LOW COST REFRIGERATION

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ABSTRACT:

The purpose of this study is to understand the industry landscape of Refrigeration in the different segment in India. It also concentrates in finding the market analysis of different technologies of Refrigeration used in India. It also identifies the major players in terms of its market share. It helps the manufacturers where to concentrate to yield more market share and also helps the customer to reveal the buying behavior.

Keywords: Refrigeration, Solar Refrigerator, Absorption refrigerator, Natural Refrigeration, Super insulated refrigeration, Evaporative cooling, Thermal conductance, Compression refrigerator, Low cost refrigerator, Low Maintenance refrigerator, Compressor less refrigerator, Power less refrigerator, New trend refrigerator

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CHAPTER -1

INTRODUCTION

1.1 Nature and scope of the project:

This internship project is to explore the market landscape of Refrigeration and to propose a Low Cost Refrigeration. The product portfolio, market analysis on the industry also conducted in this project. Industry value chain been developed in order to cut the cost. Technical analysis been done on Refrigeration to improve its efficiency. In addition to that new process/product is to 9y developed for cost saving by using value chain. Business plan to be created for the Residential Refrigeration.

1.2 What is Refrigeration?

Refrigeration is a process of moving heat from one location to another. The work of heat transport is traditionally driven by mechanical work, but can also be driven by heat, magnetism, electricity, laser, or other means. Refrigeration has many applications, including, but not limited to: household refrigerators, industrial freezers, cryogenics, and air conditioning.

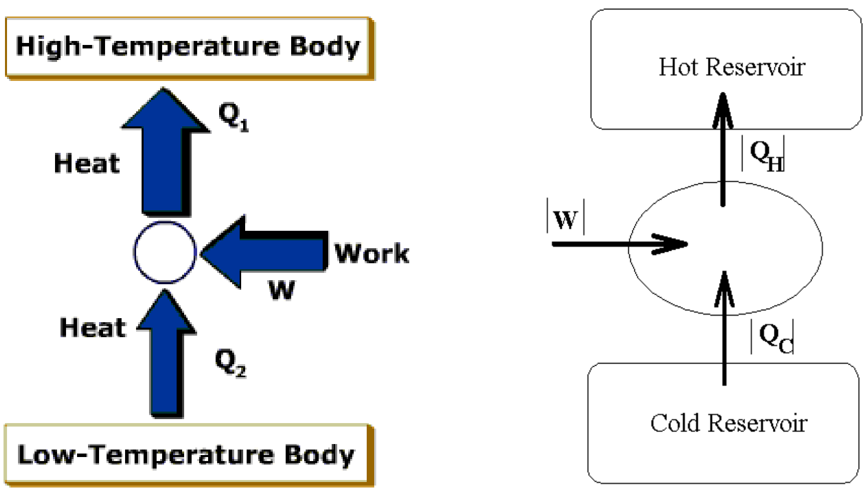


Figure1.1: Thermodynamic representation of a Refrigeration Unit

Usually heat transfer from high temperature body/sink to a Low temperature body/sink without any work is natural .But here, it is shown that the heat from low temperature body transferred to high temperature with a help of some external work. This external work is the major concern for the refrigeration effect. The external work can be done with the help of heat pump. The working concept behind the refrigeration process is that continuous removing of heat from a place/body/sink and ejecting the heat to the other surroundings so that the sink from which the heat is been cooled .Cooling is done due to the Enthalpy change between the system and surroundings .

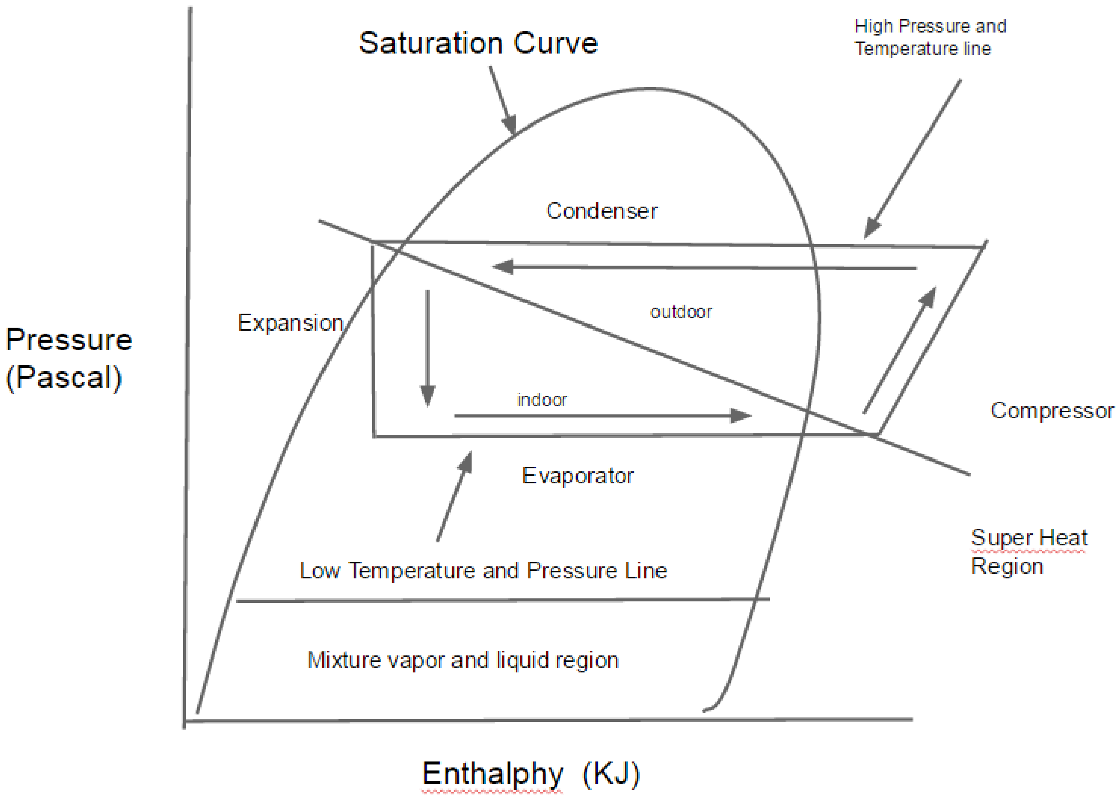


Figure1.2: Graphical representation of refrigeration cycle

Source: http://www.central-air-conditioner-and-refrigeration.com/basic-refrigeration-cycle.html

