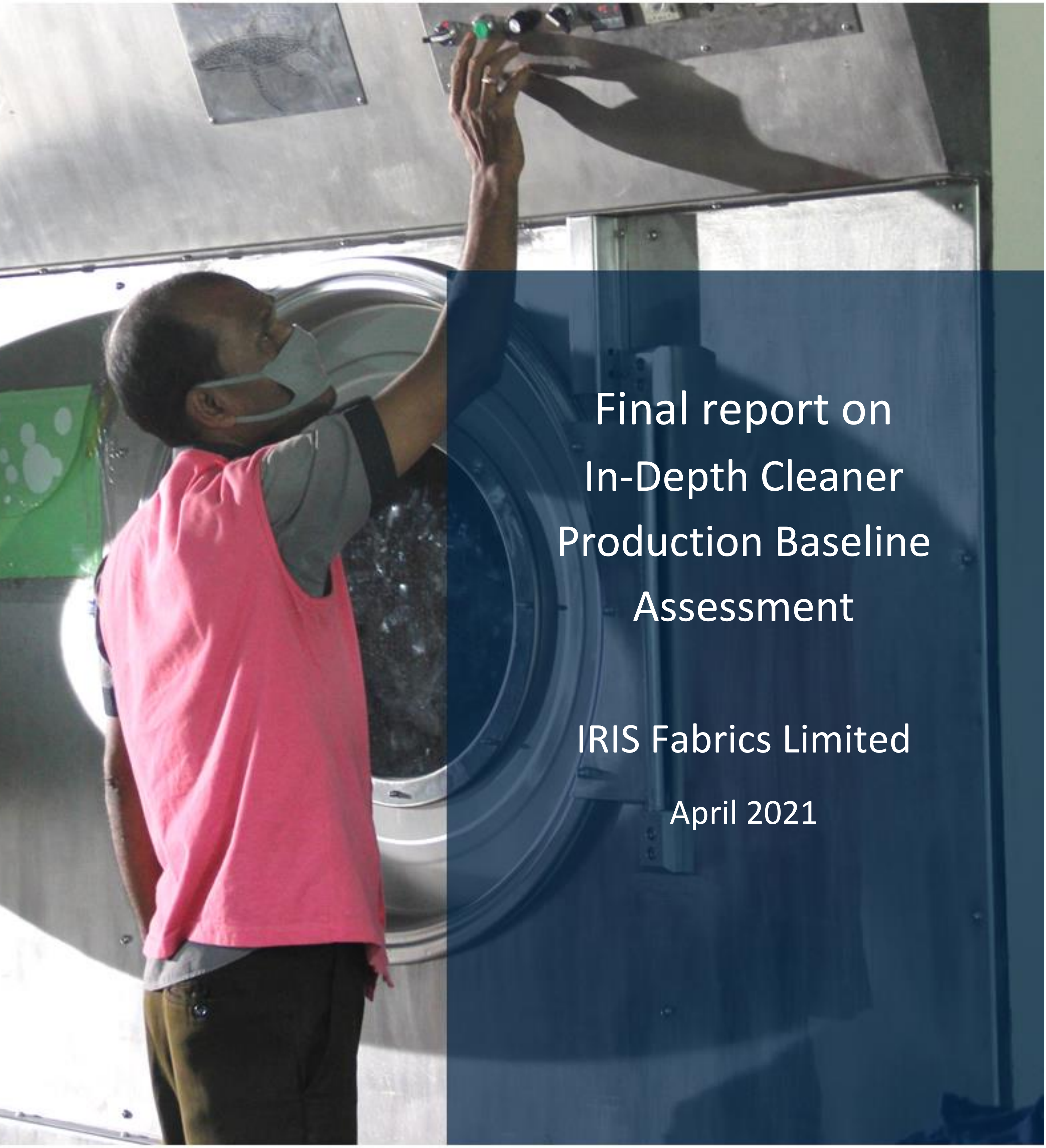

Final report on In-Depth Cleaner Production Baseline Assessment

IRIS Fabrics Limited

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About PaCT

IFC led Advisory Partnership for Cleaner Textile (PaCT), is a holistic program that supports the entire textile value chain – spinning, weaving, wet processing and garment factories in adopting cleaner production (CP) practices and engages with brands, technology suppliers, industrial associations, financial institutions, government to bring about systemic and positive environmental change for the Bangladesh textile sector and contribute to the sector's long-term competitiveness and environmental sustainability.

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Acknowledgement

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Consultant's Team

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ABBREVIATIONS

BCAS	Bangladesh Centre for Advanced Studies
BDT	Bangladesh Taka
BGMEA	The Bangladesh Garment Manufacturers and Exporters Association
CP	Cleaner production
CPA	Cleaner production assessment
CW	Cooling water
DAP	Di ammonium phosphate
DESL	Development Environergy Services Limited
ECR	Environment conservation rules
EGB	Exhaust gas boiler
ETP	Effluent treatment plant
GHG	Greenhouse gases
IFC	International Finance Corporation
IFL	Iris fabrics limited
LT	Low tension
MLR	Material to liquor ratio
NG	Natural gas
KPI	Key performance indicator
PaCT	Partnership for cleaner textile
PHE	Plate heat exchanger
PLC	Programmable logic control
RFT	Right first time
RO	Reverse osmosis
SOP	Standard operating procedure
UF	Ultra-filtration
US$	United States Dollar
VFD	Variable frequency drive
WDF	Washing, dyeing and finishing
WTA	Walk through assessment
WTP	Water treatment plant

Units of Measurements

Parameters	UOM
Ampere	A
Biochemical oxygen demand	BOD
Calorific value	CV
Cubic feet per minute	CFM
Chemical oxygen demand	COD
Days	d
Gross Calorific value	GCV
Hours	h
Horse Power	hp
Hertz	Hz
Kilogram	kg
Kilo Volt Amperes	kVA
Kilo Watt-hour	kWh
Liters	L
Liters per hour	LPH
Cubic meter	m^3
Meter	M
Power factor	PF
Parts per million	ppm
Revolutions per minute	rpm
Total dissolved solids	TDS
Tonne per day	TPD
Tonne per hour	TPH
Total suspended solids	TSS
Voltage	V
Year(s)	Y

CONVERSION FACTORS

Parameters	UOM	Value
Emission factor natural gas	kg of CO_2/nm^3 of natural gas	2.154*
Emission factor electricity	kg of CO_2/kWh	0.564*
Emission factor diesel	kg of CO_2/L	2.676*

Reference – IFC Carbon Emissions Estimator Tool (CEET)

BASELINE PARAMETERS

Parameters	Unit	Value
Costs		
• Electricity(grid)	BDT/kWh	8.45
• Natural gas (heat)	BDT/nm^3	9.59
• Natural gas (power)	BDT/nm^3	12.41
• Diesel (power)	BDT/L	65
Heating value		
• Natural gas	kcal/nm^3	8,930
• Diesel	kcal/L	10,080
• Electricity (grid)	kcal/kWh	860
Plant operations		
• Average operating hours	h/d	24
• Operating days	d/y	350
Annual production(Jan'20 to Dec'20)	kg	7,105,700
Baseline parameters		
• Ground water	l/kg production	195.5
• Process water	l/kg production	125.1
• Natural gas	nm^3/kg production	0.87
• Electricity	kWh/kg production	1.68
• GHG emissions	kg/kg production	2.59
• Chemicals	g/kg of production	573.3

1 Executive Summary

The International Finance Corporation (IFC) led Advisory Partnership for Cleaner Textile (PaCT) is a holistic program that supports the entire textile value chain – spinning, weaving, wet processing and garment factories in adopting cleaner production (CP) practices and engages with brands, technology suppliers, industrial associations, financial institutions, government to bring about systemic and positive environmental change for the Bangladesh textile sector and contribute to the sector's long-term competitiveness and environmental sustainability.

DESL (Development Environergy Services Limited) and BCAS (Bangladesh Center for Advanced Studies) were commissioned by IFC to undertake in-depth cleaner production assessment at Iris Fabrics Ltd.

1.1 In-depth cleaner production study at IRIS Fabrics Limited

Iris Fabrics Limited (IFL) a knit composite factory consists of knitting, dyeing, panel printing and garment manufacturing facility. The average daily production was 20.3tonneper day in 2020 (Jan'20 to Dec'20).

The primary sources of energy at IFL are natural gas (NG), diesel and electricity purchased from the grid. NG is used for electricity generation (gas engines), steam generation (boilers) and process heating (stenters and dryers). NG used for heating applications and electricity generation accounts for 68.7% and 23.1% of the primary energy consumption respectively. Electricity purchased from the grid (8.0%) and diesel (0.2%) accounts for the remaining primary energy consumption. Diesel engines are used as a standby power generation source. The share of various energy sources for electricity generation only are - NG 49.8%, grid- 49.9%and diesel- 0.3%.

The share of the three primary energy sources, i.e. NG, electricity purchased from the grid and diesel in the energy cost are 54.5%, 44.8%and 0.7% respectively.

Other areas of focus for CP assessment included reduction of chemicals (Glauber salt, Caustic Soda, Hydrogen peroxide, soda ash and common salt), waste water, and production improvement.

Walk through assessment was conducted on 16/01/2021.Several observations were made on the scope for process improvement. These included the following:

- **Utility Area**
  - Heat recovery from gas engine flue gas by installing exhaust gas boiler (EGB): It was observed that there is no heat recovery from the exhaust of gas engines (which is released at a temperature of 550-550^{o}c at present). This presents an opportunity to install an EGB to generate steam from the exhaust.
  - Heat recovery from jacket water of gas engines for hot water applications: Temperature of the jacket water of gas engines is maintained by releasing heat through the cooling tower. The temperature of jacket water is about 80-85^{o}C.This heat can be utilized to generate hot water.
  - Frequency reduction in gas engines: Operating frequency of gas engines was 50.6Hz. This can be optimized to 50.0Hz, resulting in lower natural gas consumption.
  - Auto blowdown control system for boiler: Currently, a system of manual blowdown is practiced, and is done at a frequency of three times/day for about two minutes each, resulting

in loss of heat and water. Installing an auto blowdown control system will eliminate these losses.

- Oxygen tuning of boiler: Measured oxygen level at the boiler was 5.57%. High oxygen levels in the flue gas will result in excess air supplied for combustion; hence resulting in higher fuel consumption. Tuning of burners to reduce oxygen level to about 2.5-3.0% will improve efficiency of the boiler, resulting in lower fuel usage.
- Thermal insulation improvements: Measured temperature at the steam header and steam valves was greater than 145°C, resulting in surface heat loss. Insulation of steam header and steam valves is recommended.
- Pressure reduction in compressed air system: VFD is installed on two of the compressors of 55kW and 75kW rating. It is recommended to reduce pressure setting of these compressors to save power and to make the operation of the compressors variable.
- Efficiency improvement of pumps: Efficiency of existing water treatment service pumps is 41%. It is recommended to refurbish or replace the pumps, to improve the efficiency upto 60%.
- Ceiling fans: Replacement of existing ceiling fans with energy efficient (brushless DC) ceiling fans will help in significant reduction in electricity usage. BLDC fans consume only 28W as against the 80W consumed by conventional ceiling fans.

- **Metering**

Status of metering for various resources and additions recommended are summarized below.

Table 1: Status of meter

Meter	Baseline Assessment (Numbers)	Recommended (Numbers)	Additional Required (Numbers)	Locations
Water	33	33	0	
Electricity	7	10	3	Dyeing-1, Finishing-1, Compressor-1
Gas	4	4	0	
Steam	3	3	0	
Total	**47**	**50**	**3**	

- **Process Area**
    - Improving dyeing process performance by improving RFT: Lab to bulk RFT is 50% and 20% of the batches are running for extra time for topping up and correction. A complete package of performance improvement activities and SOPs are required to be prepared and strictly followed for process control. These include:
        - Properly monitoring process and materials consistency between lab and bulk production
        - Use calibrated instruments on machines for measurement of temperature, pH, specific gravity, water level
        - Accurate dosing of chemicals for each batch
        - Automation control for various parameters like water level, temperature and pH can help improve the performance of the dyeing process

- Reduction of moisture in fabric before drying on stenters - Moisture content in fabric entering the stenter is not measured. It is estimated to be at 60% based on visual inspection, which is high. This results in higher fuel consumption, as more heat is required to evaporate moisture from the fabric. It is recommended to reduce the inlet moisture by 10% before the fabric enters the stenter. Inlet and outlet moisture should be monitored.
- Recovery and reuse of washing water from Corino slitting machine: Washing water (100 m^3/day) drained from the Corino slitting machine is suitable for reuse in the process after filtration.
- Waste heat recovery from hot liquor drained from dyeing machines: Recover heat from hot liquor drained at 75°C. Recovery of heat from this liquor is recommended by installing a plate type heat exchanger. This will also help in smooth functioning of the ETP. [*This recommendation has not been accepted for implementation*.]

- **ETP Area**
  - Improvements have been suggested for sludge recirculation pump (both the ETPs), chemical dosing system (both the ETPs), sludge management system, air blower for post aeration tank (ETP-2). Installation of water recycling system has been recommended. [*The recommendation for providing stand by sludge feed pump in the sludge management system has not been accepted for implementation*.]

A snapshot of the recommendations is shown in the tables below. Savings for each recommendation have been quantified and included in the following table. The table also includes the monetary savings, estimated investment, simple payback period, contribution to emission reduction and categorization based as short, medium or long term based on the payback period. The criteria for categorization of recommendations based on payback period are as follows:

- Short term- payback period less than one year
- Medium term - payback period less than one to two years
- Long term - payback period more than two years

Table 2: Savings Summary

Sl. No.	Recommendation	Impact (Reduction)				Estimated investment	Annual Savings	Simple payback	Emission Reduction	Category*	Action Plan
		Water	Chemical	Natural Gas	Electricity						
		m^3/y	t/y	nm^3/y	kWh/y	BDT	BDT	Months	tCO_2/y		
A	**Utility Area**										
1	Heat recovery from exhaust of gas engines by installing EGB			237,519		3,500,000	2,208,925	19	512	Medium	Accepted
2	Heat recovery from jacket water of gas engine for hot water applications			282,195		1,000,000	2,624,412	5	608	Short	Accepted
3	Frequency reduction in gas engines			60,860	218,657	Negligible	732,756	Immediate	131	Short	Accepted
4	Auto blowdown control system for boilers	483		7,533		400,000	72,473	66	16	Long	Accepted
5	Oxygen tuning of boilers			31,201		100,000	290,173	4	67	Short	Accepted
6	Thermal insulation improvements (steam header/valves)			1,602		18,000	14,895	15	3	Medium	Accepted
7	Pressure reduction in compressed air system			15,197	54,600	Negligible	182,974	Immediate	33	Short	Accepted
8	Efficiency improvement of water treatment pumps			5,597	20,107	150,000	67,383	27	12	Long	Accepted
9	Replace conventional ceiling fans with energy efficient ceiling fans				294,112	4,040,000	2,670,537	18	166	Long	Accepted
10	Metering requirement (Water-2, Steam-1, Electricity-9)					500,000					Accepted
	Sub Total (A)	**483**		**641,703**	**587,476**	**9,708,000**	**8,864,526**	**13**	**1,548**	**Medium**	
B	**Process Area**										
11	Improving dyeing process performance by improving RFT	133,392	407	688439	1,247,851	40,000,000	47,913,798	10	2,231	Short	Accepted

Sl. No.	Recommendation	Impact (Reduction)				Estimated investment	Annual Savings	Simple payback	Emission Reduction	Category*	Action Plan
		Water	Chemical	Natural Gas	Electricity						
		m^3/y	t/y	nm^3/y	kWh/y	BDT	BDT	Months	tCO_2/y		
12	Reduction of moisture from fabric before drying on stenter		10	58352		924,000	1,459,240	8	126	Short	Accepted
13	Recovery and reuse of washing water from Corino slitting machine	29,750				150,000	148,750	12		Short	Accepted
14	Waste heat recovery from drained hot liquor from dyeing machines			578,211	96,923	3,500,000	5,052,559	8	1,245	Short	Not Accepted
	Sub Total (B)	**163,142**	**418**	**1,325,003**	**1,344,775**	**45,574,000**	**54,574,347**	**10**	**3,660**	**Short**	
C	**ETP**										
16	Sludge recirculation pumps (ETP 1)					300,000					Accepted
17	Chemical dosing system (ETP-1)					600,000					Accepted
18	Sludge management system (Common for ETP-1 and ETP-2)					200,000					Not Accepted
20	Chemical dosing system (ETP-2)					600,000					Accepted
21	Air blower for post aeration tank(ETP-2)					200,000					Accepted
22	Water recycling system					40,000,000					Accepted
	Sub Total (C)					**41,900,000**					
	Total	**163,626**	**418**	**1,966,706**	**1,835,328**	**96,182,000**	**61,438,873**	**18**	**5,150**	**Medium**	
	Total accepted recommendations	**163,626**	**418**	**1,388,495**	**1,738,405**	**92,482,000**	**56,386,314**	**20**	**3,905**	**Medium**	

****Total saving includes chemical cost reduction of BDT 38.0million***

In the table below, recommendations are categorized as short term and mid to long term. Recommendations which are recommended to be implemented in the short term, i.e. six months comprise those which have a short payback period (i.e. less than six months) or those which should be prioritized for implementation in view of their impact on overall improvement of plant's performance and /or reduction in GHG emissions. Others are categorized as mid to long term.

Table 3: Action plan for implementation

CP No.	Recommendations	Baseline Condition	Suggested Changes and Investment	Impact (%reduction)				
				Water	Chemical	Natural Gas	Electricity	GHG Emissions
A	**Utility Area**							
Short-term plan- implementation in the next six months								
1	Heat recovery from exhaust of gas engines by installing EGB	No heat recovery from engine exhaust, exhaust gas temperature is 500-550°C	Install EGB – BDT 3.5 million			3.5%		2.8%
3	Frequency reduction in gas engines	Frequency – 50.6Hz	Reduce frequency to 50.0Hz- Nil			0.9%	1.8%	0.7%
5	Oxygen tuning of boilers	Oxygen level – 5.57%	Tuning of burner to reduce oxygen level to 2.5-3% BDT 0.2 million			0.5%		0.4%
6	Thermal insulation improvements (steam header/valves)	Heat loss from header and valves, where surface temperature is more than 145oC	Insulate header and valves – BDT 18,000			0.02%		0.02%
7	Pressure reduction in compressed air system	Pressure set point – 8.0bar	Reduce in increments of 0.5 bar up to 7.0 bar- **- Nil**			0.2%	0.4%	0.2%
	Metering	As per Table1	Install 3 electricity meters BDT 0.5 million					
	Sub-total			-	-	5.0%	2.2%	4.1%
Medium to long term plan- implementation in the next 7-24 months or more								
2	Heat recovery from jacket water of gas engine for hot water application	No heat recovery from jacket water which is at a temperature of 80-85°C	Install heat recovery system – BDT 1.0 million			4.1%		3.3%

CP No.	Recommendations	Baseline Condition	Suggested Changes and Investment	Impact (%reduction)				
				Water	Chemical	Natural Gas	Electricity	GHG Emissions
4	Auto blowdown control system for boiler	Manual blowdown in 14TPH boiler, 3times/day for 2 minutes	Install auto blowdown system – BDT 0.4 million	0.1%		0.1%		0.1%
8	Efficiency improvement of water treatment pumps	Present efficiency of WTP service pumps is – 41%	Refurbishment or replacement with pumps having efficiency in the range of 60-65%- BDT 0.2 million			0.1%	0.2%	0.1%
9	Replace conventional ceiling fans with energy efficient ceiling fans	1,010 conventional ceiling fans, each consuming 80 W	Phased replacement with energy efficient BLDC fans (28 W) –BDT 4.0 million				2.4%	0.9%
	Sub-total			0.1%	0.0%	4.3%	2.5%	4.4%
	Total (Utility Area)			0.1%	0.0%	9.3%	4.7%	8.4%
B.	**Process Area**							
Short-term plan- implementation in the next six months								
11	Improving dyeing process performance by improving RFT	Lab to bulk RFT -50% (as reported) Batches exceeding schedule time - 20%	Individual water meters, calibration of machine instruments and weighing scales, and purchase/repair/calibration of new process control instruments on machines– BDT 25million	7.5%	5.0%	7.5%	7.5%	9.1%
12	Reduction of moisture from fabric before drying on stenter	Number of stenters -2 Daily production – 20. 2tonne Moisture at inlet – 60%	For rubber rollers maintenance and two moisture meters on stenters – BDT 0.9 million		0.3%	0.8%		0.7%
13	Recovery and reuse of washing water from Corino slitting machine	Washing water drained: 5 m^3/h	Filter, pump (6 m^3/h) - BDT 0.15 million	3.3%				
14	*Waste heat recovery from drained hot liquor from dyeing machines**	*Water drained at 75°C from dyeing machines*	*Heat recovery from drained liquor – BDT 3.6 million*			*8.4%*		*6.8%*

CP No.	Recommendations	Baseline Condition	Suggested Changes and Investment	Impact (%reduction)				
				Water	Chemical	Natural Gas	Electricity	GHG Emissions
	Sub-Total			**10.8%**	**5.3%**	**16.7%**	**7.5%**	**16.6%**
Medium to long term plan- implementation in the next 7-24 months or more								
11	Improving dyeing process performance by improving RFT	Lab to bulk RFT -50% (as reported) Batches exceeding schedule time - 20%	Computer aided chemical weighing system, dispensing and dosing where applicable on dyeing machines —BDT 15million	7.5%	5.0%	2.5%	2.5%	3.0%
	Sub-Total			7.5%	5.0%	2.5%	2.5%	3.0%
	Total (Process area)			18.3%	10.3%	19.2%	15.0%	19.6%
C.	**ETP Area**							
Short-term plan- implementation in the next six months								
15	Sludge recirculation pumps – ETP1	Only one working pump	Provide standby pumps– BDT 0.3 million	-	-	-	-	
16	Chemical dosing system (ETP-1)	Only one working pump for various chemicals	Provide standby dosing pumps – BDT 0.6 million	-	-	-	-	
17	*Sludge management system (Common for ETP-1 and ETP-2)**	-	*Provide standby pumps – BDT 0.2 million*	-	-	-	-	
18	Chemical dosing system (ETP-2)	Only one working pump for various chemicals	Provide standby pump– BDT 0.6 million					
19	Air blower for post aeration tank(ETP-2)	Only one air blower is available	Provide standby air bower- BDT 0.2 million					
	Sub-total			-	-	-	-	
Medium to long term plan- implementation in the next 7-24 months or more								
20	Water recycling system	Freshwater consumption - 1,389,053 m^3/y, out of which the consumption in process is 889,283 m^3/y, i.e. 64% of fresh water.	Installation of a water recycling system to re-use treated effluent in the process - 40 Million BDT	-	-	-	-	

CP No.	Recommendations	Baseline Condition	Suggested Changes and Investment	Impact (%reduction)				
				Water	Chemical	Natural Gas	Electricity	GHG Emissions
	Sub-total			-	-	-	-	
	Total (ETP Area)			-	-	-	-	
	Short Term			**10.8%**	**5.3%**	**21.8%**	**9.7%**	**20.6%**
	Medium to Long Term			**7.6%**	**5.0%**	**6.8%**	**5.0%**	**7.4%**
	Total			**18.4%**	**10.3%**	**28.6%**	**14.7%**	**28.0%**

(* CP Measure 14 and 17 have not been accepted for implementation)

1.2 Impact of CP measures

The impact on the baseline indicators would be as follows. The reduction will be possible through implementation of the accepted recommendations in utility, process and ETP.

