DETAILED PROJECT REPORT
ON
LOW LOSS & COMPACT THERMAL STORAGE TECHNOLOGY (300 TRH)
(GUJARAT DAIRY CLUSTER)










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Bureau of Energy Efficiency

Prepared By

PCRA
पी. सी. आर. ए.

Reviewed By

ISTSL

LOW LOSS & COMPACT THERMAL STORAGE TECHNOLOGY (300 TRH)

GUJARAT DAIRY CLUSTER

BEE, 2010

Detailed Project Report on Low Loss & Compact Thermal Storage System of 300 TRH

Gujarat Dairy Cluster, Gujarat (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.: ***GUJ/DRY/IBT/02***

For more information

Bureau of Energy Efficiency
Ministry of Power, Government of India
4th Floor, Sewa Bhawan, Sector - 1
R. K. Puram, New Delhi -110066

Ph: +91 11 26179699 Fax: 11 26178352
Email: jsood@beenet.in
pktiwari@beenet.in
WEB: www.bee-india.nic.in

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Dr. Ajay Mathur, Director General, BEE

Smt. Abha Shukla, Secretary, BEE

Shri Jitendra Sood, Energy Economist, BEE

Shri Pawan Kumar Tiwari, Advisor (SME), BEE

Shri Rajeev Yadav, Project Economist, BEE

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Petroleum Conservation Research Association

Ahmedabad

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List of Abbreviation

BEE	Bureau of Energy Efficiency
MoMSME	Ministry of Micro Small and Medium Enterprises
DPR	Detailed Project Report
GHG	Green House Gases
CDM	Clean Development Mechanism
DSCR	Debt Service Coverage Ratio
NPV	Net Present Value
IRR	Internal Rate of Return
ROI	Return on Investment
WHR	Waste Heat Recovery
SCM	Standard Cubic Meter
MW	Mega Watt
SIDBI	Small Industrial Development Bank of India
MT	Million Tonne
DSH	De-super Heater

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 Low loss & compact 300 TRH thermal storage technology refrigeration system would save about 71640 kWh of electricity per year.

This DPR highlights the details of the study conducted for the use of proposed technology, 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)	14.87
2	Expected Electricity Savings	kWh/annum	71640
3	Expected Additional Fuel Consumption	Liters /year	0

S.No	Particular	Unit	Value
4	Monetary benefit	(Rs. in Lakh)/annum	4.28
5	Debit equity ratio	Ratio	3:1
6	Simple payback period	Yrs	3.48
7	NPV	(Rs. in Lakh)	3.86
8	IRR	%age	16.40
9	ROI	%age	20.64
10	DSCR	Ratio	1.49
11	Process down time	Days	14

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 / Tea Milk
2) Tetra Pack Milk / Flavored Milk
3) Butter Milk
4) Curd
5) Milk Cream
6) Butter / Ghee
7) Paneer / Cheese
8) Skimmed Milk Powder
9) Whole Milk Powder
10) Baby Food (Milk Powder Based)
11) Ice Cream / 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	☼	☼					
Unit 7	☼	☼					
Unit 8	☼						
Unit 9	☼						
Unit 10	☼					☼	

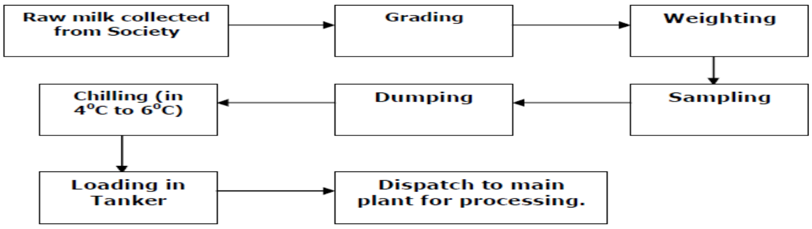
Unit 11	☼	☼					
Unit 12	☼	☼					
Unit 13	☼			☼			
Unit 14	☼			☼			
Unit 15	☼	☼					
Unit 16	☼	☼	☼				
Unit 17	☼			☼			
Unit 18	☼	☼	☼				☼ (Castor DOC)
Unit 19	☼			☼ (Saw Mill Dust)			☼ (Steam from Outside)
Unit 20	☼	☼					
Unit 21	☼	☼					
Unit 22	☼	☼					

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 day 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.

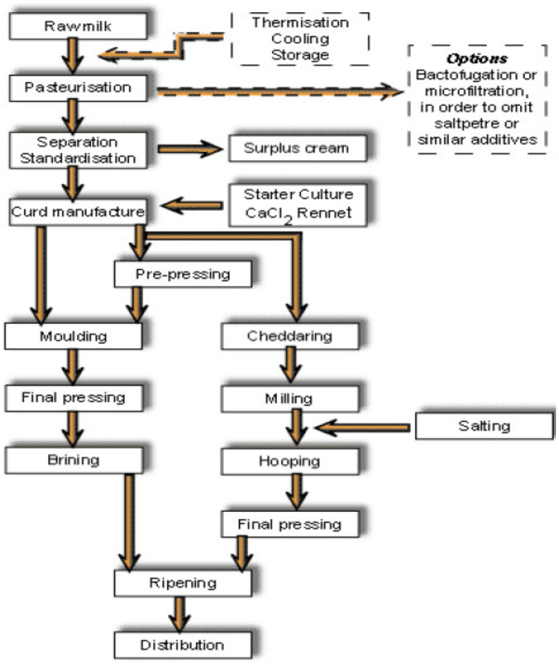
Pasteurization

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.

Cheese Manufacturing Process



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 its freshest.

Cream Extraction & Butter

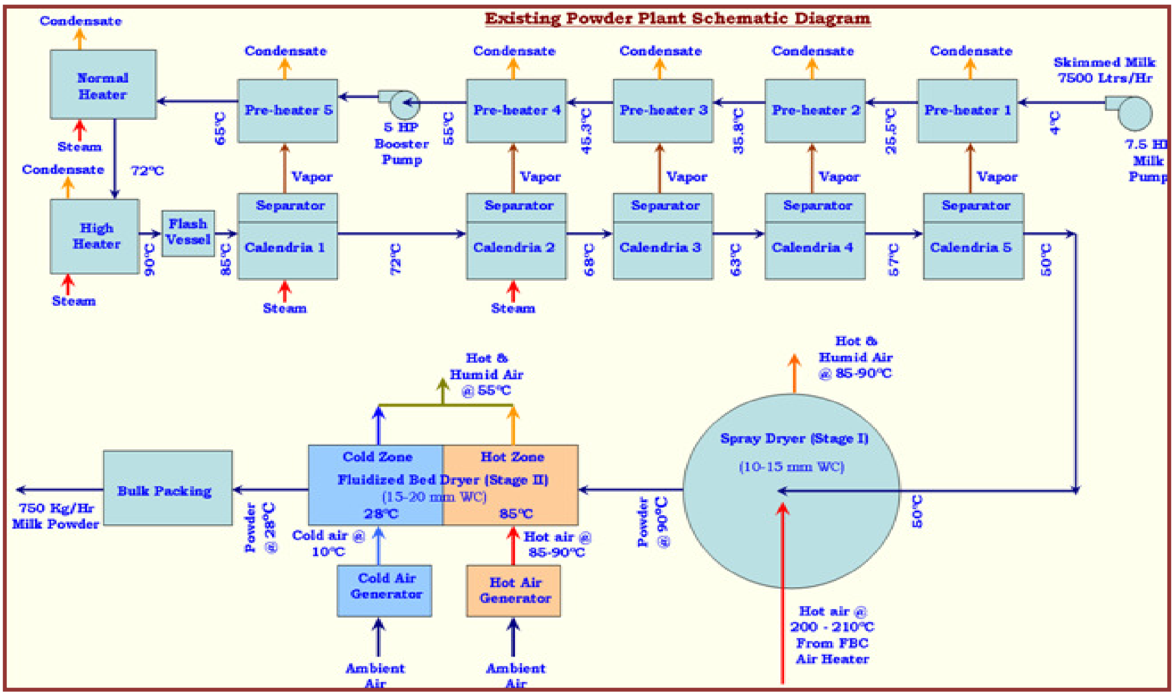
Milk cream is extracted from Milk using centrifuge. The butter making process involves quite a number of stages. The continuous butter maker has become the most common type of equipment used. The cream can be either supplied by a fluid milk dairy or separated from whole milk by the butter manufacturer. 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

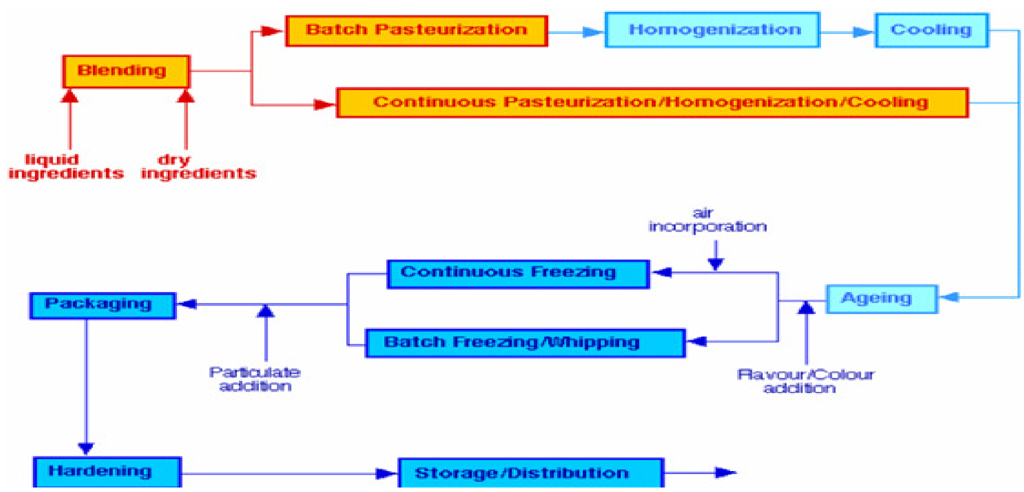
Cheese is an important product of fermentative lactic acid bacteria. Due to its reduced water content, and acidic pH, bacterial growth is severely inhibited.

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.



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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(Rs.)
Electricity	9988810.92
NG	4783472
FO	4113795
Total in	18886078

1.2.2 Average annual production

Annual production in terms of liters/year is taken in case of milk and milk products and 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

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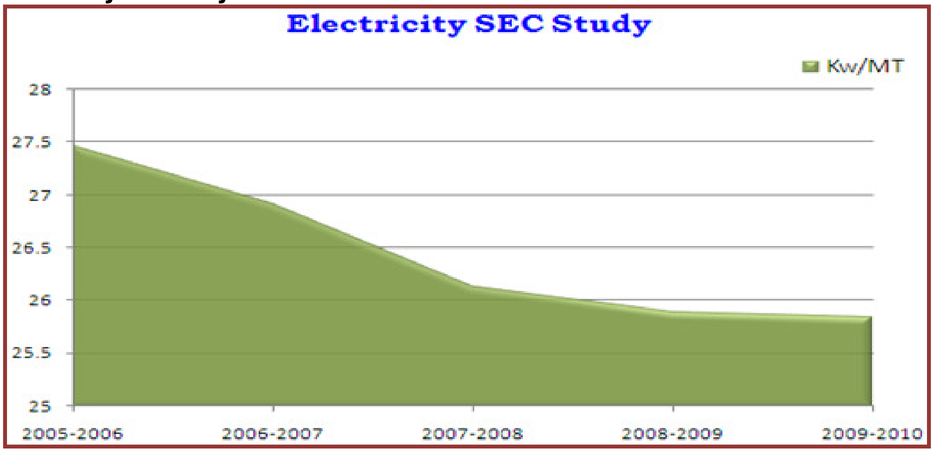
The specific electricity consumption came down from 27.5kW/MT in Yr 2005-2006 to 25.9kW/MT in Yr 2009-2010. While thermal energy consumption also shows downward trend from 0.039MMkCal/MT in year 2005-2006 to 0.36MMkCal/MT in year 2009-2010.

