August 2018

DETAILED PROJECT REPORT ON FALLING FILM CHILLER

M/s Vasundhara Dairy – Gujarat Dairy Cluster

Submitted to
(Prepared under GEF-UNIDO-BEE Project)

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List of Abbreviations

BEE	Bureau of Energy Efficiency
BMC	Bulk Milk Cooler
CHW	Chilled Water
CS	Capital Structure
°C	°Celsius
DPR	Detailed Project Report
EE	Energy Efficiency
FFC	Falling Film Chiller
FI	Financial Institution
GCMMF	Gujarat Cooperative Milk Marketing Federation
GEF	Global Environmental Facility
IBT	Ice Bank Tank
IRR	Internal Rate of Return
kW	Kilo Watt
LSP	Local Service Provider
MSME	Micro and Medium Scale Industries
NPV	Net Present Value
OEM	Original Equipment Manufacturer
PHE	Plate Heat Exchanger
RE	Renewable Energy
SBI	State Bank of India
SIDBI	Small Industrial Development Bank of India
Tr	Tonnes of Refrigeration
TOE	Tonnes of Oil Equivalent
UNIDO	United Nations Industrial Development Organisation
WACC	Weighted Average Cost of Capital

ACKNOWLEDGEMENT

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We would also like to mention that the valuable efforts being taken and the enthusiasm displayed towards energy conservation by the Gujarat Dairy Cluster is appreciable and admirable.

1. EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, in collaboration with United Nations Industrial Development Organization (UNIDO) is executing a Global Environment Facility (GEF) funded national project "Promoting energy efficiency and renewable energy in selected MSME clusters in India".

The overall aim of the project is to develop and promote a market environment for introducing energy efficiency and enhanced use of renewable energy technologies in process applications in 12 selected energy-intensive MSME clusters across 5 sectors in India (with expansion to more clusters later). This will enable improvement in the productivity and competitiveness of units, as well as reduce overall carbon emissions and improve the local environment.

Key activities involved in the project are shown below

Key activities involved in the project are shown below

- **LSP MAPPING:** Detailed Mapping of LSPs in the cluster.
- **TECHNOLOGY FEASIBILITY STUDIES:** Preparation of 10 bankable DPRs.
- **TRAINING MATERIALS:** Development of 5 customized training material based on mapping
- **TRAINING PROGRAM:** Conduct 4 training programs in the cluster for the capacity building of local service providers.
- **LSP's AS LOCAL DISTRIBUTORS:** Mapping of LSPs and OEMs so that LSPs can be local dealers for major OEMs.

1.1 Brief Unit Profile

Table 1: Unit Details

Particulars	Details
Name of Plant	Vasundhara Dairy
Name(s) of the Plant Head	Mr. Vijay N Kapadia
Contact person	Ashok R Sondhiya
Constitution	Cooperative Society
MSME Classification	Large Scale
Address:	Vasudhara, Alipur, NH No 8, Ta Chickli, Navsari Dist , Gujarat
Industry-sector	Dairy

1.2 Proposed EE Measure

After the discussion with the plant team, it has been decided to modify the existing IBT system with installing falling film chiller. The expected energy savings from the new system is around

25% from the total energy consumption to generate chilled water at 1 °C. The details of the proposed EE measure is given in below table:

Table 2: Proposed EE Measure

Sl No	EE Measure	Annual Energy Savings		Monetary Savings (Rs. Lakhs)	Investment (Rs. Lakhs)	Payback (Months)	AnnualTCO_2 reduction
		kWh	TOE				
1	Installation of 350 Tr Falling Film Chiller	5,04,000	43.34	37.80	39.78	13	413.25

1.3 Means of Finance

The details of means of finance for the proposed EE measure is as under:

Table 3; Project Finance

Sl. No.	Particulars	Unit	Value
i	Total Investment (Incl of Tax)	Rs. Lakh	**39.78**
ii	Means of Finance	Self / Bank Finance	**Self**
Iii	IRR	%	**121.28**
Iv	NPV at 70 % Debt	Rs. Lakh	**173.32**

2. INTRODUCTION ABOUT VASUNDHARA DAIRY

2.1 Unit Profile

Valsad District Cooperative Milk Producers Union Ltd has been registered in 1973 and initiated Dairy Development Activities on ANAND Pattern since 1975. The milk Union did not have any processing facilities of its own till November, 1981 and all the milk procured from the rural producers of this District used to be sent to the neighboring Dairy plant of Surat District at Surat. In 1981, Dairy Plant of 30,000 liters per day capacity was commissioned at Alipur village taking commercial loans from Financial Institution and assistance from the State Government.

Table 4: Unit Profile

Particulars	Details
Name of Plant	Vasundhara Dairy
Name(s) of the Plant Head	Mr.Vijay N Kapadia
Contact person	Mr. Ashok R Sondhiya
Contact Mail Id	mns@valsadunion.com
Contact No	07574802084
Constitution	Cooperative Society
MSME Classification	SME
No. of years in operation	37
No of operating hrs/day	24
No of operating days/year	365
Address:	Vasudhara, Alipur, NH No 8, Ta Chickli, Navsari Dist , Gujarat
Industry-sector	Dairy
Type of Products manufactured	Milk ,Ghee, Dahi, Butter milk

2.2 Production Details

The various products manufactured in Vasudhara dairy are liquid milk, butter milk, flavoured milk, lassi, ghee and ice cream. The graph below shows the milk processed during last one year