The above graph represents the pressure and enthalpy change of the refrigerant used at different stages of the general refrigeration cycle along with its phase change.

The major components used in refrigeration system are:

- Compressor
- Evaporator
- Expansion Valve
- Condenser

The different thermodynamic processes involved in the refrigeration cycle are:

Stage	Process
1-2	Isentropic Compression
2-3-4-5	Heat Rejection
5-6	Isentropic Expansion
6-7-1	Heat Addition

1.3 The Purpose of Refrigeration

The purpose for having a refrigerator is to preserve the food at lower (cold) temperature. Food preserved at lower temperature stay fresh for a longer period. The principle behind refrigeration is to reduce the activity of the bacteria which results in longer period for the bacteria to spoil the food. For example, bacteria have the capability to spoil milk within two to three hours if the milk is left in the kitchen space at room temperature. However due to refrigeration, milk will stay fresh for a week or even two. The reason is that at lower temperature the activity of the bacteria is lowered.

By freezing the milk we can stop the bacteria altogether and the milk can stay fresh for months (until effects like freezer burn turn to spoil the milk in non-bacterial ways). Refrigeration and freezing are two of the most forms of food preservation used today.

1.4 History of Refrigeration

1.4.1 Natural Refrigeration

In the past, ice was been used to achieve refrigeration. This involves natural refrigeration. The principle behind this is known as evaporative cooling. In the past ice was either:

1. Transported from colder regions,
2. Harvested in winter and stored in ice houses for summer use or,
3. By cooling of water by radiation to stratosphere (During Night).

In Europe, America and Iran a number of ice houses were built to store ice. Ice houses were made with sawdust or wood shavings as insulating materials. Later on, cork was used as insulating material. Literature states that ice has been available to aristocracy who could afford it. In India, the Mogul emperors were interested of ice during the violent summer in Delhi and Agra, and it seems that the ice was used to be made by nocturnal cooling.

In 1806, Frederic Tudor, (who was known as the "ice king") introduced the trade of ice by cutting it from the Hudson River and ponds of Massachusetts and exporting it to various countries such as India. In India Tudor's ice was cheaper than the locally manufactured ice by nocturnal cooling. In North America, ice business emerged as a flourishing business. Ice was insulated by 0.3m of cork in order to transport it to southern states of America in train. Trading in ice was also popular in several other countries such as Great Britain, Russia, Canada, Norway and France. In these countries ice was either transported from colder regions or was harvested in winter and stored in ice houses for use in summer.

The ice trade reached its peak in 1872 when America alone exported 225000 tons of ice to various countries as far as China and Australia. However, with the invention of modern refrigerator the ice trade gradually declined.

1.4.2 Art of Ice making by Nocturnal Cooling:

The art of making ice by nocturnal cooling was perfected in India. In this method ice was made by keeping a thin layer of water in a shallow earthen tray, and then exposing the tray to the night sky. Compacted hay of about 0.3 m thickness was used as insulation. The water loses heat by radiation to the stratosphere, which is at around -55˚C and by early morning hours the water in the trays freezes to ice. This method of ice production was very popular in India.

As the name indicates, evaporative cooling is the process of reducing the temperature of a system by evaporation of water. Human beings perspire and dissipate their metabolic heat by evaporative cooling if the ambient temperature is more than skin temperature. Animals such as the hippopotamus and buffalo coat themselves with mud for evaporative cooling.

Evaporative cooling has been used in India for centuries to obtain cold water in summer by storing the water in earthen pots. The water permeates through the pores of earthen vessel to its outer surface where it evaporates to the surrounding, absorbing its latent heat in part from the vessel, which cools the water. It is said that Patliputra University situated on the bank of river Ganges used to induce the evaporative-cooled air from the river. Suitably located chimneys in the rooms augmented the upward flow of warm air, which was replaced by cool air. Evaporative cooling by placing wet straw mats on the windows is also very common in India. The straw mat made from “khus” adds its inherent perfume also to the air. Nowadays desert coolers are being used in hot and dry areas to provide cooling in summer.

1.4.3. Cooling by Salt Solutions:

Certain substances such as common salt, when added to water dissolve in water and absorb its heat of solution from water (endothermic process). This reduces the temperature of the solution (water+salt). Sodium Chloride salt (NaCl) can yield temperatures up to -20˚C and Calcium Chloride (CaCl2) up to - 50˚C in properly insulated containers. However, as it is this process has limited application, as the dissolved salt has to be recovered from its solution by heating.

1.4.4. Vapor Compression Refrigeration Systems:

The basis of modern refrigeration is the ability of liquids to absorb enormous quantities of heat as they boil and evaporate. Professor William Cullen of the University of Edinburgh demonstrated this in 1755 by placing some water in thermal contact with ether under a receiver of a vacuum pump. The evaporation rate of either increased due to the vacuum pump and water could be frozen. This process involves two thermodynamic concepts, the vapor pressure and the latent heat. A liquid is in thermal equilibrium with its own vapor at a pressure called the saturation pressure, which depends on the temperature alone. If the pressure is increased for example in a pressure cooker, the water boils at higher temperature. The second concept is that the evaporation of liquid requires latent heat during evaporation. If latent heat is extracted from the liquid, the liquid gets cooled.