Electricity SEC Study in Dairy Cluster over Past Few Years



Thermal Energy SEC Study in Dairy Cluster over Past Few Years

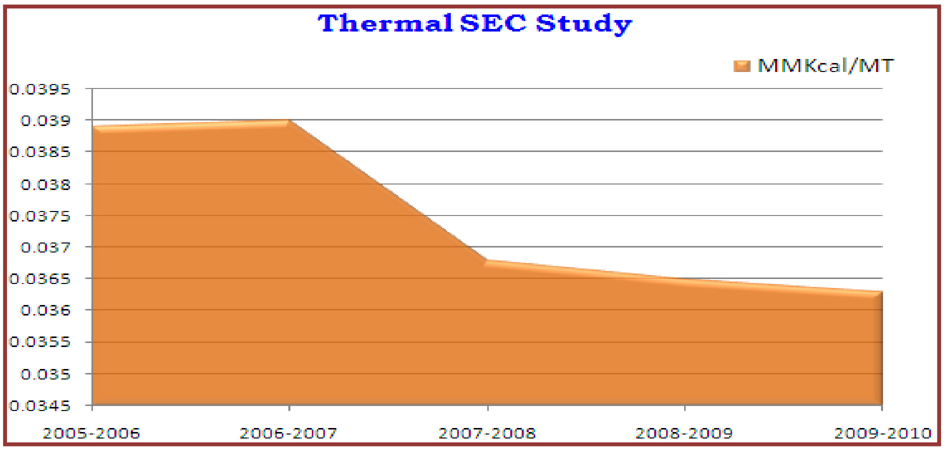


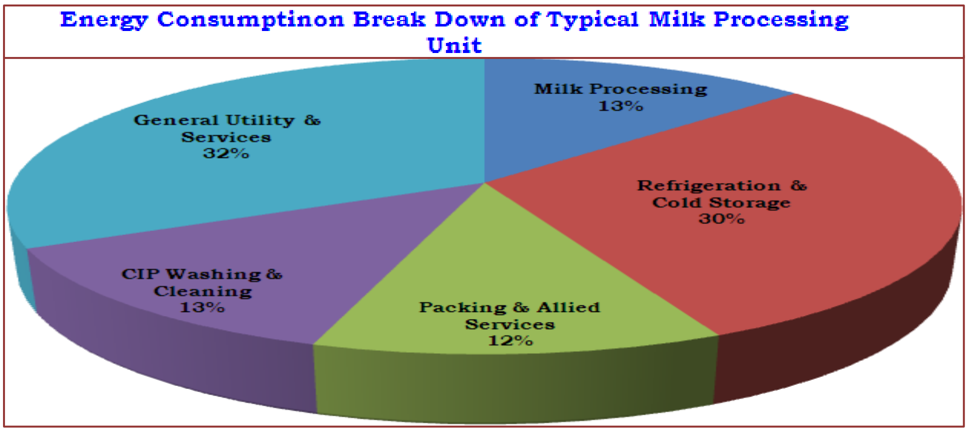
Figure 1.1 SEC Study in Dairy Cluster over Past Few Years

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

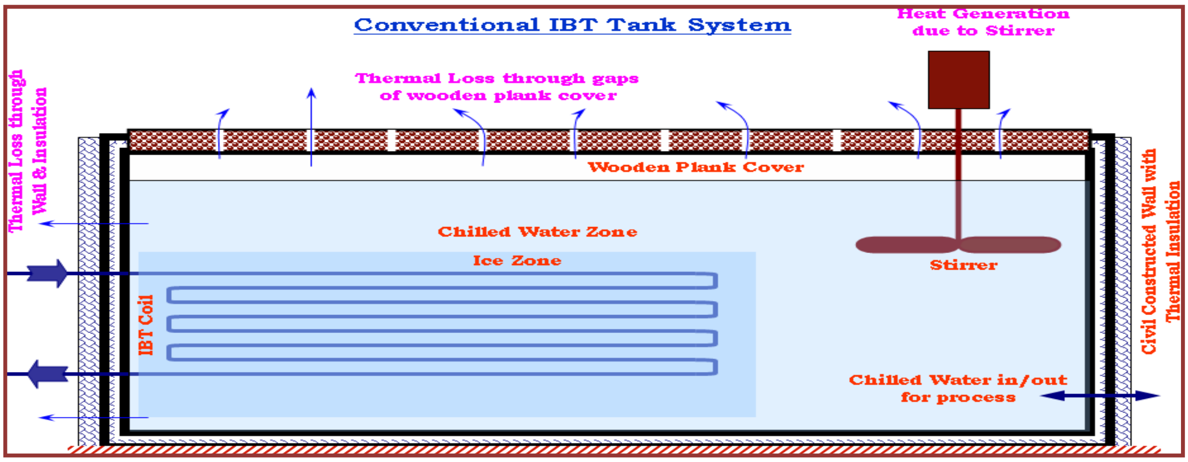
S. No.	Process Name	% age of Cost
1	Milk Processing	13
2	Refrigeration & Cold Storage	30
3	Packing & Allied Services	12
4	CIP Washing & Cleaning	13
5	General Utility & Services	32



1.3 Existing technology/equipment

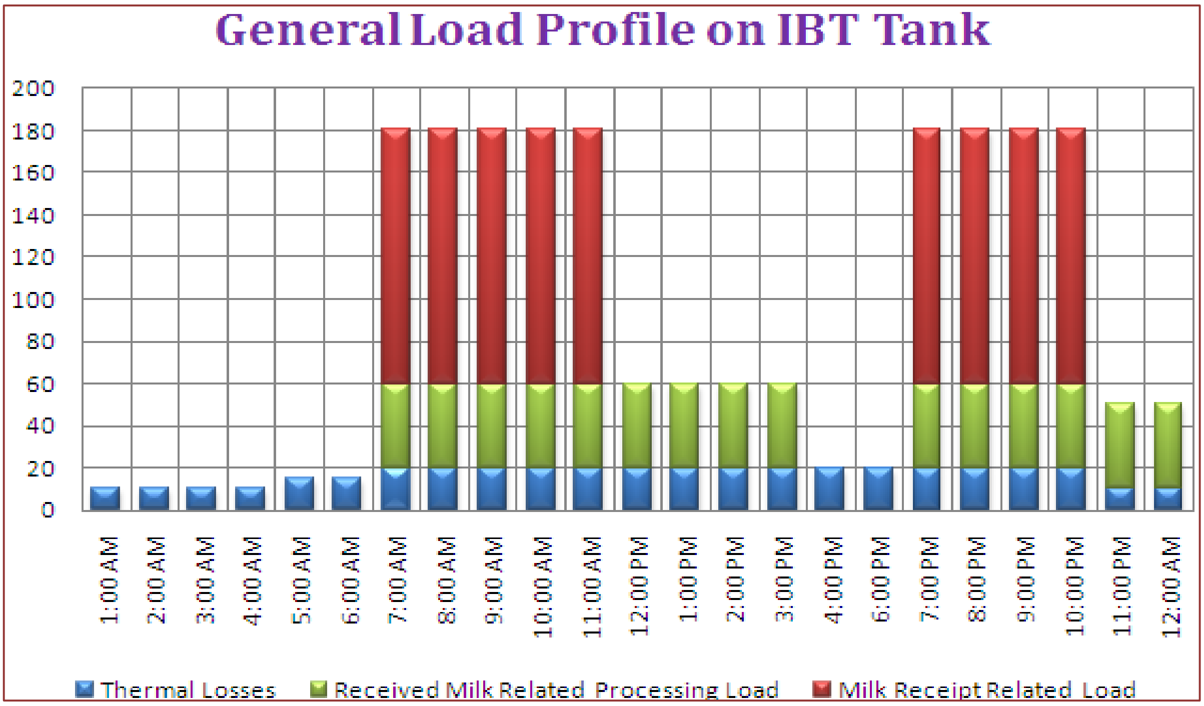
1.3.1 Description of existing technology

In Dairy cluster at least 30% of energy consumed by refrigeration system. The IBT tanks are main backbone of requirement for chilling. The conventional IBT (Ice Bank Tank) System is provided in all the milk chilling center and dairies. The conventional IBT Tank is civil constructed tank provided with all civil constructed wall (except bottom side) thermal insulation. While top face of tank is open and covered by wooden planks supported on MS angle fabricated support structure. The IBT tank is not air tight and top portion of tank covered with wooden planks have many gaps and thin spaces where outside atmospheric air comes directly in the contact of chilled water inside the IBT Tank. These leakages are one of the major components of loss of IBT tank. Individual standing on top of IBT tank feels the air conditioning effect in surrounding. Mechanical stirrers (agitator) are provided (one in each section of IBT tank) for creating forced circulation inside IBT tank for uniform cooling of water inside IBT Tank. These stirrers also induce heat inside the IBT tank proportional to BHP of shaft of stirrer at motor end. As the IBT tank is used in refrigeration system for making ice during off peak hours and using this thermal stored energy during peak hours. The charging of the IBT tank is done almost 20 hrs to 24 hrs per day depending on milk quantity received and ambient conditions.



As the IBT tank contains chilled water and some small quantity of ice almost all time of day and is in service for 24 hours each day and milk being perishable item, no dairies can allow melting of ice for loss calculation purpose for more than 2-3 hours, loss quantification in all individual dairy is not possible still study carried at two milk chilling centers & well maintained dairy. Three detailed study carried at two milk chilling center & Dairy carried to quantify the thermal losses through the IBT Tank along with suction temperature reduction.