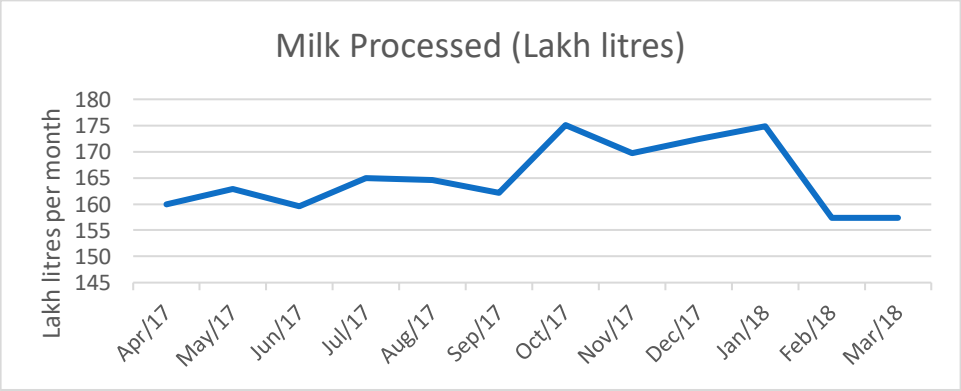


Figure 1: Milk Processed

2.3Typical Dairy Process Flow Diagram

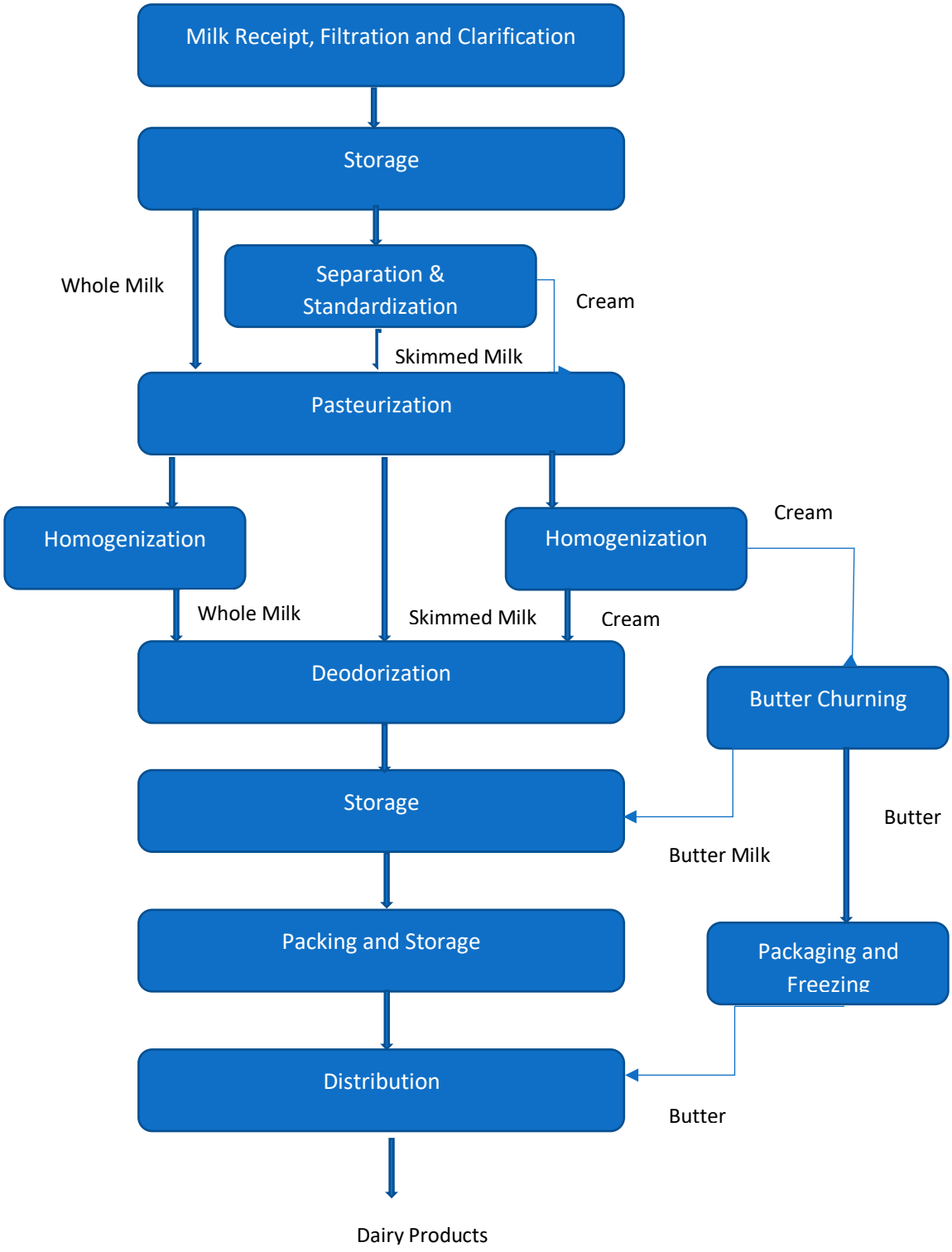


Figure 2: Typical process flow of Milk manufacturing

The processes taking place at a typical milk plant after receiving and filtration of milk from the chilling units includes:

Separation: After being held in storage tanks at the processing site, raw milk is heated to separation temperature in the regeneration zone of the pasteurizer. The milk (now hot) is standardized and homogenized by sending it to a centrifugal separator where the cream fraction is removed. The skim is then usually blended back together with the cream at predefined ratios so that the end product has the desired fat content. Surplus hot cream is cooled and usually processed in a separate pasteurizer ready for bulk storage and transportation to a cream packing plant.

Pasteurization is a process of heating milk to 72°C for 16 seconds then quickly cooling it to 4°. This process slows spoilage caused by microbial growth in the food. Unlike sterilization, pasteurization is not intended to kill all micro-organisms in the food. Instead, it aims to reduce the number of viable pathogens so they are unlikely to cause disease.

Homogenization (if required): Milk must then be homogenized. Without homogenization, the milk fat would separate from the milk and rise to the top. Milk fat is what gives milk its rich and creamy taste. Homogenization makes sure that the fat is spread out evenly in the milk so that every sip of milk has the same delicious flavor and creamy texture. Milk is transferred to a piece of equipment called a homogenizer. In this machine the milk fat is forced, under high pressure, through tiny holes that break the fat cells up in to tiny particles, 1/8 their original size. Protein, contained in the milk, quickly forms around each particle and this prevents the fat from rejoining. The milk fat cells then stay suspended evenly throughout the milk

Packaging and storage: Milk is pumped through automatic filling machines direct into bags, cartons and jugs. The machines are carefully sanitized and packages are filled and sealed without human hands. This keeps outside bacteria out of the milk which helps keep the milk stay fresh. During the entire time that milk is at the dairy, it is kept at 1°-2°C. This prevents the development of extra bacteria and keeps the milk fresh.

The table below shows the production capacity of various section in plant daily

Table 5: Production Capacity

Sl No	Product	UOM	Quantity
1	Milk Processing	Lakh Litres per Day	5.5
2	Milk Packaging in Poly Pouches	Lakh Litres per Day	3.15
3	Ghee Manufacturing and Packaging	MT/day	8.3
4	Dahi Milk Product	MT/day	7
5	Butter Plant	MT/day	8.4

2.3 Energy Profile

Both electricity and thermal energy are used for carrying out various dairy processing activities. The following fuels are used in the plant: -

Table 6: Type of fuel used

Sl. No.	Type of fuel/Energy used	Unit	Tariff	GCV
1	Electricity	Rs./kWh	7.5	
2	Steam Coal	Rs/kg	7.5	5200
3	Bio Coal	Rs/kg	5.5	3700

The table below shows the monthly consumption of various fuel used in the plant during the last one year

Table 7: Fuel Consumption Details

Month	Electricity Consumption (kWh)	Fuel Consumption - Steam coal (Tonne)	Fuel Consumption - Bio coal (Tonne)
Apr-17	5,53,170	0.000	321.515
May-17	6,11,400	0.000	336.741
Jun-17	6,06,090	0.000	347.187
Jul-17	6,07,,005	0.000	385.958
Aug-17	6,25,755	0.000	386.758
Sep-17	5,92,680	37.390	344.005
Oct-17	6,18,015	31.367	356.669
Nov-17	5,52,240	61.522	359.179
Dec-17	5,58,630	3.957	457.711
Jan-18	5,39,895	0.000	423.319
Feb-18	5,,04,960	0.000	381.651
Mar-18	6,20,085	0.000	434.103
Total	**69,899,25**	**134**	**4,535**

The major form of energy used in the plant is electricity which is from DGVCL grid. For thermal plant is using two kinds of fuel steam coal and Bio coal. But from the above table it is inferred that the dependence on Steam coal is very less as it is very costly (Rs 7.5/kg) and during the last one-year major source of thermal energy is from Bio coal which is available at cheaper rate. The percentage share of fuel cost is shown below: -

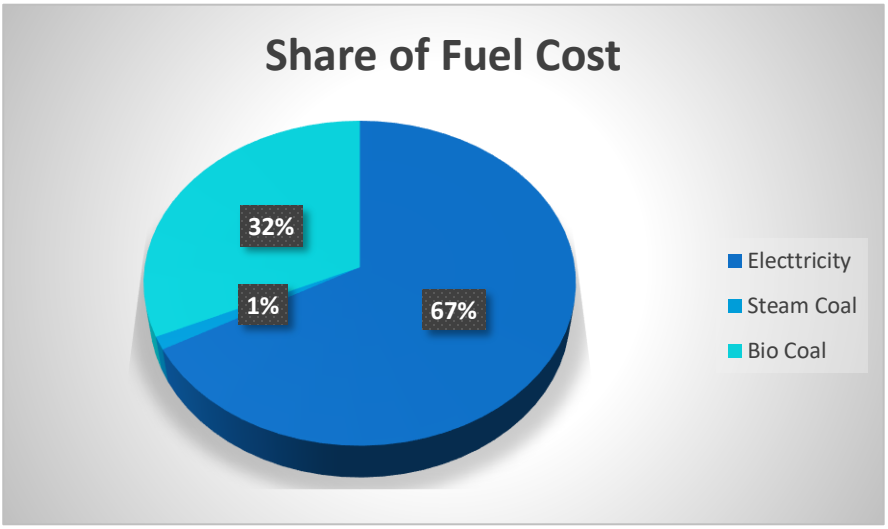


Figure 3: Share of fuel cost

Based on the data collected from the plant, the graph below shows the variation of fuel cost over the last one year. Average electricity cost is Rs 44 lakh/month whereas the average thermal energy cost is Rs 20 Lakh/month.