Table 4: Resource conservation and KPI

Resource	Key Performance Indicators				Projected Annual saving		
	Unit	As Is	To Be	% Reduction	Resource	Unit	Monetary (BDT/y)
Ground water	l/kg	195.5	172.5	11.8	163,626	m^3	818,129
Process water	l/kg	125.2	102.1	18.4			
Chemicals	g/kg	573.3	514.5	10.3	418	Tonne	37,579,158
Electricity	kWh/kg	1.76	1.51	13.9	1,738,405	kWh	7,510,600
Natural gas	nm^3/kg	0.97	0.77	20.2	1,388,495	nm^3	12,478,426
Others							
GHG emission	Tonne of CO_2	18,381	14,476	21.2	3,905	tCO_2	
Energy + Water bill	Million BDT/y	133.2	112	15.7	20.85	Million BDT/y	

Impact of CP measures on the utilities and GHG emissions is shown in the figure below:

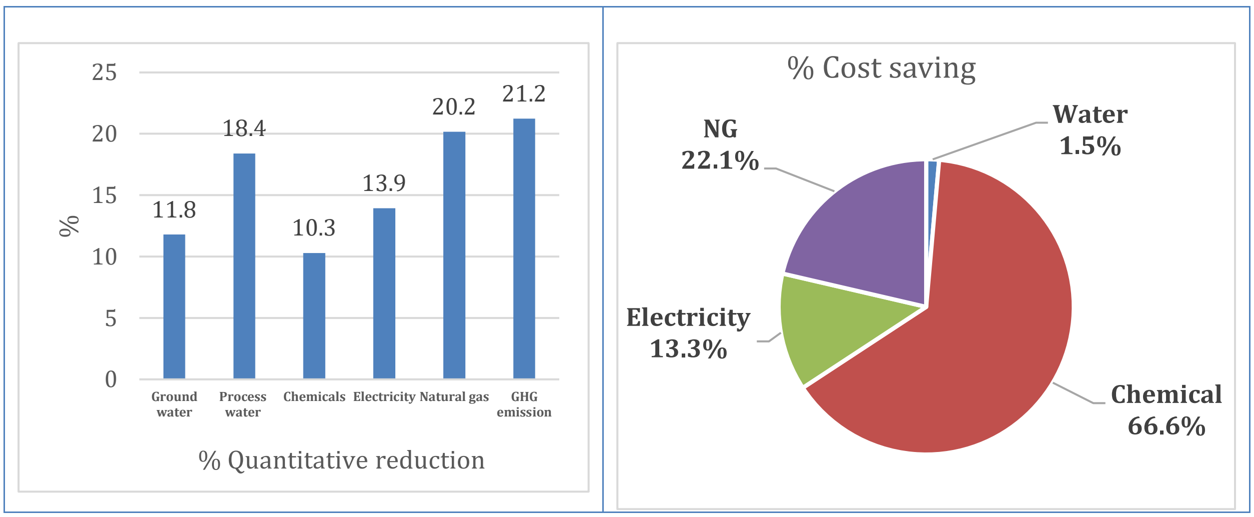


Figure 1: Impact of CP measures -% reduction in resources and GHG emissions

On an overall basis, the GHG emissions will reduce by 21.2% (through reduction of natural gas and electricity consumption). In addition, reduction of process water consumption by 18.4% and chemical usage by 10.3% is also expected. Nearly 67% of monetary savings will be from reduction in chemical consumption, and the remaining from the utilities.

GHG emission reduction will be possible by heat recovery from gas engine exhaust and jacket water, blow down optimization, tuning of boiler (burner), insulation improvements, pressure reduction in compressor, efficiency improvement of pumps, installation of energy efficient ceiling fans, improving dyeing performance, reduction of moisture in fabric before drying and heat recovery from drained liquor.

2 Introduction

International Finance Corporation's (IFC) Partnership for Cleaner Textile (PaCT) program was launched to focus on reducing the environmental impact and resource consumption of Bangladesh's textile sector. This helped local suppliers meet the standards required by global brands, thereby remaining competitive and building the sector's sustainability. PaCT conducted on-site assessments at washing, dyeing, and finishing (WDF) factories, and then customized individual plans to reduce resource and chemical consumption. These ranged from low-cost or no-cost changes in management and housekeeping practices, to process modifications, to larger investments such as new equipment.

One of the core services provided by this program was supporting factories in setting up cleaner production (CP) goals and objectives. This is being implemented in three steps, by building factory awareness, providing factory level advice on adoption of low cost/no-cost measures and by providing in-depth CP assessments, leading to investment in technologies with significant resource efficiency benefits. CP assessments focus on water as the primary driver for change and addresses and chemical use (water-energy chemical nexus) for an integrated approach to resource efficiency.

Development Environergy Services Limited (DESL), New Delhi and Bangladesh Centre for Advanced Studies (BCAS), Dhaka have been engaged by IFC to provide in-depth assessments to Iris Fabrics Ltd.

2.1 Objective

The specific objectives of this assignment for identified factories are to:

1. Assess current usage of water, energy, chemicals, greenhouse gases (GHG) emission and wastewater discharge in the factory.
2. Identify saving opportunities by assessing wet dyeing process, i.e. washing, dyeing and finishing operations in textile units for delivering water and energy in a more efficient/less wasteful manner.
3. Identify various options and investment plan to reduce water, energy, chemical consumption and effluent generation in the textile processing with improvement in effluent treatment plant (ETP) and water treatment plant (WTP).
4. Improve efficiency in resource utilization to **enable** cleaner production at factory level and making the factory owners and decision makers aware of advantages of investing in technologies that significantly reduce consumption of resources like energy, water and chemical use, as well as reduce water.
5. Identify opportunities for improving energy and water management system.
6. Form a CP team in each factory and train the CP team.
7. On an ongoing system, share with IFC insights and lessons learned from the assessments, and prepare a formal note on lessons learned midway and at the end of the assignment.

2.2 Scope of work

The objective will be achieved through:

- Baseline data collection.
- Detailed technical assessment.
- Advice and demonstration of good practices in the dye house, ETP and utilities in selected textile wet processing factories.
- Follow-up visits to factories for monitoring.
- Dissemination of results and awareness raising.

2.3 Methodology

Assessment of opportunities through cleaner production to improve energy efficiency and reduce water consumption has been done by conducting a field study. The field study was carried out jointly by a team from DESL and BCAS. The general methodology for the assessment study was as follows:

- Walk through assessment was planned and conducted to understand the process, practices and ground condition of the plant
  - During the assessment, review of production operations and supporting utility systems such as boilers, thermic fluid heaters, diesel generator set, waste heat recovery systems, insulation systems, dryer system operation, fans and blowers, pumps, compressed air systems, lighting systems and effluent treatment plants was carried out.
  - Through field observations and interactions with plant personnel, opportunities for potential savings in electrical and thermal energy usage and improvement of process operations were identified.
  - Use of energy, water and chemical were critically studied to identify need for measurements (by BCAS) during detailed assessment of the plant.
  - ETP and water treatment were studied to understand and identify the needs to improve the process and reduce consumption where possible.
- Data collection
  - Historical data collection of resource consumption required for baseline establishment.
  - Measure, monitor and collect all energy (electrical and thermal) and resource consumption data of the wet processing textile units including water, chemical usage, effluent treatment plants' operation and chemical used for the ETP.
  - Create a resource map of energy and water sources and usage in the textile processing facility. Data analysis and develop an energy/water balance.
  - BCAS carried out field measurements of different parameters such as energy consumption, fuel consumption, water consumption, steam consumption, performance of the boiler, compressed air consumption, thermal energy user areas and other relevant data points to map the usage of resources (energy, water, chemical and effluent).
  - BCAS also collected the data for chemicals used in different processes, effluent discharge quantity, quality and effluent treatment process used.
- Conceptualization of CP measures.
  - Identify measures to reduce end-use demand for energy, chemical and water; for example by improving equipment or systems in the process and utility areas.

    - Identify measures for improving the efficiency of utility service; examples include, steam distribution system improvements, reduction of heat loss, water consumption reduction potential, use of high-efficiency luminaires/motors, etc.
    - Identify measures to enhance heat recovery or heat generation efficiency, processes, and also identify measures for improvement of ETP functionality, design, upgradation, etc.
- For each saving opportunity identified above,
    - Estimate the annual saving energy (kWh), water saving, chemical saving, avoided water discharge, GHG emission (tCO_2e), cost (BDT and US$) for the measure.
    - Estimate the project cost or cost of implementation.
    - Calculate the simple payback period.

2.4 In-depth cleaner production assessment in IRIS Fabrics Limited

Iris Fabrics Limited (IFL) is participating in the project as a partner unit. IFL started operations in the current location in 2007. It is an export oriented knit garment manufacturing factory. The dyeing and finishing section of IFL are covered in the current assignment.

2.4.1 Unit Details

IFL is situated at Zirani, Kashipur, Gazipur in Dhaka. The whole premise has facilities for knitting, dyeing, finishing, panel printing and garment manufacturing.

Table 5: Industry details

Parameters	Details
Name of the industry	Iris Fabrics Limited
Address	Zirani, Kashimpur, Gazipur
Actual Production	7,105,700 kg
Products	Knitting, Dyeing, Finishing, Printing
Average number of staff	250 (including workers)
Number of female staff	5 (including workers)
Work shifts/day (1/2/3)	3
Number of working days in a year	350

The utilities and water consumption for the period- Jan-20 to Dec-20, areas follows:

Table 6: Utilities consumed

Particulars	Unit	Value
Quantity of electrical energy (grid)	kWh/y	6,231,384
Quantity of diesel used	l/y	14,094
Quantity of natural gas used	nm^3/y	6,884,394
Quantity of ground water used	m^3/y	1,389,053
Quantity of treated water used	m^3/y	889,283
Chemical consumption	tonne/y	4,074
GHG emissions on account of production	tCO_2/y	**18,381**

2.4.2 CP assessment process

This report describes the result of in-depth cleaner production assessment (CPA) of IFL. The process for CP assessment was as follows:

- IFC along with the brand sent a deep dive questionnaire to the units for further data validation. Data was requested before the pre-assessment visit.
- Walk through assessment (WTA) was conducted on 16/01/2021 to verify resources available, utilization, resources for process, water and chemical consumption in process, water and wastewater utilization and recoveries. Walk through assessment report was prepared outlining the preliminary observations and the requirement for further data collection.
- BCAS then followed up with the unit for further data collection and verification.
- Based on the inputs received and the observations during the walk-through assessment, the CP assessment report was prepared.
- This report has been prepared based on the data received and the feedback received from IFL. This report is organized as follows:
    - Section 3: Energy and Utilities
    - Section 4: Process and Operations
    - Section 5: Water and Water treatment
    - Section 6: Effluent Treatment Plant
    - Section 7: Concluding Recommendations

3 Energy and Utility

3.1 Utility Mapping

The primary energy sources used in IFL are natural gas (NG), electricity purchased from the grid and diesel. Natural gas is not only used for steam and electricity generation but is also used in the process. Diesel is used for standby electricity generation. Break-up of various energy sources for different applications at IFL is tabulated below.

Table 7: Utility mapping

Section Name	Water (%)	Electricity (%)	Gas (%)	Steam (%)
Dyeing	64	-	31	80
Dyeing and knitting	-	70	-	-
Printing	-	4	2	-
Garments	-	26	-	20
Office, domestic and others	28	-	-	-
Fire tank	7	-	-	-
Compressor	-	-	-	-
Generator, boiler	1	-	67	-

The utility mapping is prepared based on meter data, estimation and discussion between Facility Engineer and BCAS.

Dyeing and finishing plant accounts for about 64% of the total water consumption. Electricity is mainly consumed in process area; steam is mainly consumed in dyeing process (80%) and natural gas is consumed in utility (67%) and finishing process (33%).

3.2 Annual Energy Consumption

Various energy sources used at IFL, the energy content, energy cost per unit of resource and total energy cost of the unit are summarized below.

Table 8: Energy content and costing

Resource	Unit	Energy consumption	Unit	Energy Cost (BDT)	Unit	Specific energy cost
Electricity (grid)	kWh/y	6,231,384	BDT/y	56,580,967	BDT/kWh	9.08
Natural gas (heat)	nm^3/y	2,870,148	BDT/y	26,692,376	BDT/nm^3	9.30
Natural gas (power)	nm^3/y	1,731,294	BDT/y	20,844,780	BDT/nm^3	12.04
Natural gas (process)	nm^3/y	2,282,952	BDT/y	21,231,454	BDT/nm^3	9.30
Diesel	liter/y	14,094	BDT/y	916,110	BDT/liter	65.00
Total			**BDT/y**	**126,265,686**		

Share of energy resource based on energy content and cost is shown in the figures below.

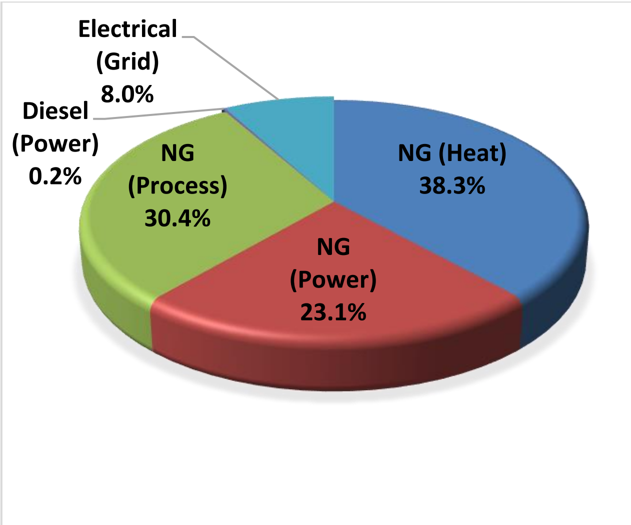


Figure 2: Energy consumption by source

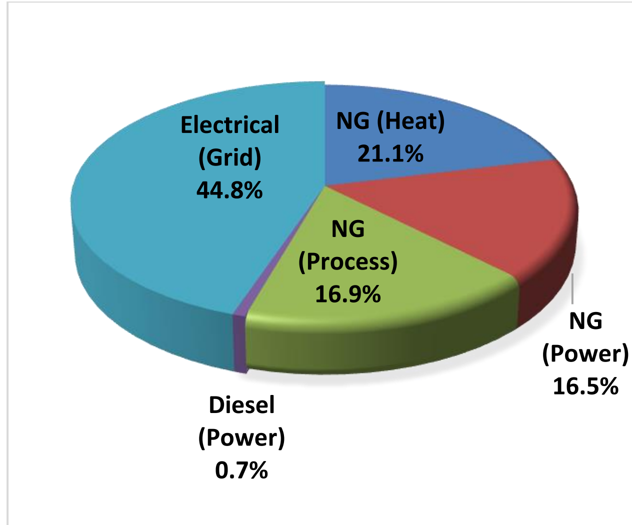


Figure 3: Energy cost by source

Energy consumption from various sources of energy at IFL for the last 12 months is tabulated and attached as

Annexure 3 – Details of Energy Consumption.

3.3 Factory specific key baseline indictors

Factory specific baseline conditions based on data provided by IFL are summarized below.

Table 9: Baseline conditions – energy

Resource	Unit	Value	Production	KPI (Key Performance Indicators)	
			kg	Value	Unit for KPI
Electricity	kWh	12,478,514	7,105,700	1.76	kWh/kg
Natural gas	nm^3	6,884,394	7,105,700	0.97	nm^3/kg
GHG emission	tonne of CO_2	18,381	7,105,700	2.59	kg/kg

3.4 Natural Gas Consumption

The equipment where natural gas is being used is included in the following table:

Table 10: Natural gas consuming equipment

Equipment	Quantity (numbers)
Gas engine	2
Boilers	2
Stenter	2
Dryer	1
Printing dryer	1
Total	**8**

The month-wise variation in gas consumption is shown below:

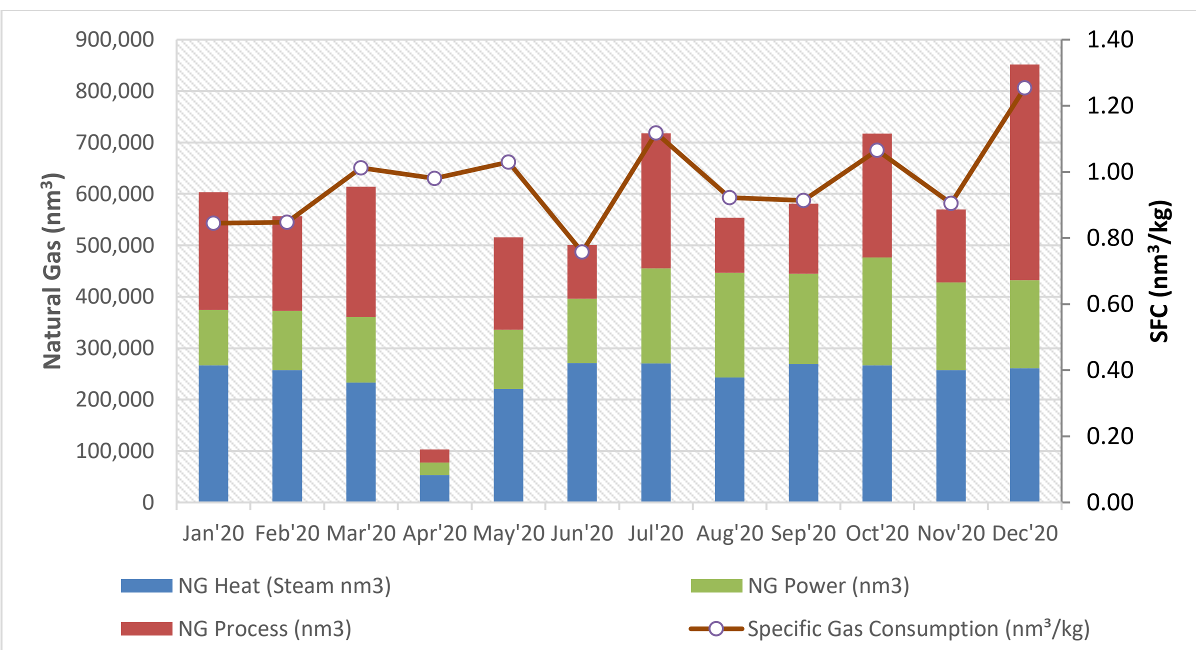


Figure 4: Monthly Gas Consumption (Heat + Power)

Specific fuel consumption has a relation with production volume. For the month of Apr'20, when production volume was lowest, the specific fuel consumption was at 0.98nm^3/kg. On the other hand, when the production volume was higher in the month of Jan'20, the specific fuel consumption was down up to 0.84nm^3/kg. Gas consumption was highest in the month of Dec'20 and least in Apr'20.Averagegas consumption was573,700 nm^3/month.

3.5 Thermal Energy

Installation details of thermal energy equipment are tabulated below.

Table 11: Installation details of boilers

Parameters/Boiler Tag	Unit	1	2
Location	-	-	-
Manufacturer	-	BOSCH	Mechmar
Model	-	UL-S 12000	AS2400/150
Running status	-	Operating	Operating
Fuel type	-	Natural gas	Natural gas
Rated output	TPH	14.0	10.9
Maximum pressure	Bar	8.0	8.0
Quantity	Numbers	1	1

Thermal energy in the form of steam is generated from boilers. Steam generated is mainly utilized in the process for generating hot water and also used in steam dryers. One of the boilers is continuously operated as per requirement and the second boiler is kept as standby. Monthly gas consumption data is attached as

Annexure 3 – Details of Energy Consumption.

3.5.1 Steam distribution

Steam distribution system for IFL is shown in the schematic below. Steam is mainly used in dyeing, finishing, and drying and garments section.

