DETAILED PROJECT REPORT
ON
WHRS IN REFRIGERATION SYSTEM BY DE-SUPER HEATER TECHNOLOGY (50 TRX02 NOS)
(GUJARAT DAIRY CLUSTER)










ENERGY IS LIFE
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Bureau of Energy Efficiency

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WASTE HEAT RECOVERY IN REFRIGERATION SYSTEM BY DE-SUPER HEATER TECHNOLOGY (50 TR X 2 nos.)

GUJARAT DAIRY CLUSTER

BEE, 2010
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Petroleum Conservation Research Association

Ahmedabad

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List of Abbreviation

BEE	Bureau of Energy Efficiency
DPR	Detailed Project Report
DSCR	Debt Service Coverage Ratio
DSH	De-super Heater
GHG	Green House Gases
IRR	Internal Rate of Return
NPV	Net Present Value
ROI	Return on Investment
SIDBI	Small Industrial Development Bank of India
MoMSME	Ministry of Micro Small and Medium Enterprises
WHR	Waste Heat Recovery

EXECUTIVE SUMMARY

Petroleum Conservation & Research Association (PCRA) is executing BEE-SME program in Gujarat Dairy Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Gujarat Dairy cluster is one of the very important clusters in India. Gujarat is 5th largest milk producer state in India. This explains the importance of dairy cluster in Gujarat State. Accordingly this cluster was chosen for energy efficiency improvements by implementing energy efficient measures/technological upgradation, so as to facilitate maximum replication in other dairy clusters in India. The main energy forms used in the cluster units are grid electricity, Natural gas and small quantity of diesel oil.

The cluster comprises of mainly two type of dairy activity viz Milk chilling center & main dairy. In milk chilling center energy is mainly consumed for milk chilling process while in dairy the major consumer of energy is various milk processes. The cluster comprises of about 80% milk chilling center & 20% dairies. In a typical milk chilling center, cost wise 61% electrical energy & 39% thermal energy being consumed.

Installation of proposed technology i.e. use of de-super heater technology for WHR from the refrigeration system would save about 19047 kg of FO per year.

This DPR highlights the details of the study conducted for the use of de-super heater technology for WHR from the refrigeration system, possible Energy saving and its monetary benefit, availability of the technologies/design, local service providers, technical features & proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, sensitivity analysis in different scenarios and schedule of Project Implementation

This bankable DPR also found eligible for subsidy scheme of MoMSME for “Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises” under “National Manufacturing and Competitiveness Programme”. The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table below:

S. No	***Particular***	***Unit***	***Value***
1	Project cost	(Rs. in Lakh)	20.81
2	Expected Fuel Savings	kg/annum	19047
3	Expected electricity Consumption	kWh/year	2686

S. No	Particular	Unit	Value
4	Monetary benefit	(₹ in Lakh)/annum	5.36
5	Debit equity ratio	Ratio	3 : 1
6	Simple payback period	Yrs	3.88
7	NPV	(₹ in Lakh)	2.80
8	IRR	%age	13.38
9	ROI	%age	19.77
10	DSCR	Ratio	1.30
11	Process down time	Days	7

The projected profitability and cash flow statements indicate that the project implementation will be financially viable and technically feasible solution for Gujarat Dairy cluster.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Gujarat Dairy Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up-gradation through studies and pilot projects in these SMEs clusters.

***Major activities in the BEE -SME program are furnished below*:**

Activity 1: Energy use and technology audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Activity 2: Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ Managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting up of energy efficiency projects in the clusters

Activity 3: Implementation of energy efficiency measures

To implement the technology up-gradation project in the clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Activity 4: Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion.

1 INTRODUCTION

1.1 Brief introduction about cluster

The global objective of the BEE SME programme is to improve the energy intensity of the Indian economy by undertaking actions in the SME sector which directly or indirectly produced 60% of the GDP. The immediate objective of this programme is to create the awareness to accelerate the adoption of EE technologies and practices in 29 chosen clusters in the SME sector through knowledge sharing, capacity building and development of innovative financing mechanisms. To build the energy efficiency awareness by funding/subsidizing need based studies in large number units in the SMEs and giving energy conservation recommendations including technology up-gradation opportunities.

Under "BEE-SME Programme - Gujarat Dairy", the primary task was to carry preliminary energy audit in 15 units & detail audit in 7 units. The aim of conducting preliminary energy audit in 15 Units is to identify the areas of high energy consumption and to carry out detailed audit and comprehensive technology gap assessment in remaining 7 Units. Preliminary energy audit has been carried out for, assessing the overall energy use in the unit, based on measurements such as various monthly energy consumption rate, production rate, temperature measurement of thermal & chilling system, illumination etc. Energy audit and Technology gap assessment study at the plant results in identification of the following energy saving opportunities and however the detail calculations of the identified saving measures is given in detail energy audit study.

The main form of energy used by the cluster units are grid electricity, Natural Gas, charcoal, lignite, and diesel oil. Major consumptions of energy are in the form of Natural Gas and lignite. Details of total energy consumption at Gujarat Dairy cluster are furnished in Table 1.1 below:

Table 1.1 Details of annual energy consumption

a) A Typical Dairy (With majority of products mix)

Energy Type	Unit	Monthly Average Consumption	% Contribution (MCal Basis)	% Contribution (Cost Basis)
Electricity	kWh	1539108	16%	53%
NG	SCM	597934	66%	25%
FO	Ltrs	141855	18%	22%

b) A Typical Milk Chilling Center

Energy Type	Unit	Monthly Average Consumption	% Contribution (Mcal Basis)	% Contribution (Cost Basis)
Electricity	kWh	149056	14%	65%
FO	kgs	17671	59%	35%

Classification of Units

The Gujarat Dairy Cluster units can be broadly categorized into two types based on types of process.

- Milk Chilling Center
- Dairy Units

Preliminary Energy Carried in 15 Nos. of units out of which 12 Nos. milk chilling centers & 03 Nos. are dairies. Detailed Energy audit carried in 7 units out which 5 Nos. of Dairies & 02 Nos. of milk chilling center.

Products Manufactured

The various product manufactured in dairies covered under 'Gujarat Dairy Cluster' are as follow-

Dairies process following products from Milk while milk chilling center collects milk, weighs, chills & dispatch to dairy.

1) Tone Milk
2) Tea Milk
3) Tetra Pack Milk
4) Flavored Milk
5) Butter Milk
6) Curd
7) Milk Cream
8) Butter
9) Ghee
10) Paneer
11) Cheese
12) Skimmed Milk Powder
13) Whole Milk Powder
14) Baby Food (Milk Powder Based)
15) Ice Cream.
16) Indian Sweets.

In dairy industry production capacity is mainly decided by milk processed in Kgs(Ltrs) per day.

Table 1.2 Details of types of product manufactured

Details of units of cluster subjected to Preliminary Energy Audit.

S.No.	Particulars of SME	Dairy / Chilling Center	Production Capacity in ltrs/day
1.	Unit 1	Dairy	25000
2.	Unit 2	Dairy	14500
3.	Unit 3	Dairy	9000
4.	Unit 4	Chilling Center	30000
5.	Unit 5	Chilling Center	140000
6.	Unit 6	Chilling Center	165000
7.	Unit 7	Chilling Center	160000
8.	Unit 8	Chilling Center	160000
9.	Unit 9	Chilling Center	150000
10.	Unit 10	Chilling Center	140000
11.	Unit 11	Chilling Center	160000
12.	Unit 12	Chilling Center	36000
13.	Unit 13	Chilling Center	20000
14.	Unit 14	Chilling Center	20000
15.	Unit 15	Chilling Center	30000
16.	Unit 16	Dairy	160000
17.	Unit 17	Dairy	1280000
18.	Unit 18	Dairy	5000
19.	Unit 19	Dairy	500000
20.	Unit 20	Dairy	400000
21.	Unit 21	Chilling Center	450000
22.	Unit 22	Chilling Center	200000

Energy usages pattern

Electricity is mainly used for dairy cluster units apart from other fuels such as FO, PNG, Bio-mass (wood), HSD, LDO etc. The dairy wise the pattern varies.

The details of energy uses pattern are as given below-

Table 1.3 Energy usages pattern

Name of Unit	Electricity	FO	PNG	Wood	HSD	LDO	Other
Unit 1	☼	☼					
Unit 2	☼						
Unit 3	☼	☼					
Unit 4	☼				☼		
Unit 5	☼			☼		☼	
Unit 6	☼	☼					

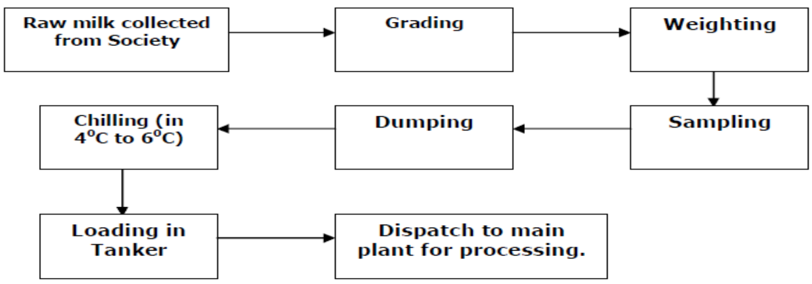
Name of Unit	Electricity	FO	PNG	Wood	HSD	LDO	Other
Unit 7	☼	☼					
Unit 8	☼						
Unit 9	☼						
Unit 10	☼					☼	
Unit 11	☼	☼					
Unit 12	☼	☼					
Unit 13	☼			☼			
Unit 14	☼			☼			
Unit 15	☼	☼					
Unit 16	☼	☼	☼				
Unit 17	☼			☼			
Unit 18	☼	☼	☼				☼ (Castor DOC)
Unit 19	☼			☼ (Saw Mill Dust)			☼ (Steam from Outside)
Unit 20	☼	☼					
Unit 21	☼	☼					
Unit 22	☼	☼					

General production process for Dairy cluster

The units of Gujarat Dairy cluster are basically two types i.e. Milk Chilling Centers & Dairies. The process at milk chilling center is basically to collect the milk, segregation based on type of animal (cow or buffalo), weighing, Quality study, milk chilling & dispatch to mother dairy.

While the process at mother dairy comprises of various products mix such as packaged milk, curd, butter, butter milk, Ghee, Various types of milk powder etc.

Process Diagram for Typical Milk Chilling Center



Milk collection process involves Grading, Weighing (Milk is recorded in Kgs), Chilling, Dumping, Sampling, Loading in Tanker & dispatch to main processing plant. Most of the chilling centers are located in remote villages to collect the milk from various local 'Mandalis'. Now a days a new trend of providing BMC (Bulk Milk Storage) is emerging. These give added advantages of directly preserving milk even in small space. At few places even BMC are further divided in small numbers & placed in various remote places.