General Load Profile on IBT Tank



Energy charges

Table 1.7 Energy charges

S. No.	Contract Demand, KVA	Energy Charges, Rs. /kWh
1	Up to 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

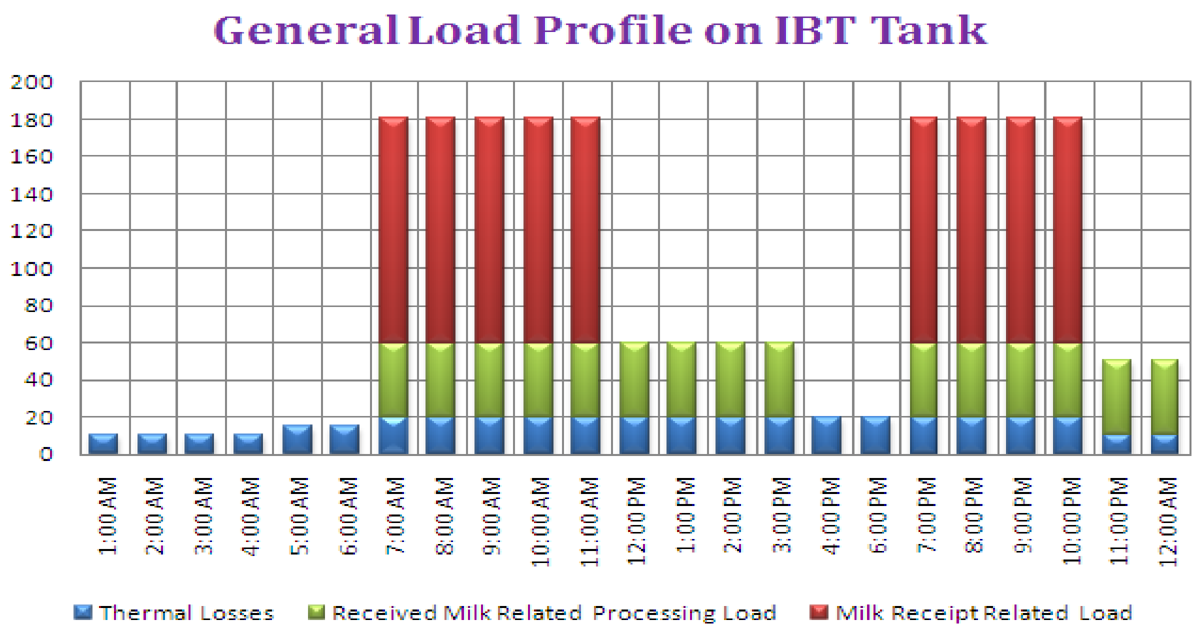
Therefore, total electricity Charges (including the maximum demand charges & other taxes) is Rs. 5.98 per kWh in considered case

1.3.2 Role in process

The IBT tanks are basically a thermal storage system, storing the energy in the form of chilled water/Ice bank. To meet the demand supply gap the IBT tanks are provided as buffer to meet the process chilled water demand. IBT tank plays most important role to manage the demand of chilled water for the process.

1.4 Baseline establishment for existing technology

The existing IBT (Ice Bank Tanks) are basically a thermal storage system which is bulky in nature utilizing old technology for of ice bank with agitator. The loss result due to age old insulation method, agitator provided for maintaining uniform temperature in the IBT Tank also contribute to additional loss due to heat input. For establishing the base line loss, detailed field study of two units carried. The extensive study across two important seasons of winter & summer resulted in establishment of loss as given below-



Unit 1: Typical Dairy

Loss Assessment carried on 10/03/2010 [Ambient Temp: - 29˚C]

S.no.	IBT Tank Particulars	L in mtrs	W in mtrs	H in mtrs	Volume	Initial Time	Initial Temp in ˚C	Final Time	Final Temp in ˚C	Total Heat in Kcal	Heat Loss in Kcal	Time in hrs	% Loss	Remark
1.	IBT Tank No.1	7.2	2.8	2.8	56.45	2.30 pm	1.6	4:00 PM	1.8	90320	11290	1.5	8.33	With Agitator
2.	IBT Tank No.2	7.2	2.8	2.8	56.45	2.30 pm	1.5	4:00 PM	1.7	84675	11290	1.5	8.89	With Agitator
3.	IBT Tank No.3	7.2	2.8	2.8	56.45	2.30 pm	1.5	4:00 PM	1.7	84675	11290	1.5	8.89	With Agitator
				Total	169.35					259670	33870	Average	8.7	

Unit 2: Typical Milk Chilling Center

Loss Assessment carried on 05/02/2010 [Ambient Temp :- 30˚C]

S.no.	IBT Tank Particulars	L in mtrs	W in mtrs	H in mtrs	Volume	Initial Time	Initial Temp in ˚C	Final Time	Final Temp in ˚C	Total Heat in Kcal	Heat Loss in Kcal	Time in hrs	% Loss	Remark
1.	IBT Tank No.1	4.42	4.05	1.768	31.7	3.00 pm	1.1	6.00 pm	1.5	34870	12680	3	12.1	Without Agitator
2.	IBT Tank No.2	5.09	5.06	1.89	48.71	3.00 pm	1.3	6.00 pm	1.7	63323	19484	3	10.3	Without Agitator
3.	IBT Tank No.3	5.09	5.06	1.89	48.71	3.00 pm		6.00 pm		0	0	1.5	---	Unable to assess
				Total	129.12					98193	32164	Average	11.2	

Unit 2: Typical Milk Chilling Center

Loss Assessment carried on 26/06/2010 [Ambient Temp: - 40˚C]

S.No.	IBT Tank Particulars	L in mtrs	W in mtrs	H in mtrs	Volume	Initial Time	Initial Temp in ˚C	Final Time	Final Temp in ˚C	Total Heat in Kcal	Heat Loss in Kcal	Time in hrs	% Loss	Remark
1.	IBT Tank No.1	4.42	4.05	1.768	31.7	3.30 pm	0.9	6.00 pm	1.3	28530	12680	2.5	17.8	Without Agitator
2.	IBT Tank No.2	5.09	5.06	1.89	48.71	3.30 pm	1	6.00 pm	1.7	48710	34097	2.5	28	Without Agitator
3.	IBT Tank No.3	5.09	5.06	1.89	48.71	3.30 pm		6.00 pm		0	0	2.5	---	Unable to assess
				Total	129.12					77240	46777	Average	22.9	

Base Line Loss Observed in various Units

Sr. No.	Unit Particulars	% Loss Observed
1	Unit 1	8 to 20%
2	Unit 2	About 20%

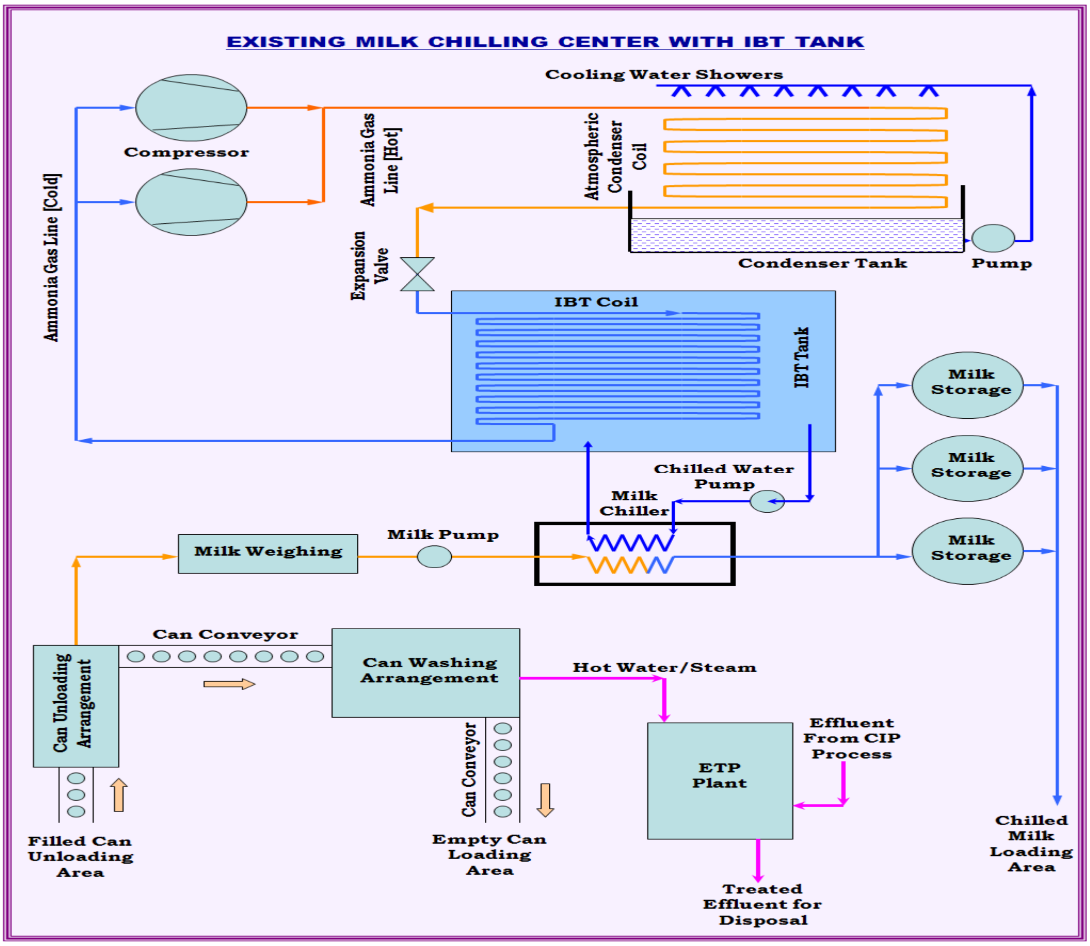
Thus the thermal losses in existing system are of the order 8 to 20% depending on ambient conditions, maintenance & conditioning.

Also the suction temperature of compressor found to be -9℃ during IBT tank charging (For properly maintained dairy) or even lower up to -11℃ in some cases due to ice thickness inside the IBT tank. This results in at least additional energy consumption for compressor about 6% (minimum considered).

1.4.1 Design and operating parameters

Existing IBT tanks are civil constructed tanks with insulation. Wooden cover provided for the tanks along with agitator for agitation. The detailed sketch of the same is given above. The load varies on IBT tank. During milk receipt and or during peak of milk process, the load on IBT tank is highest. During night hours the demand also varies.

The existing Milk chilling center / Dairies are provided with conventional IBT Tank. Please refer schematic diagram of existing milk chilling center employing conventional IBT Tank. Wooden planks covers are provided. Heat ingress takes place through wooden plank cover, side wall, bottom of tank. This results in substantial energy loss in the existing system. Also agitator is required to create turbulence inside the IBT tank so that the ice thickness is maintained & the temperature distribution across the IBT tank remains uniform.



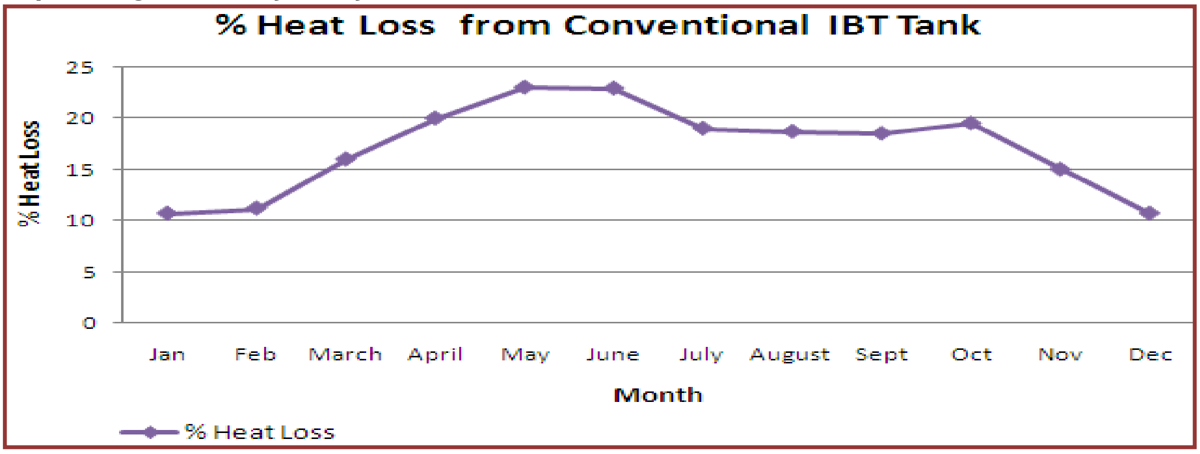
1.4.2 Operating efficiency analysis (Existing Loss Study)

- The energy consumption is much higher than the estimated required energy
- The specific energy consumption in summer is about 50-100% more than that of winter
- Condensing Pressures are higher in summer and hence Condensing Temperatures are about 5 Deg. C higher in summer.
- Energy consumption is 10% higher for 5 Deg. C higher condensing
- Ice Bank System have poor charging and discharging characteristics, it increases energy consumption
- Stirrer adds to the energy consumed
- The compressors operate much longer, especially in the summer. This also adds to cooling tower load and hence inefficient chiller operation
- In summer, recorded Cooled Milk temperature was much higher as system is not able to meet the cooling demand. It is estimated that it fell short by 20%.