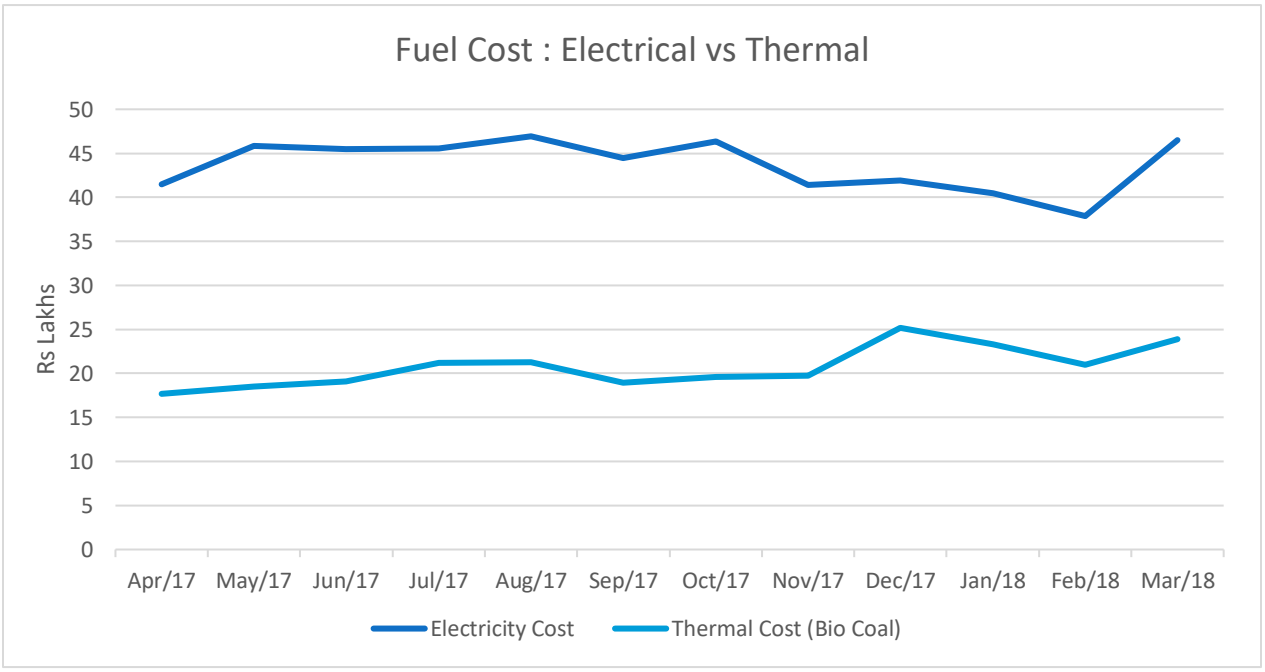


Figure 4: Fuel Cost Electrical vs Thermal

3. PROPOSED EE MEASURE – FALLING FILM CHILLER

3.1 Present System

The plant is presently handling VLC (Village Level Collection) Milk, BMC (Bulk Milk Cooler) Milk at different temperatures. This milk is processed and after pasteurization and chilling @ 4 and @2 °C is dispatched to various destinations in following form:

- City supply in Tankers
- Thru Road Milk Tankers (for out of State supplies)
- Pollack for end customers

Besides, certain quantity of Milk is processed for butter and Dahi manufacturing.

Refrigeration facilities

To meet the above requirements, there is a total installed capacity of 450 TR consisting of various refrigeration compressors of Blitzer. Usually, a base load of 300 TR is running and additional compressors are run based on load requirements.

There are 3 IBT's used for thermal energy storage. The following table shows the performance of chiller compressor installed in the plant:-

Figure 5: Ammonia Compressor installed

Table 8: Compressor Performance

Parameters	UOM	
Compressor design Power	kW	360
Compressor design load	TR	450
Suction Pressure	bar	3.51
Discharge Pressure	bar	13.44
Discharge Temperature	°C	95
Evaporator Temperature	°C	-2
Condensing Temperature	°C	39
Operating Power	kW	332
Operating TR	TR	350
SEC	kW/TR	0.95

The table below shows the specific energy consumption trend of the refrigeration system installed on the plant:

Table 9: Specific Power Consumption Trend

Month	TR/Month	kWh/Month	Specific Power kW/TR
April 17	283311	288977	1.02

May 17	302200	299178	0.99
June 17	289561	277979	0.96
July 17	292623	280918	0.96
August 17	299128	287163	0.96
Sep.17	273489	251610	0.92
October 17	292392	277772	0.95
Nov. 17	263539	250362	0.95
Dec. 17	259329	241176	0.93
Jan. 18	245170	223105	0.91
Feb. 18	230501	209756	0.91
March 18	299638	290649	0.97
Average	**2,77,573**	**2,64,887**	**0.95**

Observations

As the incoming milk is received at various temperatures, the load on refrigeration system fluctuates and the IBT temperatures rise very quickly. Once these temperatures rise due to high process return water temperature, IBT's are unable to meet the technical requirements of cooling the milk to 4 °C for polypack and other tanker sale requirements.

The process return water is mainly from pasteurization process which is at 7 °C to 10 °C and from raw milk reception which is at 12 °C to 14 °C. There is an unevenness in the return water temperature and this is directly going to IBT tank. For IBT the main requirement is to produce ice on coil and for that chiller is used. In the present condition the temperature on IBT is around 7 °C to 10 °C as a result it is difficult to maintain 4 °C for milk dispatch. At the current situation the temperature the plant is getting is around 5 – 6 °C for milk dispatch and it is uneven. Because of this load on refrigeration is also on higher side and specific power consumption is around 0.95 kW/Tr.

3.2 Recommendations

The present difficulties can be overcome by installing a Falling Film Chiller of 350 TR capacity which will help in instantly bringing down the return process water temperature to between 0.5-1°C. This will help in maintaining the chiller water temperature to process at 0.5°C at all times and will improve the quality of Chilled Milk and Milk products. As a result, the IBT can meet the requirement of cooling the milk to 4°C. This will also reduce the load on refrigeration compressor. The figure shows below the schematic of proposed system:

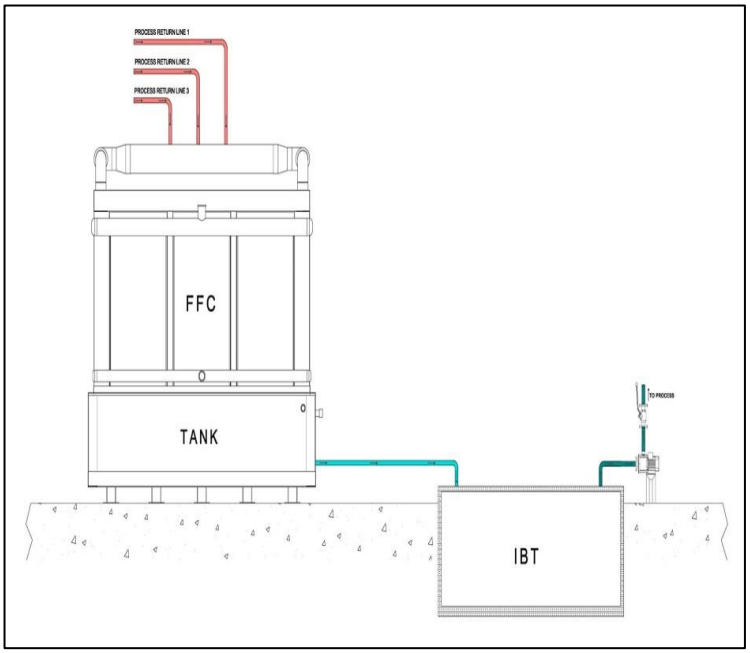


Figure 6: Proposed system FFC with Tank

Falling Film Chiller

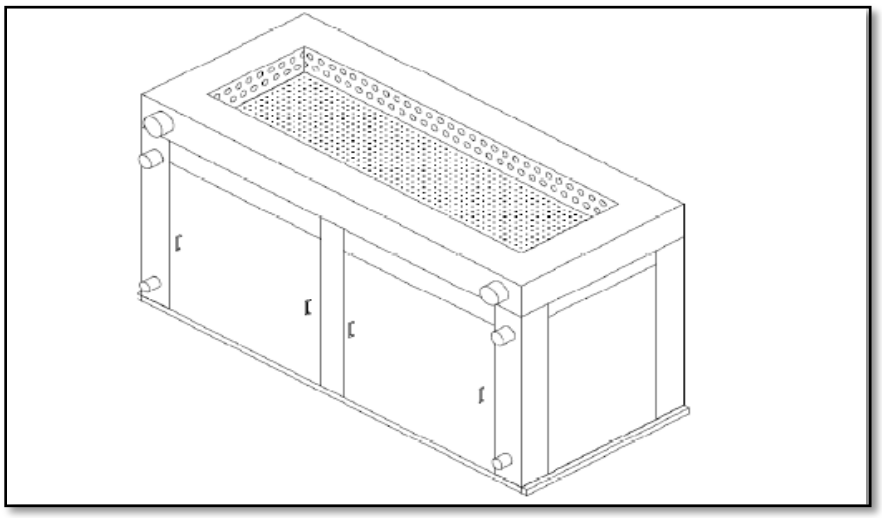


Figure 7: Falling Film Chiller

Falling Film Chillers are suitable for continuous chilling of liquids close to their freezing point (i.e. water to 0, 5°C). Also, viscous liquids, detergents, etc. and polluted liquids not easily handled in large quantity by conventional heat exchangers can all be chilled with the Falling Film Chiller. The water to be cooled is pumped into a distribution tank and as previously described the water is evenly distributed so that it falls as a continuous film over the cooling surface and into a base

tank or directly over the product. The refrigerant runs through the pillow plate. It can be either a primary refrigerant such as ammonia, R134a, R22 etc. evaporating directly in the plate which can be circuited for dry expansion, flooded or pumped systems or as a secondary refrigerant such as glycol, brine or a similar heat transfer fluid.

When Using NH_3 as the refrigerant oil drains have to be provided in the lowest point of the evaporator (liquid) supply. For Flooded systems the separator liquid level has to be a minimum of 0.5 m above the suction when using NH3 and 1.0 using R22. Using a falling film chiller with a DX system a suction gas heat exchanger is required if the temperature difference between refrigerant and water inlet is less than 10°C. This suction heat exchanger provides the gas superheat. The minimum evaporation temperature is: -3°C with water of 1°C and -2.5°C with water of 0.5°C. This to prevent ice-build-up on the plates.