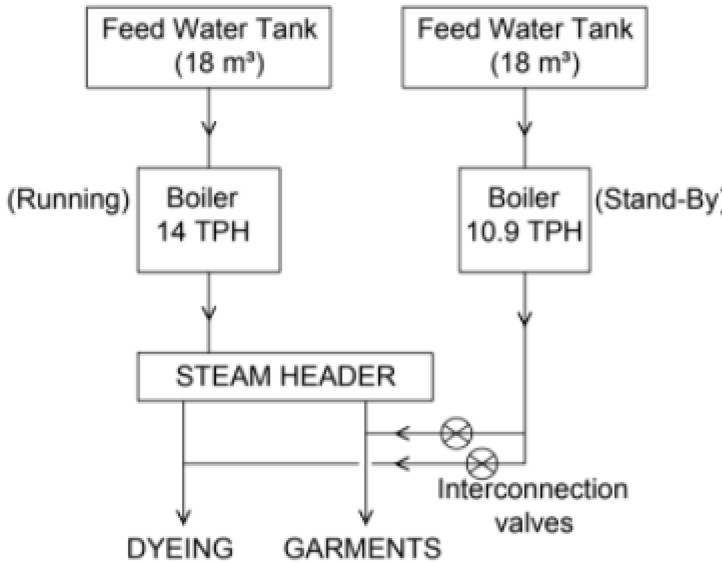


Figure 5: Steam distribution layout

3.5.2 Observations – Thermal consumption areas

Observations on steam generation and steam distribution system are as follows:

- Steam generation and gas consumption
  - There is one common gas flow meter recording gas consumption in boilers and process equipment.
  - As per estimation, average steam generation from boilers is about 5-6 TPH.
  - 14TPH boiler is operated continuously, whereas 10.9TPH boiler is kept as standby.
  - Steam flow meters are not installed on the boilers. Steam consumption is estimated based on water consumption.
  - Steam to fuel ratio as per data provided is at9.6 kg of steam/nm^3 of gas.
- Oxygen Tuning
  - Oxygen level as measured in 14TPH boiler is 5.57%.
  - The 14TPH boiler needs tuning for optimizing oxygen level, and hence reduce fuel consumption.
  - For gas fired boilers, optimum oxygen level should be maintained in the range of 2-3%.
- Performance evaluation of all the boilers, based on flue gas report provided, is mentioned below.

Table 12: Performance evaluation of boilers (In-direct Method)

Parameters	Unit	14.0TPH
Boiler number	#	1
Calorific value of fuel	kcal/nm^3	8,930
O_2 % in flue gas	%	5.57
Excess air	%	36.1
CO	ppm	1,854
CO_2	%	8.6
Fuel consumption	Nm^3/h	530
Ambient temperature	°C	32.8
Stack temperature	°C	120
Combustion efficiency	%	75.35

- Blow down
    - Manual blowdown is practiced in all the boilers.
    - Blowdown is done about 3times/day.
    - Duration of each blowdown is about 2minutes.
    - Blowdown TDS is recommended to be maintained up to 3,000ppm.
- Condensate is recovered from dyeing, finishing and garments section as per information provided.
- Feed water inlet temperature from feed water tank to economizer is in the range of 90-95°C, and after economizer the temperature rises up to 120°C
- Heat recovery is done from boiler flue gas in the 14TPH boiler through economizer.
- Flue gas temperature is between 120-130°C at the outlet of14TPH boiler.
- Insulation is recommended in steam valves and steam headers.

3.6 Electrical Energy

At IFL, electrical energy requirement is met from gas engines, electricity purchased from grid and electricity from diesel engines. Out of the total power requirement, power generated from gas engines meets 49.8% of the requirement, 49.9% is met from the grid and the remaining 0.3% from diesel engines. Diesel engines are installed for standby requirement if there is power unavailability from gas engine and grid.

Installation details of gas engines are tabulated below.

Table 13: Gas engine specification

Parameters/Gas Engine	Unit	Gas Engine#1	Gas Engine#2
Make	-	Caterpillar	Caterpillar
Model	-	G3512H	G3516
Serial number	-	-	-
Capacity	kW	1500	1030
Frequency	Hz	50	50
Voltage	V	400	400

Parameters/Gas Engine	Unit	Gas Engine#1	Gas Engine#2
Current	A	-	-
Power factor	pf	1.0	1.0
Quantity	#	1	1

3.6.1 Electricity consumption

The month-wise variation in electricity consumption (all sources) is shown graphically in the figure below.

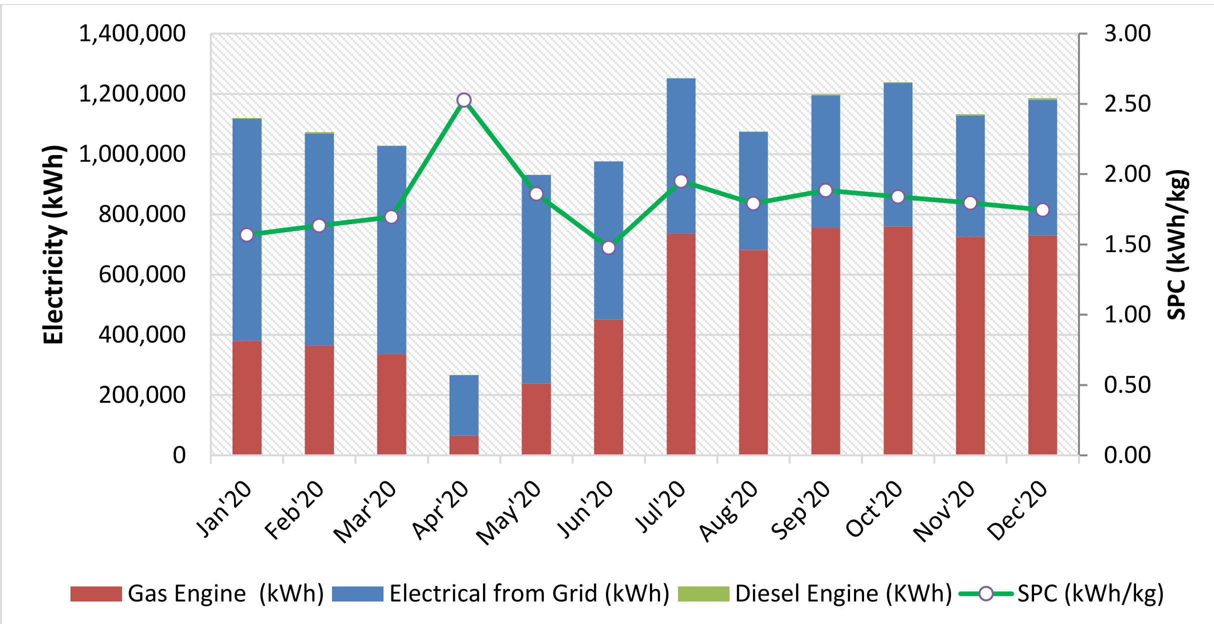


Figure 6: Monthly electricity consumption

Specific power consumption has a relationship with production. In the month of Apr'20, when production was lowest, the SPC was highest at 2.53 kWh/kg; whereas in the month of Jan'20, when production was highest, the SPC was low at 1.57 kWh/kg. Lowest SPC was achieved in the month of Jun'20 at 1.48 kWh/kg. Electricity consumption was highest in the month of Jul'20 and lowest in Apr'20. Average electricity consumption is 1,039,876 kWh/month

3.6.2 Electricity distribution

Single line diagram for electrical distribution system is shown below:

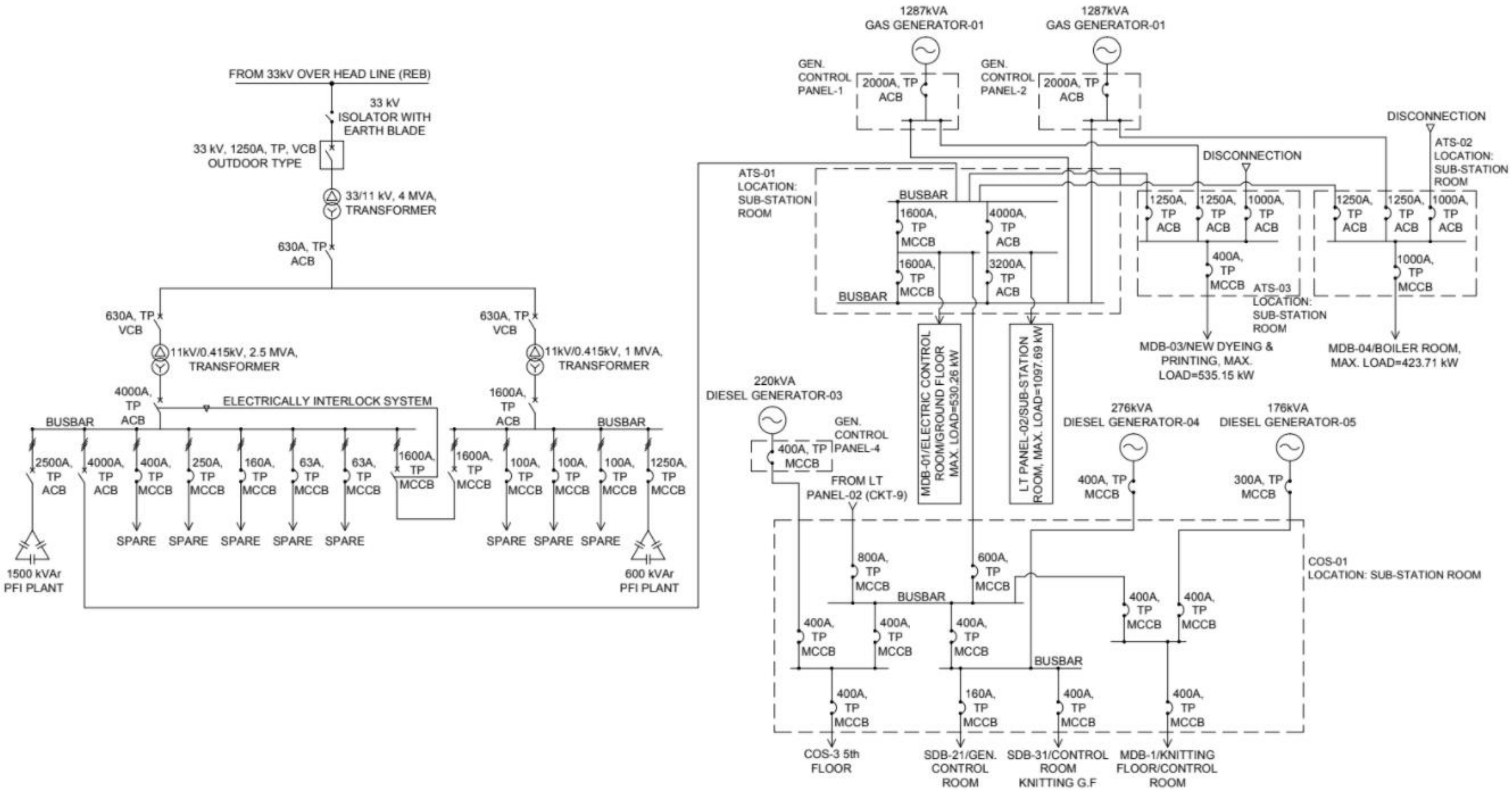


Figure 7: Electrical single line diagram

Observations and recommendations:

- Power supply from grid and gas engines are synchronized.
- Power from grid and gas engines are fed to LT panel.
- From LT panel, power is supplied to various main distribution boards (MDB), distribution boards (DB) and sub distribution boards (SDB).
- Gas flow meters are installed by utility supplying authority.
- Specific power generation from gas engine is 3.59kWh/nm^3.
- Specific power generation from diesel engine is 1.91kWh/L.
- At present, there is no heat recovery from the gas engines.

3.6.3 Compressed Air System

Air compressors are installed to generate compressed air which are used in process area mainly for pneumatic equipment/instruments. Compressed air is also widely used in industry for cleaning purpose. Specifications of the air compresors installed at IFLare tabulated below.

Table 14: Air compressors – installation details

Description	Unit	Compressor#1	Compressor #2, #3 and #4	Compressor #5 and #6	Compressor #7 and #8	Compressor#9
Model	-	-	-	-	-	-
Type	-	Screw	Screw	Screw	Screw	Screw
Quantity	#	1	3	2	2	1
Status	-	Running	Running	Running	Running	Running
Flow rate	CFM	110	152	240	364	407
Maximum pressure	Bar	10	10	10	10	10
Motor rating	kW	20	30	37	37	75
Air dryer		Yes	Yes	Yes	Yes	Yes

Compressed air distribution schematic is shown below.

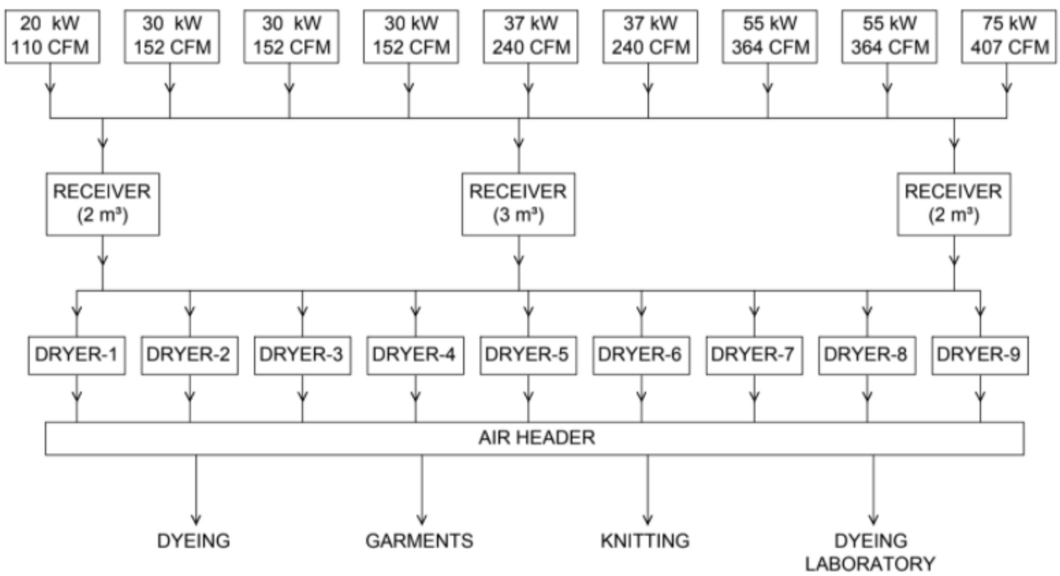


Figure 8: Compressed air distribution schematic

IFL has installed nine air compressors in utility section as per requirement. Air is collected in the receiver, passed through air dryer to remove moisture. Aftr drying, the air is distributed through a common header to various sections.Two(2) of the compressors of 55kW and 75kW rating are equipped with variable frequency drive (VFD).

Observations

- Air compressors were being operatedbased on air demand.
- Operating pressure was between 7.0-8.0bar.
- All the air compressors are operatedin load/unload mode except two compressors of 55kW and 75kW rating which are equipped with VFD.
- Air leakages were observed in the process area.

Recommendations

- Perform regular leakage test and monitor the leakage level.
- After identification of leakages, they should be plugged out as a regular maintenance practice.
- Compressed air leakages should not be more than 15%.
- Regular pump up test can also be performed to check capacity delivery.
- Reduce the pressure set point of compressors equipped with VFD so that these compressors take care of variable air demand.

3.7 Action plan for CP Measures – Electrical and Thermal Utilities

Based on the analysis, cleaner production actions have been identified; each of which are described below:

Table 15: Utility recommendations for improvement

Sl. No.	Utility area	Observations	Recommendations/ Remarks
1	Gas engine	There is no heat recovery from gas engines. Flue gas is released into atmosphere at a temperature of 500-550^{o}C.	Recover this high-grade heat by installing exhaust gas boiler.
		There is no heat recovery from jacket water of gas engines from all of the engines. Jacket water is at a temperature of 80-85^{o}C. This heat is un-utilized and is released through cooling tower.	Heat recovery from jacket water for generating hot water; the hot water can be used in process or as boiler feed water.
		Gas engines are running at a frequency of 50.6Hz.	Optimize frequency up to 50.0Hz to reduce natural gas consumption.
2	Boiler and steam system	Blowdown is done manually at present. Blowdown is practiced 3times/day and the blow down duration is 2 minutes.	Install auto blowdown system to reduce fuel and water losses due to manual practice. Blowdown TDS can be increased up to 3,000ppm in consultation with OEM.

Sl. No.	Utility area	Observations	Recommendations/ Remarks
		Oxygen level of 14TPH boiler is in the range of 5.57%.	Tuning of burner to maintain oxygen level in between 2.0% to 3.0%. This will reduce excess air and hence fuel consumption will be optimum.
		Surface heat loss is taking place from steam header and steam valves. Temperature of steam header and steam valves is greater than 145°C.	Insulate and hence reduce surface heat losses.
3	Compressed Air	All the compressors are operated in load/unload mode at pressure set point of 7.0-8.0bar except two compressors of 55kW and 75kW capacity that are equipped with VFD.	Reduce the set point of VFD equipped compressors from 8.0bar to 7.5bar in first step and then to 7.0bar to achieve power saving and make the operation of compressor variable.
4	Pumps	Present efficiency of WTP service pump is 41%.	Improve efficiency of pump up to 60% by refurbishment/replacement.
5	Ceiling Fan	Conventional ceiling fans are consuming more than 80W per fan.	Replace existing ceiling fans by energy efficient brushless DC (BLDC) fans which will consume 28W.

3.7.1 CP measure no 1: Heat recovery from exhaust of gas engine by installing EGB

→ ***Project***

Utilize flue gas of gas engine to run exhaust gas fired boiler to generate steam.

→ ***Study and Investigation***

During the field visit, it was observed that flue gas of gas engines running at IFL is being released at a temperature of more than 500-550°Cinto atmosphere without any heat recovery.

Figure 9: Gas Engine exhaust gas duct

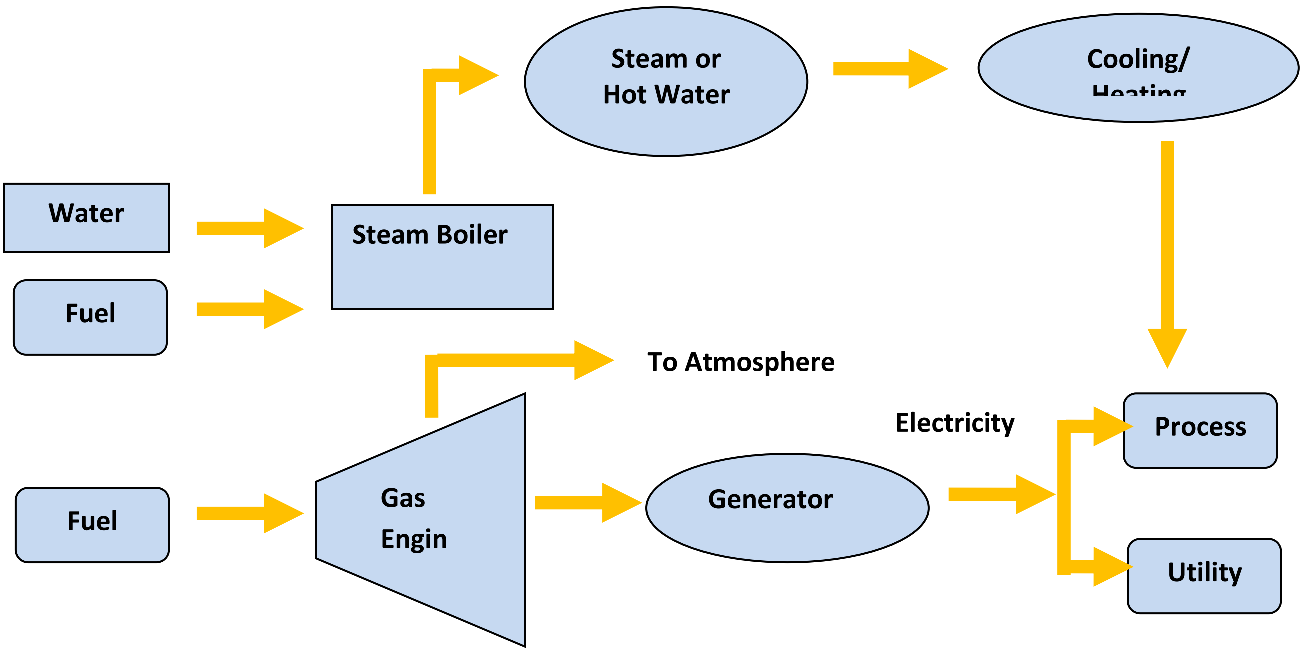


Figure 10: Existing steam and electricity system

→ *Recommended Action*

Install exhaust gas boiler (EGB) at the outlet of gas engine to recover heat from the flue gas. Temperature can be brought down from existing level of 550°C to 220°C. Steam generated can be utilized in the process.