- Ice Bank system is not getting charged to optimum level and not able to discharge when required
- Theoretical energy consumption estimates are much lower than the actual consumption; hence there is a scope of incorporating energy efficiency device like Thermal Energy Storage System to improve the performance of the system and to achieve better cooling during summer as well.

Operating efficiency of the IBT tank carried at two milk chilling center & one dairy. The details are given in Table

Operating efficiency analysis for different Locations



Detailed parameters and calculations used for operating efficiency evaluation of existing IBT tanks are given in the Annexure 1.

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 age old Ice Bank technology. The design and operation of the plant is standardized on Ice Bank system. 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 is lost through Ice Bank 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 units like ammonia compressors, hot air generators for spray dryers etc, are generally taken care by the equipment suppliers itself as they station one of their experienced technical representative 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)

Being new technology introduction, penetration of technology will required all round efforts from all stake holders. No other barrier is seen. It appears that apart from high initial cost & new technology, there is no other barrier.

2. PROPOSED EQUIPMENT FOR ENERGY EFFICENCY IMPROVEMENT

2.1 Description of proposed equipment

The Proposed Low loss compact thermal Storage System (STL) is composed of a tank filled with "nodules". The tank has upper manholes to allow the filling with nodules. A lower manhole allows emptying. Inside the tank two diffusers (inlet and outlet) spread the heat transfer fluid along the tank. The pressure drop through the tank is 2.5 mWG. The inlet in charge mode must be via the lower diffuser in order to ensure the natural stratification.

The tanks are manufactured in black steel (test pressure between 4.5 to 10 bar), are delivered empty and positioned on site or, if the access to site is impossible, constructed on site. The nodules are spherical with a diameter of 77 mm, 78 mm or 98 mm (depending on the nodule type).

The nodules contain the Phase Change Material (PCM). The mechanical and chemical characteristics of the nodule shell (manufactured in polyolefin) are well adapted to the conditions encountered in Air Conditioning or Refrigeration systems. Once filled with PCM the nodule plugs are sealed by ultrasonic to ensure perfect water tightness. The nodules are delivered in 22 kg bags. Tanks are filled on site. The filling is regular and homogeneous. A standard globule filling procedures are followed. The tank shape is usually cylindrical in order to withstand service pressure higher than 3 bar. The test pressure varies between 4.5 to 10 bar. The spherical shape allows an easy filling. The nodule diameter has been calculated to meet economical and technical requirements. The size allows high exchanges until the end of the cycle.

The use of modern technologies permits quality control. The materials used are completely neutral to the phase change materials and heat transfer fluid. The phase change materials used by Thermal Energy Storage Systems, and also the nodules, have been laboratory tested in France and abroad. This product development work has led to a very high reliability of the STL. Thermal Energy Storage Systems offers a range of temperatures i.e. - 33℃ to + 27℃

2.1.1 Detailed of proposed equipment

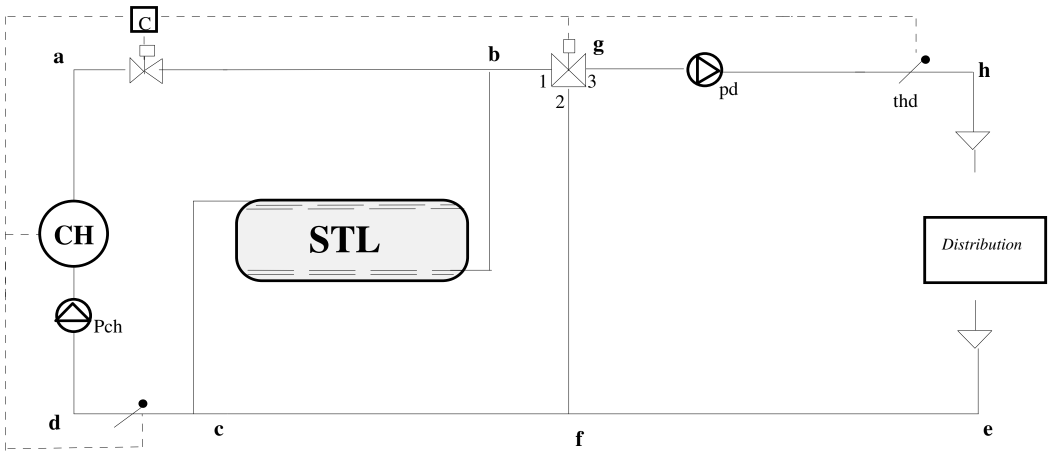
The operating cycle of the Thermal Storage System (STL) is divided into two distinct modes: charge and discharge - during which the nodules remain virtually at a constant temperature

The charge mode: the store is charged by crystallisation of the salts contained within the nodules. This takes place when the temperature of the heat transfer fluid passing through the STL is lower than the phase change temperature of the salts. The store then acts as a heat exchanger, the heat transfer fluid releasing its energy to the nodules.

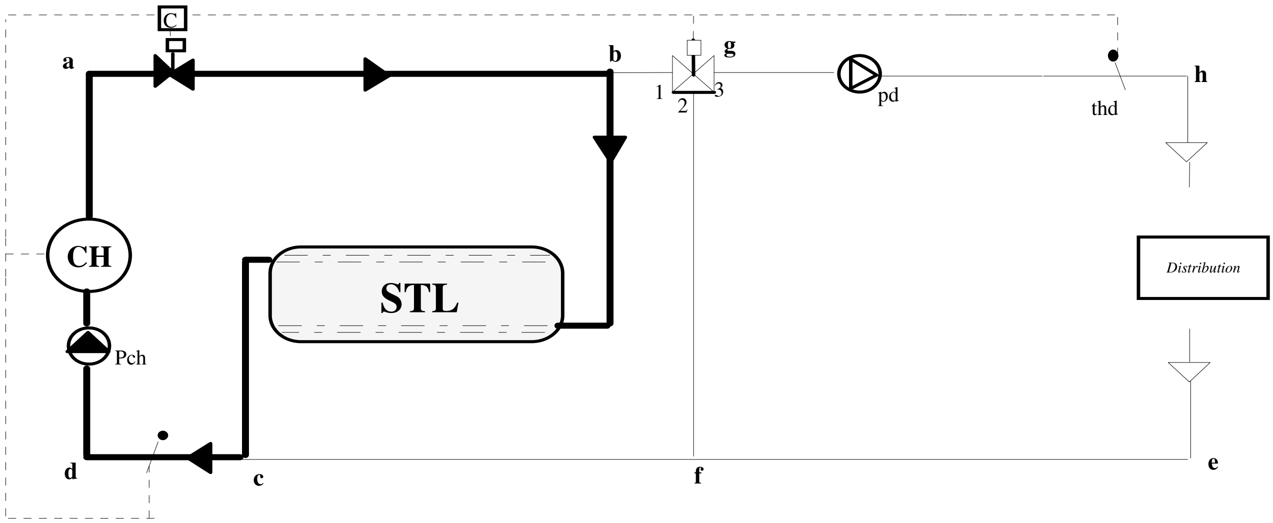
The discharge mode: the stored energy is released by fusion of the salts contained in the nodules. This takes place when the temperature of the heat transfer fluid passing through the store is higher than the phase change temperature of the salts. The STL then acts as a heat exchanger, the heat transfer fluid absorbing the energy of the nodules.

RUNNING PRINCIPLE

During the charge and discharge cycle the temperature of the heat transfer fluid passing through the STL should vary as little as possible relative to the temperature at the end of the release mode. Distribution flow temperature is normally constant. The following lay-out meets these requirements. In this type of lay-out, there are two loops in parallel: a primary loop (ABCD) and secondary loops (EFGH) which are connected to BG and CF.



Primary loop (ABCD): This has constant flow and varying temperature. The fluid is circulated by the charging pump (P_{ch} .The temperature of the heat transfer fluid entering the evaporator (E_v) decreases, the chillier output reduces. A dynamic balance is created between energy absorbed by the store and chillier output.



Secondary loop (EFGH): This has constant or variable flow and a constant temperature. The fluid is circulated by the distribution pump (Pd). The temperature is kept constant by mixing the return heat transfer fluid with the fluid coming from the chillier plant under control of a 3 way valve.

Regulation of the system*:* The chillers compressor is controlled by a thermostat at outlet or inlet of the evaporator (E_v).This thermostat unloads the compressor when the temperature is equal to or below the temperature set for the primary loop (abcd) at the end of the charging mode.

A shut-off valve can be installed at the inlet of the evaporator if one wants to shut down the chillier during certain periods. A temperature probe (T_{hd}.), controlling the operating temperature of the outgoing heat transfer fluid, is placed after the pump (P_d) keeping the fluid at a constant temperature in combination with a 3 way valve.

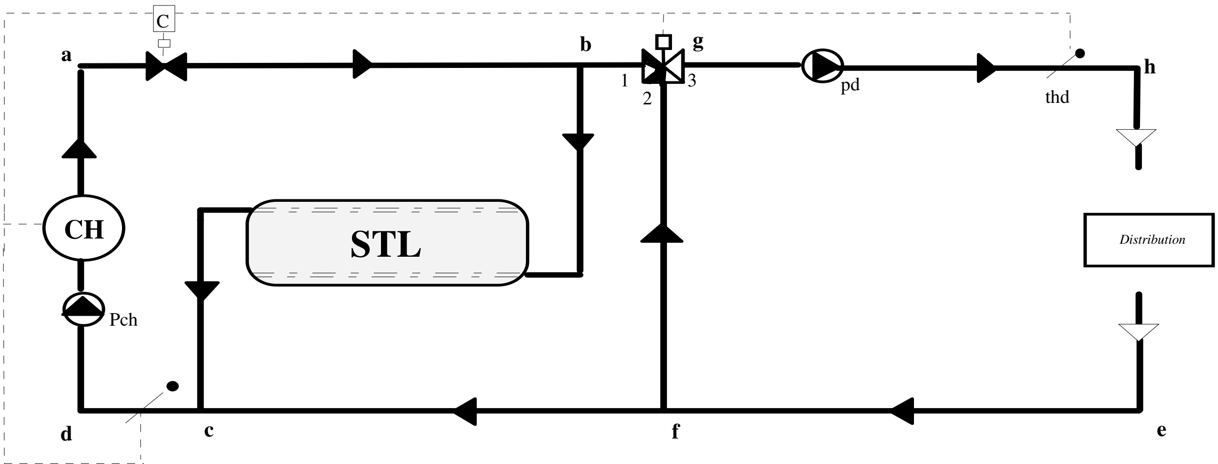
There are 4 different modes of operation:

- Charge mode
- Charge and chillier operation mode
- Discharge and chillier operation mode
- Discharge mode only.