The temperature of either will remain constant as long as the vacuum pump maintains a pressure equal to saturation pressure at the desired temperature. This requires the removal of all the vapors formed due to vaporization. If a lower temperature is desired, then a lower saturation pressure will have to be maintained by the vacuum pump. The component of the modern day refrigeration system where cooling is produced by this method is called evaporator.

If this process of cooling is to be made continuous the vapors have to be recycled by condensation to the liquid state. The condensation process requires heat rejection to the surroundings. It can be condensed at atmospheric temperature by increasing its pressure. The

Schematic representation of the Vapor Compression System is shown below:

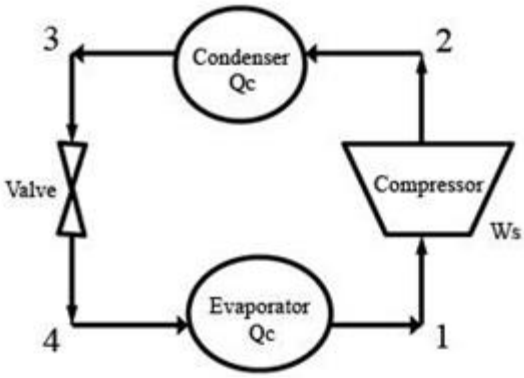


Figure1.3: Schematic representation of vapor compression cycle

(Source:www.unity.com.ph)

1.4.5. Vapor Absorption Refrigeration Systems:

The schematic representation of vapor absorption system is shown below:

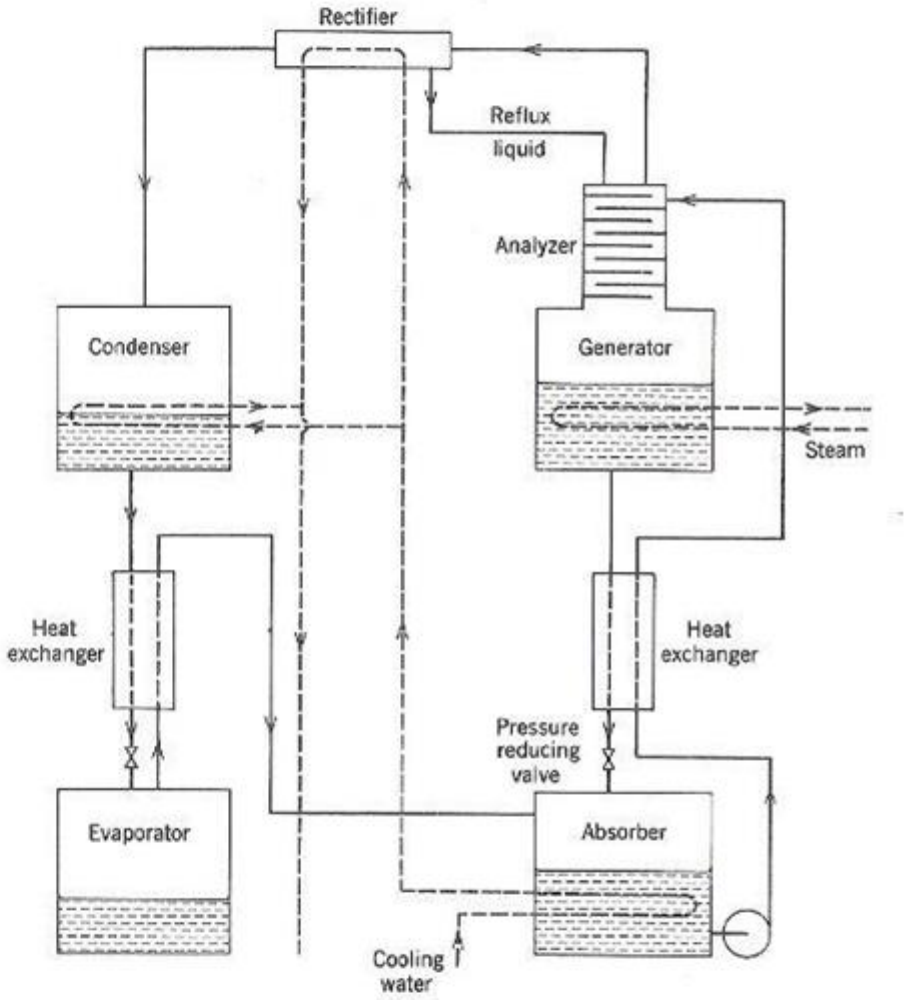


Figure1.4: Schematic representation of vapor absorption cycle

(source:www.brighthubengineering.com)

1.4.6. Domestic refrigeration systems:

The domestic refrigerator using natural ice (domestic ice box) was invented in 1803 and was used for 150 years without any significant alteration. The domestic ice box to be used is made up of wood with sufficient and suitable insulation. Ice was kept at the top of the box, and low temperatures were produced in the box due to the heat transfer from ice due to natural convection. A drip pan or vessel was used to collect the water formed due to the melting of ice. The box was been replenished with fresh ice once all the ice melts. Even though the concept was simple, the domestic ice box suffered from several disadvantages.

The user has to replenish the ice as soon as it is consumed, and there exist a limitation in acquiring the lowest temperature. In addition, it appears that warm winters caused severe shortage of natural ice in USA. Hence, efforts were taken from 1887 to develop domestic refrigerators using mechanical systems. The initial domestic mechanical refrigerators were costly, not completely automatic and were not very reliable. However, the development of mechanically operated residential refrigerator on large scale was made possible by development of small compressors, automatic refrigerant controls, better shaft seals, better electrical power system and induction motors.