Pasteurization

Pasteurization is the process that purifies milk and helps it stay fresher, longer. Milk is pasteurized by heating it to 72°C for 16 seconds then quickly cooling it to 4°C. Pasteurization is named after Louis Pasteur, the famous scientist who discovered that the process destroyed bacteria that naturally develops in raw milk. By destroying the bacteria, milk becomes safe to drink and holds its delicious flavor for much longer.

Homogenization

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 Milk

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 freshest.

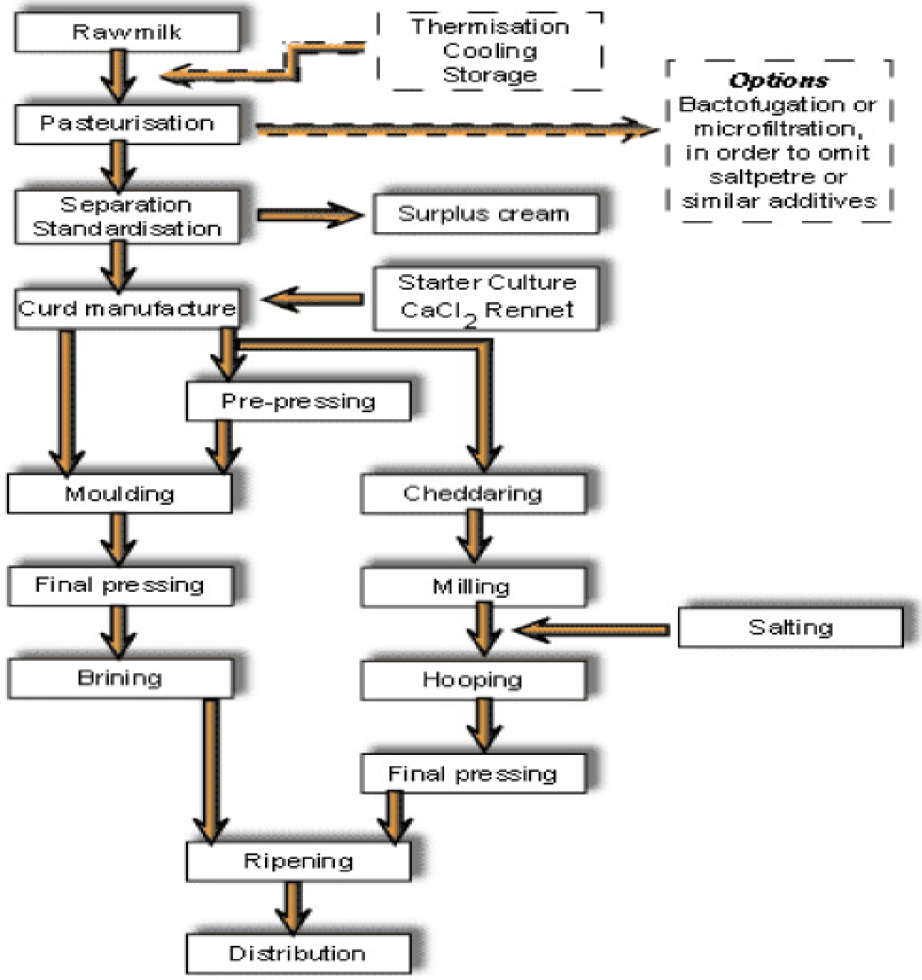
Cream Extraction & Butter

Milk cream is extracted from Milk using centrifuge. The butter making process involves quite a number of stages. The continuous butter maker has become the most common type of equipment used. The cream can be either supplied by a fluid milk dairy or separated from whole milk by the butter manufacturer. The cream should be sweet (pH >6.6, TA = 0.10 - 0.12%), not rancid and not oxidized. If the cream is separated by the butter manufacturer, the whole milk is preheated to the required temperature in a milk pasteurizer before being passed through a separator. The cream is cooled and led to a storage tank where the fat content is analyzed and adjusted to the desired value, if necessary. The skim milk from the separator is pasteurized and cooled before being pumped to storage. It is usually destined for concentration and drying. From the intermediate storage tanks, the cream goes to pasteurization at a temperature of 95oC or more. The high temperature is needed to destroy enzymes and micro-organisms that would impair the keeping quality of the butter.

Cheese

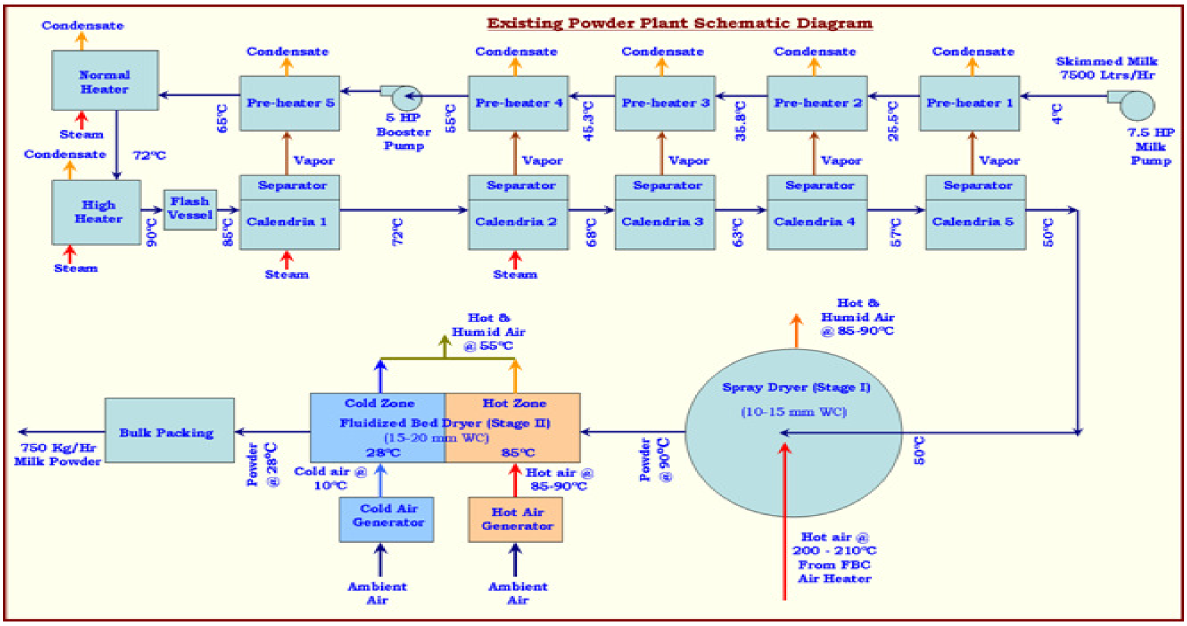
Cheese is an important product of fermentative lactic acid bacteria. Due to its reduced water content, and acidic pH, bacterial growth is severely inhibited.

Cheese Manufacturing Process

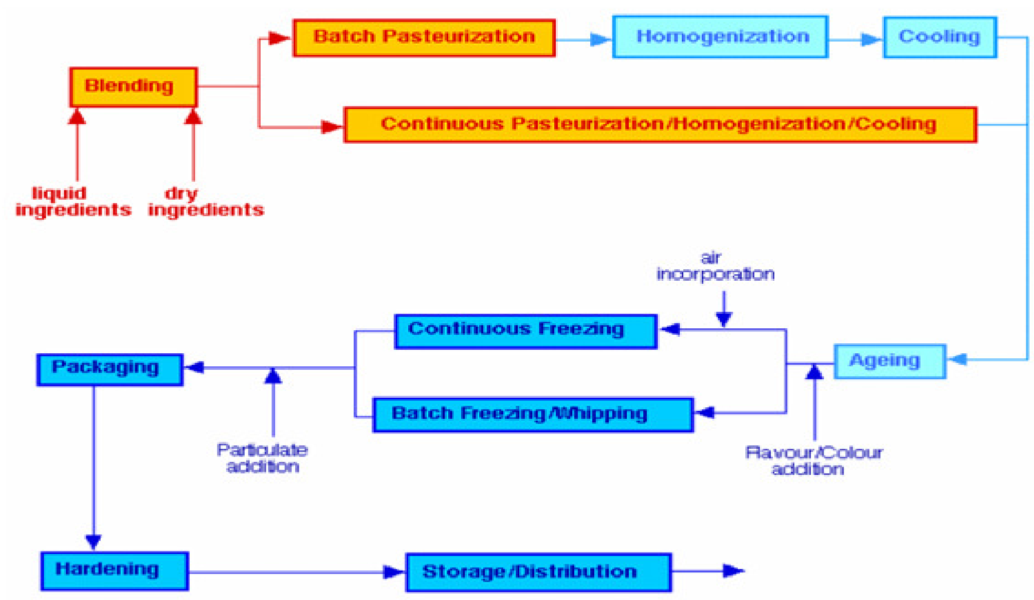


Milk Powder

Skimmed Milk powder, Whole milk powder, baby food etc are various types of milk powder processes employed in units of dairy.



Ice Cream: The Ice cream process can be briefly explained from sketch below.



1.2 Energy performance in existing system

1.2.1 Fuel consumption

Average fuel and electricity consumption in a typical Gujarat Dairy Cluster unit is given in Table 1.4 below:

Table 1.4 Average fuel and electricity consumption

a) On Mcal Basis

Energy Type	Unit	Monthly Average Consumption	Monthly Consumption in MCal
Electricity	kWh	1539108	1323632.9
NG	SCM	597934	5381406.0
FO	Ltrs	141855	1489477.5
Total	MCal	-----	8194516.4

b) On Cost Basis

Energy Type	Average Monthly Consumption
Electricity	9988810.92
NG	4783472
FO	4113795
Total in Rs.	18886078

1.2.2 Average annual production

Annual production in terms of liters per/year is taken in case of Milk and Milk products solids and semi solids are in their liter equivalent are given in the following Table 1.5 below:

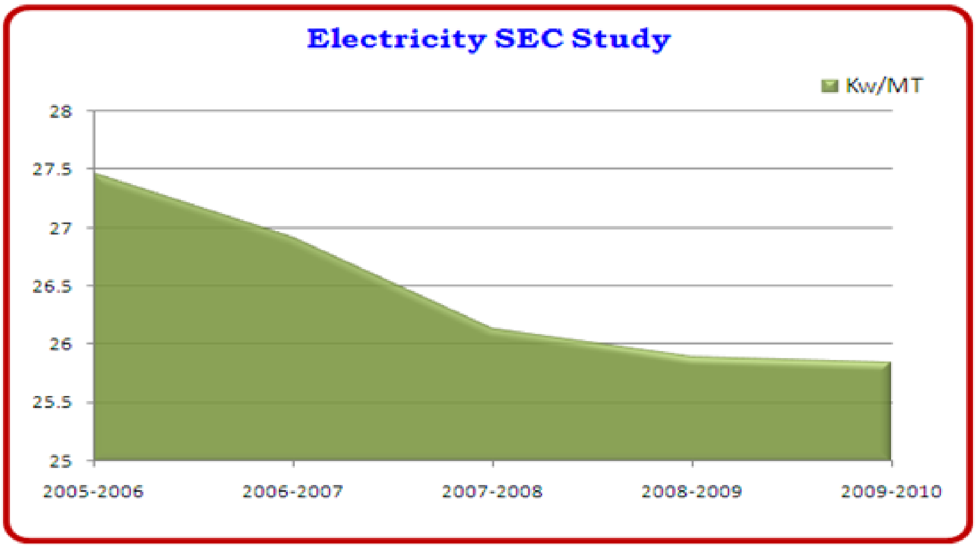
1.2.3 Specific energy consumption

In dairy industry the specific energy consumption individual product wise cannot be maintained due to wide range of production mix variation depending on market condition, season and availability of Milk etc. The specific power consumption of dairy industry is continuously decreasing day by day.