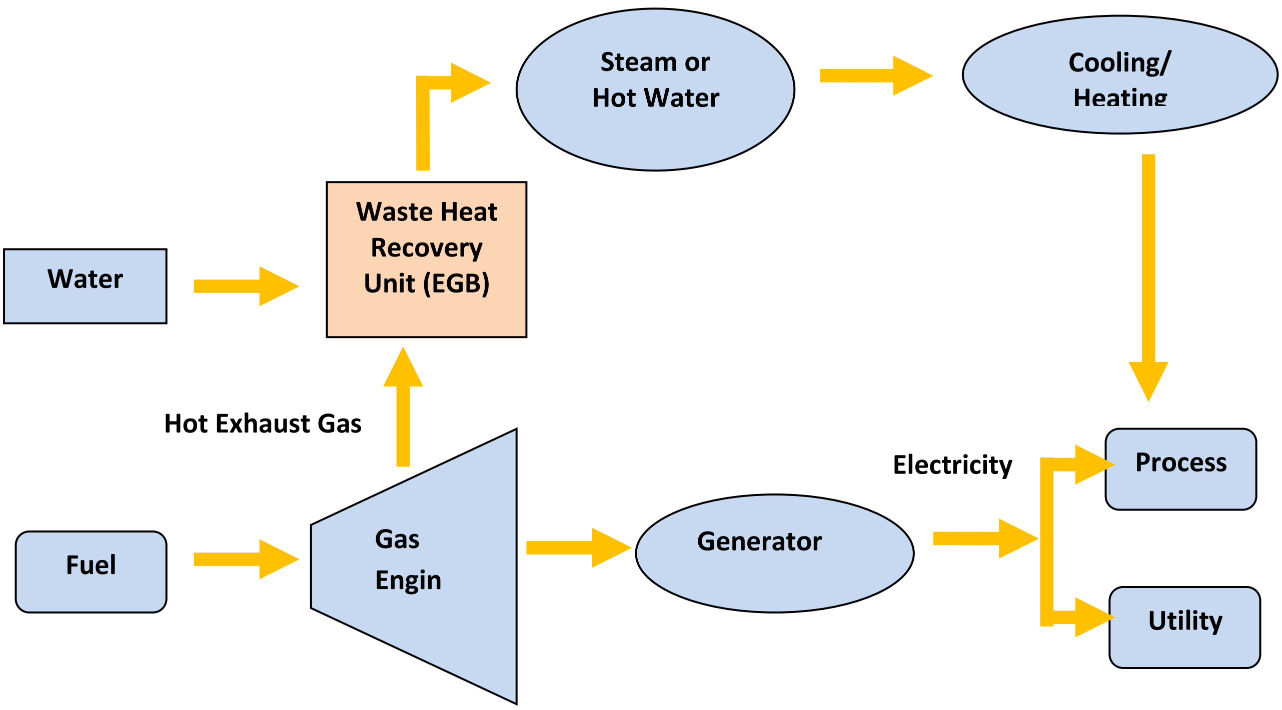


Figure 11: Proposed steam and electricity system

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below:

Table 16: Saving and cost benefit for installation of exhaust gas boiler

Parameters	Unit	Values	Remarks
Temperature of flue gas	°C	530	Factory Data
Proposed flue gas temperature	°C	220	Proposed
Temperature difference of flue gas	°C	310	Calculated
NG consumption in gas engine	nm^3/h	206	Factory Data
Actual load on engine	%	75%	Factory Data
Flue gas per nm^3 of NG	nm^3/nm^3	19	Standard
Flue gas flow rate	m^3/h	3916	Calculated
Density of flue gas	kg/nm^3	0.80	Standard
Specific heat of the substance	kcal/kg-°C	0.26	Standard
Heat loss	kcal/h	252,505	Calculated
Steam generation	kg/h	414	Calculated
Operating days	d	350	Factory Data
Operating hours	h	24	Factory Data
NG saving	nm^3/h	28	Calculated
NG price	BDT/m^3	9.30	Gas Tariff
NG saving (annual)	nm^3/y	237,519	Calculated
Financial saving	BDT/y	2,208,925	Calculated
	US$/y	26,150	Calculated
Investment	BDT	3,500,000	Estimated
	US$	41,435	Estimated
Simple payback period	Months	19	Calculated

→ *Action Plan*

Item	Action
Operation and maintenance	Installation of exhaust gas boiler would require regular maintenance of water side, flue side and air side path for efficient performance of boiler.
Retrofit	Install exhaust gas boiler in the flue gas path.
Replacement	Arrangement should o be made in the flue gas path for the installation of exhaust gas boiler.
Procurement	Exhaust gas boiler, steam piping, water piping, electrical connection, and compressed air supply to commission exhaust gas boiler.
Construction	Necessary fabrication work to install EGB in the flue gas path.
Costing	Estimate BDT 3,500,000 (Confirm with TTBC for options)
Project specific baseline parameters	Exhaust flue gas temperature – 530°C.
Baseline	Present fuel consumption for power generation –1,731,294nm^3/y.
Implication, if any and precaution	None
Other benefits	Improved working conditions, reduced surrounding air temperature.

3.7.2 CP measure no 2: Heat recovery from jacket water of gas engine for hot water application

→ *Project*

Install heat recovery system to recover available heat from jacket water of gas engines.

→ *Study and Investigation*

During the field visit, it was observed that jacket water heat is being released through cooling tower into the atmosphere. Substantial heat is available in the jacket water which can be utilized for generating hot water, which can be used in the process.

Figure 12: Jacket water cooling PHE

→ *Recommended Action*

Install hot water recovery system in parallel with existing heat exchanger, which will recover heat from jacket water and generate hot water. This hot water can be utilized either as boiler feed water or for process requirement.

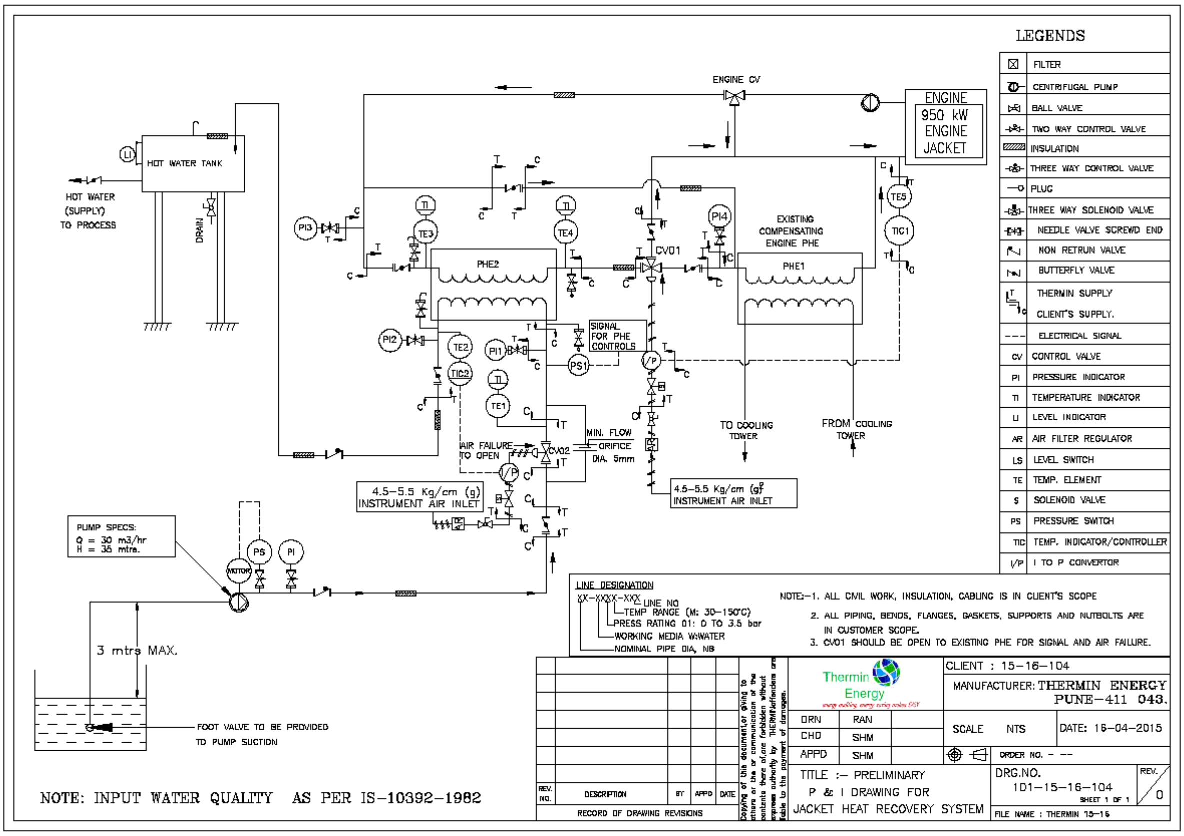


Figure 13: Jacket water heat recovery system (Illustrative)

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below:

Table 17: Saving and cost benefit for jacket water heat recovery system

Parameters	Unit	Values	Remarks
Water flow rate in gas engine	m^3/h	100	Factory data
Jacket water inlet temperature	°C	82	Factory data
Jacket water outlet temperature	°C	77	Factory data
Heat recoverable	kcal/h	375,000	Calculated
Hot water inlet temperature	°C	35	Factory data
Hot water outlet temperature	°C	70	Proposed
Hot water generation	m^3/h	10.7	Calculated
Operating days	d	350	Factory data
Operating hours	h	24	Factory data
NG price	BDT/nm^3	9.30	Gas Tariff
NG saving	nm^3/h	34	Calculated
NG saving (annual)	nm^3/y	282,195	Calculated
Financial saving	BDT/y	2,624,412	Calculated
	US$/y	31,069	Calculated
Investment for hot water system	BDT	1,000,000	Estimated
	US$	11,839	Estimated
Simple payback period	Months	5	Calculated

→ Action Plan

Item	Action
Operation and maintenance	Operation and maintenance of plate type heat exchanger (PHE), operation of instrumentation and automation system.
Retrofit	Some provisions are required for retrofitting so that both existing as well as new system will work as per requirement.
Replacement	None
Procurement	New heat recovery system will include plate type heat exchanger (PHE), hot water tanks, diverter valves, piping, etc.
Construction	Installation of plate type heat exchanger, pumps, tanks, piping, valves, instrumentation, and piping.
Costing	Estimate: BDT 1.0 million.
Project specific baseline parameters	Jacket water inlet temperature – 82°C. Jacket water flow rate – 100m^3/h
Baseline	Natural gas consumption (power) – 1,731,294nm^3/y.
Implication, if any and precaution	None
Other benefits	Reduced natural gas consumption for water heating purpose.

3.7.3 CP measure no 3: Frequency reduction in gas engines

→ Project

Frequency reduction in gas engines.

→ Study and Investigation

During the field visit, it was observed that operating frequency of gas engines was more than 50.6 Hz. Higher frequency will lead to higher RPM of gas engines and hence power consumption of all the centrifugal equipment will increase substantially.

Figure 14: Operating frequency of gas engines

→ Recommended Action

Reduce frequency of gas engines from 50.6 Hz to 50.0 Hz, in consultation with the manufacturer. Regular monitoring to ensure that frequency does not increase beyond 50.0 Hz.

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below:

Table 18: Saving and cost benefit for frequency reduction in gas engines

Parameters	Unit	Values	Remarks
Present frequency	Hz	50.6	Factory Data
Proposed frequency	Hz	50.0	Proposed
Existing load on engine	kW	740	Factory Data
Frequency reduction	Hz	0.6	Calculated
Percentage of centrifugal load	%	70	Assumption
Proposed load on engine	kW	714	Calculated
Saving in power	kW	26	Calculated
Operating days	d	350	Factory Data
Operating hours	h	24	Factory Data
Saving in power	kWh/y	218,657	Calculated
NG price	BDT/nm^3	12.0	Gas Tariff
NG saving (annual)	nm^3/y	60,860	Calculated
Financial saving	BDT/y	732,756	Calculated
	US$/y	8,675	Calculated
Investment	BDT	Negligible	Estimated
	US$/y	Negligible	Estimated
Simple payback period	Months	Immediate	Calculated

→ *Action Plan*

Item	Action
Operation and maintenance	No operation and maintenance issues. Frequency should be set close to motor RPM rating.
Retrofit	None
Replacement	None
Procurement	None
Construction	No construction only tuning of frequency set point.
Costing	Negligible
Project specific baseline parameter	Present frequency of gas engines – 50.6 Hz.
Baseline	Present operating load – 740 kW.
Implication, if any and precaution	None
Other benefits	Improved working conditions.

3.7.4 CP measure no 4: Auto blowdown control system for steam boiler

→ *Project*

Auto blowdown control system on steam boiler for optimum blowdown, and hence reduce energy loss through manual blow down.

→ *Study and Investigation*

Manual blowdown is being practiced at present on steam boilers at the rate of about 3blowdown/day for about 2 minutes each. Manual blowdown leads to loss of thermal energy. Blowdown TDS should be maintained as per OEM recommendations. Best practice is to blowdown so as to maintain boiler TDS between 2,500-3,000ppm.

Auto blow control system will open blowdown valve only when TDS level in the boiler water reaches the set value at which blowdown is required as per OEM design.

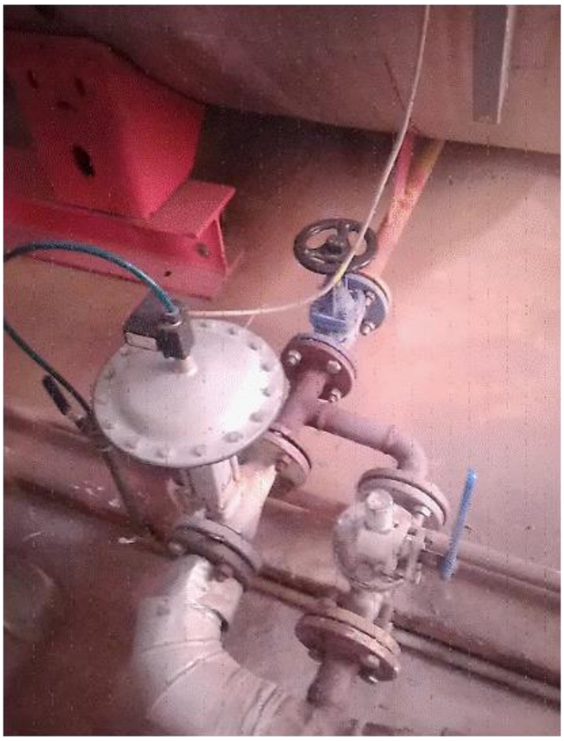


Figure 15: Manual blowdown practice

→ *Recommended Action*

Install auto blowdown system on steam boiler. Auto blowdown system will have TDS sensor to check TDS level of boiler water. Once the TDS level reaches the set value, the blowdown valve opens automatically and flushes out boiler water with impurities and reduces the TDS level in boiler. Once the TDS level reach, the valve closes. Energy losses are reduced due to auto blowdown system, hence saving fuel and water to the tune of 3-5%.

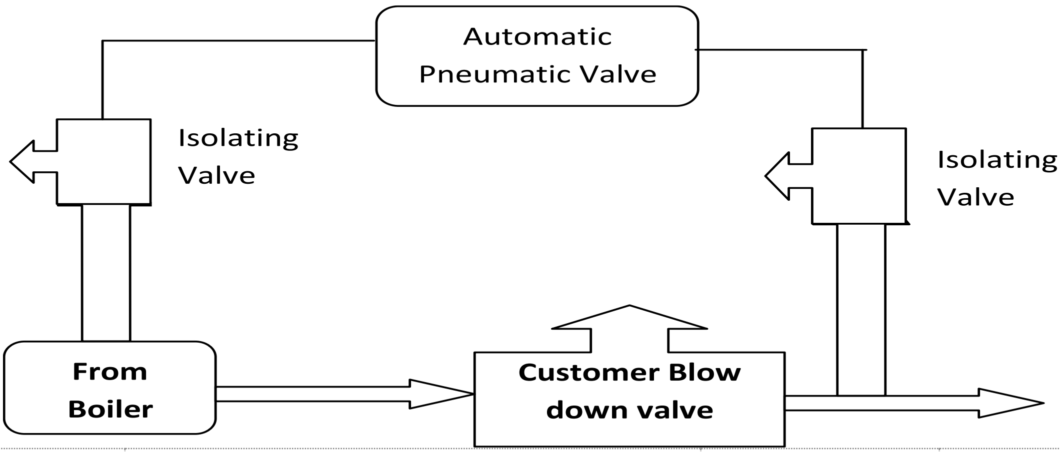


Figure 16: Auto blowdown control system

Advantages of auto blow down control system:

- Automatic timed blowdown avoids heat loss
- Adjustable blowdown intervals and duration
- Repetition or omission of blowdown avoided
- Valve closes on power failure
- Lesser water, fuel and treatment chemicals are needed
- Cleaner and more efficient boiler
- Reduced operating cost
- Minimized energy loss from boiler
- Safer boiler operation and reduced labor cost

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below:

Table 19: Saving and cost benefit for auto blow down control system

Parameters	Units	Actual	Recommended	Remarks
		14.0TPH Boiler		
Blowdown pipe size	Inch	2.0		Factory Data
Blowdown pipe size	mm	50		Factory Data
Duration of blowdown	minute	2	Auto	Factory Data
Duration of blowdown	seconds	135	Auto	Factory Data
Number of blowdown per day	number	3	Auto	Factory Data
Flow of water during blowdown	kg/s	16		Standard
Amount of water per blowdown	kg	2,106		Calculated
Amount of blowdown water	kg/d	6,318	4,937	Calculated
Boiler efficiency	%	75%		Calculated
Boiler capacity	kg/h	14,000		Calculated
Steam generation/day	kg/d	164,563		Calculated
Blowdown percentage	%	3.84	3.00	Calculated
Steam pressure	bar	7.0	7.0	Factory Data
Enthalpy of blowdown water at NTP	kcal/kg	25	25	Standard
Enthalpy of blowdown water at rated pressure	kcal/kg	164	164	Standard
Heat loss	kcal/kg	139	139	Calculated
Heat loss per day	kcal/d	879,219	687,023	Calculated
Calorific value of NG	kcal/nm^3	8,930	8,930	Titas Gas
Steam loss	kg/d	1,330	1,039	Calculated
Loss of NG	nm^3/d	98	77	Calculated
Water loss	m^3/d	6.3	4.9	Calculated
Number of working days per year	d	350		Factory Data
Steam saving	kg/y	101,768		Calculated
NG saving	nm^3/y	7,533		Calculated
Water saving	m^3/y	483		Calculated
Cost of NG	BDT/nm^3	9.30		Gas Tariff
Cost of water	BDT/m^3	5.00		Factory Data
Total saving	BDT/y	72,473		Calculated

Parameters	Units	Actual	Recommended	Remarks
	US$	858		Calculated
Investment for auto blowdown system	BDT	400,000		Estimated
	US$	4,735		Estimated
Simple payback period	months	66		Calculated

→ *Action Plan*

Item	Action
Operation and maintenance	Installation of auto blowdown control system to maintain optimum TDS level in the boiler. The blowdown valve opens only when TDS level reaches the set value. Once the TDS level is maintained, the valve automatically closes.
Retrofit	Install TDS sensor along with pneumatically operated valve as a blowdown system.
Replacement	None
Procurement	TDS level sensor, blow down valve, air supply for pneumatic valves.
Construction	Necessary fabrication work to install TDS sensor along with valve in the blowdown pipeline.
Costing	Estimate BDT 400,000
Project specific baseline parameter	Blowdown water – 6.3tonne/day
Baseline	Efficiency of boiler – 75%.
Implication, if any and precaution	None
Other benefits	Reduced noise level and better steam quality.

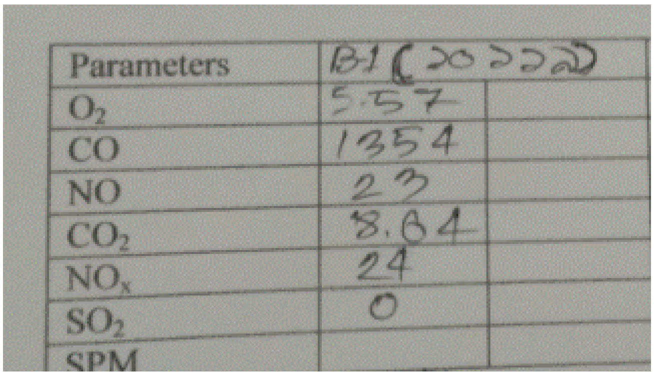
3.7.5 CP measure no 5: Oxygen tuning of boiler

→ *Project*

Optimum oxygen level in the boiler to reduce natural gas consumption.

→ *Study and Investigation*

During the field visit, it was observed that oxygen level in14TPH boiler was 5.57%, which is high for gas boiler of this capacity.



Parameters	B-1 [illegible]	
O_2	5.57	
CO	1354	
NO	23	
CO_2	8.64	
NO_x	24	
SO_2	0	
SPM		

Figure 17: Boiler flue gas measurement

→ *Recommended Action*

Tuning of burner is recommended to maintain the oxygen level in the range of 2-3%. An online oxygen analyzer can be installed at the boiler. This oxygen analyzer will work in closed loop with combustion blower. Based on the feedback from the oxygen sensor, the sensor will sense set oxygen level and continuously operate the fan damper to maintain the oxygen level. With oxygen controller, the combustion efficiency of the boiler can be improved in between 2-4%.

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below:

Table 20: Saving and cost benefit for oxygen tuning of boiler

Parameters	Unit	Boiler#1 14.0TPH As Is	Boiler#1 14.0TPH To Be	Remarks
Oxygen level	%	5.57	2.50	Measured data
Present heat loss in dry flue gas	%	4.42	3.72	Calculated
Flue gas heat loss	kcal/nm^3	395	332	Calculated
Fuel consumption	nm^3/h	530	530	Factory data
Flue gas heat loss	kcal/h	209,128	175,958	Calculated
Flue gas heat loss - Difference	kcal/h	33,170		Calculated
Fuel loss due to flue gas heat loss	nm^3/h	3.71		Calculated
	nm^3/d	89		Calculated
	nm^3/y	31,201		Calculated
Cost of natural gas	BDT/nm^3	9.30		Gas Tariff
Financial saving	BDT/y	290,173		Calculated
	US$/y	3,435		Calculated
Investment for oxygen tuning	BDT	100,000		Estimated
	US$	1,184		Estimated
Simple payback period	months	8		Calculated

→ *Action Plan*

Item	Action
Operation and maintenance	At present, there is no oxygen analyzer installed at this boiler. The oxygen analyzer can be installed in closed loop to maintain optimum oxygen level of 2-3% by controlling combustion blower damper based on feedback from oxygen sensor. Alternatively, oxygen tuning can be done on a regular basis.
Retrofit	Online Oxygen analyzer (or regular checking of oxygen level, and hence monitor excess air in the boiler).
Replacement	Automation required if oxygen analyzer is installed.
Procurement	Oxygen analyzer
Construction	None
Costing	Estimate BDT 100,000 (For measurement).
Project specific baseline parameter	Boiler oxygen level –5.57%
Baseline	Present fuel consumption -530nm^3/h Boiler Efficiency – 75%
Implication, if any and precaution	None

Item	Action
Other benefits	Improved working conditions.