The table below shows the advantages of using FFC over PHE

Table 10: FFC vs. PHE

Sl No	Falling Film Chiller	Plate Heat Exchanger
1	Water Chilling down to temperature as low as 0.5 °C	Not suitable for low water temperature applications
2	FFC allows the operation with polluted liquid as well	Not suitable for polluted liquid applications
3	In case of ice building on plates there is no damage to the plates	Plates get damaged during ice building
4	U value or efficiency of FFC remains same	Due to scale deposition the efficiency of PHE or U value decreases drastically. Needs frequent cleaning
5	Low or no maintenance and operating cost	Periodic maintenance which adds to operating costs
6	Design and operating parameters may vary based on load requirements	Design and operating parameters need to be same for low temp application because any change in operating parameters may result in heavy losses or damage of PHE
7	Low affinity of soiling , easy to clean	
8	No Gaskets	Require time to time change of gaskets
9	Flexibility of usage	Limitations of Usage

The other advantage of a Falling Film Chiller will come in the form of energy savings as the IBT often run at low evaporation temperatures which result in lowering of refrigeration capacity and higher power consumption vis a vis a Falling Film Chiller which runs at much higher evaporation temperature. The Falling Film Chiller being an open system also results in low or zero maintenance and therefore free from such botherations due to which the plant always maintains a high efficiency.

3.3 Supplier Details

Table 11: Supplier Detail

Equipment Detail[1]	Falling Film Chiller – FFC 400
Supplier Name	Omega Ice Chill Pvt Ltd
Address	Omega Ice Chill Pvt Ltd 39, First Floor Raghushree Market Near Ajmeri Gate Delhi
Contact Person	Mr Abhishek Jindal
Mail Id	abhishek.jindal@omega-icehill.in

3.4 Savings

The expected energy savings is around 25% from the total energy consumption to generate Chilled water at 1°Cwhich is requirement of cooling while exiting system having specific power of CW is 0.95 kW/TR and with proposed system it is 0.75 kW/T [2]and estimated electricity saving of 5,04,000 kWh/Year resulting in an energy reduction of 43.34 TOE/year. The annual monetary saving for this project is ***Rs 37.80 Lakhs with an investment of Rs 39.78 lakhs and payback for the project is 13 months.***

Detailed savings calculations is given in below table

Table 12: Savings Calculation

Parameters	UOM	Option 1 - CHW supply from existing IBT system	Option - 2 CHW supply from dedicated FF chiller
Actual CHW Temperature requirement °C	°C	1	1
CHW supply temperature °C	°C	Varying due to incoming fluctuations in process water return temp 10 - 14 °C	1
Refrigeration load	TR	350	350
Power Consumption	kW	332	262
Specific power	kW/TR	0.95	0.75
Operating days/annum	Days	300	300
Operating hrs/day	hrs	24	24
Annual Energy Consumption	kWh	23,94,000	18,90,000
Annual electricity saving	kWh	5,04,000	
Power cost Rs.7.5/kWh	Rs. Lakhs	179.55	141 .75

[1] FFC is a unique technology provided Omega Ice Chill
[2] SEC with the new system guaranteed by Vendor

Annual energy saving	Rs. Lakhs	37.80
Investment	Lakhs	39.78
Payback	Months	13

4. FINANCIAL ANALYSIS

4.1 Project Cost

Table 13: Project Cost

Parameter	Amount in Rs Lakhs
Equipment cost –Model FFC 400	19.37
Water tank 5000 Litres – MOC SS304	2.45
Control Panel, Pipe with fittings and line insulation cost	8.65
Modification, correction, installation and commissioning charges	3.25
Total Project Cost (Excl of Packing & Forwarding and Freight Charges)	**33.72**
GST @18%	**6.06**
Total Project Cost	**39.78**

4.2 Assumptions for Financial Analysis

- Interest rate taken as 12 %
- Yearly increase in electricity cost by 2% for cash flow analysis
- Life cycle of the project is taken as 7 years
- Three different Capital Structure considered
    - CS1 – 70:30 Debt Equity Ratio
    - CS2 – 50:50 Debt Equity Ratio
    - CS3 – 100 % Equity
- Return on equity is taken as 15 %
- Depreciation – 40%
- Operation and Maintenance Cost taken as 5% of Initial investment
- For calculating weighted average cost of capital, tax rate is assumed as 30 %

4.3 Cash Flow Analysis

Table 14: Cash flow of the project

Cash flow for the project		1	2	3	4	5	6	7
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Required Investment	39.78							
Energy Savings		37.80	38.56	39.33	40.11	40.92	41.73	42.57
O&M Cost		-1.99	-1.99	-1.99	-1.99	-1.99	-1.99	-1.99
Depreciation		15.9	9.5	5.73	3.4	2.1	1.2	0.7
Net Cash Flow	-39.78	51.72	46.11	43.07	41.56	40.99	40.98	41.32

The table below shows the various capital structure assumed for the project finance

Table 15: Capital Structure

Capital Structure			
Particulars	CS 1	CS 2	CS 3
Debt	70	50	0
Cost of Debt	0.12	0.12	0.12
Equity	30	50	100
Cost of Equity	0.15	0.15	0.15
WACC	10.38	11.7	15

Table 16: NPV Calculation

NPV Calculation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	NPV
NPV at CS 1 (70:30)	**-39.78**	**46.9**	**37.8**	**32.0**	**28.0**	**25.0**	**22.7**	**20.7**	**173.3**
NPV at CS 2 (50:50)	**-39.78**	**46.3**	**37.0**	**30.9**	**26.7**	**23.6**	**21.1**	**19.0**	**164.8**
NPV at CS 3 (100% Equity)	**-39.78**	**45.0**	**34.9**	**28.3**	**23.8**	**20.4**	**17.7**	**15.5**	**145.8**

4.3 Sensitivity Analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave In different situations such as

- Change in energy savings
- Change in operating hours
- Change in interest rate

A good sensitivity analysis will help to estimate the behavioral nature thereby helping to understand the financial viability over a long period of time.

Table 17: Sensitivity analysis: based on energy savings

Based on Savings	at 100% Savings	at 75% Savings	at 50% Savings
NPV at CS 1 (D70:E30)	173.3	125.4	77.6
NPV at CS2 (D50:E50)	164.8	110.8	67.5
NPV at CS3 (D0:E100)	145.8	104.5	63.2
IRR	121%	95%	68%

Table 18: Sensitivity analysis: change in operating hrs

Based on Operating Hours	at 100% operating hours	at 90% Operating hours	at 80% Operating hours
NPV at CS 1 (D70:E30)	173.3	154.2	135.0
NPV at CS2 (D50:E50)	164.8	146.5	128.1
NPV at CS3 (D0:E100)	145.8	129.3	112.7
IRR	121%	111%	101%

Table 19: Sensitivity analysis: change in interest rate

Based on Interest Rate	at 9.5% interest rate	at 10.05% interest rate	at 11% interest rate	at 12% Interest Rate	at 12.5% Interest Rate	at 13% Interest Rate
NPV (70:30)	181.8	178.3	176.6	173.32	171.70	170.10

5. ENERGY EFFICIENCY FINANCING IN MSMEs

Financing plays a key role in facilitating procurement and implementation of energy efficient technologies and products in any industry. Government has given EE financing in MSMEs top priority since the sector contributes significantly towards India's economic growth. However, existing financing options are not sufficient to meet the financing requirement in the sector due to the large size of the sector. MSMEs using various financing schemes for technological up-gradation are still very less, as most of them use their own capital fund rather than making use of external financing models. Although financing models were very successful in some clusters, the scale-up of such activities is rather slow. This slow pace in implementation of energy efficiency financing in MSMEs is due to the various sector specific challenges in the sector.