Table 1.5 Average annual production

Month	Butter	Ghee	Paneer	Khoa	Masti Dahi	Shrikhand	Amul Kool	S.M.P.	W.M.P.	Amulya	A.S.P.	White Butter
Apr-08	575978	189680	256118	1584	513452	143034	54316	173702	0	119587	1448676	0
May-08	507932	207837	249070	2194	534548	139859	112387	136202	197120	168263	1357065	0
Jun-08	364098	218436	221571	6272	428235	102749	79282	181035	156395	130695	1111404	0
Jul-08	286876	261851	140133	10430	465042	59437	20395	79653	156670	131594	872464	0
Aug-08	339197	286478	182647	25238	471037	171928	38304	179587	0	174919	1228071	0
Sep-08	491342	130691	211473	26482	476500	127843	0	188894	0	176953	1279321	0
Oct-08	417499	249239	243018	15382	565186	89376	47505	151032	0	65639	1692232	0
Nov-08	641696	242069	199052	4160	471105	89793	46766	324071	0	108567	1279682	0
Dec-08	886070	276967	265026	2004	462144	83644	10531	673321	0	123342	1180249	20500
Jan-09	850727	332264	224976	3952	461303	80787	21811	755462	0	80019	1236977	148035
Feb-09	792976	216979	230908	1238	436874	189645	4570	444278	70560	76862	1190432	48510
Mar-09	830203	242737	246304	768	619591	260349	64675	280888	0	89862	1711364	0
Apr-09	592886	232994	241562	9268	729099	159234	42346	247185	0	114262	1469411	10740
May-09	343760	202062	222580	6238	756364	193894	49075	206245	0	127661	1385012	0
Jun-09	190937	196763	259340	2430	717423	106483	59928	139687	0	81213	854819	0
Jul-09	267301	302857	57230	7104	663288	120180	10862	21075	0	15541	646280	0
Aug-09	360404	150111	142175	21386	729928	159988	16555	55147	0	92258	1024997	0
Sep-09	326550	256971	138200	15868	593518	98544	30619	100520	0	31009	999004	6150
Oct-09	503432	228263	180021	20136	620770	93232	32362	170815	0	72966	1404444	0
Nov-09	582951	243360	162538	3564	486056	44187	17453	288975	0	197931	1650920	0
Dec-09	563161	243172	213106	3126	481483	97244	45336	323287	0	81506	1576643	147630
Jan-10	941065	184012	236080	5884	459258	86421	57922	315275	0	46227	1663932	37605
Feb-10	818991	181823	197486	8352	487500	174375	57158	286889	0	108915	1458871	5220
Average	542436	229462	205244	8829	549118	124879	40007	248836	25250	105034	1292273	18452

Electricity SEC Study in Dairy Cluster over Past Few Years



Thermal Energy SEC Study in Dairy Cluster over Past Few Years

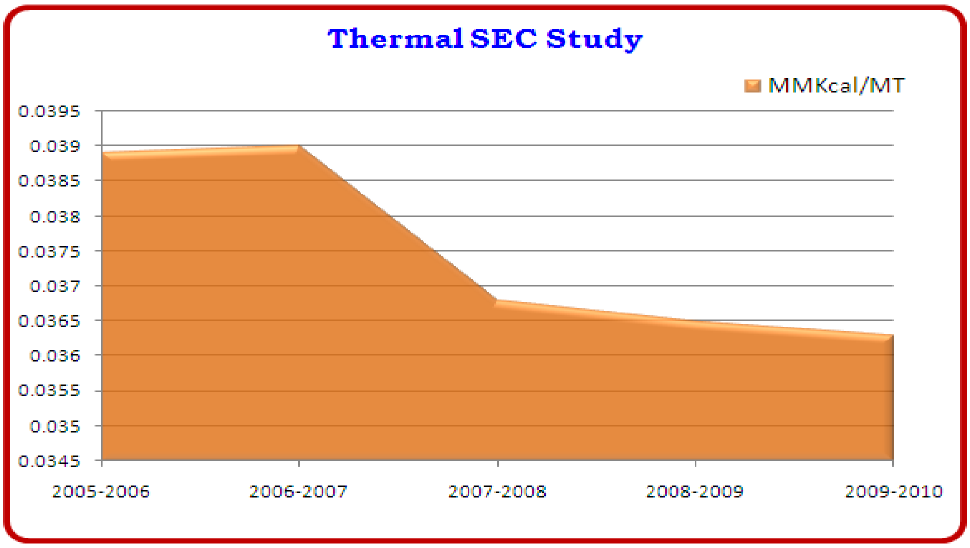


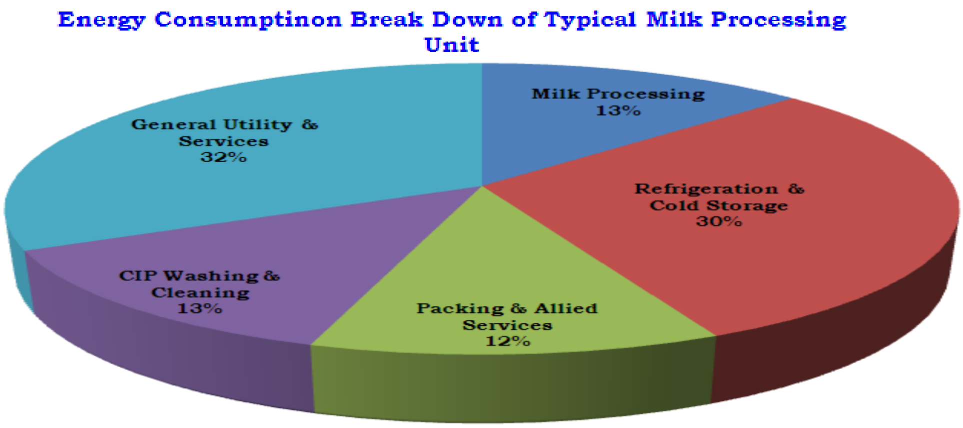
Figure 1.1 SEC Study in Dairy Cluster over Past Few Years

Process (Main Equipments) wise cost of energy consumption

The specific energy consumption of the typical Industry is as given in Table 1.6 below-

Table 1.6 Process wise (Main Equipment) wise cost of energy consumption

S.No.	Process Name	% age of Cost
1	Milk Processing	13
2	Refrigeration & Cold Storage	30
3	Packing & Allied Services	12
4	CIP Washing & Cleaning	13
5	General Utility & Services	32



1.3 Existing technology/equipment

1.3.1 Description of existing technology

In Dairy cluster, refrigeration system consumed at least 30% of total energy consumption. All the units are employing vapor compression based ammonia cycle for refrigeration requirements. The main purpose of providing de-super heater is to extract this consumed energy back by way of waste heat recovery for use full utilization.

The refrigeration system typically comprises of the following:-

- A reciprocating refrigeration compressor for compressor refrigerant gas from the evaporator.
- A condenser heat exchanger for condensing high pressure high temperature discharge from the compressor.
- A cooling tower for supplying cooling water to the condenser. Alternatively, instead of a condenser & cooling tower, an atmospheric condenser is installed at a number of chilling centers.
- An ice bank tank for heat storage. The condensed refrigerant (ammonia) is sent to an accumulator from the receiver. The ammonia is expanded in expansion valves for sending low pressure low temperature ammonia to the cooling coils in the ice bank tank.

Belt driven agitators are used for homogenizing the chilled water temperature in the ice bank tank.

- Chilled water is circulated by a chilled water pump to the milk chiller for reducing the temperature of raw milk from ambient to 6 – 8 deg c.
- The chilled water return from the milk chiller is around 15-20 deg c depending on the milk: chilled water circulation ratio. Ammonia pre-chiller is installed to pre-chill the chilled water from 15-20 deg c to 8 – 12 deg c. The chilled water temperature difference achieved in the ammonia pre-chiller is 6 – 8 deg c.
- The refrigeration system is typically operated for 3 hours during morning milk receiving & 3 hours during evening milk receiving.

Energy charges

Table 1.7 Energy charges

S. No.	Contract Demand, KVA	Energy Charges, Rs. /KWh
1	Upto 1000	3.85
2	From 1001 to 2500	4.05
3	Above 2500	4.15

Demand Charges

Table 1.8 Demand charge

Sr. No.	Billing Demand, KVA	Demand Charges, Rs. /KVA
1	For first 500	98
2	For next 500	139
3	For next 1500	208
4	Billing demand in Excess of 2500	237
5	Billing Demand Excess of contract demand	369

Therefore, total electricity Charges (including the maximum demand charges & other taxes) is **Rs. 5.98 per kWh** in considered case viz. Kadi Milk Chilling Center.

1.3.2 Role in process

The refrigeration system is the heart of the chilling centre. The very purpose of the chilling centre is to chill the raw milk received from distant societies & transport it to the main dairy. Thus the refrigeration system is fundamental to the operation of the chilling centre. The main purpose of providing de-super heater is to extract this consumed energy back by way of waste heat recovery for use full utilization. De-super heater to be provided on Reciprocating Chiller system to harness waste heat of NH_3 gas. De-super heater is installed on discharge side of NH_3 compressor.

1.4 Baseline establishment for existing technology

Typical Unit 1 is large capacity milk chilling center. Milk from nearby areas is delivered to this centre for cooling and pasteurization. Part of the collected milk is pasteurized and is sent to various consumers, whole sellers & milk traders.

This plant on an average receives 200000 Liters/Day of raw milk from the nearby areas. Currently per annum 808956 kWh are consumed & FO consumption is 105972 Kg/Annum. The FO primarily used for hot water requirements for various processes such as pasteurization, CIP requirements etc.

By providing the De-super heater the Electricity consumption (indirectly FO consumption) will be reduced to certain extent.

The heat pumped out from system where lower temperature are desired, is not utilized & thrown in to atmosphere.

- Hot water requirement of dairy industry is considerable for various requirements such as CIP, preheated water for boiler/hot water generator, pasteurization etc. Currently the hot water demand is met by special hot water generator/boiler.
- Almost 12-14% of energy spent on refrigeration system (which is major consumer of energy for milk chilling centers/dairies) can be recovered by provision of de-super heater.
- Also not recovering waste heat by de-super heater results in adding heat load on water cooling system. The extra energy in cooling water along with extra need of cooling water is required if waste heat not recovered.