3.7.6 CP measure no 6: Thermal insulation improvements

→ ***Project***

Insulation of steam header and steam valves.

→ ***Study and Investigation***

During the field visit, it was observed that surface heat losses are taking place at the steam header and steam valves. Surface heat loss is taking place from bare and uninsulated surface. Surface temperature, as measured, is greater than 145^{0}C at these locations.

Figure 18: Insulation requirements

→ ***Recommended Action***

Insulation of steam header and steam valves is recommended. Insulation material should be used to cover the hot surfaces identified so that surface temperature after insulation does not exceed 40^{o}C.

→ ***Saving Assessment***

The cost-benefit analysis of the project is as shown in the table below:

Table 21: Saving and cost benefit for insulation

Parameters	Unit	Steam Header/Valves	Remarks
Surface area	m^2	0.80	Measured data
Average surface temperature	°C	145	Measured data
Proposed surface temperature	°C	40	Standard
Surface heat loss	kcal/h	1,283	Calculated
Boiler efficiency	%	75%	Calculated
Operating days	d	350	Factory data
Operating hours	h	24	Factory data
NG saving	nm^3/h	0.191	Calculated
NG price	BDT/nm^3	9.30	Factory data
NG saving (annual)	nm^3/y	1,602	Calculated

Parameters	Unit	Steam Header/Valves	Remarks
Financial saving	BDT/y	14,895	Calculated
	US$/y	176	Calculated
Investment for insulation	BDT	18,000	Estimated
	US$	213	Estimated
Simple payback period	Months	15	Calculated

→ ***Action Plan***

Item	Action
Operation and maintenance	Once proper insulation is applied, then negligible maintenance is expected. Care should be taken so that no water seeps into insulated portion of the tank, otherwise it will damage the insulation.
Retrofit	Bare surface area of the steam header and valves should be insulated by providing proper insulation support, so that insulating material is properly fixed.
Replacement	None
Procurement	Insulation material, Aluminum cladding, Iron supports, etc.
Construction	None except cleaning of surface properly before applying insulation so that insulation material is fixed properly.
Costing	Estimate BDT 18,000
Project specific baseline parameters	Present surface temperature of steam header and steam valvesgreater than 145°C.
Baseline	Boiler efficiency – 75%.
Implication, if any and precaution	None
Other benefits	Improved working conditions, reduced chances of accident due to hot surface.

3.7.7 CP measure no 7: Pressure reduction in compressed air system

→ ***Project***

Reduce pressure in existing air VFD operated air compressors.

→ ***Study and Investigation***

During the field visit, it was observed that nine compressors with cumulative capacity of 2,181CFM are installed at IFL. Out of these nine compressors, two compressors which have rated power of 55kW and 75kW that are equipped with VFD. Pressure set point of these two compressors is 8.0bar.

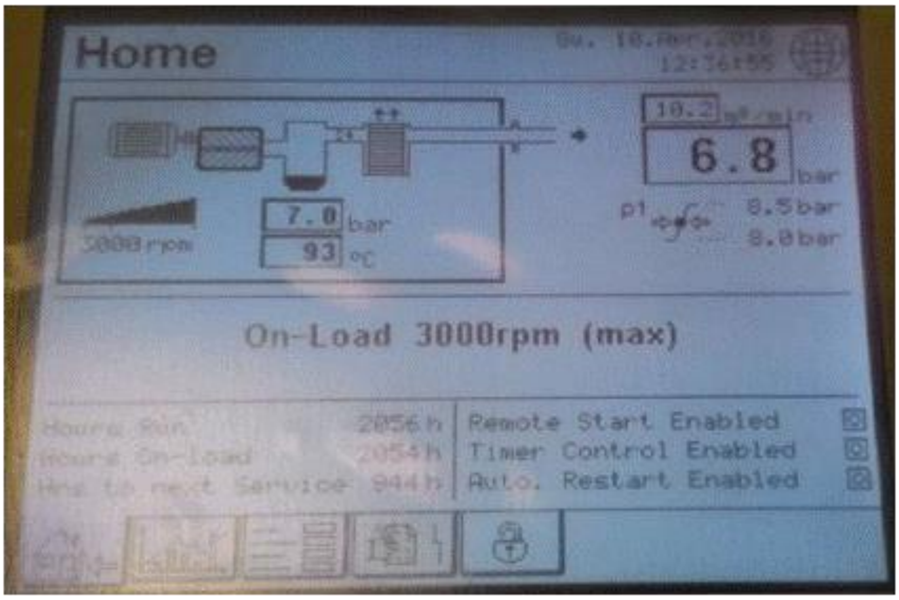


Figure 19: Compressor panel display

→ *Recommended Action*

Reduce the pressure set point of 55kW and 75kW compressor in increments of 0.5 bar, i.e. from 8.0bar to 7.5bar as first step; and then from 7.5bar to 7.0bar as second step. During periods of low demand, the speed of the compressor will be reduced by VFD, and hence CFM generation will be adjusted as per demand. Again, when demand increases, speed will be increased. Reduced pressure setting will save power.

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below:

Table 22: Saving and cost benefit by reducing pressure set point

Parameters	Unit	Value	Remarks
Present pressure set point	kg/cm^2	8.0	Factory Data
Proposed pressure set point	kg/cm^2	7.5	Proposed
Pressure reduction in air compressor	kg/cm^2	0.5	Calculated
Saving potential	%	5.0	Estimated
Present power consumption	kW	130	Calculated
Proposed power consumption	kW	124	Calculated
Saving potential	kW	6.5	Calculated
Operating days	d	350	Factory Data
Operating hours	h	24	Factory Data
Saving potential	kWh/y	54,600	Calculated
Equivalent NG saving	nm^3/y	15,197	Calculated
Cost of NG (power)	BDT/nm^3	12.04	Gas Tariff
Financial saving	BDT/y	182,974	Calculated
	US$/y	2,166	Calculated
Investment	BDT	Negligible	Estimated
	US$/y	Negligible	Estimated
Simple payback period	Months	Immediate	Calculated

→ *Action Plan*

Item	Action
Operation and maintenance	VFD is installed on 55kW – one and 75kW – one air compressors. VFD will need periodic maintenance as per OEM guidelines. Change pressure set point from 8.0 bar-7.5 bar-7.0 bar.
Retrofit	None
Replacement	None
Procurement	None, VFD with pressure sensor for feedback is available.
Construction	None
Costing	Estimate BDT - Negligible.
Project specific baseline parameter	Operating pressure – 7.0bar-8.0bar.
Baseline	Compressor installed capacity – 2,181CFM
Implication, if any and precaution	None
Other benefits	Reduced compressor maintenance cost.

3.7.8 CP measure no 8: Efficiency improvement of water treatment pumps

→ *Project*

Refurbish or replace existing water treatment (WTP) service pumps to improve efficiency.

→ *Study and Investigation*

During the field visit, it was observed through measurement of flow, head and power that the efficiency of existing WTP service pumps was 41%.

Figure 20: WTP Service Pumps

→ *Recommended Action*

Refurbish or replace existing WTP service pumps. Pumps of this capacity will have efficiency in the range of 60-65%.

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below:

Table 23: Saving and cost benefit for refurbishment/replacement of WTP service pumps

Parameters	Unit	WTP Service Pump	Remarks
Existing water flow	m^3/h	143.9	Flow meter
Existing pump head	M	20.0	Factory Data
Existing pump power	kW	22.6	Measured
Pump efficiency	%	40.9	Calculated
Proposed flow	m^3/h	143.9	Proposed
Proposed head	M	20.0	Proposed
Proposed efficiency	%	60.0	Proposed
Proposed power	kW	15.4	Calculated
Saving potential	kW	7.2	Calculated
Saving potential	kWh/y	20,107	Calculated
Equivalent NG saving	nm^3/y	5,597	Calculated
Cost of NG	BDT/nm^3	12.04	Gas Tariff
Financial saving	BDT/y	67,383	Calculated
	US$/y	798	Calculated
Investment	BDT	150,000	Estimated
	US$	1,776	Estimated
Simple payback period	months	27	Calculated

→ *Action Plan*

Item	Action
Operation and maintenance	New pumps should be maintained as per OEM suggestions for regular maintenance.
Retrofit	Installation of energy efficient pump.
Replacement	None
Procurement	Pumps with strainer and cables.
Construction	Installation and testing of new submersible pump.
Costing	Estimate: BDT 150,000
Project specific baseline	Present flow -143.9m^3/h Present head of pump –20m Pump efficiency – 40.9%
Implication, If any and precaution	None
Other benefits	Improved working conditions.

3.7.9 CP measure no 9: Replacement of conventional ceiling fans with energy efficient ceiling fans

→ *Project*

Replacement of conventional fans with energy efficient fans will reduce electricity consumption by up to 60%.

→ *Study and Investigation*

During the field visit, it was observed that a few conventional ceiling fans are being used in the process area. These ceiling fans are consuming about 80W of electricity.

→ *Recommended Action*

It is recommended to replace existing conventional ceiling fans with energy efficient BLDC (brushless DC) fans.

Advantages of BLDC fans:

- Lower electricity consumption (65% savings)
- Longer backup on inverters (even on solar)
- Improved reliability
- Noise reduction
- Longer lifetime

Comparison of conventional fans with BLDC fans is shown in the table below.

Table 24: Comparison of conventional and BLDC fans

Parameters	BLDC Fan	Conventional Fan
Features		
Input voltage(V)	110-285	Not available (Range will be much lower)
Power consumption(W)	**28**	**80**
Frequency(Hz)	48-52	48-52
Air delivery(CMM)	230	230
Rated speed(RPM)	380	380
Power factor	0.95	0.9
Service value(CMM/W)	**8.21**	**2.88**
Warranty (in years)	3 Years	Only 1 Year warranty
Regulator	No (Saving cost of regulator)	Yes
Remote	Yes	No
Timer mode	Yes	No
Number of blades	3	3
Span(mm)	1,200	1,200
MRP (BDT)	4500-5000	

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below:

Table 25: Saving and cost benefit for BLDC fans

Parameters	Units	Ordinary fan	EE Fan	Remarks
Number of fans in the facility	#	1010	1010	Factory data
Run hours per day	h/d	16	16	Factory data
Power consumption at maximum speed	W	80	28	Standard
Operating days	d/y	350	350	Factory data
Power demand	kW	81	28	Calculated
Annual electricity consumption	kWh/y	452,480	158,368	Calculated
Electricity saving	kWh/y	294,112		Calculated
Unit cost of electricity (grid)	BDT/kWh	9.08		Tariff

Parameters	Units	Ordinary fan	EE Fan	Remarks
Financial saving	BDT/y	2,670,537		Calculated
	US$/y	31,615		Calculated
Estimated investment	BDT	4,040,000		Estimated
	US$	47,828		Estimated
Simple payback period	months	18		Calculated

→ *Action Plan*

Item	Action
Operation and maintenance	No maintenance.
Retrofit	None
Replacement	Installation of BLDC ceiling fans to replace existing ceiling fans.
Procurement	BLDC fans – Quantity - 1010.
Construction	BLDC fans will be installed at existing locations, no construction work needed.
Costing	Estimate BDT 4,040,000
Project specific baseline parameter	Power consumption (conventional ceiling fan)- 80W.
Baseline	Number of ceiling fans in use 1,010
Implication, If any and precaution	None
Other benefits	Improved working conditions.

4 Process and Operations

This section includes details of process description, production data, process performance, observations made during the process study and resulting recommendations.

4.1 Raw material and finished products

Iris Fabrics Limited (IFL) is a fabric dyeing unit of IRIS group. IFL is a vertically integrated garment manufacturing unit having knitting, dyeing, finishing, panel printing and garment making facility in its premises. IFL processes a variety of textile materials as per the style, fashion and colour of customers' requirements and order preferences. This includes 100% cotton, blends like cotton (C) /polyester (P), cotton/lycra, cotton/viscose (V), C/V/P, cotton/modal.

The production details for the year 2020 are given in the table below.

Table 26: Monthly production

Month	Dyeing Production (kg)
Jan'20	714,419
Feb'20	656,722
Mar'20	606,422
Apr'20	105,429
May'20	501,114
Jun'20	660,670
Jul'20	642,340
Aug'20	600,230
Sep'20	635,523
Oct'20	673,521
Nov'20	630,335
Dec'20	678,975
Total	**7,105,700**

4.2 Manufacturing process description – Fabric dyeing and finishing

The production facility comprises fabric dyeing and finishing process. A detailed list of machines and equipment installed is given in Annexure2 – Plant and Machinery.

4.2.1 Dyeing Process

At IFL, total 29 dyeing machines including 14 bulk dyeing machines and 15 sample dyeing machines are installed. Installed capacity of the bulk production machines is 12,700 kg and that of sample machines is 335 kg. The total installed capacity is 13,035 kg for a single batch. Considering 2.5 batches per machine per day, installed dyeing capacity is 32,588 kg per day.

Target production set by the factory considering 85% loading of machines and 2.5 batches per day per machine is 27.70 tonne/day, but average production for the last year is about 20.3 tonne/day including white and washing. Actual production is 73.3% of target set and 62.2% of the installed capacity, which is low as per industry norms.

The plant's process flow diagrams are shown inAnnexure1 – Process Flow Diagram.

4.2.2 Finishing Process

The finishing process includes final treatment and process of every kind of fabric for better appearance and serviceability. Finishing chemicals are applied to the textile material either by mechanical deposition and held thereby physical forces or chemical reaction. Finishing chemicals are applied on the fiber according to the end use of the fabric, e.g. Apparel softeners are used to give soft feel. Finishing is therefore carried out for improving the aesthetics/ serviceability of the fabric or to impart certain desirable properties.

At IFL, finishing section has two stenters, one dryer, three open width compactors, two tube compactors, two slitter, one sueding machine and one tube compactor.

4.2.3 Laboratory procedures for testing and establishing the process/sample

There is an in-house laboratory where regular physical and chemical testing on fabric and garment samples are carried out for various tests including pH testing, colour fastness to water, wash fastness, rubbing fastness, perspiration fastness, tear strength of fabric, etc. The laboratory set-up has good infrastructure for various testing requirements. However, there is no colour dispenser, and manual weighing method is used for preparing dye solution.

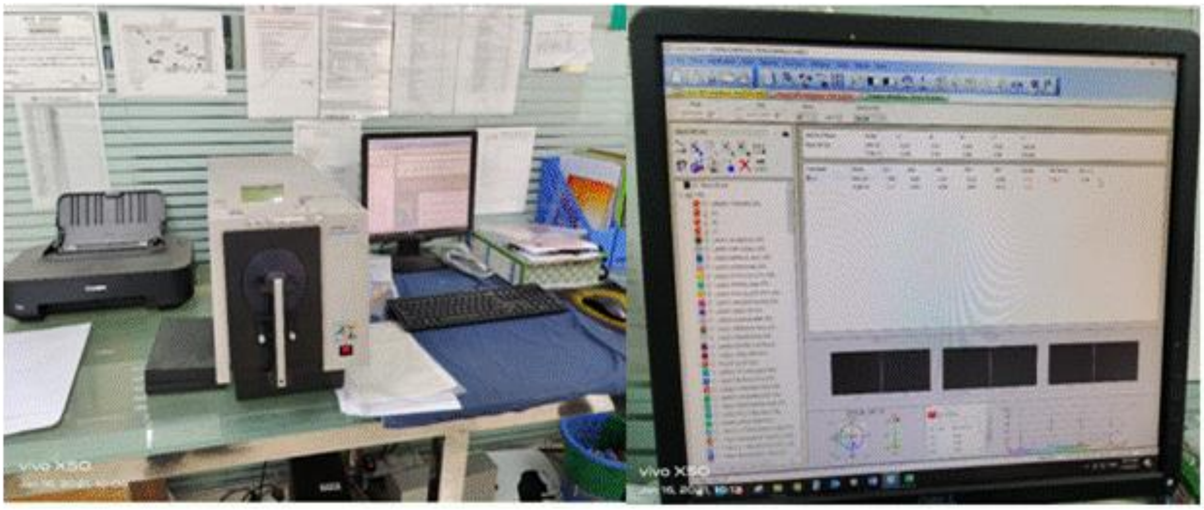


Figure 21 : Testing lab setup – Spectro photometer and failed sample during recheck

4.2.4 Performance results of sample to bulk production

The record of lab sample to bulk RFT is 50 % and bulk to bulk process RFT is 80% as reported by the dyeing manager. The lab process parameter and bulk process parameters like liquor ratio, batch cycle time, temperature, pH, specific gravity, dyes and chemical dosing as per recipes are strictly monitored and recorded. Every batch which is reprocessed should be carefully investigated for root causes. If variations are found due to chemicals, procedures, manual operational mistakes or fabric quality, etc. they should be recorded, and corrective actions need to be taken for improving the bulk RFT.

The table below summarizes the established parameters as per data available:

Table 27: Process performance

Process Parameters	Description	Values
Lab RFT to bulk RFT	Lab to Bulk right first time %	50
	Bulk right first time %	80
	% Batches topped up	20
Re-Wash	% Batches re-washed	-
	% batches completed within the set programme time	80
	% downgrades as reported	-
Liquor Ratio	Liquor ratio for bulk washing (as per recipe)	1:8 to1:10

4.2.5 Chemical dispensing methodology used for process

Greta Macbath spectrophotometer is available for shade matching in the testing laboratory. Manual weighing and dispensing of dyes and chemical is practiced in the lab for making colour pots for preparing dyeing recipes of sample and bulk dyeing.

During the bulk dyeing, occasionally recipe correction is done using spectrophotometer with the help of laboratory, but normally dyeing managers use their experience for correction in shade.

Figure 22: Dye weighing system

4.2.6 Calibration status of dyes and chemicals weighing scales

There is a procedure of calibration of weighing scales in the dye stores and on machines. There is no practice of daily calibration for weighing scales. In chemical stores, the weighing scales in use are not calibrated, after setting they did not show zero mark.

4.3 Observations in wet process area – dyeing

The average production is 20.32 TPD including white and washing as per the last one year's (Jan-20 to Dec-20) record, which is nearly 62.2% utilization of the installed capacity. This is low as per the industry norms. Some of the reasons for lower productivity include:

Observations and Recommendations:

Table 28: Process area recommendations for improvement

Sl. No.	Process area	Observations	Recommendations / Remarks	Impact
1	Chemical testing l	• Colour spectrophotometer is available and found calibrated.	• Calibration is essential for good result of colour matching.	• If the most important equipment and instruments in testing labs are not calibrated, it can lead to wrong judgment to all recipes resulting in poor RFT percentage and corrections will be needed for more batches
		• For dye testing, passing limit of ΔE value is up to 0.5 which is a wide range for prediction. It may have large variations during matching on the dyeing floor.	• Closer matching between ΔE 0.1 to ΔE 0.3 to have better RFT on the dyeing floor.	
		• 44dye solution pots are prepared by manually weighing the dyes.	• Use dye dispensing system for all dyes to minimize the error of weighing and dosing the solution in the dyeing pot.	
		• The colour solutions are kept for24 to 36 hours.	• Storage for longer than 12 hour scan deteriorate the strength of dye solutions. Regularly change the dye solution after every 12 hours.	
		• There is no practice of maintaining record for dye preparation. • In the absence of record, information is not available on when the solution is prepared, strength deteriorates after 12 hours.	• Maintain record of time and date of preparation of dye solution. It will give correct data of solutions for better RFT.	
2	Light inspection box	• In the lab, light was box found calibrated and in good condition but the same on production floor is in poor condition.	• Change the light box or get is properly painted and calibrated.	• Accuracy in shade inspection.
		• Optical whitener tint is found in sample fabric used for making colour swatch.	• Absence of basic testing process-Sample fabric should be tested for optical whitener.	
		• Wall colour is faded.	• Repaint it.	

Sl. No.	Process area	Observations	Recommendations / Remarks	Impact
		• Samples and files are stored in the light box	• Storage in light box will damage the surface of light box, which will not give correct judgment of shade and better RFT.	
3	Chemical stores	• Small quantity dye is weighed on piece of paper instead of watch glass. • Dyes always stick to the paper and gives inaccuracy in weight.	• Use watch glass for weighing as it is easy to use for small weight in all laboratories and chemical stores.	• Inaccuracy in chemical weighing can give multiple problems at all production machines giving quality issues resulting in reprocess and corrections.
		• Two weighing scales are available in the store. On the small weighing scale, it is difficult to weigh dyes easily as it is placed on the floor level.	• Keep small weighing scale at an accessible height so that it is easy to weigh the dyes accurately.	
		• Auxiliaries cannot be weighed accurately on the scale as it is not calibrated and has an error of 500 grams.	• Replace the weighing scale immediately. • Change the method of preparing the recipes to have accurate weighing of chemicals.	
4	Dyeing process	• On recipe card, reel speed and cycle time is perfectly calculated but on almost all machines, the reel speed is different due to which the chemical dosing cycle varies and not matching with fabric cycle.	• Proper process control is required for uniform dyeing. Match the fabric reel speed and chemical dosing cycle for uniform dyeing.	• Reduce reprocess, top up and correction of batches and reducing resource consumption.
		• 1:5 to1:11 MLR noticed for sample and bulk dyeing.	• Lab to sample dyeing - Proper process control, monitoring and records should be kept for improvement during bulk dyeing for recipe correction.	
		• On sample dyeing almost 50% batches are reprocessed or topped up.	• Use spectrophotometer regularly for matching and correction of shade. This will help in minimizing the human error of judgment and improve RFT percentage.	
		• On daily production, record the cause of delay is recorded. Stoppages of machines due to mechanical issues in Dec-20 included:	• Corrective action should be taken for increasing machine reliability with preventive maintenance planning.	