DESCRIPTION OF THE DIFFERENT MODES OF OPERATION

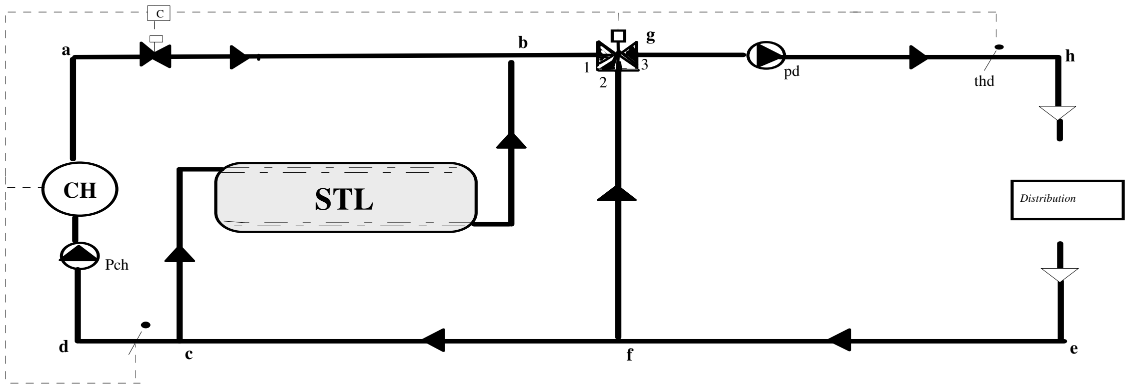
Charge mode: In this situation no cooling is required (e.g. A/C office building during night hours). The pump (Pd) is shut down and the 3 way valve closes port 1 leading to the distribution system (see lay-out below). The chillers cool the primary loop (abcd) to below the crystallisation temperature of the nodules, which then start to change phase, absorbing the cooling energy from the chillier. Inside the nodules the crystallisation begins peripherally around the walls. The thickness of the crystals influences the energy transfer so that the exchange coefficient gradually decreases during this mode, proportionally diminishing the heat absorbing capacity of the nodules. The temperature of the heat transfer fluid from the chillier will decrease until it reaches the minimum temperature corresponding to the end of the charge (storage) period. Further sensible cooling of the solid PCM takes place causing the temperature of the heat transfer fluid to decrease rapidly. This temperature decrease indicates the end of the charge phase and the control thermostat shuts down the chillier.

Store charge with distribution load: This occurs when the cooling demand is smaller than the chillier output (e.g. A/C of an office building in the morning) . The pump (Pd) runs and the 3 way valve modulates in accordance with the requirements of the temperature probe (t_{hd}) controlling the temperature of the distribution system flow (EFGH). The fluid circulated by the charge pump (P_{ch}) is led partly through port 1 of the 3 way valve, partly through the store STL in the direction b to c thus charging the store (see lay-out below).



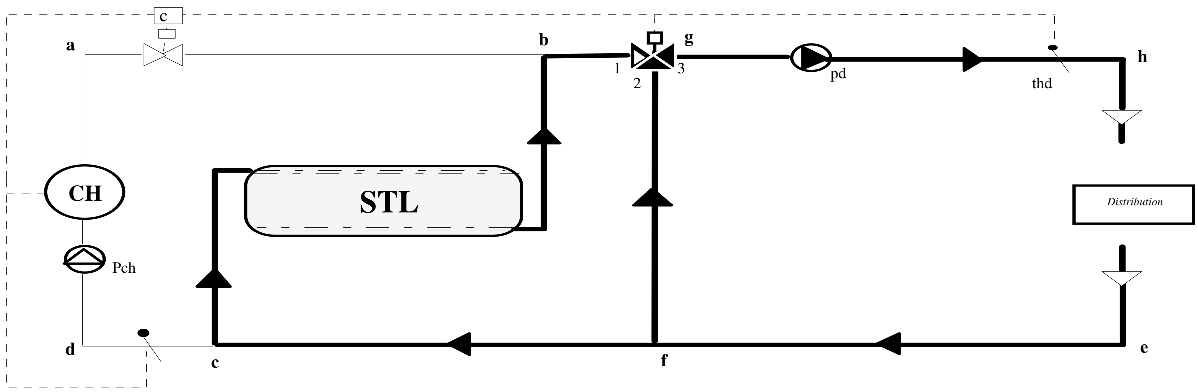
Store discharge with distribution load: This situation occurs when the cooling requirement is higher than the chillers output (e.g. during maximum demand of A/C for an office building).The pump (P_d) and (P_{ch}) are operating and the 3-way valve modulates as described before (see lay-out below). The energy required by the temperature probe (T_{hd}) cannot be met by the fluid circulated through the 3 way valve. The flow circulated by pump (P_d) in direction (f_c) is separated two ways:

- Constant flow (FDAG) cooled by the chillier through the pump (P_{ch}).
- Variable flow through the STL (FCBG).



Discharge mode only: This situation occurs when the user wishes to shut down the chillers and use the STL only during peak demand.

In this mode, the chillers is controlled by a "stop" system (electric utilities) in response to which the charge pump (P_{ch}) and the chillier are shut down during peak hours. A shut off valve, placed after the evaporator, closes automatically when the pump (P_{ch}) is shut down, so that the heat transfer fluid flows through the STL store alone.



2.1.2 Equipment/technology specification

DESCRIPTION

The quantity of energy stored for each type of nodule is proportional to the storage volume. The number of nodules in a system determines the heat exchange rate between the nodules and the heat transfer fluid.

TECHNICAL SPECIFICATIONS

THERMAL STORAGE SYSTEM:

- The latent heat storage system is composed of a cylindrical shape steel tank, filled with "Nodules". The supplier shall in accordance with the schedule of quantities, supply and install phase change based latent thermal storage unit.
- The total latent thermal storage capacity of the units shall not be less than the specified TR hours.
- The service, for which the system is being proposed, is for back up.
- The system is designed to withstand a continuous working pressure of 3 Kgf/cm^2.
- The Thermal Storage Container shall be self-standing, made from MS, and shall be fully insulated.
- The heat loss from the Thermal Storage is to be less than 1% of the stored thermal energy in 24 hours, if the unit is not operational.

MS Tank:

- The tank shall be fabricated MS of adequate thickness, hydraulically tested for adequate pressure and shall be delivered empty and positioned on site.
- Red Oxide coating shall be applied to all exposed edges and welds. The tanks shall be able to withstand total freezing of the water within it through repeated cycles without damage.
- Storage Tank shall thoroughly cleaned from inside by flushing the system with clean water.
- External surface of Thermal Storage tank does not require any treatment. After the tank surface is cleaned, it is painted by Red Oxide primer. Subsequently bitumen is used for insulation and over insulation vapors barrier is used; hence, there is no corrosion from outside.

Features of the Tank:

- The tank will have internal distribution diffusers to spread heat transfer fluid along the tank, water inlet and outlet connections, drain connections and manholes, (man-hole to allow the filling of nodules in tank). Diffuser pipes shall be provided inside the tank with number of holes. Diameter of holes and its numbers are designed by the manufacturer of Thermal Storage tanks to ensure that all nodules inside the tank shall freeze and melt to have 100% capacity utilization with minimum pressure drop. This design is critical for proper operation of Thermal Storage system.

- Maximum allowable pressure drop in storage tank is 2.5 m of W.G.

Insulation: The Thermal Storage Tank shall be insulated in order to reduce thermal losses and condensation. The Thermal Storage Tank shall be insulated with the expanded polystyrene (Thermocol) insulation of 22 Kg/m³ density and 100 mm thick sheets. The tank insulation is important and it has been selected based on following criteria:

- Reduce thermal losses to the minimum
- Avoid condensation and corrosion

For the tanks located in open atmosphere or inside the building, final layer will be 26G Aluminum Sheets.

Thermal Storage Nodules:

- The tanks shall be filled with adequate number of spherical nodules containing phase changing materials. Filling of Nodules with pure water is strictly not allowed. The Nodules will be filled with ionized phase change material. This phase change material has higher crystallization temperature resulting in Power Consumption less than in case of pure water.
- The spherical nodules are produced on blow moulding machines from a blend of polyolefin. The nodules are filled with PCM (Phase Change Material) and are then ultrasonically welded. The Phase Change Material shall not leak out from the hermetically sealed nodules.
- The nodules shall be designed and manufactured for pressures up to 10 Bar.

Glycol: The tank containing nodules shall be filled with 27-30% water solution of mono-ethylene glycol. The system's lowest operating temperature should be 3^{0}C to 4^{0}C above glycol freeze point. The freeze point for a system with 27-30% ethylene glycol is (-) 12^{0}C.PH of the glycolised water solution shall be maintained between 6.5 & 9.00.

TECHNICAL DATA SHEET OF STL		
S. NO.	THERMAL ENERGY STORAGE SYSTEM	SPECIFICATIONS
1	No. of Tank	1
2	Maximum Storage Capacity of Tank (TR-HR)	300
3	Brine Entering Temperature during STL discharging (ºC)	10
4	Brine Leaving Temperature during STL discharging (ºC)	4

5	Maximum System Pressure Drop (mWG)	2.5
6	Material of Tank	MS
7	Insulation Material	Thermocol
8	Thickness of Insulation (mm)	100
9	Type of Insulation	Aluminum Cladding
10	Type of Nodules	AC.00
11	Diameter of Tank (mm)	2000
12	Length of Tank (mm)	6016
13	Service Weight (Kg)	21 Tons

SYSTEM DETAILS: Please refer Technical Data Sheet

- ***CHARGING OF STORAGE SYSTEM:*** Brine Chillers will operate with (-) 3.1℃ Brine inlet and (-) 6.1℃ Brine Outlet of each Chiller. The Chiller shut off set point shall be (-) 8 ℃.
- ***DISCHARGING MODE:*** The Thermal Energy Storage will operate to meet backup Load during peak hours. The Thermal Storage Tank will be charged during NO LOAD with the existing chillers.

a) Terminology: A STL is determined by the phase change temperature and the volume (i.e. the storage capacity and the heat exchange rate).There are 3 types of nodules characterized by their diameter: AC (98 mm), IC and IN (78 mm)

For example:

STL – AC.00 – 15

AC: 98 mm diameter nodules

00: phase change temperature in ℃

15: tank volume in cubic meters

STL – IN.15 – 50

IN: 78 mm diameter nodules for negative temperature

15: the phase change temperature (melting) is -15℃

50: tank volume in cubic meters

STL – IC.27 – 100

IC: 78 mm diameter nodules

27: the phase change temperature (melting) is +27℃

100: tank volume in cubic meters

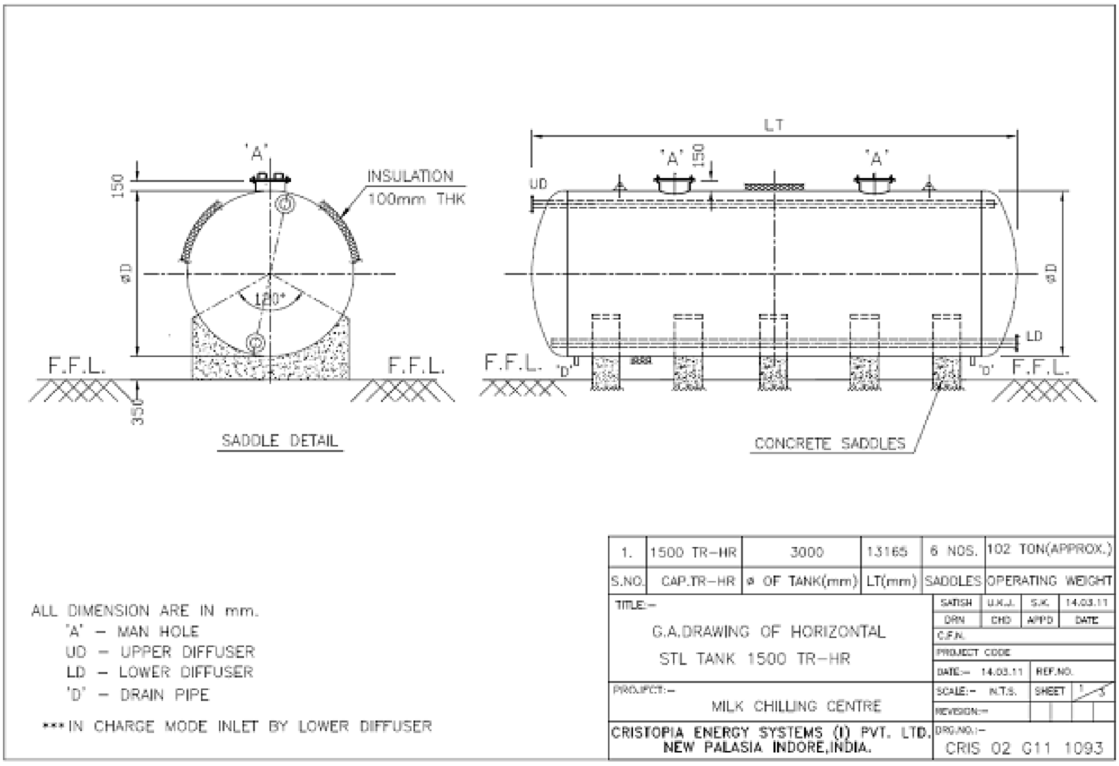
B) The Nodules:

The Envelope

- Material: blend of polyolefin
- Chemically neutral towards eutectics and heat transfer fluid
- Thickness 1.0 mm : no migration of the heat transfer fluid
- Sphere obtained by blow moulding : no leakage
- Sealing of the cap by ultrasonic welding
- Exterior diameter :
- 98 mm : Air conditioning
- 78 or 77 mm : Industrial Cooling or Back-up

Exchange surface

- Diameter 78 or 77 mm: 1.0 m2/kWh stored
- Diameter 98 mm: 0.6 m2/kWh stored
- Air pocket for expansion: no stress on the nodule shell
- Useful number of nodules per m3 :
- Diameter 77 mm: 2 548 nodules per m3.
- Diameter 78 mm: 2 444 nodules per m3.
- Diameter 98 mm: 1 222 nodules per m3.



GA Drawing for Storage Tank:

2.1.3 Integration with existing equipment

It is proposed that Thermal Energy Storage tank will be installed in parallel to existing system. Pre-Chiller PHE will be used to charge the Storage System. When load will exceed the base chiller capacity, cooling will be provided with Storage System.

The following are the reasons for selection of this technology

- The proposed system is compact and saves space.
- It will reduce the total operating energy cost of the plant.
- It reduces the GHG emissions
- Additional TOD incentives can also be availed along with energy savings.
- This project is also applicable for getting the carbon credit benefits.
- 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 resulting in 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

Similar (Ice Bank Based) technology is already implemented in various dairies and working successfully. These are running successfully and the unit owners had observed the savings in terms of energy. The proposed equipments are available within India.

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 14 days will be required for the interconnection of the Thermal Energy Storage System 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 all 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. Majority of the dairies & Milk chilling centers (22 numbers in cluster) are suitable for implementation of this measure.

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1 Technical benefit

3.1.1 Fuel saving

No direct fuel saving by this measure. The electricity saved may indirectly save the fuel.

3.1.2 Electricity saving

It is estimated that this system will save 71640 kWh per annum (6.16 KLOE per Annum) for the unit.

3.1.3 Improvement in product quality

The measure does 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 (Rs. 4.28 Lacs). It is estimated that this system will save on an average 71640 kWh/Annum will be saved for the unit Please refer following table.

Table 1.9 Energy and monetary benefit (For One Typical Unit of Gujarat Dairy Cluster)

S.no	Parameter	Unit	Value
1	Expected saving in kWh by replacing conventional IBT tank system with latest thermal storage system (Without considering saving in power of agitators)	kW/Hour	7.65
2	Expected saving by reducing IBT charging temperature from -9°C to -7°C (6% energy saving) during 8 hours per day (Non Peak hour when currently IBT tank is charged & in proposed system low loss thermal storage system will be charged)	kWh/Day	46.22
3	Expected saving in kWh per Day	kWh/Day	199
4	Cost of electricity	Rs. /kWh.	5.98
5	Expected saving in kWh per annum	kWh/Annum	71640
6	Expected saving per day	Rs./Day	1190

7	Expected saving per annum (Without considering TOD benefits)	Rs./Annum	428400
8	Expected Investment needed for proposed thermal storage system (Rated demand for peak hours without additional charging system)	Rs.	1487000
9	Simple Payback period (Without TOD benefits)	Yrs	3.48
		Months	42
10	KLOE Saving per Annum (Without TOD benefits)	KLOE	6.16

Further details of total monetary benefit are given in Annexure 3.

3.3 Social benefits

3.3.1 Improvement in working environment

Use of proposed technology in Dairy Industry reduces the energy consumption. This improves efficiency of refrigeration system and reduces CO2 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 CO2 emissions. Reduction in CO2 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 CO2 emission to an extent of 61 tonnes (60.89 tonnes per annum).

3.4.3 Reduction in other emissions like SO_X

Amount of SO_X will be reducing due to improved efficiency of the power plants due to better plant load factor.

4 INSTALLATION OF PROPOSED EQUIPMENT

4.1 Cost of project

4.1.1 Equipment cost

Cost of Energy efficient motor with installation, erection, commissioning, standard mountings & accessories including taxes are Rs.14.87 Lacs per 300 TRH thermal storage systems.

4.1.2 Erection, commissioning and other misc. cost

Total erection and commissioning cost is Rs. 2.50 lakh as discussed with supplier. The details of project cost is as given in Table 4.1 given below-

Table 4.1 Details of proposed technology project cost

Details of Proposed Technology Project Cost			
SN	Particulars	Unit	Value
1	Cost of Retrofit/Additional Plan & Machinery For Energy Saving	Rs.(in Lacs)	11.9
2	Detail Engineering, Design & related expenses	Rs.(in Lacs)	0.15
3	Erection & Commissioning cost	Rs.(in Lacs)	2.50
4	Cost of civil work	Rs.(in Lacs)	0.15
5	Custom Clearance & Transportation Charges	Rs.(in Lacs)	0
6	Import duty	Rs.(in Lacs)	0
7	Other charges (Including Contingency 10%)	Rs.(in Lacs)	0.17
	Total cost	Rs.(in Lacs)	14.87

4.2 ARRANGEMENTS OF FUNDS

4.2.1 Entrepreneur's contribution

Entrepreneur will contribute 25% of the total project cost i.e. Rs. 3.72 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. Rs. 11.15 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 Rs. 4.28 lakh.

- 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 Rs. 2.09 lakh in the first year operation and to Rs. 13.02 lakh at the end of tenth year.

4.3.2 Simple payback period

The Simple Payback period is about 3.48 years or about 42 months.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be 3.86 lakh.

4.3.4 Internal rate of return (IRR)

The after tax IRR of the project works out to be 16.40%. 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 20.64%.

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	16.40%	3.86	20.64	1.49

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	16.40%	3.86	20.64	1.49
2	5% Increase in Fuel Saving	17.87%	4.79	20.92	1.56
3	5% Decrease in Fuel Saving	14.90%	2.92	20.31	1.42

4.5 PROCUREMENT AND IMPLEMENTATION SCHEDULE

Procurement and implementation schedule required for proposed project is 2 weeks of installation and commissioning; further detailed breakups are shown in Annexure 6. In the entire project will take about 16 weeks. 14 weeks is for order placement and delivery.

S.no.	Activities	Weeks				
		1	-	14	15	16
1.	Order Placement	■				
2.	Delivery			■		
3.	Installation and commissioning				■	■
4.	Testing					■
5.	Training					■

Annexure

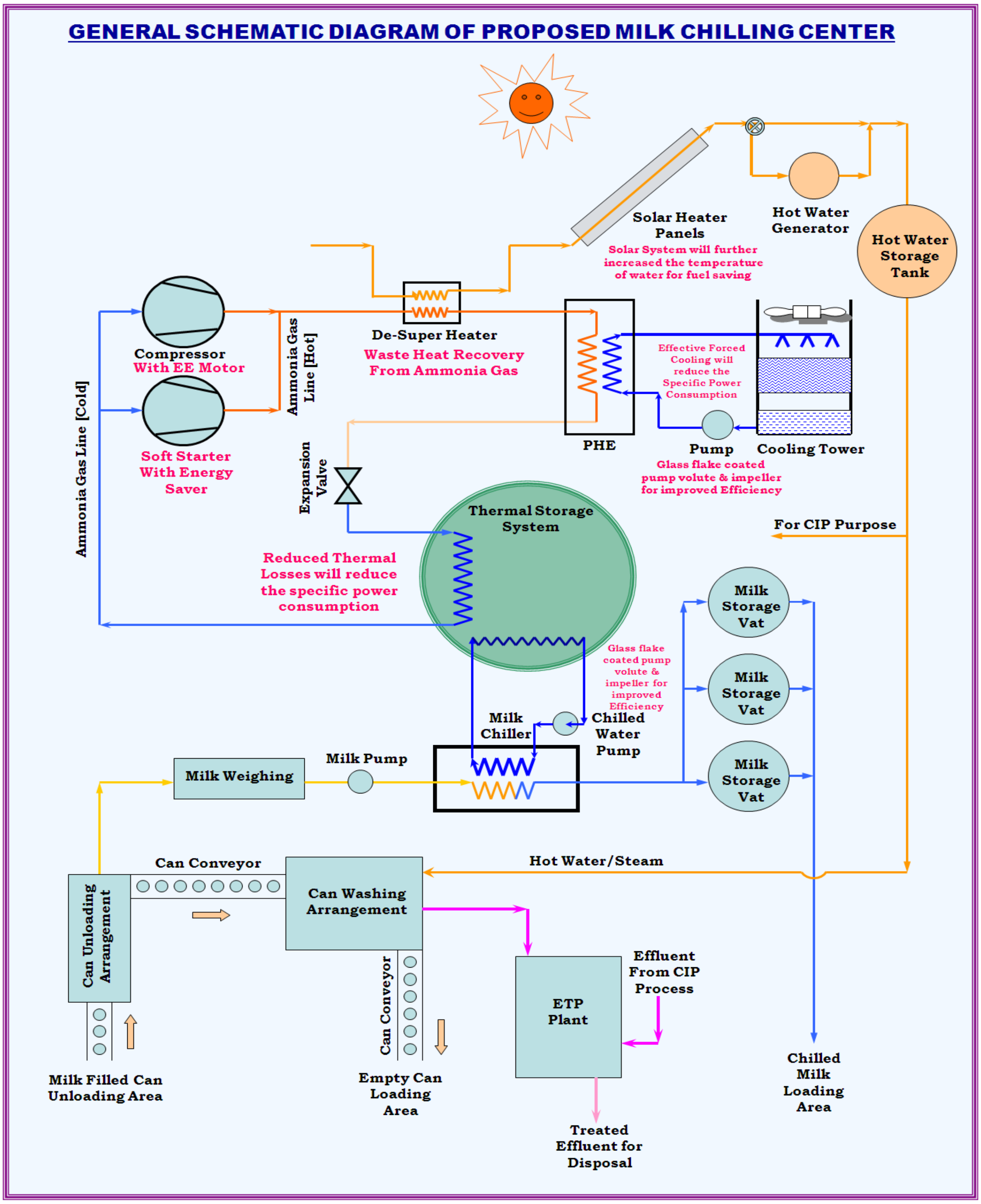
Annexure -1: Energy audit data used for baseline establishment