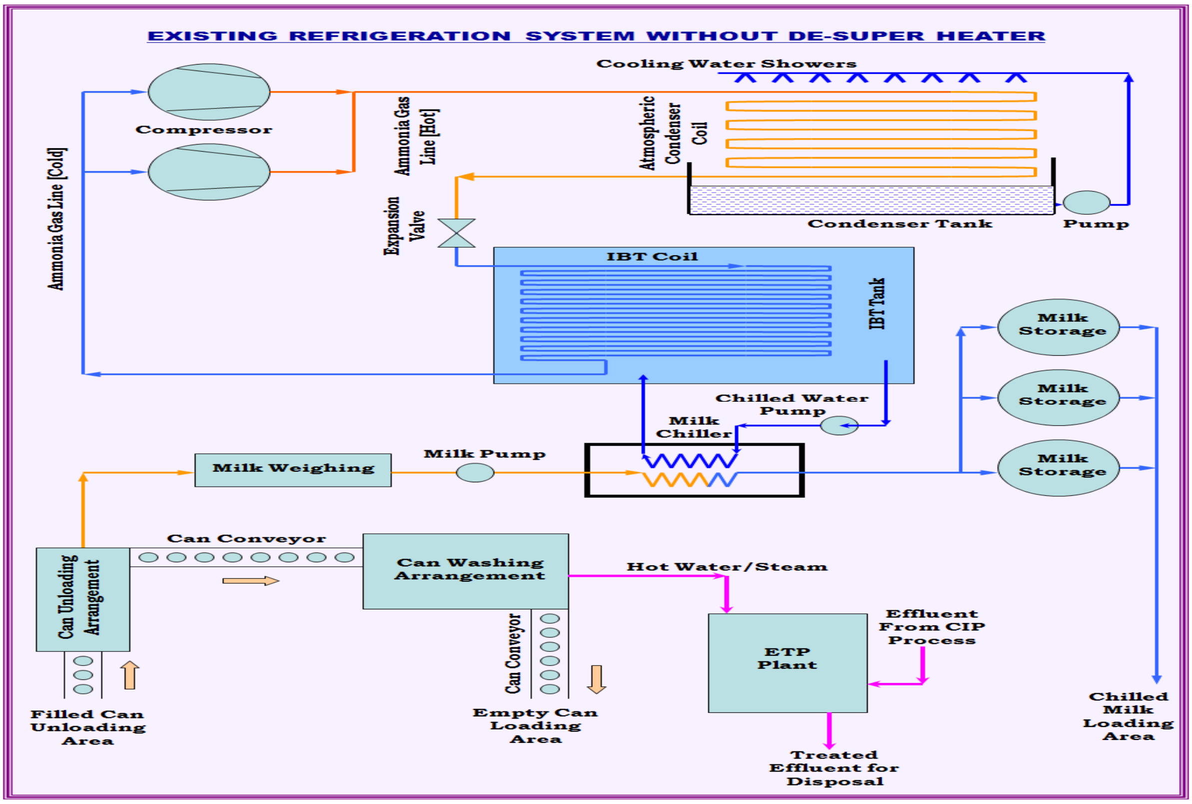
Considering all above points, at least 10% to 14% of energy consumed by refrigeration system can be recovered by provision of De-super Heater.

Table 1.9 Baseline Establishment

Ammonia Compressor Particulars	Model	Motor Rated kW	Measured kW	Rated TR
Chilled Water Section Comp. No.1	KC-3	56	48.8	45
Chilled Water Section Comp. No.2	SRA-300	56	47.5	45
Total		***112***	***96.3***	***90***

1.4.1 Design and operating parameters

The existing most of the Milk chilling center / Dairies are not provided with De-super heater.



1.5 Barriers in adoption of proposed equipment

1.5.1 Technological barrier

In Gujarat Dairy Cluster, overall technical understanding on Dairy product manufacturing is good and rapidly increasing. Many of the dairy engineers/managers are well informed and ready to adopt new technology. It has been observed that at cluster level there is committed interested for leadership and following up is quick. In general, there is readiness to adopt provided delivery, outcome and results are demonstrated.

However the first change is still a challenge, upon success, later on duplication and adaptation is extremely prevalent in the cluster. The technologies need to be demonstrated within the cluster. While carrying out the audits and presenting the Energy audit reports to the units, in the discussion with the plant owners & other personnel, many of them agreed with many of the identified energy saving measures and technologies but they demanded demonstration of the energy saving technologies in any plant and thereafter they have readiness to follow.

Milk chilling centers and dairy plants are using conventional technology. The design and operation of the plant is standardized as per old practices. It was fine, till energy was available relatively cheap and there was no global drive to better energy management.

While carrying out the audits and presenting the Energy audit reports to the units, it was found that significant energy can be saved by provision of De-super heater system. And hence there is a need for a better technology for efficient energy management.

1.5.2 Financial barrier

Availing finance is not the major issue. Among the SMEs, the larger units, if convinced are capable of either financing it themselves or get the finance from their banks. The smaller units will require competitive loan and other support to raise the loan. However as most of them have been able to expand their setup and grow, there is readiness to spend for energy efficiency technologies which have good returns. Energy Efficiency Financing Schemes such as SIDBI's, if focused on the cluster, will play a catalytic role in implementation of identified energy conservation projects & technologies.

The cluster has significant potential of technological upgradation. However though there are good returns, this project is highly capital intensive and requires support of policy as well as innovative financial mechanisms. CDM needs to be duly applied to generate additional cash flow to further improve the returns from the project.

1.5.3 Skilled manpower

In Gujarat Dairy cluster, the availability of skilled manpower is one of the problems due to more number of units. Local technical persons available at individual location take care of maintenance or repair works of major equipments. Maintenance or repair work of major equipments of Dairy cluster units like ammonia compressors, hot air generators for spray dryers etc, are generally look after by the equipment suppliers itself as they station one of their experienced technical representatives at Ahmadabad for the maintenance work.

Specialized and focused training of the local service providers on better operation and maintenance of the equipments, importance of the energy and its use and energy conservation measures will improve awareness among the unit owners and workforce. Original equipment suppliers should also participate in these programs.

1.5.4 Other barrier (If any)

Due to high TDS In the area & due to high iron contain in water, the scaling can be a problem due to certain extent. To overcome the problem the de-super heater system provided with water softening arrangement.

2. PROPOSED EQUIPMENT FOR ENERGY EFFICENCY IMPROVEMENT

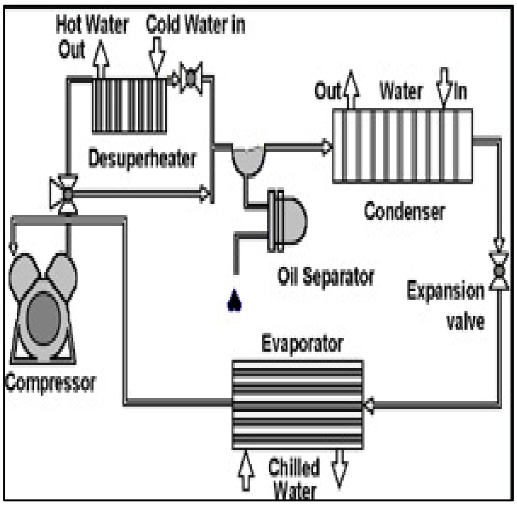
2.1 Description of proposed equipment

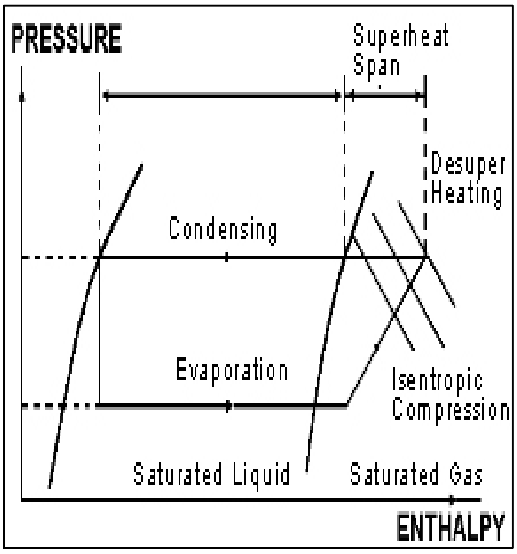
De-super heaters are heat recovery heat exchangers that can generate hot water / hot fluid up to a maximum temperature of 50°C without any increase in the operating cost of the chillers. The heat recovery is virtually at very low operating cost, alternately meaning a substantial increase in the efficiency of the water chiller. The amount of heat thus recovered is a direct saving.

Saving Potential from Various Refrigeration System is mentioned as below-

Table 2.1 Saving Potential

Compressor Type	Discharge Temperature
Screw (Indirect cooled)	70 to 80°C
Screw (Injection cooled)	50 to 60°C
Reciprocating	85 to 110°C
Boosters (Rotary & Reciprocating)	75 to 85°C