Sl. No.	Process area	Observations	Recommendations / Remarks	Impact
		M/c # 18 - 6 times and M/c # 3 -4 times • Record shows that many dyeing machines have idle time for next batch operation. • Production achieved is about 73% of targeted production, which is lower than normal industry standard.	• Proper production planning should be done for material and machines availability. • Recheck the program on machine and correct the loading and unloading time avoiding the delay for full utilization of machine's production capacity.	
		• Process liquor is drained at 75°C after Aquachron cooling.	• Additional cooling by waste heat recovery up to 50°C before draining.	
		• Many operators are not aware of parameters and its result and impacts on the process.	• Training is required to operators for machines and process.	
5	pH checking during process	• On dyeing floor, regular checking of pH (4 times per batch) is required during the process which is not done.	• Use calibrated portable pH tester for regular use. • pH must be recorded on batch card for proper process control and dosing of chemicals.	• Saving in neutralizing chemicals and improved process control.
6	Inconsistency in caustic use	• There is an inconsistency in use of caustic for light-medium-dark and white shades as per recipe.	• Proper control of caustic is required in lab recipe during sampling and in bulk production for uniform results	• Saving of caustic in process and neutralizing chemicals in ETP.
7	Slitting machines	• On slitting machine- turn table and cutting sensors are not working.	• Machine maintenance to be taken on priority basis.	• Improved productivity.
		• Washing water is drained continuously.	• Reuse this water after filtration.	• Significant process water saving and reduced load in ETP.
		• Cutting sensor is not working. • Operator manually adjusts the fabric on drop needle and cutting the fabric adjusting drop needle manually.	• Get the sensor repaired immediately to increase productivity.	• Improved productivity.
8	Stenters	• On stenter machines, set temperature was 130°C for drying fabric, same temperature of all chambers is not needed as this will lead to over drying of fabric which will change the shade.	• Reduce the first and last blower temperature to 100°C to save energy. Take trials and set speed. • Check all chamber temperature sensor and repair and calibrate.	• Wastage of NG due to over drying • Quality of fabric also deteriorates and becomes yellowish due to over drying.

Sl. No.	Process area	Observations	Recommendations / Remarks	Impact
		• There no procedure to check moisture or pick-up in fabric after mangle roller and before drying	• Mangle roller maintenance by grinding, checking moisture level by installing moisture meter after rubber mangle rollers.	• Optimization of heating energy

4.4 Action Plan for CP measures – Wet Processing Area

4.4.1 CP measure no 11– Improving dyeing process performance by improving RFT

→ ***Project***

Improving lab to bulk dyeing process RFT from 50 to 90% and reduction of excess time running batches from 20% to 5%.

→ ***Observations***

During the assessment visit, it was discussed with testing lab, quality and production team that lab to bulk process "Right First Time" (RFT) percentage is poor. The RFT is low due to various reasons; the following were observed in the lab and on the production floor:

- The testing lab has several problems of operating procedures for preparing sample colors and shades.
- Approved black colour sample failed while checking again with approved swatch in spectrophotometer which raises questions about the testing and colour passing procedure in the lab.
- 20% or more batches need corrections by topping in bulk production.
- 80% on time completion of running batches, remaining 20 % batches are taking more time to finish which either need correction or reprocess.
- Lab recipes are prepared using auto dosing, but the dye solutions pots are kept for more than 24 to 36 hours.
- The colour pots stored for more than 24 hours can give shade difference due to dye strength deterioration. There are no records of time and date for solution preparation.
- Operators are changing process parameter in PLC of machine without authorization.
- Poor analysis for batches taking more time resulting in reprocess and correction as regular procedure for every batch.
- On bulk production, correction of shade is by visual check by the dyers. Spectrophotometer is hardly used for re-matching or correction of shade which should be done more frequently, particularly in the cases of reprocessed batches.
- Material to liquor ratios at sample dyeing lot and bulk production level are not maintained as per recipes.
- Bulk chemicals are not tested regularly. The last record of testing found was on 08-11-2019.

- Auxiliary chemicals are also not tested. Hard rock from Glauber salt was found which shows the poor quality and direct chemical weight loss.
- Other parameters like chemical strength, solid content, active content of auxiliary, pH, moisture content, dissolution of dyes, etc. should be tested for auxiliary, chemicals and dyes. This will help in improving the RFT.
- Dyes approval criteria is based on ∆E value less than 0.5 which is a wrong practice. ∆E value can range from 0.1 to 0.5, indicating difference in L, a, b, c and h values of dyes. By following these criteria, dyes of ∆E 0.1 and 0.5 both will be passed but the strength could be weaker or stronger.
- It is recommended that dyes, auxiliary approval criteria should be redefined. It should be on the strength, solid content, performance test base. Limits should also be defined.
- For process parameter monitoring, calibration of liquor sensors, temperature and pH are practiced and recorded, but it was observed that MLR is not followed strictly as per recipes.

Figure 23: Dyeing floor

→ *Recommended Action*

Improving dyeing performance RFT is a long and continuous process which needs involvement and coordination between testing lab, production team and quality assurance teams with a well-defined quality policy, SOPs for testing lab, quality parameters, testing limits, production process and operation on machines.

- Action plan for implementation in the next six months:
  - Lab recipe preparation should be done most accurately using auto dye dispensing system for preparing dye bath which should not be kept more than 12 hours.
  - Only regularly used dye pots should be prepared and used for 12 hours; unused and less used dyes pots should be emptied and prepared afresh when required.
  - Use of spectrophotometer to check dye shade rather using visual judgment.
  - Most important testing instruments like pH meter, micro weighing balances for fabric sample, etc. should be calibrated externally once /twice in a year. Using small

standard weights, in-house calibration should be practiced on a daily basis, with proper records maintained.

  - It is recommended that dyes approval should be compared with standard and for the parameters like strength, moisture content, pH of dye solutions instead of only ΔE value. Limit should also be set for pass/fail of the batches like± 1%.
  - Operating parameters should not be changed by operators without any authorization. Preferably, only responsible shift in-charge should have authority to change the parameters with password protection on PLC.
  - MLR should be followed strictly as per recipe. It is advisable to use the designed liquor ratio for all dyeing machines.
  - Any topping or correction made to working batch should be authorized by responsible dyeing manager. Proper record should be made in batch card for all topping, correction and additional dyes and chemicals used for correction.
  - If repeated batches need correction for same shade, root cause analysis should be done for identification of possible reasons so that repeated mistakes can be avoided.
  - Operators should not change any process parameters on their own judgment.
  - Process control instruments like water flow meters, temperature controller and timers must be functioning properly, and these instruments should also be checked and calibrated regularly.
  - Use of proper requisition slips and related documents for issue and proper control of chemicals required for production. Any additional chemicals, auxiliary chemicals and dyes must be authorized by responsible production in-charge.
- Action plan for medium to long term
  - Automation in weighing system by installing software and computers for accuracy.
  - A well-structured training campaign should be started for various levels of people for building a quality culture and understanding about quality.

→ *Saving Assessment*

Exact cost-benefit is difficult to calculate, as there are multidimensional impacts of saving in all resources, improvement in productivity, reduction in water, chemical and energy, etc. It can be estimated only on normative basis as follows:

Table 29 : Saving and cost benefit for improvement of RFT

Parameters	Unit	Values	Reference
Annual dyeing production	kg	7,105,700	Factory Data
Baseline process water consumption	L/kg	125	Calculated
Baseline chemical consumption	grams/kg	573	Calculated
Baseline electricity consumption	kWh/kg	1.76	Calculated
Baseline NG (fuel) consumption	nm^3/kg	0.97	Calculated
Operating days in year	d	350	Factory Data
Considering improving dyeing RFT			
a. Water savings potential	%	15	Estimate
	L/kg	19	Calculated
Annual water saving potential	m^3/y	133,392	Calculated
Unit cost of water	**BDT/m^3**	5	Factory Data
Corresponding monetary saving	Million BDT/y	0.667	Calculated

Parameters	Unit	Values	Reference
b. Estimated reduction in electricity consumption	%	10	Estimate
	kWh/y	1,247,851	Calculated
Equivalent NG fuel saving on gas engine	nm^3/y	347,322	Calculated
Corresponding monetary saving	Million BDT/y	4.182	Calculated
c. NG (fuel) consumption reduction for heating	%	10	Estimate
	nm^3/y	688,439	Calculated
Corresponding monetary saving	Million BDT/y	6.40	Calculated
d. Chemical saving potential @	%	10	Estimate
	Grams/kg	57	Calculated
Chemical saving potential	Tonne/y	407	Calculated
Chemical cost	BDT/Tonne	90,000	Factory Data
Corresponding monetary saving	Million BDT	36.7	Calculated
Total saving potential (Water, energy and chemicals)	Million BDT/y	47.9	Calculated
	US$	567,229	Calculated
Investment	Million BDT	40.0	Estimated
	US$	473,541	Estimated
Simple payback period	Months	10	Calculated

→ *Action Plan*

Item	Action
Implementation strategy	Prepare strategy for RFT optimization after dyes and auxiliary chemical testing, supported by accurate electronic weighing system and training.
Maintenance	Calibration of instruments, meters and weighing scales.
Procurement	Details below, procurement from local / international vendors.
Installation	Auto colour dispenser for lab, Computer aided chemical weighing.
Investment	a. Short term within six months–Auto colour dispensing for lab, Calibration of machine instruments and weighing scales, and purchase/repair/calibration of new process control instruments on machines– BDT 25 Million. b. Medium term- within 1-2 years- computer aided chemical weighing system, dispensing and dosing where applicable on dyeing machines– BDT 15 million.
Project specific baseline parameters	Present lab to bulk RFT -50% as reported. Present batches exceeding schedule time by 20%.
Baseline	Annual production- 7,105,700kg Key performance indicators: Process water - 125 L/kg Chemical - 573 g/kg Electricity - 1.76 kWh/kg Natural gas (fuel) - 0.97 nm^3/kg
Implication, if any and precaution	None
Other benefits	Reduced production cost, improved productivity.

4.4.2 CP measure no. 12: Reduction of moisture from fabric before drying on stenters

→ *Project*

Checking padding mangle pressure and maintenance of rubber rollers by recoating/regrinding for reducing moisture percentage in Stenter drying.

→ *Observations*

There is no information available about moisture content in the wet fabric before entry to drying chambers. There is no measurement / checking of moisture level before and after drying. From visual inspection, higher percentage of moisture was found, which can consume higher thermal energy for drying and higher pickup percentage of finishing chemicals.

→ ***Recommended Actions***

- Develop standard operating procedure (SOP) to check moisture content by either measurement by portable moisture meter or by cutting wet fabric swatch and drying in lab oven by checking its weight in wet and dry condition. Proper record should be maintained for different construction and type of fabric for verification when needed.
- Pneumatic pressure system on rubber rollers to be checked and maintenance should be done for its proper function. Any air pressure leakage from air pipes / cylinder or pressure regulators should be arrested. The air pressure gauge for padding pressure should be checked and calibrated once in a year.
- As a routine maintenance procedure, blue paper impression should be taken once in a month on rubber roller to check uniform pressure throughout the maximum fabric width working on the machine.
- Rubber roller's hardness also should be checked once in six months and recoating/regrinding of rubber mangle rollers is also recommended to squeeze the water / finishing liquid from fabric to reduce moisture at desired level before the fabric enters the stenter.
- Moisture meter should be installed at the stenter entry which can continuously display moister percentage to monitor and control the speed of the machine.
- Drying chamber temperature setting should be reduced as suggested in observation table above in section 4.3.3.

Figure 24: Illustrative image for rubber mangle rollers

→ ***Saving Assessment***

The cost-benefit analysis of the project is as shown in the table below.

Table 30: Saving and cost benefit by reducing moisture before drying in mangle

Parameters	Unit	Values	Reference
Number of stenters	Numbers	2	Factory Data
Machines operational	Numbers	2	Factory Data
Moisture content by weight before drying	%	60	Estimate
Estimated reduction in moisture	%	50	Estimate
Average production of stenter and dryer	tonne/d	20	Factory data
Reduction in moisture	tonne/d	2	Calculated
Reduction in thermal energy required	Million kcal	1,117	Calculated
GCV of natural gas used for heating	kcal/nm^3	8,930	Titas Gas
Combustion efficiency	%	75	Assumption
Equivalent reduction in fuel consumption	nm^3/d	167	Calculated
Operating days	d	350	Factory Data
Annual saving in fuel consumption	nm^3/y	58,352	Calculated
Unit cost of natural gas fuel for heating	BDT/nm^3	9.30	Titas gas
Corresponding annual monetary saving	Million BDT/y	0.54	Calculated
	US$/y	6,424	Calculated
Baseline chemical consumption	g/kg	573	Calculated
Saving in finishing chemicals by proper pressure control	%	0.25	Estimate
	kg/d	29	Calculated
Annual saving of chemicals	tonne/y	10	Calculated
Average chemical cost	BDT/tonne	90,000	Factory data
Corresponding annual monetary saving	Million BDT/y	0.9	Calculated
Estimated total saving potential	Million BDT/y	1.5	Calculated
	US$	17,275	Calculated
Investment	Million BDT	0.9	Estimated
	US$	10,939	Estimated
Simple payback period	Months	8	Calculated

→ *Action Plan*

Item	Action
Implementation strategy	Initial trials can be taken in one machine by checking performance of rubber roller by regrinding/ recoating and then replacing by new when necessary.
Maintenance	Existing rubber mangles need annual maintenance by regrinding.
Procurement	From local service providers / vendors.
Installation	As per vendor's instruction.
Investment	Short term within six months- For rubber rollers maintenance and two moisture meters on stenters –BDT 0.9 million.
Project specific baseline parameters Baseline	Number of Stenter machines -2 Present moisture of fabric– 60% (estimate) Present daily production – 20tonne/d.
Implication, if any and precaution	None
Other benefits	Uniform fabric drying, improved fabric quality.

4.4.3 CP measure no. 13: Recovery and reuse of washing water in Corino Slitting machine

→ *Project*

Recovery and reuse of washing water used in Corino slitting machine

→ *Observations*

It was observed that Corino slitting machine was draining washing water and continuously using fresh process water. The estimated water consumption on the machine is @ 5 m^3/h.

→ *Recommended Actions*

There is a potential of recovering this washing water which can be filtered and re-circulated using small circulation pump with filter having capacity of circulation of water @ 6m^3/h.

Figure 25: Illustrative image of working system on Corino slitting machine

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below.

Table 31: Saving and cost benefit for water recovery and reuse

Parameters	Unit	Values	Reference
Blanket cooling water consumption	m^3/h	5	Assumption
Average running of shrinking range machine	h/d	20	Factory data
Water saving potential	m^3/d	100	Calculation
Operating days	d	350	Factory data
Estimated recovery of cooling water	m^3/y	29,750	Calculation
Monetary saving	BDT/y	148,750	Calculation
	US$/y	1,761	Calculation
Investment	BDT	150,000	Estimate
	US$	1,776	Estimate

Parameters	Unit	Values	Reference
Simple payback period	Months	12	Calculation

→ *Action Plan*

Item	Action
Implementation strategy	Collection of washing water in a small tank and installation of filter and circulating pump.
Maintenance	Filter cleaning daily and periodic maintenance for pump and motor.
Procurement	Filters and pump-6m^3/h capacity from local vendors. Small cooling tower and circulation pump with filter.
Construction	Fabrication as per vendor's instruction.
Costing	Estimated BDT 150,000.
Project specific baseline parameters	Water consumption: 5 m^3/h. Average daily operation of machine – 20 hours.
Baseline	Process water consumption KPI – 125 liters/kg.
Implication, if any and precaution	None
Other benefits	Reduced water consumption, reduced effluent load and treatment cost.

4.4.4 CP measure no. 14: Waste heat recovery from drained hot liquor from dyeing machines

→ *Project*

Installation of heat recovery system for hot liquor drained at high temperature from dyeing machines.

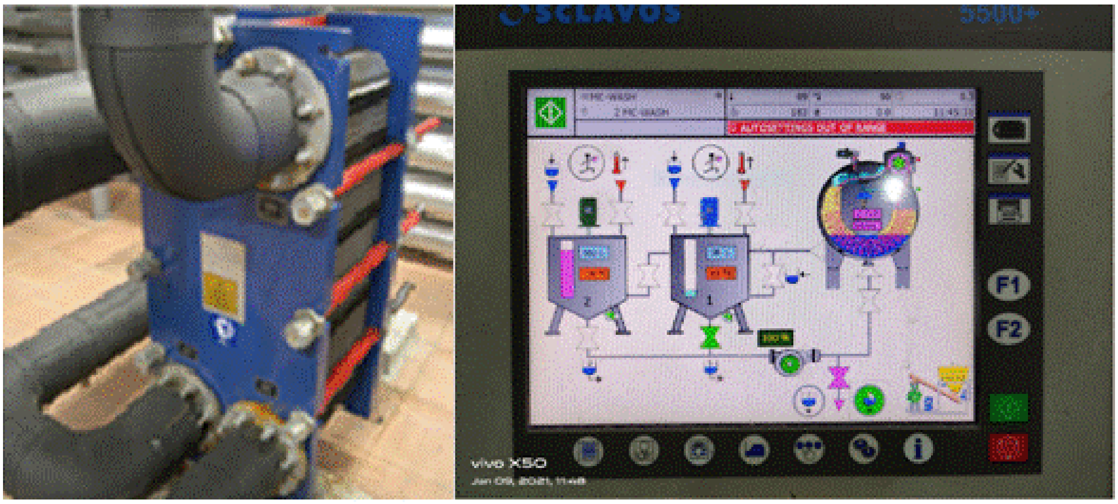


Figure 26: Representative image of plate heat exchanger for waste heat recovery from hot liquor

→ *Observations*

It was observed that the hot liquor from all dyeing machines are drained at temperature in the range of 75°C which is heat loss. Additionally, energy is consumed in the ETP to cool the wastewater before treatment.

→ *Recommended Actions*

For reducing drained liquor temperature, the following is recommended:

Reduce the liquor temperature to 50°C before draining using cooling water. This cooling water should be stored in a separate insulated hot storage water tank in the department which can be used for hot water requirement for washing / scouring-bleaching / rinsing, etc. in the dyeing machines.

→ *Saving Assessment*

The cost-benefit analysis of the project is as shown in the table below:

Table 32: Saving and cost benefit for heat recovery

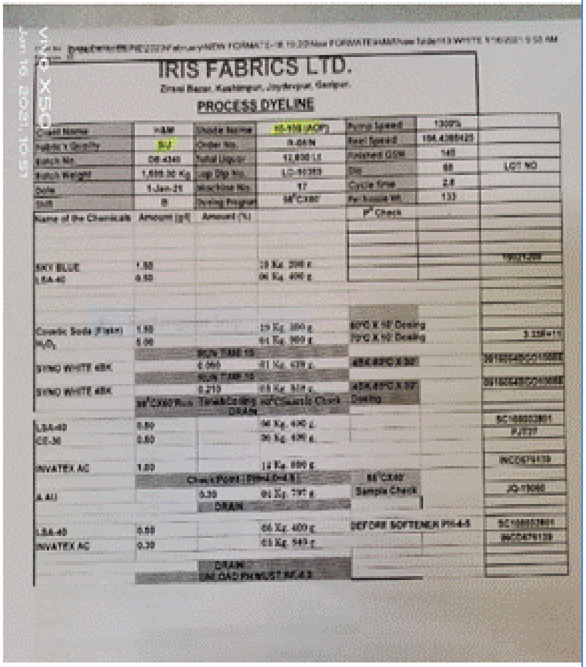
Parameters	Unit	Values	Reference
Annual dyeing production	kg	7,105,700	Factory data
Annual working days	d	350	Factory data
Baseline process water consumption	L/kg	125	Calculated
Water used in high temperature processes	% (of total)	25	Estimate
	L/kg	31	Calculated
Temperature of drained water	^0C	75	Factory data
Temperature of drained water (after heat recovery)	^0C	50	Estimate
Differential temperature	^0C	25	Calculated
Heat gained by cooling water @ 70 % efficiency of PHE	kcal/kg	548	Calculated
Total heat gained by cooling water	Million kcal /y	3,891	Calculated
Equivalent saving of fuel in boiler (GCV: 8,930 kcal/nm^3, η- 75%)	nm^3/y	578,211	Calculated
Monetary Saving	Million BDT/y	5.38	Calculated
	US$/y	63,660	Calculated
Operational cost for circulation pump and insulation7.5 kW pump running for 12 hours per day, estimated total efficiency -65%	kWh/y	96,923	Calculated
Equivalent NG fuel in gas engine	nm3/y	26,977	Calculated
Unit cost of NG fuel for power	BDT/nm^3	12.04	Gas Tariff
Operating cost	Million BDT/y	0.32	Calculated
Net saving	Million BDT/y	5.05	Estimate
	US$/y	59,815	Estimate
Estimated investment	Million BDT	3.5	Calculated
	US$	41,435	Calculated
Simple payback period	Months	8	Calculated

→ *Action Plan*

This CP measure has not been accepted for implementation.

4.5 Baseline photographs

Steam leakage in dyeing

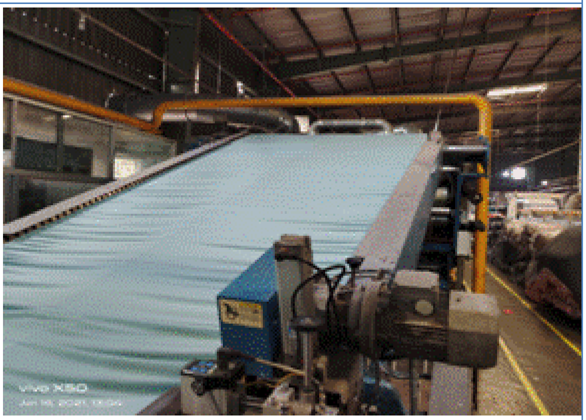


Dyeing recipe-2

Dyeing floor

Chemical testing lab

Stenter machine



Dryer machine

5 Water and Water Treatment

Water requirement is met using submersible pumps (2 pumps). These pumps lift water from the ground which is collected in raw water tanks. The raw water is treated in water treatment plant (WTP) and then distributed to various process areas, domestic and drinking purpose as per requirement through a number of distribution water pumps. Sufficient number of water meters are installed to measure ground water, process water and water consumption in major water consuming areas. Water diagram for IFL is shown below.