CHAPTER -2

MARKET SCENARIO

The consumer durable industry in India is one which contributes revenues of about Rs. 350 Billion. The refrigerator market would come under the White goods category of the Consumer Durable industry. However, the margin on the products of the industry is quite less and is highly dependent on the volume of sales of the product.

2.1 Major Players:

Indian players are:

- Godrej
- Kelvinator
- Allwyn
- Voltas

These players have dominated the refrigerator market from 1950s to 1990s. But the situation is completely changed with the liberalization of the economy. Many MNC players like

- LG
- Samsung
- Whirlpool

have entered the Indian market in 1990s and became the market leaders now.

The refrigerators are broadly divided into two categories, such as,

1. Direct Cool (DC) refrigerators.
2. Frost Free (FF) refrigerators.

Most of the basic models fall under Direct Cool category and almost all other modern refrigerators fall under Frost free category. As per the industry sources, the DC segment occupies around 75 percent of total market share and rest of 25 percent occupied by FF models. Looking at the current market trend, both of these segments would continue to be strong for the next 5 years, however in long run FF models will occupy larger market share. As like other household appliances, refrigerator industry has also seen drastic changes in technology, consumer demand and competition over the last 10 years.

Economic slowdown notwithstanding, demand for refrigerators went up by 17 per cent in the first eight months of this year against the corresponding period last year, according to the market research firm GfK.

Out of the two main types of refrigerator that exists in the Indian market, single door or direct cool segment dominates and continues to remain popular, accounting for three in every four refrigerators purchased last year. The company added that there is a growing demand for high-end, higher capacity frost-free refrigerators. In the first eight months of 2014, frost-free refrigerators with capacity greater than 400 litres registered a surge of more than 25 percent in volume and 36 percent in value, GfK retail track for refrigerator across urban India reported over 300 new models introduced in the first eight months of 2014. Nearly two out of three of the new launches were frost-free models, of which around 50 of them were above 400 litres in capacity, it said.

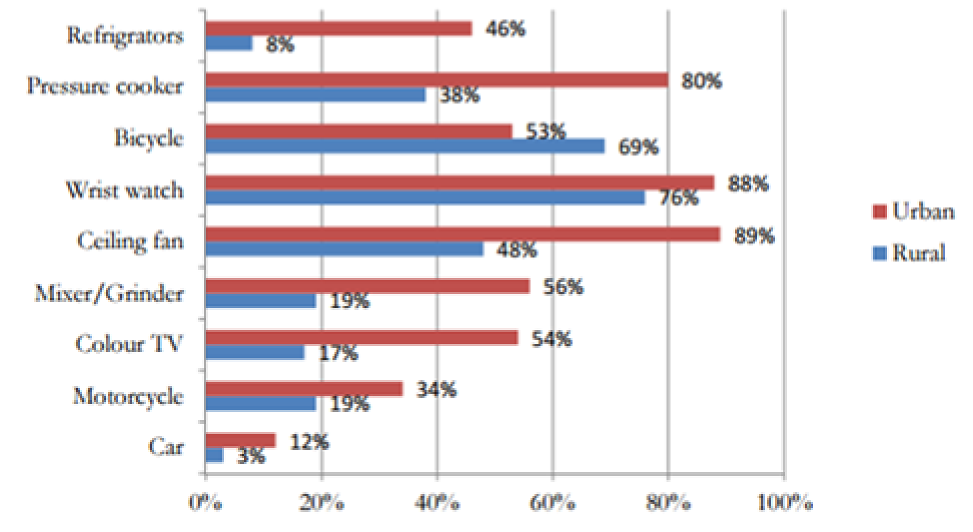


Figure1.5: Ownership of consumer durables (% of household)

The penetration rate of refrigerators in India is still at very low when compared with other emerging markets or developed countries. As per the reports, currently about 46 percent of urban households and 8 percent of rural households in India own a refrigerator. According to CRISIL, the southern region of India leads with 34 percent market share of sales in volume, followed by northern region 29 percent, western region 24 percent, and eastern region 13 percent.

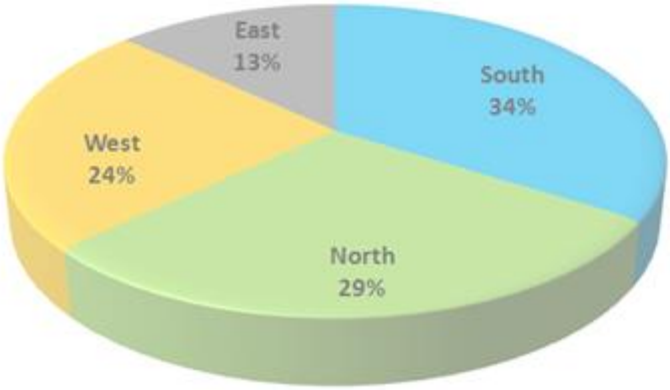


Figure2.2:Region-wise refrigerator sales in India

According to “Refrigerator Market Forecast to 2015”, a recent report by RNCOS, the refrigerator market is estimated to grow at a CAGR of 25.7% during 2012-2015. The efforts of players to offer affordable and eco-friendly variants and strategies to penetrate into smaller towns are acting as a driving force for the industry. Further, rising per capita income, increasing role of the government to support FDI in India and easy availability of financing will also drive the industry. The refrigerator market in India is clearly dominated by five players LG, Samsung, Videocon, Godrej and Whirlpool accounting for 97 percent of overall market share.