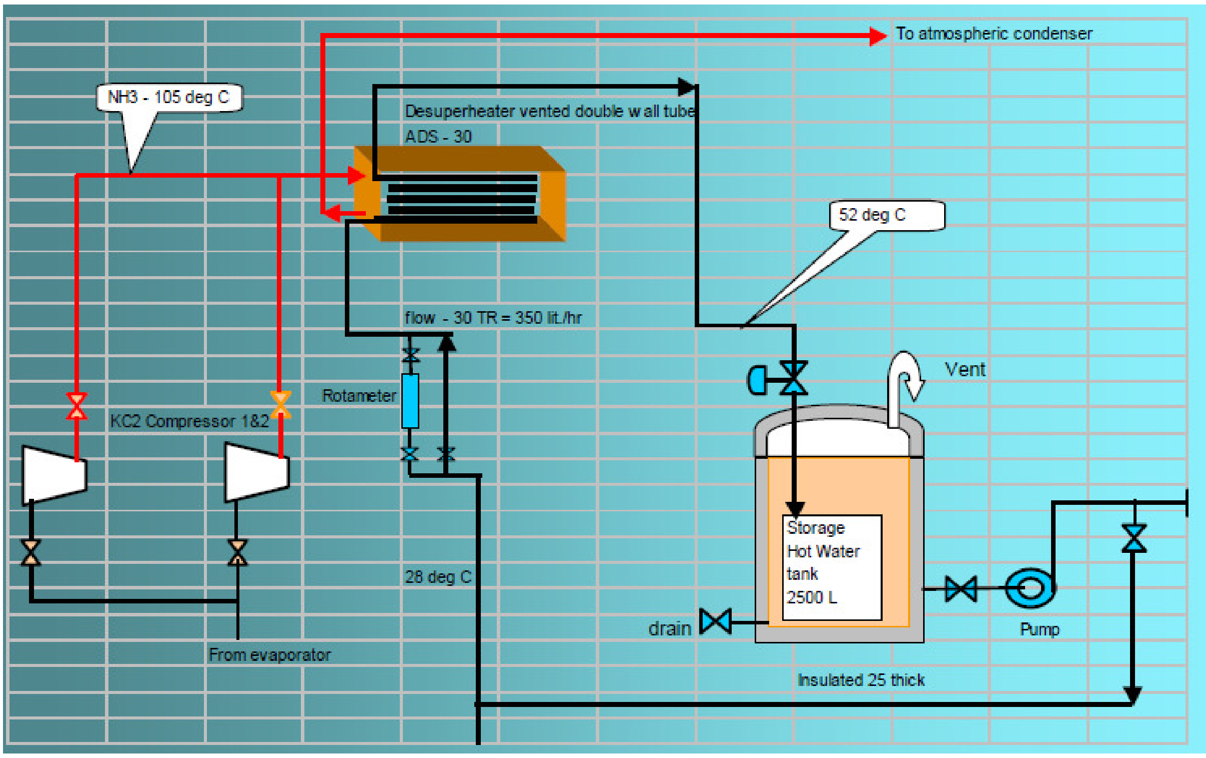


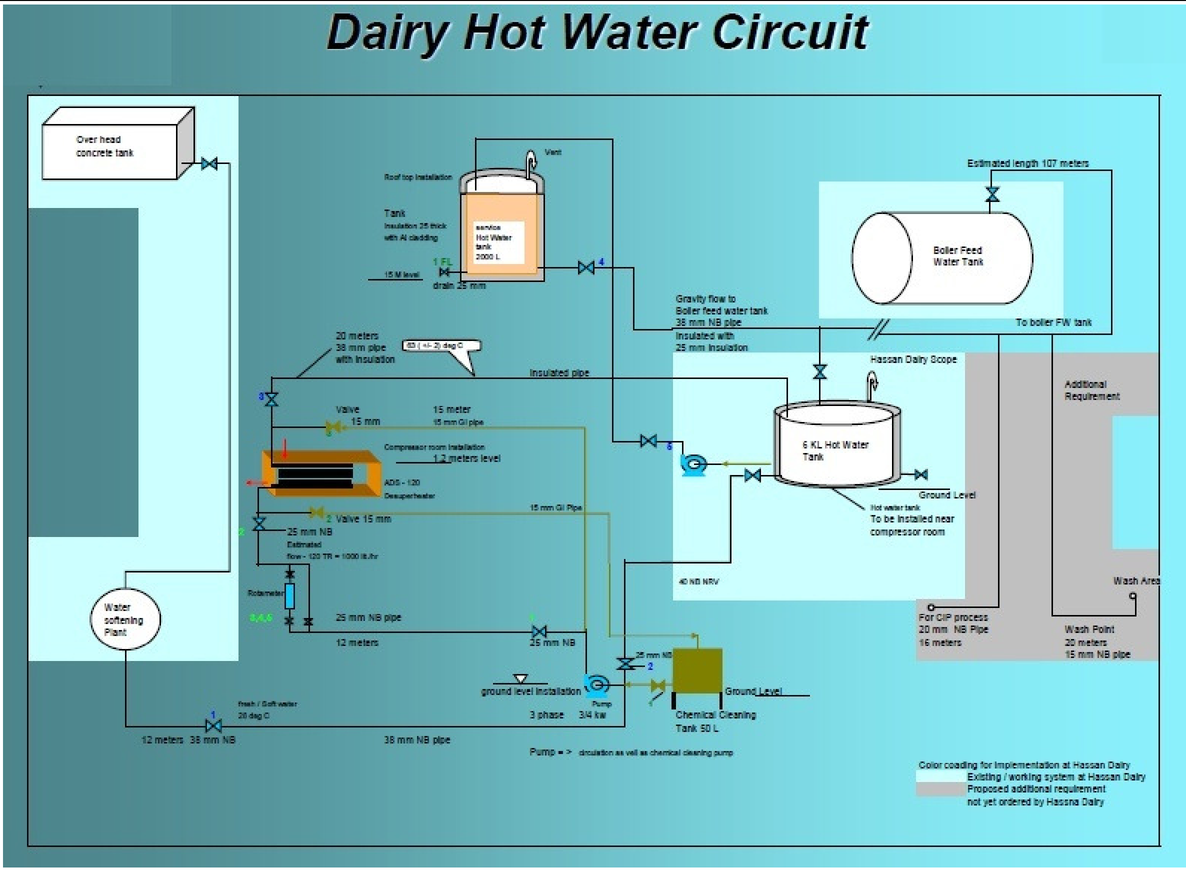
The temperature of the high pressure ammonia discharge from the compressor is at over 100 deg c. The de-super heater (proposed) is a heat exchanger to be installed between the compressor & the condenser.

2.1.1 Detailed of proposed equipment

De-super heater to be provided on Reciprocating Chiller system to harness waste heat of NH_3 gas. De-super heater is installed on discharge side of NH_3 compressor. The temperature of NH_3 gas observed to be 92 to 95ºC. It is standard practice to harness 12 to 15% of Waste heat rejected in condenser by providing De-super heater. The arrangement of de-super heater can be by providing PHE or in case of small reciprocating NH_3 compressor by providing shell and tube type heat exchanger. The hot water temperature can be maintained up to 70ºC by proper design of de-super heater along with maintaining flow rate. Apart from the direct energy saving after getting hot water, the heat load on condensing coil or cooling system will be reduced which will further open possibilities of downgrading the cooling water pumps.

The energy saving considered for implementation of De-super heater measure is 14% (Only direct saving is considered. Though when de-super heater is provided, down grading of condenser pump can be done or overall performance of condenser will enhance resulting in increased in COP of refrigeration system. The hot water can be used for heating makeup water for boiler, for CIP requirements and other process heating purpose.





2.1.2 Equipment/technology specification

As the two numbers of 45 TR rated refrigeration systems are provided in this capacity, de-super having capacity i.e. 50 TR can be provided for each of two compressor system.

Consisting of De super heater unit and its accessories, Changes in ammonia piping, Insulated hot water piping 100 meters, Installation, built in provision for chemical cleaning for de super heater system, Hot water tank 5 kilolitre capacity, DM plant / soft water plant for water quality, 10 kilolitre soft water storage capacity, connected cold water piping, Pumps, and instruments required for system.

Technical Specification considered

Type	Tube in Tube type Heat Exchanger
AC Compressor Outlet Temp °C	120°C (+/-5°C)
Estimated Water Outlet Temp °C	28/57°C (+/-2°C)
MOC Gas Tube / Water Tube	ASTM-A179MS / SS 304 Seamless
Test pressure Gas Side	25 kg/cm²
Test pressure Water Side	8 kg/cm²
Other Standard Mountings & accessories	De-super heater & support structures, Water flow measuring rotameter, Temperature indicators, base frame etc.
Ambient Water Temperature	30°C

Type	Tube in Tube type Heat Exchanger
Hot water expected Temperature	91°C

2.1.3 Integration with existing equipment

It is proposed that De-super heater will be installed in series to existing system. There is no problem expected in installing & integration of de-super heater with the existing system.

The following are the reasons for selection of this technology

- The proposed system does not consume additional space.
- It will reduce the total operating energy cost of the plant.
- It reduces the GHG emissions
- The cooling load on cooling tower/evaporative cooling system will be reduced.
- It is a clean technology.

2.1.4 Superiority over existing system

Use of this technology reduces the overall plant energy cost. It also reduces the dependency for electricity on the state electricity grid. The proposed measure bears better technology than the existing one results both energy saving & technological up gradation. Also water softener arrangement provided which will help to reduce the scaling in the plant.

2.1.5 Source of equipment

The recommended technology is proven one and in various industries on normal basis. These are running successfully and the unit owners had observed the savings in terms of energy.

2.1.6 Availability of technology/equipment

Suppliers of this technology are available at local level as well as at international level very easily. Even most of the suppliers took initiative and interacting with the dairy unit owners for creating the awareness of use of this technology.

2.1.7 Service providers

Details of technology service providers are shown in Annexure 7.

2.1.8 Terms and conditions in sales of equipment

The suppliers have already extended standard warrantee conditions for exchange, replace or repair against manufacturing defects for a period of 12 months after the date of commissioning. Promoters will have to promptly notify the supplier in writing of obvious defects or deficiencies after detection thereof. Replaced parts shall become the property of the supplier upon request of the supplier.

Supplier is not liable or defects or deficiencies which are resulting from the following reasons, as long as they are not resulting from a default of Supplier: Improper, unsuitable or negligent use, handling and/or operation of the system by promoters or by third parties; use of spare parts other than Genuine Parts; normal wear and tear; use of unsuitable consumables (such as, fuel, oil cooling liquid or any other consumables), particularly the use of consumables not conciliated in the operation manuals; improper building ground; chemical, electro- chemical or electric influences.

All conditions associated with this system are standard in nature. No special clause is incorporated. The conditions are very common in most of the plant & machinery sales.

2.1.9 Process down time

Process down time of Milk Chilling Unit of about 1 weeks maximum will be required for the interconnection of the De-super heater with the existing system.

2.2 Life cycle assessment and risks analysis

Life of the equipment is about 15 years. Risk involves in the installation of proposed project are as follows:

- Risk involved in delay in implementation of the proposed project is due to the high initial investment cost.

2.3 Suitable unit for implementation of proposed technology

The measure & technology is suitable for the milk chilling center & dairy units under the Gujarat Dairy Cluster & similar units outside cluster. This measure in fact will result in technological up gradation in vital energy consuming area of these units.

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1 Technical benefit

3.1.1 Fuel saving

The Furnace oil saved is about 19047 kg per year on a nominal cost of electricity consumption which is around few hundred of Electricity units per year.

3.1.2 Electricity saving

There is no direct electricity savings, however, at the same time additional electricity consumption would be 2686 kWh annually.

3.1.3 Improvement in product quality

The measures do not have any impact on quality of product ***directly or indirectly***.

3.1.4 Increase in production

Production will be the same as in present.

3.1.5 Reduction in raw material

Raw material consumption is same even after the implementation of proposed technology.

3.1.6 Reduction in other losses

No impact on other losses ***directly or indirectly***.

3.2 Monetary benefits

Implementation of project will result in good, consistent monetary benefit. Total monetary saving is Rs. 5.36 lakh per year. Details of total monetary benefit are given in Annexure 3.

3.3 Social benefits

3.3.1 Improvement in working environment

Use of De-super heater technology in Dairy Industry reduces the energy consumption. This improves efficiency of refrigeration system and reduces CO_2 generation.

3.3.2 Improvement in workers skill

Technical skills of persons will definitely be improved. As the training will be provided by equipment suppliers which improve the technical skills of manpower required for operating of the equipment and also the technology implementation will create awareness among the workforce about energy efficiency and energy saving.