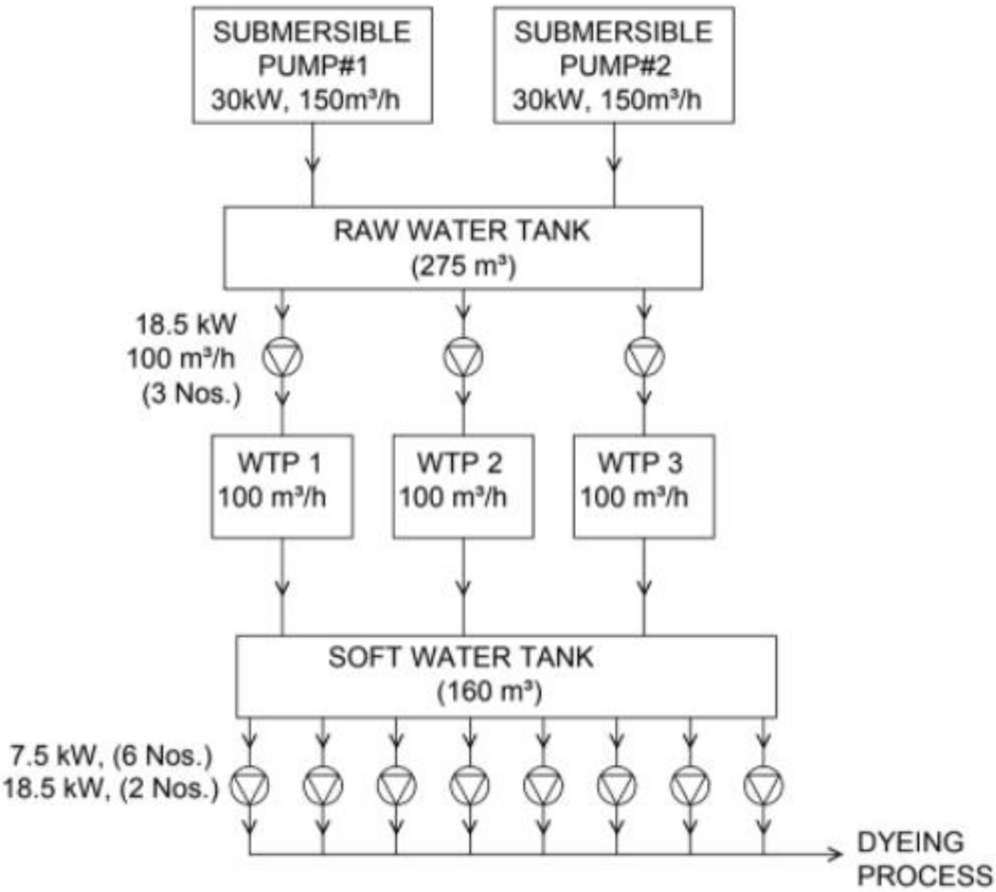


Figure 27: Water Diagram

5.1 Water pumps and WTP (Water Treatment Plant) - Installation

Two submersible pumps are installed at IFL to meet the water requirements of process (dyeing, and finishing), ETP, boilers, printing, R&D and domestic use. Installation details of submersible pumps are tabulated below. Distribution pumps are installed as per requirement and shown in Figure-27.

Table 33: Pump installation details

Parameters	Unit	Submersible Pump#1	Submersible Pump#2	WTP Service Pump	Distribution Pump	Distribution Pump
Make	-	-	-	-	-	-
Model	-	-	-	KSB	-	-

Parameters	Unit	Submersible Pump#1	Submersible Pump#2	WTP Service Pump	Distribution Pump	Distribution Pump
Flow rate	m^3/h	150	150	100	-	-
Head	M	-	-	30	-	-
Motor rating	kW	30	30	18.5	7.5	18.5
Quantity	#	1	1	3	6	2

5.2 Water generation, distribution - Consumption

Water consumption data has been provided by IFL. Monthly water consumption is attached as **Annexure4 – Water Consumption Details**.

The baseline indicators for water are as follows:

Table 34: Baseline indicators for water consumption

Resource	Value	Production (kg)	KPI (Key Performance Indicators)	
	m^3	kg	Value	Unit for KPI
Ground water	1,389,053	7,105,700	195.5	l/kg
Process water	889,283	7,105,700	125.2	l/kg

5.3 Observations and Recommendations

Performance evaluation of submersible pumps was carried out during the field visit. Efficiency of submersible pumps and WTP service pumps has been derived based on simultaneous measurement of flow, pressure and power. The table below shows the efficiency of pumps.

Table 35: Pump performance

Parameters	Unit	Submersible Pump#1	Submersible Pump#1	WTP Service Pump
Design flow	m^3/h	150	150	100
Motor rpm	rpm	1450	1450	1450
Motor	kW	30	30	18.5
Measured flow	m^3/h	173	155	143.9
Measured head	m	37	37	20.0
Measured power	kW	29.1	26.1	22.6
Efficiency	%	69.7	69.5	40.9 (Two pump operation)

As the measured efficiency of the WTP service pump is poor, refurbishment or replacement of this pump is recommended.

In addition, the following recommendations may be considered for reducing domestic water consumption:

- General washing
    - Replace hoses with efficient equipment (water brooms, cleaning scrubber machines, mops)
    - Reduce the frequency of washing in sparsely used areas

- Use non potable sources (for e.g. recycled water, harvested rainwater) for general washing
- Use floor mats to minimize spread of dirt in enclosed spaces

- Kitchen / Dining/ Pantry
  - Use fittings with flow rate less than or equal to six liters per minute at sink taps
  - Wash dishes with low flow rinse or in a sink instead of under running taps
  - Soak utensils and dishes in water before cleaning for easy removal of food residues
  - Use pressure sprays to pre rinse the dishes
  - Run dish washers at full load
  - Recycle rinse water from dish washers to wash away food residue on dishes
  - For manual dishwashing provide three compartments– one for soaking, one for washing and one for rinsing to reduce water use and enable easy recycling of rinse water
- Toilets and washrooms
  - Adopt a flow rate of two liters per minute at wash basins in toilets
  - Adopt a flow rate of seven liters per minute for delayed action shower taps where the timing is in between 13-15 seconds
  - Adopt dual flush low capacity flushing cisterns (LCFCs), which use 2.5 liters (or less) for low flush and 3.5 liters (or less) for full flush
  - Adopt waterless urinals
  - Remove ball valve handles to prevent any tampering of flow rates
  - Display contact numbers of maintenance team to be contacted in case of water leakages
- Horticulture/ Irrigation
  - Water plants in the morning or late evening, to reduce evaporation loss. Review frequency based on weather conditions
  - Water the plants with a can instead of a running hose
  - If a hose is use, attach a spring-loaded nozzle to the hose
  - If the irrigation system is automatic, incorporate a rain sensor and/or soil moisture sensor to avoid wastage

6 Effluent Treatment Plant (ETP)

6.1 Design Details

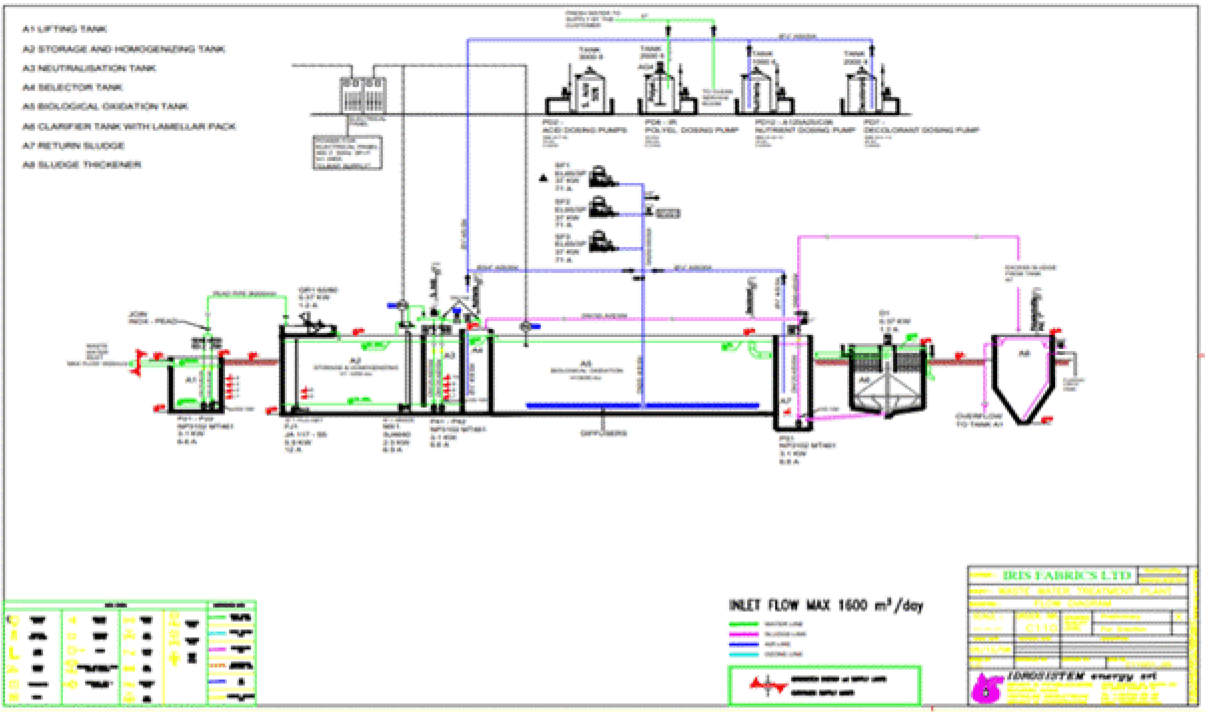
The ETP has been designed to treat wastewater generated from various wet processes. The wastewater is conveyed through a drain to the ETP inlet and distributed to two ETPs for further treatment. The design capacity of ETP-1 is 1,600 m^3/day and ETP -2 is 2,800 m^3/day. The treatment process of both the ETPs is based on aerobic biological treatment. There are separate flow meters at the inlet of each ETP to regulate the flow as per the design capacity. As per the flow meter data (Jan 2020- Dec2020), the average operating load of ETP-1 is 800 m^3/day and ETP-2 is 1,725 m^3/day.

Since the present wastewater generation is 1,725 m^3/day, capacity of ETP-2 is adequate to handle hydraulic as well as organic load to achieve desired treated effluent quality. Treat the effluent in ETP-2 and once effluent load exceeds 2,800 m^3/day, ETP-1 can be taken into operation. This will save energy and other resources.

Treatment scheme: Mechanical bar screen, collection with lifting pumps, equalization tank with mixing arrangement, neutralization tank with acid dosing arrangement, aeration tank with diffused aeration system followed by clarifier with sludge recirculation arrangement and post aeration tank.

The excess bio-sludge is collected in the sludge holding tank and pumped to sludge dewatering filter press with poly dosing arrangement. The dewatered sludge is stored in the storage area and disposed of as per requirement.

Schematic in block diagram for simple understanding of ETP is shown below.



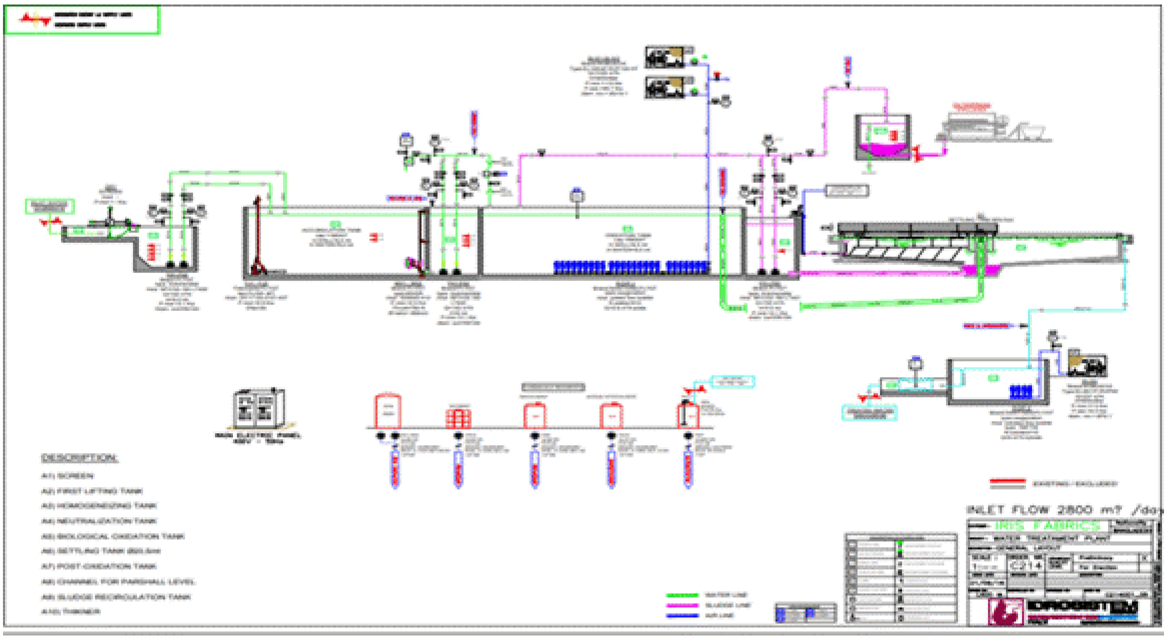


Figure 28: Schematic diagram of wastewater distribution

Design details of ETP plant is shown in Table 38**.**

6.2 Field Observations

The ETP was visited on 16.01.2021. Following are certain key observations:

- The ETP area is neat and clean.
- Log sheets and records are maintained daily.
- There is a separate in-house laboratory for ETP. The laboratory is equipped with analytical equipment and instruments for measuring temperature, pH, Total Suspended Solid (TSS), Total Dissolved solids (TDS), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). Measurement of above-mentioned parameters except COD and BOD are carried out daily and duly documented. COD and BOD test are performed weekly.
- There is no practice to add nutrients for aerobic system. Add the required nutrients, i.e. DAP and urea based on BOD of incoming effluent for healthy growth of bacteria.
- Single chemical dosing pumps are provided; standby pumps may be provided for smooth operation of the system.

ETP-1 (1600 m^3/h)	
 Collection and effluent lifting tank	 Mechanical screen


Equalisation tank


Neutralisation tank


Aeration tank

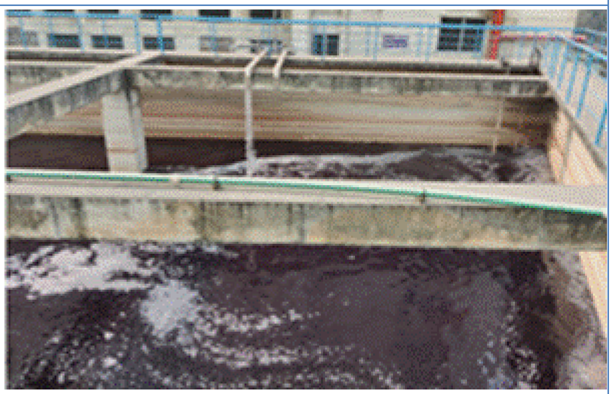

Lamella clarifier


Sludge recirculation tank

Chemical dosing system

Etp-2 (2800 m^3/h)


Mechanicalscreen and lifting tank


Equalisation tank

Neutralisation tank

Aeration tank

Secondary clarifier

Sludge recirculation tank

Post aeration tank

Chemical dosing system

Sludge management system (combined for etp-1 and etp-2)

Sludge holding tank

Sludge dewatering filter press

	
Sludge storage shed	Laboratory

6.2.1 Inlet and outlet effluent quantity and quality test certificate records

Inlet and outlet effluent quantity and quality parameters tested by IFL on different days are tabulated below.

Table 36: ETP quantity and quality test report

Sl. No.	Parameters	Inlet to ETP	Treated effluent
1	pH	8.0-11.0[(1)],10.1[(2)]	7.0-8.0[(1)] ,7.90[(2)]
2	Colour (Pt. Co)	100-1500[(1)]	400 [(1)]
3	Temperature (°C)	35[(1)], 39[(2)]	30[(1)],32[(2]
4	Suspended solids (mg/l)	200-400[(1)]	20-40[(1)]
5	Dissolved solids (mg/l)	1880[(2)]	1410-1840[(2)]
6	COD (mg/l)	1200[(1)],690[(2)]	160[(1)], 74-48[(2)]
7	BOD (mg/l)	350-500[(1)]190[(2)]	30[(1)] ,19-27[(2)]
8	DO (mg/l)	-	5.6-7.3[(2)]
	Source: Design Basis[1)] In-house analysis – 26.12. 2020 [(2)]		

6.2.2 Metering facility for effluent inlet and outlet

Metering details of ETP are as shown in the table below:

Table 37: ETP water flow meters

Sl. No.	Location	Type
1	Inlet	Electromagnetic flow meter at inlet to ETP-1 and ETP-2
2	Outlet	ETP-1: Mechanical flow meter,ETP-2: Ultrasonic flow meter
3	Any other location	-

6.2.3 Metering facility at other locations

Water meters are installed at raw water, dyeing, domestic water, drinking water, utility, boiler, etc.

6.2.4 Segregation of effluent steam

There is no segregation of wastewater generation from boiler blowdown, cooling towers and wastewater generated from the various wet processes.

6.2.5 Sewage generation and treatment facility

There is no record of exact quantity of sewage generated per day. The water used for human consumption and other applications like washrooms/ basins, canteen, etc. can be metered and log should be maintained to keep control on wastage of fresh water. Sewage treatment plant should be installed with filtration and disinfection system so that it can be used for toilet flushing, car washing and gardening purpose. The estimated cost of a 400 m^3/d (10% of total water consumption) domestic water treatment plant is BDT 5 million.

6.2.6 Chemicals dosing practices in ETP

Various chemicals used for dosing in ETP for the period of Jan-2020 to Dec-2020 along with quantity are given below.

Table 38: Chemical Dosing in ETP

Chemicals	Location	Quantity (kg/month)
H_2SO_4	Neutralization tanks	ETP-1: 2,450-3,150 ETP-2: 3,850-6,200
De-coloring agent	Sec. clarifier inlet	ETP-1: 840-1,680 ETP-2: 1,230-2,400
Antifoam	Aeration tank	Depending on requirement in winter season
Urea	Aeration tank	Not used
DAP	Aeration tank	Not used
Dewatering polyelectrolyte	Sludge dewatering filter press	As per requirement

6.2.7 Recovery of Salt and Reuse of water

At present, there is no salt recovery from effluent.

It is recommended to install 1,000 m^3/day capacity water recycling system which includes tertiary polishing treatment to remove the colloidal particles/traces of colour followed by disinfection and filtration. Ultra- filtration and RO system to recover 85% of installed capacity permeate water can be used for process and other application.

6.2.8 Discharge water: Prevailing Norms in Bangladesh

Table 39: ECR Norms in Bangladesh – 1997

Sl. No.	Parameter	ECR 1997 Inland
1	Colour	NA
2	pH	6.0-9.0
3	Suspended solids (mg/L)	30
4	Dissolved solids (mg/L)	2,100
5	COD (mg/L)	200
6	BOD (mg/L)	50
7	DO (mg/L)	4.5-8.0

6.2.9 Disposal of sludge and hazardous chemicals

The biological dewatered sludge is stored in the storage area and disposed of as per requirement. The semi dried sludge generation is about 4.16tonne per year.

6.2.10 Issues discussed with client

All the operational issues of existing ETP, problematic areas, action to be taken at each stage, importance of record keeping were discussed in detail with the top management and supporting staff of each section.

- Importance of day-to-day monitoring of important parameters like COD and BOD at the inlet and outlet.
- Use of urea and DAP based on BOD load to biological treatment.
- Importance of field instrumentation to monitor the temperature, pH at the inlet of ETP.
- Importance of standby equipment.
- Importance of routine maintenance of the equipment.