Figure2.3: Market share of major players in the refrigerator market

The growth in consumer durable and automobile industry is driving the demand in refrigerant industry. Additionally, the major suppliers are responding towards the phase-out of CFC's and HCFC's by providing a wide range of alternative refrigerants and maintaining their supply globally.

STAKEHOLDERS IN THE INDUSTRY:

- Refrigerant traders, distributors, and suppliers
- Fluorochemical manufacturers
- Manufacturers in end-use industries such as refrigerators
- Government and research organizations
- Raw material suppliers
- Associations and industry bodies

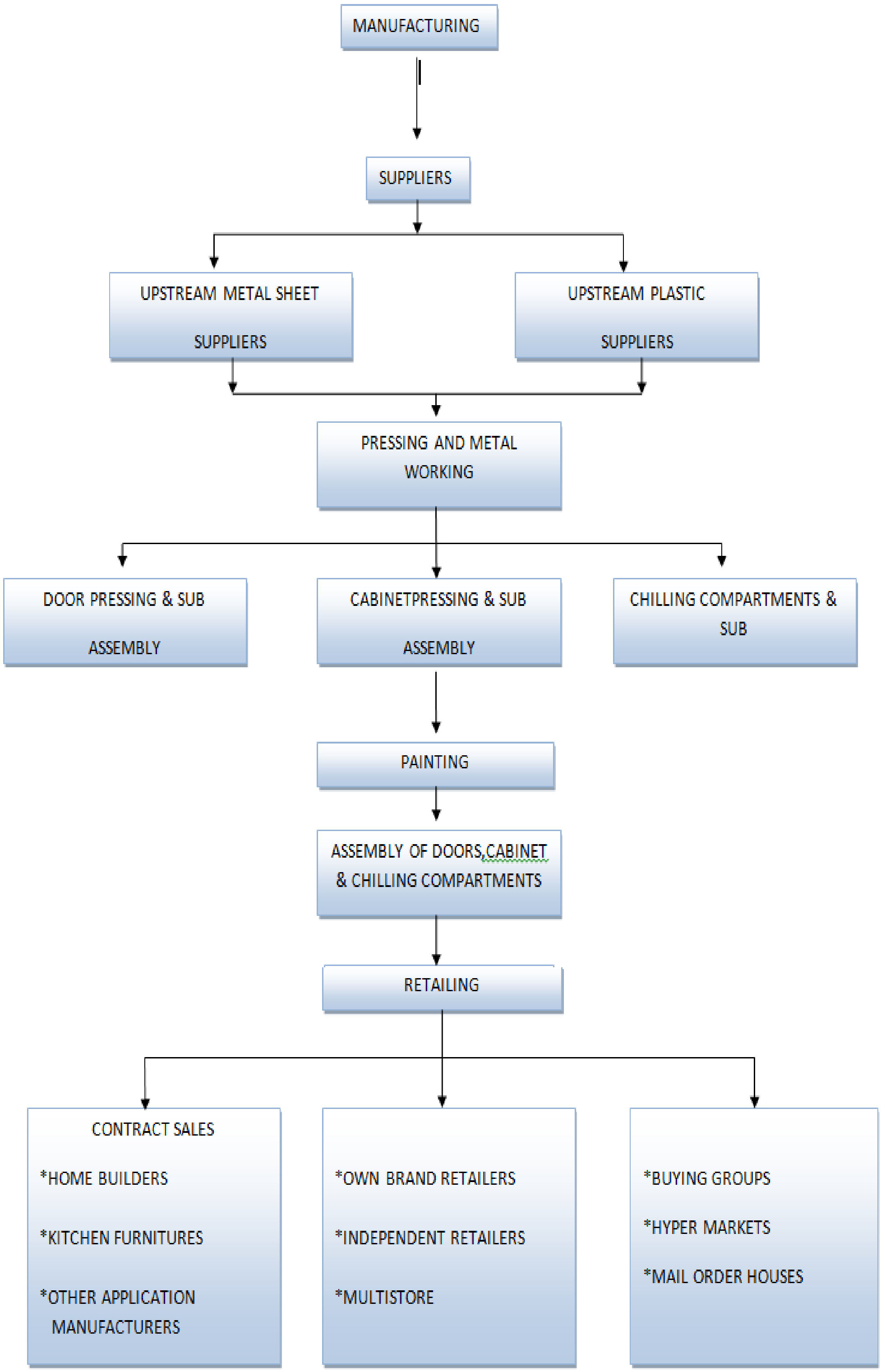
DRIVERS IN THE REFRIGERATOR MARKET:

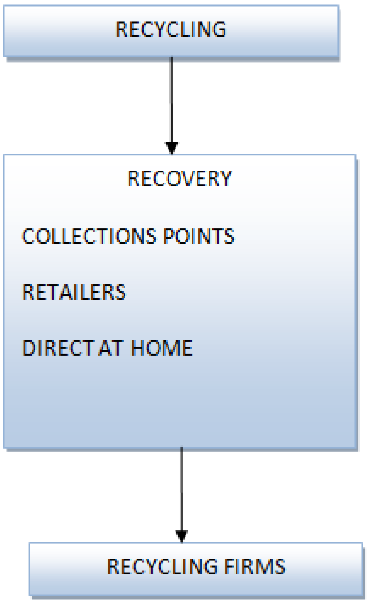
- Increasing disposable income
- Growth in retail sector
- Improving social indicators
- Government initiatives and product enhancement
- Increasing number of nuclear families
- Easy terms of financing

CHALLENGES IN THE REFRIGERATOR MARKET:

- Low acceptance rate in rural areas
- Environmental hazards
- Market constraints

Chapter -3 Value chain




RECYCLING
RECOVERY
COLLECTIONS POINTS
RETAILERS
DIRECT AT HOME
RECYCLING FIRMS

CHAPTER -4

OPPORTUNITIES TO BE EXPLORED

4.1 Gap Analysis

From a small survey using questionnaire it is found that gap

CONSUMER
- low cost
- Efficiency
- new features
- Compact size

GAP

COMPANY
- cost management
- Innovation
- safety precaution

4.2 EMERGING TECHNOLOGIES:

- Super chilling
- Smart packaging
- Magnetic refrigeration
- Air cycle
- Nano particle
- Solar (industry)
- Claude's Process
- Linde's Process

CHAPTER -5

CONCEPTS

5.1 NATURAL REFRIGERATION

Refrigeration is simply transfer of heat from one place to another so that the temperature can be reduced in that particular place. Refrigeration can be done by natural modes.