Some of the key barriers to finance EE projects in the sector are:-

- Lack of available capital for investment as EE interventions being small may not get financed through FIs as they do not qualify as term loans
- Lack of clarity on financing schemes- repayment mechanism and complex procedural requirements
- Lack of availability of financing model that cater to the particular requirement of the MSME
- Lack of awareness among MSMEs with respect to benefits of implementing EE technologies
- FIs consider MSMEs as a high risk category due to low credit flow to this sector. This is due to several factors such as poor book-keeping practices, weak balance sheets, poor credit history and smaller sizes of MSME loans.
- Collateral based lending, advocated by FIs, restricts MSMEs from availing loans
- No formal M&V procedure available to estimate the savings achieved by implementing EE measure
- Risks associated with repayment of loans which include technical, commercial and performance risks

5.2 FI Schemes in Gujarat

Table 20: FI schemes in Gujarat

Sl.No	Name of Scheme	Purpose	Financial Details	Contact Address
1	SIDBI Make in India Soft Loan Fund for Micro, Small & Medium Enterprises (SMILE)	• The focus of the scheme is on technology upgradation which helps in reducing the impacts from process and operations as the reduction in resource consumption and productivity improvements are major outcome of technology upgradation • The program aims to bridge the gap by providing financial support to the companies.	• Rate of interest is according to credit rating • Interest rates for soft loans are from (8.90 % to 8.95 % pa) and term loans are in the range of (9.45% to 9.60% pa) • Min loan amount: Rs 25 Lakhs • Term Loan: 75% of the project cost as debt	Mr Chandan SIDBI, Bhavan, Ist Floor, P.B.No. 10, Navjivan P.O., Ahmedabad Ph No : : 8769436639 Mail Id: ahmedabad@sidbi.co.in
2	4E scheme (End to End Energy Efficiency Financing scheme)	• The 4E scheme promoted by SIDBI aims to assist the industries in implementation of energy efficiency and renewable energy projects. • The scheme addresses all aspects of energy efficiency in a company from assessment and identification of energy efficiency interventions to facilitating implementation by providing technical and financial support	• Interest rate - 2.5% below market interest rate • Min loan amount: Rs 10 Lakhs • Max loan amount: Rs 150 Lakhs • 90% of the project cost as debt	Mr Chandan SIDBI, Bhavan, Ist Floor, P.B.No. 10, Navjivan P.O., Ahmedabad. Ph No : 8769436639 Mail Id: ahmedabad@sidbi.co.in
3	Partial Risk Sharing Facility for Energy Efficiency project (PRSF)	• The partial risk sharing facility aims at transforming the energy efficiency market in India and promotion of Energy Service Contracting Model for the Energy Efficiency. • The scheme address barrier related to the financing aspects for energy efficiency	• Term Loan: 12%-15% • Min loan amount: Rs 10 Lakhs • Max loan amount: Rs 15 Cr • Total Project funding of – USD 43 million • Risk Sharing facility component of USD 37 million to be managed by SIDBI • Technical assistance component of USD 6 billion to be managed by SIDBI and EESL	Mr Chandan SIDBI, Bhavan, Ist Floor, P.B.No. 10, Navjivan P.O., Ahmedabad. Ph No : 0562-2521023 Mail Id: ahmedabad@sidbi.co.in

4	Bank of Baroda's Scheme for Financing Energy Efficiency Projects	All these Schemes from various banks (SBI, Bank of Baroda, and Canara Bank) have their focus towards technology upgradation. Technology upgradation can lead to improvement in energy, productivity, and lower emission from the MSME company. As technology upgradation could be capital intensive most of the schemes from banking institutions aim at bridging the gaps for access to finance for MSME sector	• Loans of up to 75% of the total project cost, subject to maximum of Rs. 1 crore, will be provided. (Minimum amount of loan Rs. 5 Lakhs • Collateral will be required for all loans. An interest rate of bank base rate + 4% will be applicable, to be paid back over a period of 5 years.	SME Loan Factory Baroda Regional Office, 1st,4th Floor, Suraj Plaza-III Sayajiganj, Baroda - 390 005 Ph No : 9909023060 Mail Id : cpc.sme.baroda@bankofbaroda.com
5	Canara Bank's Loan scheme for Energy Savings for SMEs		• The scheme covers up to 90% of project costs of up to INR 1 million (EUR 13,000). • Max. loan: INR 10 million (EUR 130,000) • Security: collateral free up to INR 5 million (EUR 65,000), beyond INR 5 million collateral required as determined by the bank • Margin: 10% of project costs	Canara SME Branch Opp Express Hotel, RC Dutta Road, Alkapuri, Vadodara Ph No : 0265 2353111 Email Id : sbi.05019@sbi.co.in
6	SBI's Project Uptech for Energy Efficiency		• SBI identifies industrial clusters with potential for quick technology upgradation and a supporting environment. Based on studies in interested units, technology upgradation is undertaken if the same in viable. • With a ceiling of INR 1 lakh, an amount equal to that invested by the unit is provided under this loan. There is a start-up period of 3 years, with a repayment period of 5-7 years, at zero interest.	SBI SMECC 6th Floor, Commerce Center Opp BBC Tower , SayajiGunj Vadodara Ph No : 0265 2631165 Email Id : sbi.05019@sbi.co.in
7	Solar Roof Top Financing Scheme IREDA	The loan scheme is applicable to grid interactive, rooftop solar PV plants for industries, institutions and commercial establishments.	• Interest rate: 9.9% - 10.75% • Max. repayment time: 9 years	IREDA Camp Office 603, Atlanta Towers Near Panchvati Circle,

		Financing can be accessed for single or aggregated investments.	• Minimum promoter's contribution: 30% • The applicant's minimum capacity needs to be 1MW	Gulabi Tekra Ahmedabad Ph No : 9811889805 Email Id : ashokyadav@ireda.in
8	SBI - World Bank: Grid Connected Rooftop Solar PV Program	Loans for financing grid connected rooftop solar photovoltaic (GS- RSPV)	• Loan amount is 75% of the project cost • Fixed Asset coverage ratio: >1.25 • Moratorium period: up to 12 months from date of commencement of commercial operations • Guarantee: in case of sole proprietorship/partnership firm/personal guarantee of partners	SBI SMECC 6th Floor, Commerce Center Opp BBC Tower , SayajiGunj Vadodara Ph No : 0265 2631165 Email Id : sbi.05019@sbi.co.in

6. ENVIRONMENTAL AND SOCIAL BENEFIT

6.1 Environmental Benefit

A resource-efficient business demonstrates a responsibility towards the environment. Energy and the environment are so closely linked, that, in addition to saving energy and reducing utility expenses, there are additional and often unreported benefits from conserving energy, saving natural resources being an important benefit.

Energy efficiency plays a major role, even where company output is increased, energy efficiency improvements can contribute significantly in most cases to reducing the negative impact of energy consumption per unit of output. Any increase in pollutant emissions will thus be minimized. Significant environmental benefits gained by adopting energy efficient technologies and processes may include lowering the demand for natural resources, reducing the emission of air pollutants, improving water quality, reducing the accumulation of solid waste and also reducing climate change impacts. Improving energy conservation at the facility can improve the facility's overall efficiency, which leads to a cleaner environment.

Reduction in Pollution Parameters

The proposed EE measure of installing FFC in IBT will result in reduction in electricity consumption by 5,04,000 kWh per annum. As the electricity consumption is reduced, the unit has to purchase lesser energy from grid thus resulting in fuel/coal savings at the utility thermal power plant and that there is a reduction of 43.34 TOE per annum. The proposed EE measure will result in decrease of CO2 emissions by 413 TCO2 annually, thus resulting in reduced GHG effect.

6.2 Social Benefit

Work Environment

The Factories Act, 1948 covers various aspects relating to working environment maintenance and improvement. The good maintenance practices, technology up gradation, efficient use of energy and resource conservation not only contribute to energy and pollutant reduction but also contributes in ensuring safe and clean working environment to the employees of the organization. Many units have also been doing review of safety process and have provided access to safe working environment to the workers. Basic facilities such as first aid kit, PPE gears and many others have been made available

Skill Improvement

Implementing energy efficiency measures requires mix of people and skills. It involves up skilling workers at all levels from the shop floor to the board room to understand how companies manage their energy use—and to identify, evaluate and implement opportunities to improve energy performance. As the project involved identifying energy saving projects, implementing and verifying the savings, the unit have understood how to estimate energy savings with respect to energy saving

proposals and also energy wastage have been identified. The activity has been successful in bringing the awareness among workers on energy wastage reduction, technology up gradation possible, etc. Each new technology implemented in a dairy plant will create an impact on the entire Gujarat Dairy cluster as each dairy units can replicate the new technology and promote the concept of energy efficiency in entire Gujarat Dairy Cluster and thus reduce the overall energy consumption of the cluster as a whole.

Technical skills of persons will be definitely improved. As the training provided by the OEMS' on latest technology will create awareness among the employees on new trends happening in market. The training also helps in improving the operational and maintenance skills of manpower required for efficient operation of the equipment.

7. CONCLUSION

Energy efficiency is an instrument to address the issue of energy crisis and also be employed as a cost-effective means to attain sustainability and business. Cost of energy is considered as a vital component for industries and warrant judicious use of energy. Amid spiraling power cost energy efficiency assumes at most importance for the sector to remain competitive.

The GEF, UNIDO and BEE project through its various engagements is able to demonstrate energy efficiency potential in Gujarat Dairy cluster. The project is able to promote the concept of energy efficiency and renewable energy in dairy cluster through various capacity building programs for local service providers, technology feasibility studies in dairy units, training programs on EE/RE technologies and also helped in penetrating new /latest technologies into the cluster.