3.4 ENVIRONMENTAL BENEFITS

3.4.1 Reduction in effluent generation

There is no impact in effluent generation due to implementation of the project.

3.4.2 Reduction in GHG emission

Implementation of this technology will reduce the CO_2 emissions. Reduction in CO_2 emissions will be possible due to Energy saving. This project results in reduction of peak demand and uses off-peak electricity. Hence it will help in reducing CO_2 emission to an extent of 65 tonnes per year.

3.4.3 Reduction in other emissions like SO_X

Amount of SO_X will be reduced due to increased efficiency of the plant because better load factor.

4 INSTALLATION OF PROPOSED EQUIPMENT

4.1 Cost of project

4.1.1 Equipment cost

Cost of De-super heater including taxes is ₹ 9.25 Lacs per 50 TR System thus for two 50 TR system the expected investment is ₹ 18.5 Lacs (after considering vendor discount).

4.1.2 Erection, commissioning and other misc. cost

The details of project cost is as given in Table 4.1 given below-

Table 4.1 Details of proposed technology project cost

S.No.	Particulars	Unit	Value
1	Cost of Retrofit/Additional Plan & Machinery	(₹in Lacs)	18.5
2	Detail Engineering, Design & related expenses	(₹in Lacs)	0.625
3	Erection & Commissioning cost	(₹in Lacs)	1.25
4	Cost of civil work	(₹in Lacs)	0.22
6	Custom Clearance & Transportation Charges	(₹in Lacs)	0
7	Import duty	(₹in Lacs)	0
8	Other charges (Including Contingency 10%)	(₹in Lacs)	0.22
9	Total cost	(₹in Lacs)	20.81

4.2 ARRANGEMENTS OF FUNDS

4.2.1 Entrepreneur's contribution

Entrepreneur will contribute 25% of the total project cost i.e. ₹ 5.20 Lakh & financial institutes can extend loan of 75%.

4.2.2 Loan amount.

The term loan is 75% of the total project cost i.e. ₹ 15.61 Lakh, with repayment of 7 years considered for the estimation purpose.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10% which is SIDBI's rate of interest for energy efficient projects. The loan tenure is 7 years excluding initial moratorium period is 6 months from the date of first disbursement of loan.

4.3 FINANCIAL INDICATORS

4.3.1 Cash flow analysis

Profitability and cash flow statements have been worked out for a period of 10 years. The financials have been worked out on the basis of certain reasonable assumptions, which are outlined below.

The project is expected to achieve monetary savings of ₹ 5.36 lakh per.

- The Operation and Maintenance cost is estimated at 2% of cost of total project with 5% increase in every year as escalations.
- Interest on term loan is estimated at 10%.
- Depreciation is provided as per the rates provided in the companies act.

Considering the above mentioned assumptions, the net cash accruals starting with ₹ 2.53 lakh in the first's year operation and ₹13.32 lakh at the end of tenth year.

4.3.2 Simple payback period

The Simple Payback period is about 3.88 years or about 47 months.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be Rs. 2.80 lakh.

4.3.4 Internal rate of return (IRR)

The after tax IRR of the project works out to be 13.38%. Thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 19.77%.

Financial indicator of proposed technology is furnished in Table 4.2 below:

Table 4.2 Financial indicators of proposed technology/equipment

SN	Scenario	IRR	NPV	ROI	DSCR
1	Normal	13.38%	2.80	19.77	1.30

4.4 SENSITIVITY ANALYSIS

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different situations like when there is an increase in fuel savings or decrease in fuel savings. For the purpose of sensitive analysis, two following scenarios has been considered

- Optimistic scenario (Increase in fuel savings by 5%)

- Pessimistic scenario (Decrease in fuel savings by 5%)

In each scenario, other inputs are assumed as a constant. The financial indicators in each of the above situation are indicated along with standard indicators.

Details of sensitivity analysis at different scenarios are shown in Table 4.3 below:

Table 4.3 Sensitivity analysis at different scenarios

SN	Scenario	IRR	NPV	ROI	DSCR
1	Normal	13.38%	2.80	19.77	1.30
2	5% Increase in Fuel Saving	14.79%	4.00	21.14	1.37
3	5% Decrease in Fuel Saving	11.95%	1.59	19.34	1.23

4.5 PROCUREMENT AND IMPLEMENTATION SCHEDULE

Procurement and implementation schedule required for proposed project is 4 weeks in which three weeks be there for order placement and delivery and rest further detailed breakups are shown in Annexure 6.

SN	Activities	Weeks			
		1	2	3	4
1	Order Placement	■			
2	Delivery			■	
3	Foundation & civil work / Gas removal				■
4	Installation				■
5	Testing				■
6	Training				■

Annexure

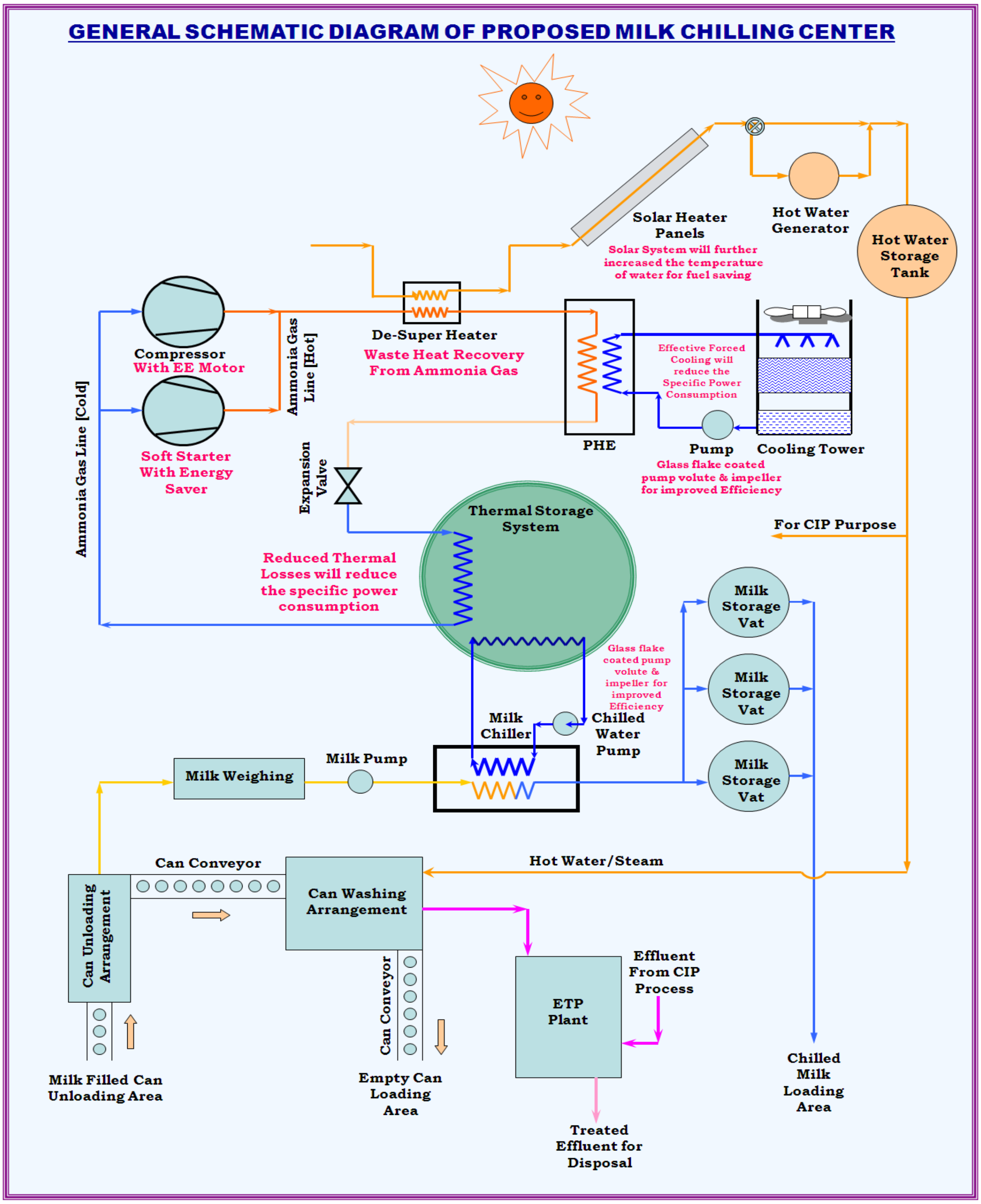
Annexure -1: Energy audit data used for baseline establishment

Considering a typical case of dairy under cluster, the details of consumption of compressor is as given below-

S.No.	Ammonia Compressor Particulars	Model	Motor Rated kW	Measured kW	Rated TR
1	Chilled Water Section Comp. No.1	KC-3	56	48.8	45
2	Chilled Water Section Comp. No.2	SRA-300	56	47.5	45
3	Total	-----	112	96.3	90

Measured actual consumption of 96.3 kW to be considered as base consumption of compressor & the wastage of energy due to non harnessing waste heat from hot compressed ammonia gas is 14% i.e. 13.48kWh & the compressor works for about 20 Hrs per day average.

Annexure -2: Process flow diagram after project implementation



The process flow will not change. The only change will be the ammonia vapor compression system will be provided with De-super heater system.

Annexure -3: Detailed technology assessment report

Currently most of the industries have not provided de-super heater, by provision of De-super heater, considerable amount of energy can be recovered. Different units are using different fuels for generating hot water, to have uniformity in savings, the energy audit team decided to calculate saving on the basis of Furnace Oil. This will give the correct & uniform picture of savings.