Natural Modes of Refrigeration:

Natural modes of refrigeration can be done by using air, water, clay sand as a medium for transfer of heat.

Why Natural Refrigeration:

Refrigeration is of many sectors such as industrial refrigeration, Residential refrigeration, Ice bakers. We are focusing in the residential refrigeration. In household refrigeration mostly the refrigeration temperature to be maintained is about 15 degree. This 15 degree can be maintained in a refrigerant space using natural modes such as air, water, clay sand.

Purpose:

To provide a low cost refrigeration along with low maintenance cost and a user friendly model of residential refrigeration in terms of

- Design
- Usage
- Maintenance

Principle behind Natural Refrigeration:

The Refrigerator outer walls are made hollow with clay sand which has the minute air holes in it. The hollow outer case of the refrigerator is filled with water. The Refrigerator space is now surrounded by water. The heat inside the refrigerator space is absorbed by the water through the air holes in the clay covering and the heat is dissipated to the atmosphere through the other wall.

Advantages:

- No Mechanical components
- Noiseless
- Power is not Required
- Eco-friendly

Steps to be followed:

Step 1: Calculate the refrigerant space

Step 2: Determine the inner and outer temperature

Step 3: Calculate the thickness of the wall

Step 4: Calculate the volume of water to be filled

Step 5: Determine the time required to cool the refrigerant space

Basic Calculation:

Temperature inside the system	(T1)	= 15 deg C
Temperature outside the system	(T2)	= 30 deg C
Change in Temperature	(T2-T1)	= 15 deg C
Length of the outer wall (clay)	(L1)	= 0.5 m
Length of the intermediate wall	(L2)	= 0.5 m
Length of the inner wall	(L3)	= 0.5 m
Thermal Conductivity of outer wall	(K1)	= 0.72 W/m K
Thermal Conductivity of inter wall	(K2)	= 0.56 W/m K
Thermal Conductivity of outer wall	(K3)	= 0.72 W/m K
Convective Co-efficient of Clay	(h1)	= 7.2 W/m2K
Overall Heat Transfer Coefficient	(U)	= 0.390 W/m K
Transmission Heat	(Q)	= 0.879 KJ
Volume to be filled	(Qv)	= 0.05 m3
Quantity of water	(Qu)	= 12 litres
Air Volume	(V)	= 0.0536
Evaporation Rate		= 0.120 litres / day

(Note: This calculation is done for a prototype assumption.)

TOOL:

An Excel tool has been created in order to find the specification of the refrigerator components for a specified area of refrigeration with the materials of the sidewalls of the refrigerator are known. The Hyperlink of the tool is given below:

Excel Tool

5.2 SOLAR REFRIGERATION

Solar-powered refrigerators are pretty easy to come by these days, and they get around the energy-consumption issues associated with traditional fridges. They also get around the fact that 2 billion people around the globe have no access to electricity in the first place.

Why Solar power:

- Need to produce Refrigeration where there is no connection to the Grid
- Need to reduce the Environmental Impact and Fuel Costing

Solar power can be used for a refrigerator which works either in vapor absorption mode or vapor compression mode. Solar is a energy which is abundant and can be obtained easily especially for a country like India where there are nearly 300 sunny days in a year. The maintenance cost of a solar system is comparatively low compared to that of other sources of energy.

Purpose:

To make a effective refrigerator using Solar Energy
To provide a onetime investment with minimum running expense
To make a pollution free system
Refrigeration system having low maintenance Cost

PRINCIPLE:

VAPOR COMPRESSION REFRIGERATION:

In a Vapor compression cycle, the power driver is the compressor which is used to convert the low pressure refrigerant vapor into high pressure vapor. Using solar energy, the power required for the compressor to run for a whole day can be produced. The Schematic representation of Solar powered Vapor compression cycle is shown below:

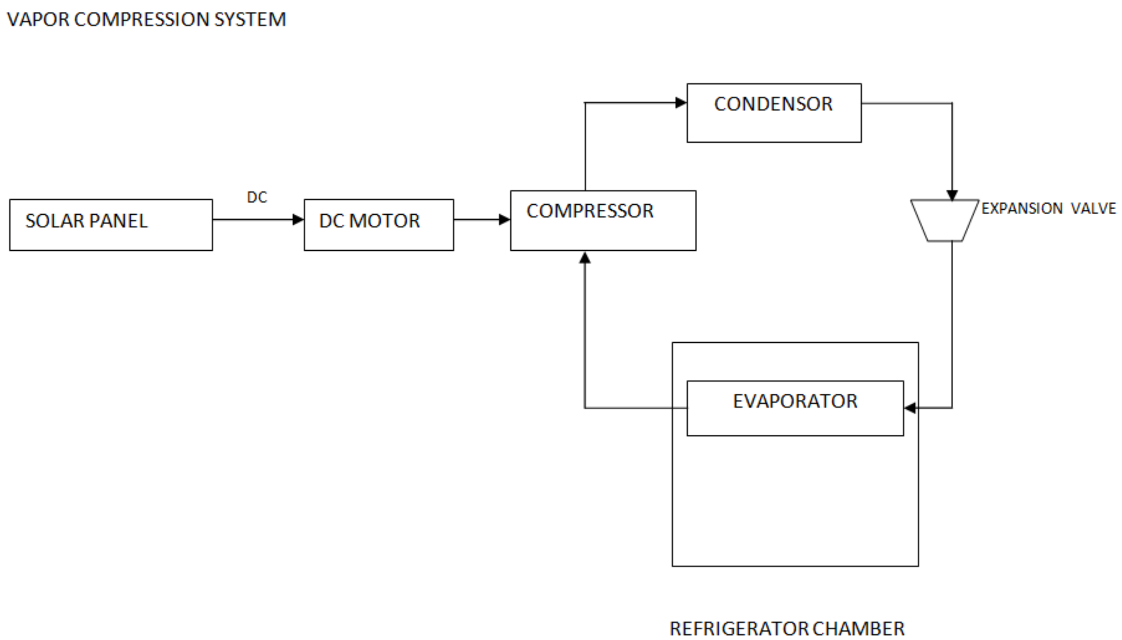


Figure5.1: Vapor compression cycle

ADVANTAGES OF VAPOR COMPRESSION REFRIGERATION:

Lots of Heat energy can be removed

Heat transfer rate remains constant

VAPOR ABSORPTION REFRIGERATION:

In case of a Vapor absorption cycle, the power is required for a small pump that circulates the refrigerant mixture throughout the system and additional power is required by the generator which separates the absorption mixture. Absorptive chillers like solar refrigerators use a heat source rather than a compressor to change the refrigerant from vapor to liquid .This total power can be produced using a compact solar system.

The heat in the Generator can be given through other modes such as kerosene/oil lamp or even with Gas flame. The schematic representation of solar powered Vapor absorption refrigerator is shown below:

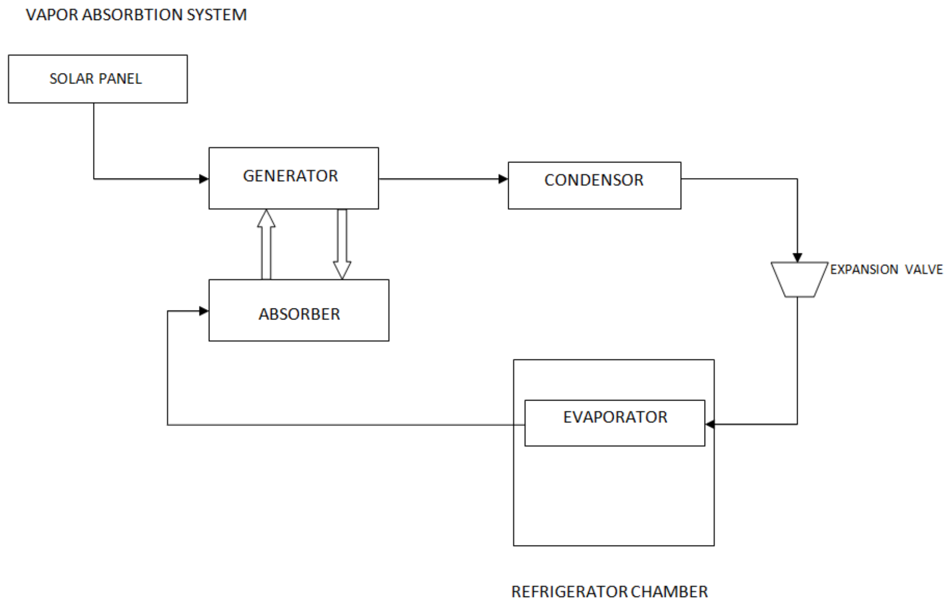


Figure5.2: Vapor absorption system

The two most common combinations are water mixed with either lithium bromide or ammonia. In each case, the refrigerating gas is absorbed until heat is applied, which raises the temperature and pressure. At higher pressure, the refrigerant condenses into liquid. Turning off the heat lowers the pressure, causing that liquid to evaporate back into a gas, thereby creating the cooling effect.

ADVANTAGES OF VAPOR ABSORPTION REFRIGERATION:

- Reduced vaporization Temperature and Pressure
- Moving part is only the pump
- Load variation does affect the performance
- As capacity increases the percentage of electricity saving increases

Calculation of a Simple Vapor Absorption Refrigeration Model:

Specifications:

ABSORBER:

Length= 10 cm, Breadth= 10 cm, Height= 12.5 cm.

Material used: Galvanized iron.

GENERATOR:

Length= 10 cm, Breadth= 10 cm, Height= 12.5 cm.

Material used: Galvanized iron.

HEATING COIL:

It is made of nichrome wire.

Specifications: Length 20 cm

EXPANSION COIL:

Length = 35cm

Outer diameter= 0.175 cm

Material used: Copper

CONDENSER:

Length= 15 cm, Width= 8 cm, Height= 17 cm.

Number of turns= 28

Inner diameter = 0.4297 cm.

CAPILLARY TUBE:

Length= 35 cm, Outer diameter=0.4297 cm.

Calculation:

Heat absorbed in evaporator $= m_r (h_6 – h_5)$

$= 210$ kJ/min.

Heat generated in generator $= m_r (h_3 – h_2)$

$= 304.2$ kJ/min.

Heat rejected from condenser $= m_r (h_4 – h_3)$

= 211.6 kJ/min.

Work input to pump = 9.6 W

COP = heat absorbed in evaporator / (work done by pump + heat supplied in generator)

COP = 0.69

COST:

The initial cost may be high but the maintenance cost is low and the cost saving is significantly high. The return on investment also plays a major role.