The DPR on for installation of FFC before IBT has been prepared after the OEM came to the dairy and done a detailed feasibility study. This measure will significantly reduce the load on refrigeration compressor which will result in an annual energy savings of 5,04,000 units with 413 TCO_2 reduction. The following table gives the overall summary of the savings achieved:

Table 21: Proposed EE Measure

Sl No	EE Measure	Annual Energy Savings		Monetary Savings (Rs. Lakhs)	Investment (Rs. Lakhs)	Payback (Months)	AnnualTCO_2 reduction
		kWh	TOE				
1	Installation of 350 Tr Falling Film Chiller	5,04,000	43.34	37.80	39.78	13	413.25

The summary of financial analysis given in the below table clearly indicates that implementation of this project is economically and financially viable with an attractive payback period. So it is recommended to modify the existing IBT system by installing Falling Film Chiller.

Table 22: Financial Analysis

Sl. No.	Particulars	Unit	Value
i	Total Investment (Incl of Tax)	Rs. Lakh	**39.78**
ii	Means of Finance	Self / Bank Finance	**Self**
Iii	IRR	%	**121.28**
Iv	NPV at 70 % Debt	Rs. Lakh	**173.32**

7.1 Replication Potential

Most of the units in Gujarat Dairy cluster have a similar milk manufacturing process, concept of FFC has a huge replication potential in the cluster. The implementation of this project will inspire other units to take up similar energy efficiency initiatives which eventually will lower the bottom line and increase the top line therefore the margin increases. Secondly, the very clear specifications on vendor and the cost base is already available which makes it easy for other units in the Gujarat Dairy cluster to access the technology and gives them a very good idea about the cost and benefits associated with the projects. Overall, the holistic approach adopted by the project will be extremely useful in achieving the goal of improving EE in the cluster.

8. ANNEXURE

8.1 Financial Quotation

OMEGA ICE HILL
Tailormade solution in Heat Transfer Technology

Telefax: +91, 23232619,23239513,

R.O: 39,1st Floor Raghushree Market, Ajmeri gate, New Delhi -110006

Ref No: OIPL/QUO/18207-R01/2017-18 Date: 03.05.18

To,
Valsad District Cooperative Milk Producers' Union Limited
Vasudhara Dairy, Alipore,NH no. 8, Tal.: Chikhali, Dist: Navsari,
Gujarat - 396 409
Mobile: +919377040688; Direct: (02634) 278508
E-mail id: projects@valsadunion.com;
projects.vdcmpul@gmail.com

Dear Sir,
This refers to your requirement of Falling Film Chiller made of Laser Welded Pillow Plates. We are pleased to submit herewith our most Competitive offer as under :

SR. NO.	DESCRIPTION	QUANTITY (NOS.)	UNIT RATE	AMOUNT
1.	**Falling Film Chiller** Model - FFC 400 Made of SS 304 Cooling capacity 1311 Kw system Refrigerant R 717 (Ammonia) (FFC Made of Laser welded evaporator Plates Made of SS 304) System Consist of :- a.) Evaporator consists of Laser welded Evaporator plates made of SS 304.	01	19,37,000.00	19,37,000.00
2.	Water base tank 5000 Liters MOC – SS 304	01	2,45,000.00	2,45,000.00
3.	Suction accumulator with controls ,		Pumped ammonia Not Required	
4.	Control panel for above system	01	1,10,000.00	1,10,000.00
5.	Ammonia and water Pipeline with fittings and line insulation (as per BOM attached)	Lot	7,55,000.00	7,55,000.00
6.	Valves and controls	Lot		
7.	Modification, correction , Installation and commissioning charges	01	3,25,000.00	3,25,000.00
	TOTAL			33,72,000.00
	PACKING & FORWARDING			EXTRA
	FREIGHT			EXTRA
	GST 28%			EXTRA
	Amount in words:- Thirty Three Lakh Seventy two thousand only			33,72,000.00

Factory: Sec - IV, Plot No. 37, IIE Sidcul, Pant Nagar, RUDRAPUR, Dist. Udham Singh Nagar (Uttarakhand)

Telefax: +91, 23232619,23239513,

R.O: 39,1st Floor Raghushree Market, Ajmeri gate, New Delhi -110006

Note: - Above system is limited to system internal interconnections.

Connections to our system like pipes, fittings, valves and cabling will be in your scope. Civil work, unloading of equipment's, equipment internal handling will also be your responsibility.

Suitable structure for Falling film chiller on tank with material is in customer Scope, any additional work other than mentioned above will be charged Extra.

Terms of sales :-

1	Price	:	As Above
2	Installation Charge	:	As Above
3	Other Charges	:	
	➲ Freight Charge	:	At Actual to be borne by you.
	➲ GST	:	28 %, Extra.
	➲ Packing charge	:	As Actual to be borne by you.
4	Payment	:	50% Advance and 50% Balance against Performa Invoice before Dispatch
5	Delivery	:	Within 4 to 6 Weeks after receipt of your confirmed PO with advance.
6	Validity	:	Prices are valid up to 30.07.18
7	Warranty	:	One year from date of supply.
8	Other Requirement	:	Road permit to be provided by you.

Further technical/commercial clarification; please consider us at your disposal.

Thanking you.
For Omega IceHill Pvt. Ltd.

Abhishek Jindal

Abhishek Jindal

Omega IceHill Pvt. Ltd
Mob:- +91-9990425111
E-mail:-abhishek.jindal@omega-icehill.in,

E&OE

Factory: Sec - IV, Plot No. 37, IIE Sidcul, Pant Nagar, RUDRAPUR, Dist. Udham Singh Nagar (Uttarakhand)

8.2 Technical Details

Telefax: +91, 23232619,23239513,

R.O: 39,1st Floor Raghushree Market, Ajmeri gate, New Delhi -110006

Design Parameter of Chiller

Chiller design Data

Water flow	:	150/300 m3/hr
Refrigeration Capacity	:	375 Tr
Inlet Water Temp	:	As per technical annexure
Outlet Water Temp	:	As per technical annexure
Material of Construction	:	SS 304
Chiller Dimensions	:	As per technical annexure

Evaporator Data

Evaporator make : OMEGA ICEHILL

(Omega IceHill Pvt Ltd is a Joint Venture Partner with Omega Holland and all the design comes from Omega Europe)

Material of Construction : SS 304 (Complete Evaporator is made of SS 304)

Water Base Tank

Water Capacity	:	5000 Ltrs
Material of Construction	:	SS 304 (Tank 2.5 mm thick with 0.8 mm outside)
Tank Insulation	:	Excellent Insulation using Special Dow Chemical.

Factory: Sec - IV, Plot No. 37, IIE Sidcul, Pant Nagar, RUDRAPUR, Dist. Udham Singh Nagar (Uttarakhand)

OMEGA ICEHILL PVT. LTD. INDIA

VASUDHARA DAIRY

MANUAL FALLING FILM CHILLER

FFC- 1399 KW

Installation, Maintenance, General description & Drawings of Falling film chiller FFC- 1399 KW

MANUAL FALLING FILM CHILLER

Operating and Instruction Manual for Falling Film Chiller.

INDEX

FFC- Falling Film Chiller
OIPL- Omega Icehill Pvt. Pltd.

MANUAL FALLING FILM CHILLER

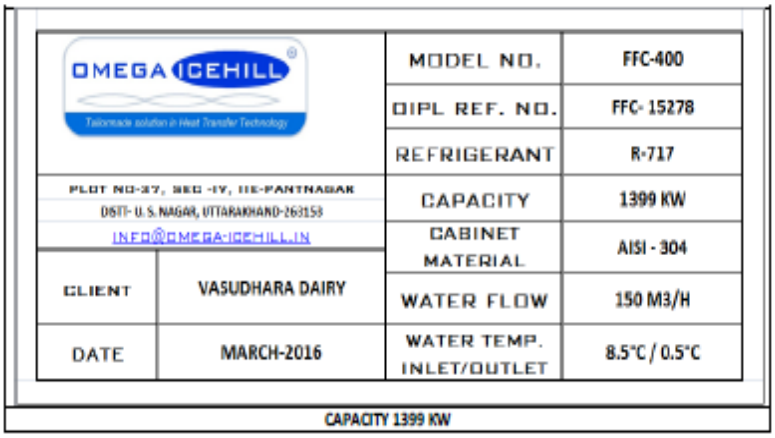
Warnings

This Operation Manual is to be followed by all persons working with the unit. It is imperative that this Manual is made freely available at all times to service personnel and is kept at the point where the unit is installed.

The basic maintenance should be carried out by properly trained personnel and, if necessary, under the supervision of a person qualified for this job.

Omega Icehill personnel, or personnel authorized by Omega Icehill, should carry out any work in the refrigerating or electric circuit during the warranty period. After the warranty period, the work must be carried out by qualified personnel.