Base Line Loss Observed in various Units

Sr. No.	Unit Particulars	% Loss Observed
1	Unit 1	8 to 20%
2	Unit 2	About 20%

Thus the thermal losses in existing system are of the order 8 to 20% depending on ambient conditions, maintenance & conditioning. Also the suction temperature of compressor found to be -9°C during IBT tank charging (For properly maintained dairy) or even lower up to -11°C in some cases due to ice thickness inside the IBT tank. This results in at least additional energy consumption for compressor about 6% (minimum considered).

Annexure -2: Process flow diagram after project implementation



The process flow will not change.

Annexure -3: Detailed technology assessment report

Apart from saving of thermal losses, phase change thermal energy storage offers a unique solution to any of the following energy management problems:

- Reduction of installed power
- Peak 'shaving' or 'lopping' of cyclic loads
- Optimization of electrical resources.
- Increase cooling output to meet higher demand without increasing existing plant capacity.
- Energy management (off-peak electricity)
- Increase system reliability
- Back-up function
- Protect ozone area by a limitation of CFC and HCFC.

The details of cost benefit analysis are as given below –

S.No.	Parameter	Unit	Value
1)	Total rated capacity of refrigeration system per hour (Excluding Stand by)	TR	90
2)	Normal working hours of refrigeration system per day	Hours	20
3)	Actual refrigeration TR generated	TR	72.9
4)	Actual electricity consumption	kW	96.3
5)	Specific Power Consumption based on actual performance and actual consumption	kW/TR	1.32
6)	Expected Capacity in Hours for Thermal Storage System (Considering Working hours in peak milk received load and Peak TOD tariff)	Hrs/Day	4
7)	Thermal loss through conventional concrete constructed IBT tank with wooden plank cover and due to agitator provided for water churning (Actual study carried at two Milk chilling center & One Dairy having similar conditions higher losses found and also carried at dairy where also losses observed)	%	8
8)	Expected losses in proposed thermal storage system (Total loss of 1.5% in one Day)	%	0.063
9)	Expected net saving in thermal losses by replacing conventional IBT tank with latest thermal storage system.	%	7.94
10) a)	Expected saving in kWh by replacing conventional IBT tank system with latest thermal storage system (Without considering saving in power of agitators)	kW/Hour	7.65

S.No.	Parameter	Unit	Value
b)	Expected saving by reducing IBT charging temperature from -9°C to -7°C (6% energy saving) during 8 hours per day (Non Peak hour when currently IBT tank is charged & in proposed system low loss thermal storage system will be charged)	kW/Day	46.22
11)	Expected saving in kWh per Day	kWh/Day	199
12)	Cost of electricity	Rs/ kWh.	5.98
13)	Expected saving in kWh per annum	kWh/Annum	71640
14)	Expected saving per day	Rs./Day	1190
15)	Expected saving per annum (Without considering TOD benefits)	Rs./Annum	428400
16)	Expected Investment needed for proposed thermal storage system (Rated demand for peak hours without additional charging system)	Rs.	1487000
17)	Simple Payback period (Without TOD benefits)	Yrs	3.48
		Months	42
18)	KLOE Saving per Annum (Without TOD benefits)	KLOE	6.16

Annexure -4 Drawings for proposed electrical & civil works

No additional electric work is required. Only piping rework is required. Simple leveled civil constructed platform required for keeping the thermal storage system

Annexure -5: Detailed financial analysis

Name of the Technology	TRH THERMAL STORAGE TECHNOLOGY		
Rated Capacity	300 TRH		
Details	**Unit**	**Value**	**Basis**
Installed Capacity	TRH	300	
No of working days	Days	360	
No of Shifts per day	Shifts	2	(Assumed)
Proposed Investment			
Plant & Machinery	Rs. (in lakh)	12.05	
Civil Work	Rs. (in lakh)	0.15	
Erection & Commissioning	Rs. (in lakh)	0.50	
Investment without IDC	Rs. (in lakh)	3.70	
Misc. Cost	Rs. (in lakh)	0.17	
Total Investment	Rs. (in lakh)	14.87	
Financing pattern			
Own Funds (Equity)	Rs. (in lakh)	3.72	Feasibility Study
Loan Funds (Term Loan)	Rs. (in lakh)	11.15	Feasibility Study
Loan Tenure	Years	7.00	Assumed
Moratorium Period	Months	6.00	Assumed
Repayment Period	Months	90.00	Assumed
Interest Rate	%age	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	2.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Electricity Saving	kWh/Year	71640	
Cost of electricity	Rs. /kWh	5.98	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	80.00	Income Tax Rules
Income Tax	%age	33.99	Income Tax

Estimation of Interest on Term Loan **Rs. (in lakh)**

Years	Opening Balance	Repayment	Closing Balance	Interest
1	11.15	0.60	10.55	1.29
2	10.55	1.20	9.35	1.00
3	9.35	1.40	7.95	0.88
4	7.95	1.50	6.45	0.73
5	6.45	1.60	4.85	0.58
6	4.85	2.00	2.85	0.41
7	2.85	2.20	0.65	0.19
8	0.65	0.65	0.00	0.02
		11.15		

WDV Depreciation **Rs. (in lakh)**

Particulars / years	1	2
Plant and Machinery		
Cost	14.87	2.97
Depreciation	11.90	2.38
WDV	2.97	0.59

Projected Profitability **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Fuel savings	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Total Revenue (A)	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Expenses										
O & M Expenses	0.30	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44	0.46
Total Expenses (B)	0.30	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44	0.46
PBDIT (A)-(B)	3.99	3.97	3.96	3.94	3.92	3.90	3.89	3.87	3.84	3.82
Interest	1.29	1.00	0.88	0.73	0.58	0.41	0.19	0.02	0.00	0.00
PBDT	2.69	2.97	3.08	3.21	3.34	3.50	3.69	3.85	3.84	3.82
Depreciation	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
PBT	1.91	2.19	2.29	2.42	2.56	2.71	2.91	3.06	3.06	3.04
Income tax	0.00	0.20	1.05	1.09	1.14	1.19	1.25	1.31	1.31	1.30
Profit after tax (PAT)	1.91	1.98	1.25	1.33	1.42	1.52	1.65	1.75	1.75	1.74

Computation of Tax **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Profit before tax	1.91	2.19	2.29	2.42	2.56	2.71	2.91	3.06	3.06	3.04
Add: Book depreciation	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Less: WDV depreciation	11.90	2.38	-	-	-	-	-	-	-	-
Taxable profit	(9.20)	0.59	3.08	3.21	3.34	3.50	3.69	3.85	3.84	3.82
Income Tax	-	0.20	1.05	1.09	1.14	1.19	1.25	1.31	1.31	1.30

Projected Balance Sheet **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Share Capital (D)	3.72	3.72	3.72	3.72	3.72	3.72	3.72	3.72	3.72	3.72
Reserves & Surplus (E)	1.91	3.89	5.14	6.47	7.89	9.42	11.07	12.82	14.57	16.31
Term Loans (F)	10.55	9.35	7.95	6.45	4.85	2.85	0.65	0.00	0.00	0.00
Total Liabilities (D)+(E)+(F)	16.18	16.96	16.81	16.64	16.46	15.99	15.44	16.54	18.29	20.03
Assets	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Gross Fixed Assets	14.87	14.87	14.87	14.87	14.87	14.87	14.87	14.87	14.87	14.87
Less Accm. Depreciation	0.79	1.57	2.36	3.14	3.93	4.71	5.50	6.28	7.07	7.85
Net Fixed Assets	14.08	13.30	12.51	11.73	10.94	10.16	9.37	8.59	7.80	7.02
Cash & Bank Balance	2.09	3.66	4.30	4.91	5.52	5.83	6.06	7.95	10.49	13.01
TOTAL ASSETS	16.18	16.96	16.81	16.64	16.46	15.99	15.44	16.54	18.29	20.03
Net Worth	5.63	7.61	8.86	10.19	11.61	13.13	14.79	16.54	18.29	20.03
Debt Equity Ratio	2.84	2.52	2.14	1.74	1.31	0.77	0.18	0.00	0.00	0.00

Projected Cash Flow **Rs. (in lakh)**

Particulars / Years	0	1	2	3	4	5	6	7	8	9	10
Sources											
Share Capital	3.72	-	-	-	-	-	-	-	-	-	-
Term Loan	11.15										
Profit After tax		1.91	1.98	1.25	1.33	1.42	1.52	1.65	1.75	1.75	1.74
Depreciation		0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Total Sources	14.87	2.69	2.77	2.03	2.12	2.21	2.31	2.44	2.54	2.54	2.52
Application											
Capital Expenditure	14.87										
Repayment Of Loan	-	0.60	1.20	1.40	1.50	1.60	2.00	2.20	0.65	0.00	0.00
Total Application	14.87	0.60	1.20	1.40	1.50	1.60	2.00	2.20	0.65	0.00	0.00
Net Surplus	-	2.09	1.57	0.63	0.62	0.61	0.31	0.24	1.89	2.54	2.52
Add: Opening Balance	-	-	2.09	3.66	4.30	4.91	5.52	5.83	6.06	7.95	10.49
Closing Balance	-	2.09	3.66	4.30	4.91	5.52	5.83	6.06	7.95	10.49	13.01

IRR **Rs. (in lakh)**

Particulars / months	0	1	2	3	4	5	6	7	8	9	10
Profit after Tax		1.91	1.98	1.25	1.33	1.42	1.52	1.65	1.75	1.75	1.74
Depreciation		0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Interest on Term Loan		1.29	1.00	0.88	0.73	0.58	0.41	0.19	0.02	-	-
Cash outflow	(14.87)	-	-	-	-	-	-	-	-	-	-
Net Cash flow	(14.87)	3.99	3.77	2.91	2.85	2.79	2.71	2.63	2.56	2.54	2.52
IRR	16.40										