TOOL:

An Excel Tool has been used to find the initial setup cost of the system, the cost that can be saved annually and along with Return on Investment (ROI) period. The Hypertext to the tool is given below.

Excel Tool

5.3 Super Insulated Refrigeration

The key to effective insulation is thermal conductivity - the lower the better - and super-insulation materials are distinguished by their extremely low thermal conductivity.

In porous insulation materials, heat is transferred via conduction through the solid material structure, the intervening gas and by thermal radiation. But in super-insulation materials heat normally conducted via the gas inside the pores is prevented by means of evacuation and by microporous materials.

By evacuating insulation systems with porous fillings, super-evacuated insulation materials can be produced which have a thermal conductivity of less than 0.005 W/(m·K) at 20°C. Compare this with air which has a thermal conductivity of 0.026 W/(m·K). The insulation system's vacuum-tight casing comprises, for example, multi-layered compound film or thin stainless-steel sheeting.

Evacuated foil insulation has outstanding insulation properties at low temperatures, making it most suitable for cryo-applications (T< -180°C). Effective thermal conductivity values of far less than 0.001 W/(m·K) can be achieved, using layered, highly-reflective metallic foils separated with spacers.

Why Super Insulation:

The heat removal is the main aim of the refrigeration which can be done by the other methods but with help of super insulator the heat from the atmosphere enters at very low rate which reduces the operations of the entire system.

In this way the energy consumption of the system can also be conserved. The thickness required by the super insulator is comparatively lower than the normal insulator in order to produce the same refrigeration effect or even better refrigeration.

THERMAL INSULATION:

PRINCIPLE:

In low-energy refrigerator, the entire body envelope is highly insulated. The body envelope consists of all the building elements of the refrigerator which separate the inside from the outside. Its main purpose is to provide for a comfortable indoor temperature irrespective of the outdoor temperature which is determined by the weather.

During cold periods the temperature inside the body envelope is usually higher than it is outside. As a result, heat is lost through the envelope and, unless this heat is replaced, the inside of the body cools down adjusting to the outdoor temperature. The inverse applies for hot climates (or during hot periods) with excessive heat entering the body through its envelope. Therefore, it makes sense to restrict the heat flow in refrigerator irrespective of the climate and this is how the thermal insulation helps to maintain the temperature.

As a matter of fact, it is thermal insulation and not heat storage which is important. A high level of insulation has always proven to be effective. Heat losses through external walls and roofs account for more than 70% of the total heat losses in refrigerator which is greater than heat produced due to air infiltration rate. Therefore, improving thermal insulation is the most effective way to save energy. At the same time it will help improve thermal comfort and prevent structural damage.

The heat losses during cold periods are negligibly small, and the temperature of the interior surfaces is nearly the same as the air temperature. This leads to a very high level of comfort and reliable prevention of body damage due to moisture build up. In warmer climates or during summer months, good insulation also provides protection against heat.

Good insulation and airtight construction have proved to be extremely effective. Another essential principle is “thermal bridge free design” (which is commonly used in thermal insulated houses) the insulation is applied without any “weak spots” around the whole refrigerator body so as to eliminate cold corners as well as excessive heat losses. This method is another essential principle assuring a high level of quality and comfort.

INSULATION MATERIALS:

The following table shows some of the super insulation materials with its thermal conductivity.

TABLE 1:Thermal conductivity of super insulators

MATERIAL	Thermal Conductivity W/mK
Straw	0.055
Typical Insulation material	0.040
High quality conventional Insulation material	0.025
Nano porus Super-Insulating material under normal pressure	0.015
Vacuum Insulation material (silica)	0.008
Vacuum610 . Insulation material (high vacuum)	0.002
Perlite	1.000
Aerogel + Carbon	0.550
Multi Layer Insulation (MLI)	0.100
Silica Aerogel	0.002

TABLE 2: Thermal conductivity of normal insulators

MATERIAL	Thermal Conductivity W/mK
Air	0.024
Air (at elevation 1000 m)	0.020
Polystyrene (expanded Styro Foam)	0.030
Polyurethane Foam	0.030

COST:

Coming to the cost part super insulation material are slightly costlier than the normal insulating material which can be negligible.

TOOL:

An Excel Tool is been created to calculate the effectiveness of the Super-Insulation Material with its thermal conductivity. The Hypertext Link for the tool is given below:

Excel Tool

CONCLUSION:

Refrigeration is an essential part of food preservation. Awareness is still lower among the rural people. From the market analysis data, it is clear that still 92 percent people from rural are not aware while 54 percent of urban people are unaware of refrigeration which indicates the growth potential of the industry in the near future. The proposed concepts help to manufacture low cost refrigerator with which the unexplored market can be explored.

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Appendix I

Organization profile:

ATOA Scientific Technologies (ATOAST) is an Engineering simulations services and solution provider founded in 2005. ATOA provide advanced Computer Aided Engineering simulation for engineered material, product, process and system design. ATOA leverage cutting edge research in computational mechanics, multiphysics modeling, material, system and application technology for providing innovative simulation solution to clients.

Mission:

The business mission is to Provide high quality, cost effective, customer centric engineering services for virtual Innovative material, product, process and system development using state of the art tools and Technology. The technology mission is to devote 20% of our resources for Research and Innovation to develop breakthrough technology development for the benefit of clients. The social mission is to redirect or invest 10% of the profit or resources for the benefit of society or sustainable social causes.

Vision:

The Business vision of ATOAST is to become a global leader for Multiphysics engineering Simulation solution provider for every successful product, process, material and system design for our clients. The technical vision of ATOAST is to proliferate multiphysics engineering simulations and material unity for innovative material, product, process and system design, by bridging Atom to Application. The social vision of ATOAST is to support economic empowerment of the society with a focus on sustainable technology solution development.