NAME PLATE SNAP SHOTS:



OMEGA ICEHILL Tailormade solution in Heat Transfer Technology		MODEL NO.	FFC-400
		OIPL REF. NO.	FFC- 15278
		REFRIGERANT	R-717
PLOT NO-37, SEC -IV, IIE-PANTNAGAR DIST- U. S. NAGAR, UTTARAKHAND-263153 INFO@OMEGA-ICEHILL.IN		CAPACITY	1399 KW
		CABINET MATERIAL	AISI - 304
CLIENT	VASUDHARA DAIRY	WATER FLOW	150 M3/H
DATE	MARCH-2016	WATER TEMP. INLET/OUTLET	8.5°C / 0.5°C

CAPACITY 1399 KW

MANUAL FALLING FILM CHILLER

1. Introduction-

1.1 General Notes:

- The Company does not accept responsibility if safety regulations are not met during handling, operation, maintenance and repair, even though these may not be strictly stated in this operation manual
- We recommend the translation of this operation manual into the local language of plant workers who are directly or in directly involved in operation and maintenance of the FFC unit.
- The usability and life cycle of the Ice Bank Tank as well avoiding premature repairs depends on proper operation, maintenance, care and competent repair.
- We are constantly updating our products and are confident that they respond to the latest scientific and technological demands. However, as manufacturers, we do not always know the end use or the total range of our product's applications. Therefore we cannot accept liability for our products in applications where additional safety measures may be necessary. We highly recommend that users inform us of the intended application in order to undertake additional safety measures, if necessary.

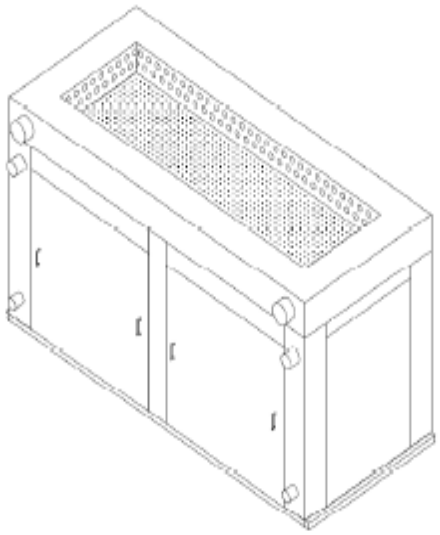
1.2 Safety Regulations-

- The operator has to observe the national working, operating and safety regulations. Also, existing internal factory regulations must be met. Maintenance and repair work must only be carried out by specially trained personnel and, if necessary, under supervision of a person qualified for this work.
- Protective or safety devices must not be removed, modified or readjusted
- During operation of the FFC none of the protective or safety devices must be removed, modified or readjusted, temporarily or permanently
- Only use the correct tools for maintenance and repair work
- Use original spare parts only
- All maintenance and repair work must only be carried out to the machine once it has been stopped and disconnected from the power supply. Ensure that the FFC cannot be switched on by mistake by unplugging it.
- Do not use flammable, alkaline or basic solvents for cleaning purpose
- Keep the surrounding area absolutely clean during maintenance and repair work. Keep free of dirt by covering the parts and free openings with clean cloth, paper or adhesive tape
- Ensure that no tools, loose parts or similar are left inside the system

MANUAL FALLING FILM CHILLER

2. DESCRIPTION

2.1 Typical arrangement of Falling Film Chiller (Ammonia Based):



Typical arrangement of Falling Film Chiller

2.2 Applications

Omega Icehill Falling Film Chillers are suitable for continuous chilling of liquids close to their freezing point (ie water to 0,5°C). Also viscous liquids, detergents, etc and polluted liquids not easily handled in large quantity by conventional heat exchangers can all be chilled with the Omega Icehill Falling Film Chiller

Typical applications include:

- Continuous production of chilled water for dairies and breweries
- Food processing, pre chilling
- Upgrading of existing ice water systems and ice banks
- Capacity range of 20 to 2500 kW
- Negligible corrosion due to the use of stainless steel
- No risk of damage from freeze ups
- Refrigerant charge is relatively small

MANUAL FALLING FILM CHILLER

2.3 Omega Icehill Design Philosophy:

Pillow plates
The design of the falling film chiller, as all 'Omega Icehill' products, is based on evaporation plates in the form of the so-called pillow plate. The pillow plate combines a large evaporation surface with a relatively low volume of refrigerant. By consequence the design of the chillers is very compact.

Laser welding
Omega Icehill use the very latest in welding technology. Our Laser welding system produces fusion welds of high joint efficiency. The connections are narrow bounded, full penetration welded, durable and reliable. Corrosion resistance properties are good. The laser-welding permits total control over weld pattern, so we are not tied to panel configurations based on machine tools, but can manufacture our panel to suit the design conditions.

High efficiency evaporator plates
Given the flexibility of laser welding we can optimize the distribution of refrigerant liquid and as in the evaporator plates. Therefore we can realize the full potential of the evaporator plate and provide a very efficient heat exchange surface.

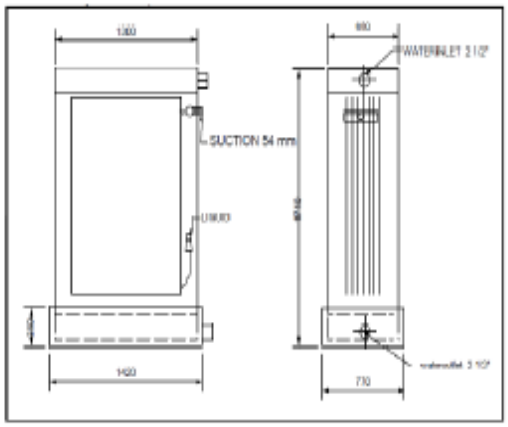
Effective Water Distribution
In our design the water distribution tank has an outer channel fed by the incoming water through which the water is equally distributed to an inner pan which is fitted with plastic inserts. The water passes through these and results in an even flow over both sides and along the length of vertically suspended panels.

In summary Omega Icehill offer a well-designed product, using the latest in laser welding engineering technology to produce reliable, high quality heat exchanger systems.
Omega Icehill Falling Film Chillers are operational in various fields of application to the full satisfaction of the users.

MANUAL FALLING FILM CHILLER

2.4 Method of Operation

The water to be cooled is pumped into a distribution tank and as previously described the water is evenly distributed so that it falls as a continuous film over the cooling surface and into a base tank or directly over the product.



Typical arrangement of Falling Film Chiller Example.

The refrigerant runs through the pillow plate. It can be either a primary refrigerant such as ammonia, R134a, R22 etc. evaporating directly in the plate which can be circuited for dry expansion, flooded or pumped systems or as a secondary refrigerant such as glycol, brine or a similar heat transfer fluid.

2.5 Main Components

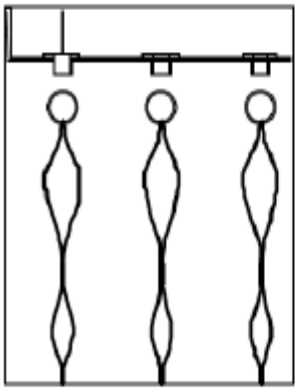
- The Omega Falling Film consists of the following main parts:
- Water distribution part
- Evaporator plates and refrigerant manifolds
- Enclosure and removable side covers
- Water base tank (optional)
- The equipment is designed for easy transport and installation.
- The water distribution tank, evaporator plates and enclosure are supplied in one piece with lifting lugs for easy installation.
- The dimensions are depending on the duty.
- The length of the chiller varies from 0.5 m to 4 m, depending on the number of evaporation plates necessary to satisfy the required duty.

MANUAL FALLING FILM CHILLER

2.6 Standard design

2.6.1 water-distribution tank- specification

- Material Quality: SS-304.
- The tank has an outer water channel that collects the incoming water.
- The inner part is provided with plastic inserts, producing an even stream of water over both sides of the evaporator plates and along their length.
- The diameter of the insert orifice varies from 4.5 to 7.2 mm depending on the quantity of water.



Water distribution over evaporator plates.

2.6.2 Evaporator Plate-Specification

- Material Quality SS-304.
- The evaporator plates are laser welded using the latest in welding technology.
- The laser welding produces fusion welds of high joint efficiency. Whose corrosion resistance properties are good.
- The burst pressure is 70 bar, many times that of the system stand still pressure.
- Stress levels are much the same as in any well designed pressurized component.
- The test pressure is at least 1.43 times the working pressure.
- The evaporator plates are assembled in a bank and are connected via a suction pipe.
- For DX systems a liquid distributor is included.