6.3 Factory Specific baseline key indicators

Table 40: ETP effluent water characteristics

Parameters	UOM	Baseline Condition
Raw wastewater parameters		
pH		10-11
Colour	Pt.Co	100-1,500
Temperature	^{0}C	35-39
Dissolved solids	mg/L	1,800-2,300
Total suspended solids	mg/L	200-400
COD	mg/L	690-1,200
BOD	mg/L	190-500
Investment facilitated	Million BDT/(US$)	42.0/ (496,034)
Water and energy management system	Not available	
Production process	Biological treatment	
ETP functionality / operation	Performance can be improved with suggested measures	

6.4 Critical findings and recommendations

6.4.1 Design details of ETP and Adequacy

Table 41: Design Adequacy

Sl. No.	Unit/ Equipment	Capacity/ specifications	Adequacy for present load
	ETP-1 (1,600 m3/d)		
1	Collection tank	31.20 m^3	Adequate
2	Mechanical bar screen chamber	-	-
3	Equalization and neutralization tank	1,400 m^3	Adequate
4	Distribution chamber	Volume included in aeration tank	Adequate
5	Aeration tank	3,457 m^3	Adequate
6	Lamella clarifier	220 m^2 Lamella Pack	Adequate
7	Sludge recirculation tank	33 m^3	Adequate
8	Raw effluent pumps	80 m^3/h (1W+1S)	Adequate
9	Mechanical brush screen	Suitable to handle 100 m^3/h flow	Adequate
10	Mixers for equalization tank	5.9 kW (1), 2.5 kW (1)	Adequate

Sl. No.	Unit/ Equipment	Capacity/ specifications	Adequacy for present load
11	Neutralized effluent transfer pumps	80 m^3/h (1W+1S)	Adequate
12	Air blower for aeration tank	1,090 m^3/h (2W+1S)	Adequate
13	Sludge recirculation pumps	80 m^3/h (1W)	Provide standby pump.
	Chemical dosing system		
14	H_2SO_4 dosing system Tank Dosing pump	 2,000 Liter HDPE (1) 50 LPH, (1W)	 Adequate Provide standby pump.
15	Antifoam dosing system Tank Dosing pump	 1,000 Liter HDPE (1) 30 LPH, (1W)	 Adequate Provide standby pump.
16	De-coloring agent dosing system Tank Dosing pump	 2,000 Liter HDPE (1) 60 LPH, (1W)	 Adequate Provide standby pump.
17	Dewatering poly dosing system Tank Dosing pump	 2,000 Liter HDPE (1) 600 LPH, (1W)	 Adequate Provide standby pump.
	ETP-2 (2,800 m^3/day)		
18	Mechanical bar screen chamber	-	-
19	Collection tank	-	-
20	Equalization and neutralization tank	1,850 m^3	Adequate
21	Distribution chamber	Volume included in aeration tank	Adequate
22	Aeration tank	5,600 m^3	Adequate
23	Secondary clarifier	22.50 m diameter	Adequate
24	Sludge recirculation tank	-	-
25	Post aeration tank	-	-
26	Mechanical brush screen	Suitable to handle 250 m^3/h flow	Adequate
27	Raw effluent pumps	120 m^3/h (1W+1S)	Adequate
28	Mixers for equalization tank	Flow Jet pump: 5.9 kW (2) Submersible mixer: 2.5 kW(2)	Adequate
29	Neutralized effluent transfer pumps	120 m^3/h (1W+1S)	Adequate
30	Air blower for aeration tank	3,160 m^3/h (1W+1S)	Adequate
31	Sludge recirculation pumps	150 m^3/h (1W + 1S)	Provide standby pump.
32	Air blower for post aeration tank	237 m^3/h (1W)	Provide standby pump.
	Chemical dosing system		
33	H_2SO_4 dosing system Tank Dosing pump	 5,000 Liter HDPE (1) 80 LPH, (1W+1S)	 Adequate Adequate
34	Antifoam dosing system Tank Dosing pump	 1,000 Liter HDPE (1) 50 LPH, (1W)	 Adequate Provide standby pump.
35	De-coloring agent dosing system Tank Dosing pump	 2,000 Liter HDPE (1) 80 LPH, (1W)	 Adequate Provide standby pump.

Sl. No.	Unit/ Equipment	Capacity/ specifications	Adequacy for present load
36	Poly dosing system Tank Dosing pump	 2,000 Liter HDPE (1) 600 LPH, (1W)	 Adequate Provide standby pump.
37	Hypo dosing system Tank Dosing pump	 2,000 Liter HDPE (1) 15 LPH, (1W)	 Adequate Provide standby pump.
	Sludge management system		
38	Sludge holding tank	78.6 m^3	Adequate
39	Sludge feed pump	------, (1 No.)	Provide standby pump.
40	Sludge dewatering filter press	-	-
	Instrumentation		
41	pH meter	Neutralization tank- ETP-1 and ETP-2)	Adequate
42	DO meters	Aeration tank (ETP-1 and ETP-2)	Adequate
43	Level sensors	All the pumps	Adequate
44	Flow meters	ETP-1: Inlet and outlet ETP-2: Inlet and Outlet	Adequate

6.4.2 Observations and Recommendations

Key recommendations for performance improvement are as follows:

Table 42: ETP Findings

Equipment	Findings	Details
Sludge recirculation pumps (ETP 1 and ETP 2)	Observation	There is no standby sludge recirculation pump.
	Impact	Difficult to recycle and maintain the required biomass in aeration tank during maintenance period of working pump.
	Recommendations	Standby pump should be provided for smooth functioning of the system.
Chemical dosing system (ETP 1 and ETP 2)	Observation	There are no standby pumps for H_2SO_4, de-coloring agent, antifoam and dewatering poly dosing system for ETP-1 There are no standby pumps for de-coloring agent, antifoam, hypo and poly dosing system for ETP-2.
	Impact	Difficult to operate the plant during maintenance period of working pumps.
	Recommendations	Standby pumps should be provided.
Sludge management system (Common for ETP-1 and ETP-2)	Observation	There is no standby sludge feed pump to filter press.
	Impact	Difficult to dewater the sludge during maintenance period of working pump.
	Recommendations	Standby pump should be provided for smooth functioning of the system.
Air blower for aeration tank (ETP-2)	Observation	Standby blower is under maintenance.
	Impact	Difficult to maintain aerobic condition in aeration tank resulting in nonfunctional biological system during maintenance period of the working blower.
	Recommendations	Standby blower should be repaired and made operational.
	Observation	There is no standby air blower.

Equipment	Findings	Details
Air blower for post aeration tank (ETP-2)	Impact	Difficult to maintain required DO in the treated effluent during maintenance period of the working blower.
	Recommendations	Standby air blower should be provided.

6.5 Action plan for CP measures (ETP section)

Table 43: Action plan of CP measures in ETP

Present Set-up	Observations during field Study and measurements	Proposed Cleaner production action	Proposed Investment or Costing(BDT)
ETP-1			
Sludge recirculation pumps	There is no standby sludge recirculation pump.	Standby pump should be provided.	300,000
Chemical dosing system	There are no standby pumps for H2SO4, de-coloring agent, antifoam and dewatering poly dosing system.	Standby pumps should be provided.	600,000
Sludge management system (Common for ETP-1 and ETP-2)*	There is no standby sludge feed pump to filter press.	Standby pump should be provided.	200,000
Chemical dosing system	There are no standby pumps for de-coloring agent, antifoam, hypo and poly dosing system.	Standby pumps should be provided.	600,000
Air blower for post aeration tank	There is no standby air blower.	Standby air blower should be provided.	300,000
Water recycling system	Water recycling system of 1,000 m^3/day with tertiary chemical treatment, disinfection and filtration system followed by UF and RO to recover water for process and other application.		40,000,000

This CP measure has not been accepted for implementation.

Note: The above proposed investments are tentative and can be verified with PaCT-TTBC[1]

[1]Textile Technology Business Center is an entity established under PaCT to provide sustainable textile solutions for textile sector in Bangladesh. TTBC promotes access to quality and reliable information on resource efficient technologies and solution providers for greater uptake of best practices, improved businesses, and environmental sustainability by textile sector in Bangladesh

7 Conclusions and Recommendations

The assessment at IFL has helped in identification of several cleaner production measures which will help in reduction of energy, water, chemical consumption and improvement in production. A summary of the CP measures which have been accepted for implementation is presented below:

Table 44 : Summary of Recommendations

Sl. No	CP Measures	Investment Million BDT	Impact – Reductions of				
			Natural Gas	Electricity	Water	Chemicals	Production
1	Heat recovery from exhaust gas engine by installing EGB	3.5	☑				
2	Heat recovery from jacket water gas engine for hot water application	1.0	☑				
3	Frequency reduction in gas engines	Negligible	☑				
4	Auto blowdown control system for boilers	0.4	☑				
5	Oxygen tuning of boilers	0.1	☑				
6	Thermal insulation improvements	0.02	☑				
7	Pressure reduction in compressed air system	Negligible	☑		☑		
8	Efficiency improvement of water treatment pumps	0.2	☑				
9	Replace conventional ceiling fan with energy efficient ceiling fan	4.0	☑	☑			
10	Metering requirement (Electricity-3)	0.5	☑	☑			
B	**Process Area**						
11	Improving dyeing process performance by improving RFT	40.0	☑	☑	☑	☑	☑
12	Reduction of moisture from fabric before drying on stenter	0.9			☑	☑	
13	Recovery and reuse of washing water from Corino slitting machine	0.15			☑		
C	**ETP**						
15	Sludge recirculation pumps (ETP 1)	0.3					☑
16	Chemical dosing system (ETP-1)	0.6					☑
18	Chemical dosing system (ETP 2)	0.6					
19	Air blower for post aeration tank (ETP 2)	0.2		☑			
20	Water recycling system	40.0			☑		
	Total	**92.5**					

The accepted cleaner production actions which when implemented would result in following:

- These measures have an estimated investment of BDT **92.5 million** and can yield savings of BDT **56.4 million, which is 15.7%**of the present energy bill**.**
- Investment for metering is estimated at BDT **0.5million.**
- Reduction in ground water consumption is estimated at **11.8%**.
- Reduction in process water consumption is estimated at 18.4 %
- Reduction in natural gas is estimated at **20.2%.**
- Reduction in electricity consumption is estimated at **13.9%.**
- GHG reduction by **21.2 %**.

The baseline KPI and the corresponding values post implementation of CP measures (both process and utility) will be as shown in the table below:

Table 45: Key performance indicators (KPI) -Current and Proposed

Resource	Unit	Value	Production (kg)	KPI (Key Performance Indicators)		
				As Is	To Be	Unit
Ground water	m^3	1,389,053	7,105,700	195.5	172.5	l/kg
Process water	m^3	889,283	7,105,700	125.2	102.1	l/kg
Electricity	kWh	12,478,514	7,105,700	1.76	1.51	kWh/kg
Natural gas	nm^3	6,884,394	7,105,700	0.97	0.77	nm^3/kg
Chemicals	kg	4,073,622	7,105,700	573.3	514.5	g/kg
GHG	Tonne of CO_2	18,381	7,105,700	2.59	2.04	kg/kg

8 Annexure

8.1 Annexure 1 – Process Flow Diagram

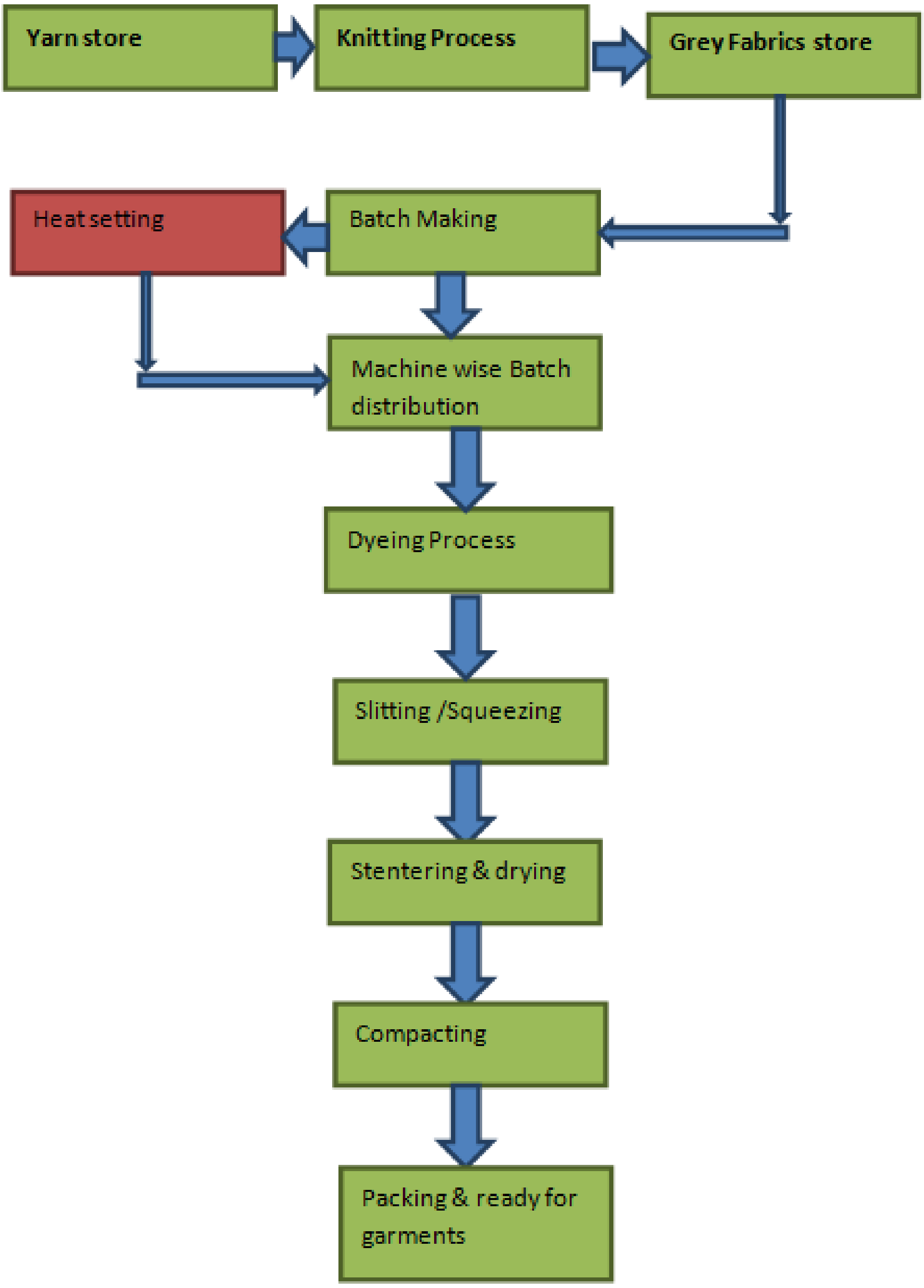


Figure 29: Process flow diagram of IFL

8.2 Annexure 2 – Plant and Machinery Details

Table 46: Machines and Equipment Details

Dyeing machines:

Sl. No.	Machine Name	Quantity
1	Dyeing machine-10 kg	1
2	Dyeing machine-150 kg	1
3	Dyeing machine-1,800 kg	3
4	Dyeing machine-200 kg	1
5	Dyeing machine-20 kg	5
6	Dyeing machine-2,400 kg	1
7	Dyeing machine-25 kg	3
8	Dyeing machine-300 kg	2
9	Dyeing machine-450 kg	2
10	Dyeing machine-50 kg	2
11	Dyeing machine-600 kg	1
12	Dyeing machine-750 kg	1
13	Dyeing machine-800 kg	1
14	Dyeing machine-900 kg	1
15	Washing- 100 kg	2
	Total	**29**

Finishing and batch section machines:

Sl. No.	Machine Name	Quantity
1	Bag sewing machine	1
2	Open fabric inspection machine	1
3	Open width compactor machine	3
4	Slitting machine	3
5	Squeezing machine	1
6	Dryer machine	1
7	Sueding machine	1
8	Tubular compacting machine	1
9	Tumbler dryer	2
10	Stenter	2

8.3 Annexure 3 – Details of Energy Consumption

→ ***Primary energy sources***

Table 47: Energy consumption

Month	Electricity from Grid (kWh)	NG (Power) in (nm^3)	NG (Heat) in (nm^3)	NG (Process) in (nm^3)	Diesel (Power) (Liter)
Jan'20	737,849	107,903	266,582	228,781	830
Feb'20	704,070	115,087	257,601	183,932	1,677
Mar'20	691,843	127,734	232,979	253,263	520
Apr'20	200,750	24,342	53,363	25,644	280
May'20	692,695	115,298	220,648	179,862	2,430
Jun'20	524,629	125,173	271,004	104,267	1,601
Jul'20	515,843	185,336	270,174	262,399	1,425
Aug'20	392,165	203,782	242,959	106,688	254
Sep'20	440,915	175,355	269,390	135,959	1,105
Oct'20	477,387	209,297	266,995	241,029	605
Nov'20	402,115	170,831	257,165	142,071	1,412
Dec'20	451,123	171,156	261,288	419,057	1,955
Total	**6,231,384**	**1,731,294**	**2,870,148**	**2,282,952**	**14,094**

→ ***Power generated from Gas and Diesel Engines***

Table 48: Monthly power generation from Gas and Diesel engines

Month	Gas Engine (kWh)	Diesel Engine (kWh)
Jan'20	379,403	2,422
Feb'20	364,282	4,713
Mar'20	335,449	808
Apr'20	65,328	300
May'20	238,087	586
Jun'20	450,800	716
Jul'20	735,978	1,196
Aug'20	682,137	782
Sep'20	753,675	3,818
Oct'20	759,750	1,500
Nov'20	725,741	4,815
Dec'20	729,529	5,315
Total	**6,220,159**	**26,971**

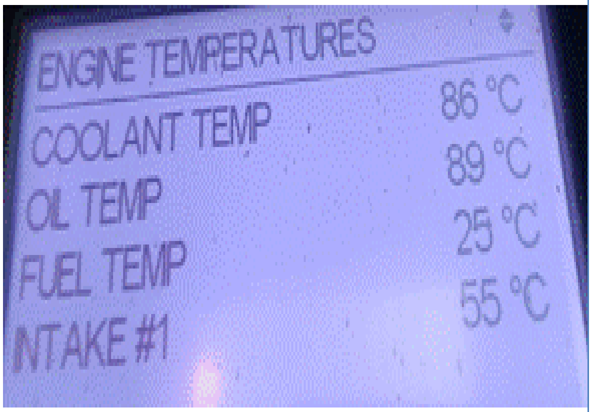
8.4 Annexure 4–Water Consumption Details

Table 49: Monthly water consumptions

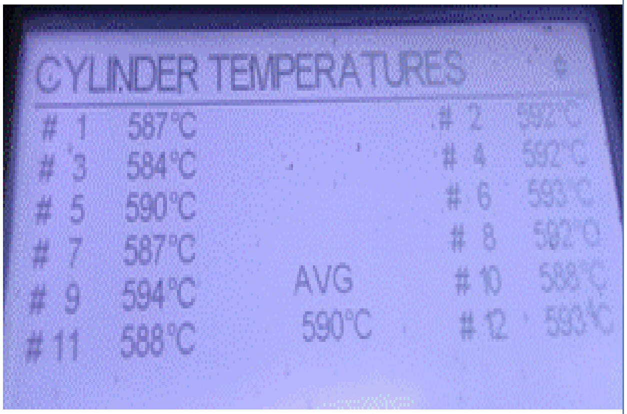
Month	Ground water (m^3)	Treated Water (m^3)
Jan'20	120,113	79,729
Feb'20	116,862	72,776

Month	Ground water (m^3)	Treated Water (m^3)
Mar'20	117,460	69,071
Apr'20	24,052	14,685
May'20	113,146	69,958
Jun'20	130,946	90,147
Jul'20	132,013	85,383
Aug'20	118,502	76,731
Sep'20	123,488	82,019
Oct'20	131,179	84,035
Nov'20	128,795	80,116
Dec'20	132,497	84,633
Total	**1,389,053**	**889,283**

8.5 Annexure 5 – Baseline pictures

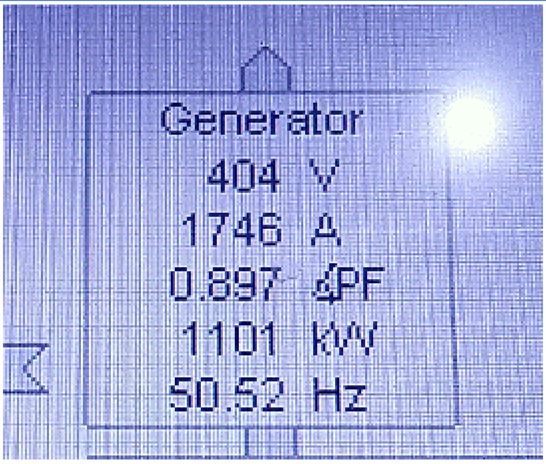


Gas Engine temperature



Gas Engine exhaust temperature

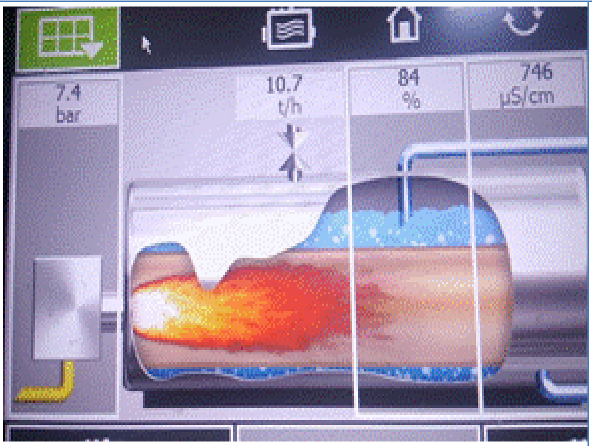
Gas Engine



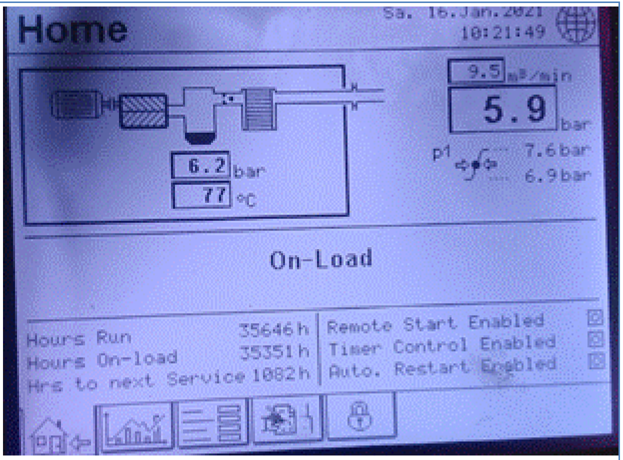
Gas Engine Electrical Parameter

Gas engine control room

14TPH Boiler

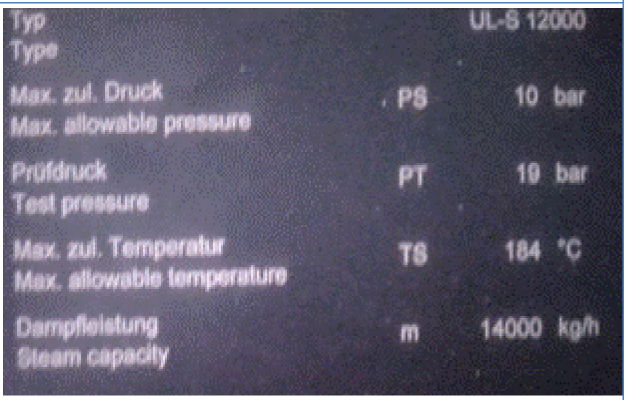


Boiler operating parameter



Compressor operating parameter


Booster pumps



Boiler name plate