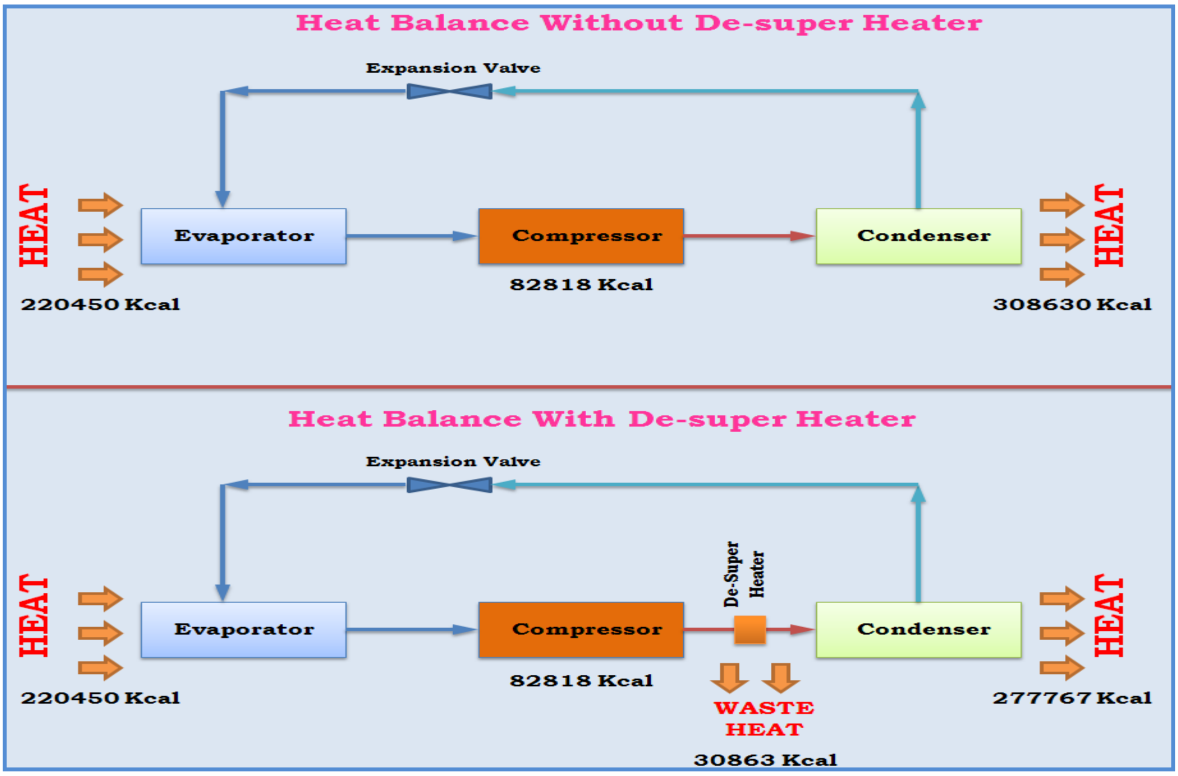
Once the De-super heater system is installed, will result in regular energy saving & in most of the cases of milk chilling center even the requirement of hot water generator will be greatly minimized.

The details of cost benefit analysis are as given below –

S No.	Parameters	Unit	Value
1.	Capacity of Existing VC Cycle Compressor (Working or on-load. But Actual average load may be lower due to load modulation)	TR	72.9
2.	Working Hours for Compressor/Day	Hrs/Day	20
3.	Ambient Water Temperature	ºC	30
4.	Temperature of Hot NH3 Gas available for WHR from De super heater	ºC	93
5.	Waste Heat Available from De super Heater (Considering 14% WHR possible for total heat)	Kcal/Hr	30863
6.	Expected Temperature of Hot water from De-super heater (Considering Flow Rate and Design of De-super heater to get 65ºC hot water for winter conditions)	ºC	60
7.	Heat Transfer Coefficient	%	90
8.	Quantity of Hot Water Available	Ltrs/Hr	925.89
9.	Total Quantity of Hot water that can be generated from De-super heater	Ltrs/Day	18517.8
10.	Thus Total Hot water at 60 ºC can be generated	Kl/Day	18.5178
11.	Cost of FO	Rs./Kg	29
12.	Expected Saving per Day in terms of FO	kg/hr	2.65
13.	Additional Electricity Consumption due to measure (Provision of water pumps for hot water circulation) ***0.5 HP Rated Water Pump***	kWh/Annum	2686
14.	Cost of Electricity	Rs./kWh	5.98
15.	Expected Saving of FO per Annum	kg/Annum	19046.88
16.	Expected Saving per Annum (Considering 360 Working Days) due to reduction in FO consumption for generation of Hot Water	Rs./Annum	552360
17.	Cost due to additional electricity consumption	Rs./Year	16060
18.	Estimated saving potential	Rs./Year	536300
19.	Estimated Investment	₹(in lakh)	20.81
20.	Simple Payback	Year	3.9

S No.	Parameters	Unit	Value
	Simple Payback	Months	47

Heat Balance for De-super Heater		
Without De-super Heater	**Unit**	**Value**
Total capacity of Refrigeration System	TR	72.9
Heat Absorbed (1 TR=3024 Kcal)	Kcal/Hr	220450
Heat Added by Compressor Motor (102.5 kW)	Kcal/Hr	88180
Total Heat Rejected From Condenser	Kcal/Hr	308630
With De-super Heater		
Waste Heat that can be harnessed by De-super Heater is 10-14%	Kcal/Hr	30863
Balance Heat Rejected from Condenser after De-super Heater	Kcal/Hr	277767
Hot water Calculations		
The Heat Available from De-super Heater	Kcal/Hr	30863
Water Inlet Temperature	ºC	30
Water Outlet Temperature	ºC	60
Thus Qty of Hot Water Available	Ltrs/Hr	1029



Annexure -4 Drawings for proposed electrical & civil works

No additional Electrical or civil work is required. Minor civil grouting for pipe support required or minor brackets for pipe line support required. No substantial civil work required.

*For Hot circulation pump, foundation will definitely be required & for support structure for De-super heater system will be required to be grouted either in wall or separate support structure grouting may be required. *

Annexure -5: Detailed financial analysis

1	Name of the Technology	50 TR De-Super Heater System		
2	Rated Capacity	50 TR X 02 Nos		
SN	Details	Unit	Value	Basis
1)	Installed Capacity	TR	100	Feasibility Study
2)	No of working days	Days	360	Feasibility Study
3)	No of Operating Hours per day	Hrs.	20	Feasibility Study
Proposed Investment				
1	Cost of Retrofit/Additional Plan & Machinery For Energy Saving	₹ (in Lacs)	19.13	Feasibility Study
2	Erection & Commissioning cost	₹ (in Lacs)	1.25	Feasibility Study
3	Cost of civil work	₹ (in Lacs)	0.22	Feasibility Study
4	Investment without IDC	₹ (in Lacs)	20.59	Feasibility Study
5	Import duty	₹ (in Lacs)	0	Feasibility Study
6	Other charges (Including Contingency 10%)	₹ (in Lacs)	0.22	Feasibility Study
7	Total Investment	₹ (in Lacs)	20.81	Feasibility Study
Financing Pattern				
1	Own Funds (Equity)	₹ (in Lacs)	5.20	Feasibility Study
2	Loan Funds (Term Loan)	₹ (in Lacs)	15.61	Feasibility Study
3	Loan Tenure	Yrs	7	Assumed
4	Moratorium Period	Months	6	Assumed
5	Repayment Period	Months	90	Assumed
6	Interest Rate	%	10	SIDBI Lending Rate
Estimation of Costs				
1	O & M Costs	% on Plant & Equip	2	Feasibility Study
2	Annual Escalation	%	5	Feasibility Study
Estimation of Revenue				
SN	Details	Unit	Value	Basis
1.	Fuel saving	Tons/Year	19047	
2.	Cost of Fuel	₹/ Ton	29	
3.	Electricity consumption	kWh/year	2686	
4.	Cost	₹/Annum	5.98	
5	St. line Depn.	%age	5.28	Indian Companies Act
6	IT Depreciation	%age	80	Income Tax Rule
7	Income Tax	%age	33.99	Income Tax Rule

Estimated Interest on Term Loan				
Yrs	Opening Balance	Repayment	Closing Balance	Interest
1	15.61	0.60	15.01	1.81
2	15.01	1.20	13.81	1.45
3	13.81	1.40	12.41	1.32
4	12.41	1.80	10.61	1.16
5	10.61	2.40	8.21	0.95

6	8.21	2.60	5.61	0.72
7	5.61	3.20	2.41	0.43
	2.41	2.41	0.00	0.08
	TOTAL	15.61		

WDV (Written Down Value) Depreciation

Particulars / years	**1**	**2**
Plant and Machinery		
Cost	20.81	4.16
Depreciation	16.65	3.33
WDV	4.16	0.83

Projected Profitability

Particulars / Years	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Revenue through Savings										
Fuel savings	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36
Total Revenue (A)	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36
Additional Expenses if Any										
O & M Expenses	0.42	0.44	0.46	0.48	0.51	0.53	0.56	0.59	0.61	0.65
Total Expenses (B)	0.42	0.44	0.46	0.48	0.51	0.53	0.56	0.59	0.61	0.65
PBDIT (A)-(B)	4.95	4.93	4.90	4.88	4.86	4.83	4.81	4.78	4.75	4.72
Interest	1.81	1.45	1.32	1.16	0.95	0.71	0.42	0.08	0.00	0.00
PBDT (Profit Before Depreciation & Tax)	3.13	3.48	3.58	3.72	3.90	4.12	4.38	4.70	4.75	4.72
Depreciation	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
PBT (Profit Before Tax)	2.03	2.38	2.48	2.62	2.80	3.02	3.28	3.60	3.65	3.62
Income tax	0.00	0.05	1.22	1.27	1.33	1.40	1.49	1.60	1.61	1.60
Profit after tax (PAT)	2.03	2.33	1.26	1.36	1.48	1.62	1.79	2.00	2.04	2.02

Computation of Tax (in Lacs)

Particulars / Years	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Profit before tax	2.03	2.38	2.48	2.62	2.80	3.02	3.28	3.60	3.65	3.62
Add: Book depreciation	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Less: WDV depreciation	16.65	3.33	-	-	-	-	-	-	-	-
Taxable profit	(13.51)	0.15	3.58	3.72	3.90	4.12	4.38	4.70	4.75	4.72
Income Tax	-	0.05	1.22	1.27	1.33	1.40	1.49	1.60	1.61	1.60

Projected Balance Sheet (in Lacs)

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Liabilities										
Share Capital (D)	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Reserves & Surplus (E)	2.03	4.36	5.63	6.99	8.47	10.09	11.88	13.89	15.92	17.94
Term Loans (F)	15.01	13.81	12.41	10.61	8.21	5.61	2.41	0.00	0.00	0.00
Total Liabilities (D)+(E)+(F)	22.24	23.37	23.24	22.80	21.88	20.90	19.49	19.09	21.12	23.14
Assets										
Gross Fixed Assets	20.81	20.81	20.81	20.81	20.81	20.81	20.81	20.81	20.81	20.81
Less: Accm. Depreciation	1.10	2.20	3.30	4.40	5.49	6.59	7.69	8.79	9.89	10.99
Net Fixed Assets	19.71	18.61	17.51	16.41	15.32	14.22	13.12	12.02	10.92	9.82
Cash & Bank Balance	2.53	4.76	5.73	6.38	6.56	6.68	6.37	7.07	10.20	13.32
TOTAL ASSETS	22.24	23.37	23.24	22.80	21.88	20.90	19.49	19.09	21.12	23.14
Net Worth	7.24	9.57	10.83	12.19	13.67	15.29	17.08	19.09	21.12	23.14
Dept equity ratio	2.88	2.65	2.38	2.04	1.58	1.08	0.46	0.00	0.00	0.00

Projected Cash Flow (in Lacs)