NPV	3.86

Break Even Point **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Variable Expenses										
Oper. & Maintenance Exp (75%)	0.22	0.23	0.25	0.26	0.27	0.28	0.30	0.31	0.33	0.35
Sub Total(G)	0.22	0.23	0.25	0.26	0.27	0.28	0.30	0.31	0.33	0.35
Fixed Expenses										
Oper. & Maintenance Exp (25%)	0.07	0.08	0.08	0.09	0.09	0.09	0.10	0.10	0.11	0.12
Interest on Term Loan	1.29	1.00	0.88	0.73	0.58	0.41	0.19	0.02	0.00	0.00
Depreciation (H)	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
Sub Total (I)	2.15	1.86	1.75	1.61	1.46	1.29	1.08	0.91	0.89	0.90
Sales (J)	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28	4.28
Contribution (K)	4.06	4.05	4.04	4.03	4.01	4.00	3.99	3.97	3.95	3.94
Break Even Point (L= G/I) in %	52.99	46.02	43.22	39.88	36.28	32.14	27.09	22.93	22.63	22.9
Cash Break Even {(I)-(H)} in %	33.65	26.63	23.78	20.38	16.72	12.51	7.39	3.15	2.78	2.93
Break Even Sales (J)*(L)	2.27	1.97	1.85	1.71	1.55	1.38	1.16	0.98	0.97	0.98

Return on Investment **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	9	10	Total
Net Profit Before Taxes	1.91	2.19	2.29	2.42	2.56	2.71	2.91	3.06	3.06	3.04	26.14
Net Worth	5.63	7.61	8.86	10.19	11.61	13.13	14.79	16.54	18.29	20.03	126.68
											20.64%

Debt Service Coverage Ratio **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	9	10	Total
Cash Inflow											
Profit after Tax	1.91	1.98	1.25	1.33	1.42	1.52	1.65	1.75	1.75	1.74	12.82
Depreciation	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	6.28
Interest on Term Loan	1.29	1.00	0.88	0.73	0.58	0.41	0.19	0.02	0.00	0.00	5.11
Total (M)	3.99	3.77	2.91	2.85	2.79	2.72	2.63	2.56	2.54	2.52	24.21

DEBT

Interest on Term Loan	1.29	1.00	0.88	0.73	0.58	0.41	0.19	0.02	0.00	0.00	5.11
Repayment of Term Loan	0.60	1.20	1.40	1.50	1.60	2.00	2.20	0.65	0.00	0.00	11.15
Total (N)	1.89	2.20	2.28	2.23	2.18	2.41	2.39	0.67	0.00	0.00	16.26
	2.11	1.71	1.28	1.28	1.28	1.13	1.10	3.82	0.00	0.00	1.49
Average DSCR (M/N)	1.49										

Annexure:-6 Procurement and implementation schedule

Day wise break up of implementation Schedule

S.no.	Activities	Days													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Civil	■													
2.	Ammonia Removal	■	■	■											
3.	Refitting & modifications in Ammonia pipes				■	■	■								
4.	Additional Indicators and Fittings					■	■	■	■	■	■				
5.	Training (Other)							■	■	■	■	■	■		
6.	Training (Operators)	■	■	■	■	■	■	■	■	■	■	■	■	■	■

1) 1 Day will be required for marking the support system, civil foundation for various support required for ammonia pipe line, Heat exchanger for Thermal storage system.

2) Simultaneously along with above operations, 2-3 days will be required for ammonia removal from vapor compression system & temporarily storing in ammonia receiver. Additional 3-4 days will be required for removal, refitting & modification of ammonia pipe line for charging proposed thermal storage system. Also during same time the pipe line for chilled water will be modified as per requirements of thermal storage system. Hydraulic pressure testing at required sections of the

3) The control panel of thermal storage system comprises of various temperature indicators, instrument panel which requires minor cable work, data cabling etc. This will be done once the pipe line as mentioned above completed. This operation along with trials, testing & calibration will require about 6 days.

4) The operator who will operate the system will also be trained simultaneously to above operation. This will be continuous process throughout installation but will take final shape at the end when entire installation is complete (About 1 entire day dedicated to training).

5) One day will be kept as contingency along with actual performance assessment & manpower training.

Annexure -7: Details of technology service providers

S.No.	Name of Service Provider	Address	Contact Person and No.
1	Thermal Energy Storage Systems (I) Pvt. Ltd.	Village Umrikheda, 12th K.M. Indore 400 020 (M.P.) India Tel.: 0731-4228333	Mr. SatishKhandelwal - 0731-4228 305, 09993823280
2	Refrecon Magic Systems Private Limited	2nd floor, Airotek House, S. No. 37/3, Vadgaon Khurd, Sinhgad Road, Pune, Maharashtra - 411 041 (India)	Mr. Vrajlal Kanetkar Mob No. 9422306717
3	Manasom Engineers Pvt Ltd	4B, BCM City, 5TH Floor, "C" Block, Navlakha Square, A.B. Road, Indore – 452 001	Mr. Ujjawal Jaiswal Phone : 0734-2402624 E-mail: manasomindore@gmail.com
4	IDMC Limited	Plot No. 124-128, GIDC Estate, Vithal Udyognagar 388 121, Gujarat, India	Mr. Manglani Mob No. 9824442498

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

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Energy Systems (India) Pvt. Ltd.

Village Umrikheda, 12th K.M
Indore – Khandwa Road,
Dist. Indore – 20 (M.P) INDIA,
Tel. : 0731-4228333
Fax No. 0731-4228342
E-mail: sales@kehems.com
kehems@bsnl.in

Date: 15.03.2011
Ref: SFIS/HQ/5071

To,

Petroleum Conservation Research Association,
Ministry of Petroleum & Natural Gas,Govt. Of India,
A-10,Devbhoomi Bungalows,
Nr. Basant Bahar,Gala Gymkhana Road,
Bopal,Ahmedabad-380058

Kind Attn.: Lt.Vijay Bariwal
Assistant Director

Dear Sir,

Sub: Proposal Thermal Energy System

We are pleased to submit hereunder our offer for Thermal Energy Storage System for 300 TRH storage capacity for Milk Chilling.

1.0 Basis Of Design

Storage Capacity - 300 TR HR

Type of Application - Backup

Discharge Timing - 4 Hrs.

CORRESPONDENCE ADDRESS: 303, Kothari Manor, 10, Diamond Colony, New Palasia, Indore -452 001 M.P. Ph. 2536624

Mumbai: B-23, Monica, 2nd floor, J.P. Road, Andheri (W) Mumbai -58 Ph. 26236858, Fax. 26241042, E-mail: mumbai@kehems.com
Bangalore: House No. 3462 13th 'A' Main, HAL II Stage, Indira Nagar, Bangalore -08. Ph. 25203185 Fax. 25203186, E-mail: kehems@gmail.com
Pune: Flat No. 16-17, Ground Floor, Building 'F' Hari Parva Residency Grime Bagh, Solapur Road Pune-13, Ph. 64002797. E-mail cristopia_pune@hotmail.com
Noida :D-191, Sector-10, Noida-201 301 **Tel** : 0120-4258731 / 2 **Telefax** : 0120-4258731 **E-mail** : kehemsdelhi@gmail.com

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2.0 SCOPE OF SUPPLY

Thermal Energy Storage System of minimum 300 TR-HR capacity complete with M.S. Tank, Tank Insulation & Thermal Storage

S.No.	Description	Unit	Qty
1.0	**Thermal Energy Storage System**		
	Consisting of Carbon Steel Tank, Tank Insulation(100 mm thick expanded Polysterene and aluminium Cladding) , Thermal Energy Storage Nodules & Glycol for Tank only	Set.	1
	Capacity – 300 TRH		

Price (For Item no. 1.0) :

Supply – Rs.11,90,000/- (Rupees Eleven Lacs Ninety Thousand Only)
Detail Engineering, Design & related expenses, Erection and Commissioning cost - Rs.2,65,000/- (Rupees Two Lacs Sixty Five Thousand Only)

(Minor retrofit means that no major additional components are required to be supplied for the retrofit)

2.0 PRICE BASIS

Prices quoted are all inclusive at site basis and valid for one month.

3.0 TAXES & DUTIES

Prices are Inclusive of Excise duty and CST against for 'C'.

4.0 PAYMENT TERMS

40% advance along with the Order.
60% against Proforma Invoice prior to dispatch of material.

CORRESPONDENCE ADDRESS: 303, Kothari Manor, 10, Diamond Colony, New Palasia, Indore -452 001 M.P. Ph. 2536624

Mumbai: B-23, Monica, 2nd floor, J.P. Road, Andheri (W) Mumbai -58.Ph. 26236858, Fax. 26241042, E-mail: mumbai@kehems.com
Bangalore: House No. 3462 13th 'A' Main, HAL II Stage, Indira Nagar, Bangalore -08. Ph. 25203185 Fax. 25203186, E-mail: kehems@gmail.com
Pune: Flat No. 16-17, Ground Floor, Building 'F' Hari Parva Residency Grime Bagh, Solapur Road Pune-13, Ph. 64002797, E-mail: cristopia_pune@hotmail.com
Noida :D-191, Sector-10, Noida-201 301Tel : 0120-4258731 / 2 Telefax : 0120-4258731 E-mail : kehemsdelhi@gmail.com

cristopia

5.0 DELIVERY

12 to 14 weeks from the date of your technically and commercial clear order.

6.0 LIST OF EXCLUSIONS

Following work and supplies are to be excluded from our scope of supply.

1) All cabling and wiring.
2) All civil works including making or breaking of walls and foundations etc.
3) Supply of water and electricity at desired points in desired quantity.
4) Any changes to refrigeration circuit
5) Piping quantities are assumed to be small on the basis of considering Storage Tank near the chiller plants.

7.0 GURANTEE

Equipment shall be warranted for a period of 12 months from the date of Installation or 18 months from the date of dispatch, whichever is earlier, against any manufacturing defects.

8.0 VALIDITY

Our offer is valid for 30 days.

We hope that above is inline with your requirement. In case you need any further clarification, please fell free to contact us.

Thanking You.

Yours faithfully,
for **Cristopia Energy Systems (I) Pvt. Ltd.**

Authorized Signatory

CORRESPONDENCE ADDRESS: 303, Kothari Manor, 10, Diamond Colony, New Palasia, Indore -452 001 M.P. Ph. 2536624

Mumbai: B-23, Monica, 2nd floor, J.P. Road, Andheri (W) Mumbai -58 Ph. 26236858, Fax. 26241042, E-mail: mumbai@kehems.com
Bangalore: House No. 3462 13th 'A' Main, HAL II Stage, Indira Nagar, Bangalore -08. Ph. 25203185 Fax. 25203186, E-mail: kehems@gmail.com
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Noida :D-191, Sector-10, Noida-201 301**Tel** : 0120-4258731 / 2 **Telefax** : 0120-4258731 E-mail : kehemsdelhi@gmail.com

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
Website: www.techsmall.com