When using R22, or an alternative, as the refrigerant the velocity of the refrigerant in the evaporator plates is designed such that oil returns to the suction line. When Using NH3 as the refrigerant oil drains have to be provided in the lowest point of the evaporator (liquid) supply. For Flooded systems the separator liquid level has to be a minimum of 0.5 m above the suction when using NH3 and 1.0 using R22. Using a falling film chiller with a DX system a suction gas heat exchanger is required if the

MANUAL FALLING FILM CHILLER

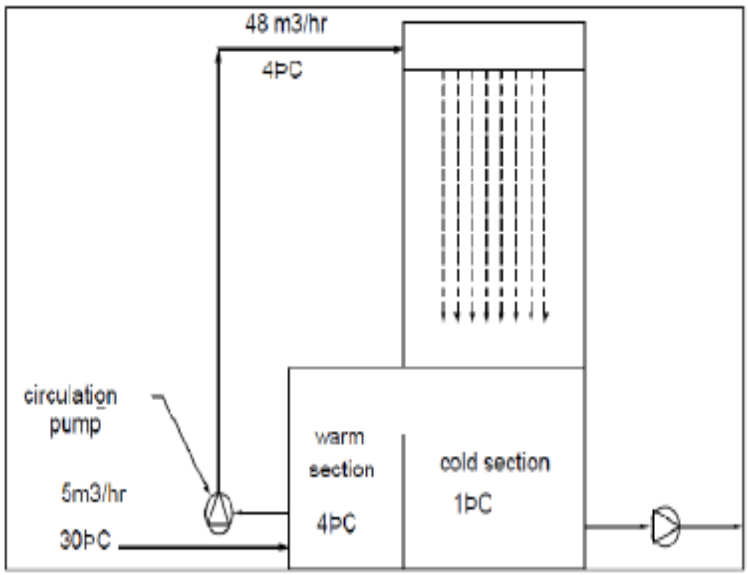
temperature difference between refrigerant and water inlet is less than 10°C. This suction heat exchanger provides the gas superheat.

The minimum evaporation temperature is: -3°C with water of 1°C
-2.5°C with water of 0.5°C
This to prevent ice-build-up on the plates.

The material quality of the refrigerant pipe is SS-304, with connections in carbon steel to ammonia systems, or copper to Freon systems. The distance between evaporator plates (50 mm) is sufficiently large to permit easy cleaning when necessary. The evaporator plates also have a self-cleaning ability.

The water volume streaming over the plate should not be less than 1.8 m^3/h per meter run of Evaporator plate with a maximum volume of 7 m^3/h per meter length of plate.

A water recirculation pump is applied in situations where the external water supply to the system is irregular or in cases where the water volume is low.



5 m3/hr 1 °C
Principle of applying a water circulation pump

The water base tank in this case is split up in to a warm and a cold section.
The cold section is situated directly below the evaporator plates.

MANUAL FALLING FILM CHILLER

2.6.3 Housing specifications

- Material Quality SS-304.
- Side covers and top cover: Polycarbonate.
- For cleaning and inspection the side covers and top cover are removable
- The housing is provided with lifting eyes for transport and installation.

2.6.4 Water-Base tank specifications

- Material Quality: Inner tank SS-304.
- Outside SS-304 Sheet metal or other finish Insulation Polystyrene (50 mm thickness).
- The sidewalls are strengthened with tube profiles and tension bolts.
- We advise that the water base tank should have a storage capacity of 2 to 4 minutes of the water volume that passes through the chiller at design conditions.
- The water base tank is vapor sealed.
- Connections: overflow drain process /pump connection

Optimal Extra's Include

- Material Quality SS-304 for evaporator plates and housing
- SS covers on top and sides of housing
- Insulation thickness of water base tank 80 mm.

General industrial applications:

It is also possible to use the chillers in applications as heat pumps with heat sources such as River, surface and ground water, with temperatures as low as +2°C.

MANUAL FALLING FILM CHILLER

3. Installation-

3.1 Receipt & Inspection:

- On receipt of the Omega Icehill FFC unit, it must be inspected for damage during transport. In the case of any damage, external or internal, this cannot be referred to the manufacturer because all units are checked before dispatch. **If any damage is observed, this should be documented and reported to the forwarding company. The OIPL warranty does not include any damages incurred during transportation.**
- The refrigerant circuit controls are set before shipment of the unit. They should not be re-adjusted under any circumstances. This would void the warranty of the unit

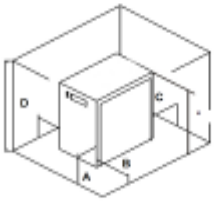
3.2 Transport:

- Keep the unit upright at all times. Do not tilt when shipping or moving. **The tilting of the FFC unit may affect the internal suspension of the pillow plate circuit and connections of refrigerating compressor**
- These units must be transported by pallet jack or fork-lift truck. Further these units must be transported by crane with appropriate nylon sealing – 2 nos load capacity 5MT each

3.3 Site-

- Unit must be installed in an atmosphere where the range of temperatures is 35 – 55°C
- The unit must be installed on a solid level surface that is capable of supporting a minimum weight of the sum of the weight of the unit and the weight of the water tank full filled.
- We recommend the installation of the FFC unit in a well-ventilated site and in a corrosive-free, dust -free and dry atmosphere. The air renewal of the room should be at least ¾ of chiller's motor fan flow
- In the case of out-door installation it is recommended to protect the FFC unit from rain with a roof and it should be installed in such way that the control panel receives as few direct sunlight as possible
- The inlet of fresh air onto the condenser should be in the most direct way possible, avoiding any chance of air recycling
- See in the picture the minimum distances (in m) that must be left around the FFC unit. (1.5 meter)

MANUAL FALLING FILM CHILLER



	A	B	C	D	E
Min Distance in m(in)	2(60")	2(60")	2(60")	2(60")	H+2 (H=60")

In case of installation in a small room it is imperative that the room has an appropriate ventilation system to evacuate all the heat generated by the chiller as explained before on this same point. If the heat is not removed the temperature in the room will quickly increase beyond the operating limits of the unit.

The FFC unit must always operate with the controlled environmental condition and enable the inlet of fresh air only through the condenser.

3.4 Connection's Water & Ref lines-

- Minimize the number of bends in the water lines. The length of pipe, number of fittings, valves, etc. will also cause an increase of the pressure drop
- The FFC should be located as close as possible to the application. Pressure drop in the pipe should not exceed 0.7 bar.
- To perform the water connections **make sure the FFC is turned Off and disconnected from any power supply** and open the lateral and back panels of the FFC
- **Always install thermal insulation for all pipes or, at least, make sure that the pipes are opaque to the light**
- To prevent rusting of the water pipes, we recommend SS pipes, plastic pipes or brass fittings
- Where flexible tubing is used, it should be of reinforced construction and rating for a minimum working pressure of 10 bar g (145 psi) within -5ºC and 50ºC

MANUAL FALLING FILM CHILLER

3.5 General Notes-

- The falling film water chiller must be positioned water level in all directions
- All connections to the chiller must be made by qualified personnel; welds must be made by personnel qualified for the right welding methods and materials.
- All connections made to the chiller must be free of tension and flexible enough to absorb vibrations.
- The Chiller is designed for indoor use, temp 35° to 50°C
- The Chiller is not secured against overpressure. You will need to install a pressure relief valve in your circuit. Check the design conditions for max working pressure.
- Lifting the chiller shall only be done using the lifting eyes as installed in our factory.

At Omega Icehill Pvt. Ltd. India the chillers have been pressure tested using nitrogen

MANUAL FALLING FILM CHILLER

4. Startup-

4.1 Operating Conditions:

- The control thermostat in the chiller will control it in order to maintain the preset cold water temperature
- Water temperature at the inlet: Maximum 30°C
- Cold water temperature at the outlet: Minimum 0.5°C
- Temperature of the ambient air: Nominal 25°C, Maximum 50°C

4.2 Falling Film Chiller Startup:

- Clean the application water circuit with tap water in order to be sure that there are no free particles
- **Turn Off the Main power switch** (to avoid any possibility of unexpected start up of the equipment during this operation). Open the tank cover and fill the tank **with water of the level of overflow**
- To start machine start control ON
- Start Re-circulation pump
- Start Chilling Unit – 1 & Unit – 2
- Initially chilling unit fan & solenoid valve will get on after a delay of 1min and after that compressor will start.
- In order to protect the water circuit of the FFC unit, the water to be cooled must have specific properties so that it is not aggressive. If this water is outside any of the limits listed in the table below, it can seriously damage some of the materials of the FFC unit

Parameter	Limit values
pH	7 – 8
Total Hardness (TH)	< 150 ppm
Total iron ions (Fe^{2+} and Fe^{3+})	< 0,02ppm
Chloride (Cl^-)	< 23 ppm
Solid particles	< 300 µm

- **Please note that the inlet water should be of good quality with low TDS level and the chloride contain in the water should not exceed 23ppm as this can cause corrosion of stainless steel evaporator plates**

MANUAL FALLING FILM CHILLER

5. Maintenance-

- Check water distribution plugs in water tray regularly for dirt and clean if necessary
- When cleaning the chiller one should use water of no hotter than 50°C
- Standard chillers made of SS 304 (1.4301) are not chloride solution resistant.
- Chillers made out of SS 316 L (or 1.4404) have a limited resistance against salty solutions. The chiller must be checked frequently for corrosion
- Chillers entirely made of SS 316 Ti, SS 321, SS 904 or SMO 254 are resistant to a low percentage chloride solution and better resistant to salty solutions.
- The side panels and the top cover are all removable, which gives ready access to all parts for routine cleaning and examination