Particulars / Years	0	1	2	3	4	5	6	7	8	9	10
Sources											
Share Capital	5.20	-	-	-	-	-	-	-	-	-	-
Term Loan	15.61										
Profit After tax		2.03	2.33	1.26	1.36	1.48	1.62	1.79	2.00	2.04	2.02
Depreciation		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Total Sources	20.81	3.13	3.43	2.36	2.46	2.58	2.72	2.89	3.10	3.13	3.11
Application											
Capital Expenditure	20.81										
Repayment of Loan	-	0.60	1.20	1.40	1.80	2.40	2.60	3.20	2.41	0.00	0.00
Total Application	20.81	0.60	1.20	1.40	1.80	2.40	2.60	3.20	2.41	0.00	0.00
Net Surplus	-	2.53	2.23	0.96	0.66	0.18	0.12	-0.31	0.69	3.13	3.11
Add: Opening Balance	-	-	2.53	4.76	5.73	6.38	6.56	6.68	6.37	7.07	10.20
Closing Balance	-	2.53	4.76	5.73	6.38	6.56	6.68	6.37	7.07	10.20	13.32

Calculation of Internal Rate of Return (in Lacs)

Particulars / Months	0	1	2	3	4	5	6	7	8	9	10
Profit after Tax		2.03	2.33	1.26	1.36	1.48	1.62	1.79	2.00	2.04	2.02
Depreciation		1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Interest on Term Loan		1.81	1.45	1.32	1.16	0.95	0.71	0.42	0.08	-	-
Cash outflow	(20.81)	-	-	-	-	-	-	-	-	-	-
Net Cash flow	(20.81)	4.95	4.87	3.69	3.62	3.53	3.43	3.32	3.18	3.13	3.11
IRR	13.38%										
NPV	2.80										

Break Even Point

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Variable Expenses										
Oper. & Maintenance Exp (75%)	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48
Sub Total (G)	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48
Fixed Expenses										
Oper. & Maintenance Exp (25%)	0.10	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.15	0.16
Interest on Term Loan	1.81	1.45	1.32	1.16	0.95	0.71	0.42	0.08	0.00	0.00
Depreciation (H)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Sub Total (I)	3.02	2.65	2.54	2.38	2.18	1.94	1.66	1.32	1.25	1.26
Sales (J)	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36	5.36
Contribution (K)	5.05	5.04	5.02	5.00	4.98	4.96	4.94	4.92	4.90	4.88
Break Even Point (L= I/K)	59.72%	52.71%	50.55%	47.54%	43.72%	39.09%	33.60%	26.82%	25.55%	25.83%
Cash Break Even ={(I)-(H)}/K	37.96%	30.89%	28.66%	25.58%	21.68%	16.96%	11.38%	4.51%	3.14%	3.31%
Break Even Sales (J)*(L)	3.20	2.83	2.71	2.55	2.34	2.10	1.80	1.44	1.37	1.39

Return on Investment

Particulars / Years	1	2	3	4	5	6	7	8	9	10	Total
Net Profit Before Taxes	2.03	2.38	2.48	2.62	2.80	3.02	3.28	3.60	3.65	3.62	29.50
Net Worth	7.24	9.57	10.83	12.19	13.67	15.29	17.08	19.09	21.12	23.14	149.22
ROI											**19.77%**

Debt Service Ratio (in Lacs)

Particulars / Years	1	2	3	4	5	6	7	8	9	10	Total
Cash Inflow											
Profit after Tax	2.03	2.33	1.26	1.36	1.48	1.62	1.79	2.00	2.04	2.02	13.89
Depreciation	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	8.79
Interest on Term Loan	1.81	1.45	1.32	1.16	0.95	0.71	0.42	0.08	0.00	0.00	7.90
Total (M)	4.95	4.87	3.69	3.62	3.53	3.43	3.32	3.18	3.13	3.11	30.58

Debt

Interest on Term Loan	1.81	1.45	1.32	1.16	0.95	0.71	0.42	0.08	0.00	0.00	7.90
Repayment of Term Loan	0.60	1.20	1.40	1.80	2.40	2.60	3.20	2.41	0.00	0.00	15.61
Total (N)	2.41	2.65	2.72	2.96	3.35	3.31	3.62	2.49	0.00	0.00	23.51
DSCR (M/N) (Debt service coverage Ratio)	1.81	1.45	1.32	1.16	0.95	0.71	0.42	0.08	0.00	0.00	7.90
Average DSCR	1.30										

Annexure:-6 Procurement and implementation schedule

Day wise break up of implementation Schedule

SN	Activities	Days						
		1	2	3	4	5	6	7
1	Foundation & civil work / Gas removal	■	■					
2	Retrofitting of Pipes		■	■				
3	Testing Hydraulic Pressure				■	■		
4	Instrument connectivity					■		
5	Trial & Testing						■	
6	Training	■	■	■	■	■	■	■

Break up of Process down Time for De-super heater: - Total Max. **7 Days.**

A) Entire Ammonia Gas removal from entire vapor compression system by re-collection in ammonia receiver (already provided in system) = 1.5 Days.

B) Retrofitting of existing pipe section from Ammonia Compressor to condenser with de-super along with pipe arrangement = 1.5 Day.

C) Hydraulic pressure testing of replaced section along with existing relevant sections at 1.5 times the safe working pressure i.e. at 25 kg/cm² = 1 Day.

D) Various instrument & connection of water pipe line to De-super heater = 1 Day.

E) Final inspection from engineer in-charge along with supplier = 6 Hrs.

F) Trial Run of Entire system starting from low pressure to high pressure = 2 Hrs

G) Contingency time for entire operation = 1 Day.

Note :- De-super heater will be designed, fabricated, surface coating, pre-installation testing such as NDT & Hydrostatic pressure testing will be carried well before commencement of actual installation. Proper planning will be done well before commissioning without affecting the working of process.

Note: - The word foundation & civil work is alternatively used for installation & erection (that includes minor/major civil work, grouting required for saddle plates, foundation modification etc). For Hot circulation pump, foundation will definitely be required & for support structure for De-super heater system will be required to be grouted either in wall or separate support structure grouting may be required.

Annexure -7: Details of technology service providers

S.No.	Name of Service Provider	Address	Contact Person and No.
1	Refercon Magic Systems Pvt Ltd	37/3, Vadgaon Khurd, AIROTEK House,, Sinhgad Road, Pune 411 041.	Shri. Vrajlal Kanetkar Ph. 95 20 2439 3418 / 2439 2545 Email: kvrajlal@vsnl.com www.refreconmagic.com
2	Opel Energy Systems Pvt Ltd	Shop No. 12, Anantnagar, Dhankawadi, Pune 411043	Mr.Y.D. Chavan - Mobile :- 9822002047; Ph. No. 020-24377646
3	Modern Refrigeration	70, Anand Vyapari Sankool, Road No.33, Near E.S.I.S Hospital, Wagle Industrial Estate, Thane (West), - 400 604, Maharashtra, India	Mobile : 09324538976, 09967538976, 09324243557

Annexure–8: Quotations or Techno-commercial bids for new technology/equipment

REFRECON MAGIC SYSTEMS PVT. LTD.

37/3, Vadgaon Khurd, AIROTEK House,, Sinhgad Road, Pune 411 041.
Ph. 95 20 2439 3418 / 2439 2545 Email: kvrajlal@vsnl.com www.refreconmagic.com

VVK/PCRA_A'BD/L_001/ 11 Date: 12 March 2011

To,

PCRA,
Ahemedabad.

Kind Attn. Mr. Vijay Bariwal. SRO. PCRA.

Dear Sir,

Subject: Free hot water from refrigeration compressors

This has reference to interaction with Mr. Shashibhushan Agrawal, after workshop at Ahmedabad on 11th March 2011. We understand that this heat recovery will play a good role in reducing operation energy cost at dairy as well as chilling centers. Two models of 50 TR and 215 TR are considered for estimates.

Enclosed is techno-economics of project about energy cost optimization details for desuperheater installation. Hope these projects will be of interest to you and you will take interest in taking up installations in coming year.

As water quality in Gujarat region is a concern it is necessary to install DM plant / water softener to improve water quality to sustain operation of heat recovery system. This makes project pay back little longer but at the same time life of system is also assured.

Please let me know what support you are expecting from us to take-up implementation

We now look forward for further communication from your end.

Thanking you
Yours faithfully

Vrajalal Kanetkar
For Refrecon Magic Systems Pvt. Ltd., Pune

DESUPERHEATER PROJECT ANYLYSIS & ECONOMICS

Free Hot Water generation form Ammonia refrigeration compressor.

	DESCRIPTION	
1	Refrigeration Compressor Nominal capacity in TR /motor HP	1X50 TR
2	No. of compressors operating simultaneously	1 X50 TR
3	Running hours of compressor estimated	16 hrs (50 TR) per day
4	"FREE" Hot water @ 60^0C generated per day	8,000 lit. / day
5	Estimated fuel oil savings per day as free hot water	30 lit./day
6	Annual fuel oil saving in Rs. @ Rs. 40/ lit.	**Rs. 432,000/-**
7	Estimated annual power savings @ Rs. 4.5 per kWh due to improved refrigeration system and reduced condenser water pumping need. Estimate is based on reported data in absence of actual field measurement.	**Rs. 40,000/-** (40 kWh per day ave.)
8	Water saved per month as result of Avoided evaporation in cooling tower	**12,000 lit. / month**
9	1. Better cooling results in improved condenser performance and reduced compressor operation hours for same refrigeration effect. This is more important for plant operation as maintaining ammonia header pressure is a serious problem in summer days. 2. Importance of water savings should be noted in the days of scares water situation when summer days water shortage is at peak.	

	Estimated Utilisation of hot water / day	Quantity of water	Thermal units saved
	a. Boiler feed water b. Crate and can washing c. General cleaning and CIP	3,000 lit. /day 2,000 lit./day 3000 lit. /day	90,000 kcal/day 60,000 kcal/day 90,000 kcal/day
	Reported use of water is more than hot water generated by desuperheater	8,000 lit./day	240,000 kcal/day
	Utilising hot water as above will reduce use of boiler fuel to equivalent amount. At present burning fuel in boiler generates this hot water.		

	Project investment	
	Estimated Investment for desuperheater system	**Rs. 9,25,000/-**
	Consisting of Desuperheater unit and its accessories, Changes in ammonia piping, Insulated hot water piping 100 meters, Installation, built in provision for chemical cleaning for desuperheater system, Hot water tank 5 kL capacity, DM plant / soft water plant for water quality, 10 kL soft water storage capacity, connected cold water piping, Pumps, and instruments required for system.	

L_PCRA dairy evaluation for 50 TR and 215 TR

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

Petroleum Conservation & Research Association
Office Address :- Western Region
C-5, Keshava Building, Bandra-Kurla Complex; Mumbai – 400051
Website: www.pcra.org

India SME Technology Services Ltd
DFC Building, Plot No.37-38,
D-Block, Pankha Road,
Institutional Area, Janakpuri, New Delhi-110058
Tel: +91-11-28525534, Fax: +91-11-28525535
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