A Project Report on

“Design Development & Experimentation of a fruit juice instant chiller”„

Submitted By

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ABSTRACT

Juice plays a important role in our life. So, it is important to drink a hygienic/fresh juice which do not affect to our health. In summer season we all drink juice which is chilled

Refrigeration is a basic method of food/juice preservation. All the refrigeration methods for food/juice preservation are based on Reverse Carnot cycle, which explains Adiabatic and Isothermal Expansion and Compression. Basic components used in these cycles are Evaporator, Compressor, Condenser and Expansion Valve. Generally used cycle is Vapor Compression Cycle. Other cycles are Vapor Absorption Cycle, Gas Cycle. Other new methods of Refrigeration are using refrigerant as cooling medium flow it from coils and a juice with it also in other coil so the refrigerant may extract the heat of juice. Various types of refrigerants are used in these cycles based upon their properties. Commercially Refrigeration is used as preservation method in various food industries like Dairy and Meat Processing industry.

In the current scenario all the juice seller uses ice to chill their juice and sell it. But we actually don't know how the ice is form in factories or which water they used for making the ice.

We all have notice that after drinking the juice in which they add ice that it somewhere affect to our throat also. So to overcome this problem we decided to make this project.

In market there are some machine which do the same work but their disadvantage is that it is costly or affect the freshness of juice.

In mall or supermarket we see that there are the juice bottles or packets which are kept at that place from a period of time so how can we say that it maintain the freshness of juice.

Keywords: - *Evacuated tube collector, evaporator coils, Storage tank, condenser kit*

CHAPTER 1

INTRODUCTION

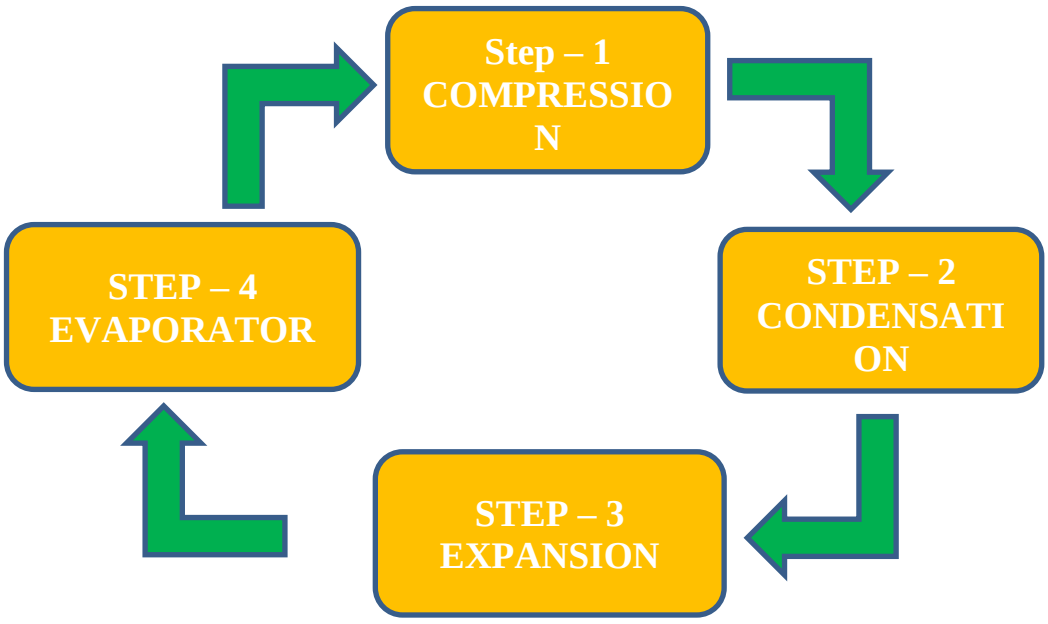
In this project we are going to do design development and experimentation of a fruit juice instant chiller. This system is work on the vapour compression refrigeration cycle. The Vapour compression refrigeration systems are the most commonly used refrigeration system among all refrigeration systems. Vapour refrigeration cycle works in four steps. Compression, Condensation, expansion, evaporation

Compression – In the compression process with the help of compressor refrigerant get compressed. Due to this pressure of refrigerant gets increased hence temperature of the refrigerant gets increased. For the compression process we are using hermetically sealed compressor.

Condensation – In the condensation process the pressurized refrigerant gets cooled down by rejecting the heat to surrounding and phase of refrigerant changes to liquid. Here we are using air cooled condenser with the fan provided.

Expansion – In the expansion process we use capillary tube as expansion device to reducing the condenser pressure to evaporator pressure.

Evaporator – In the evaporation process by extracting the heat from the system we chill the Fruit Juice



Schematic Diagram

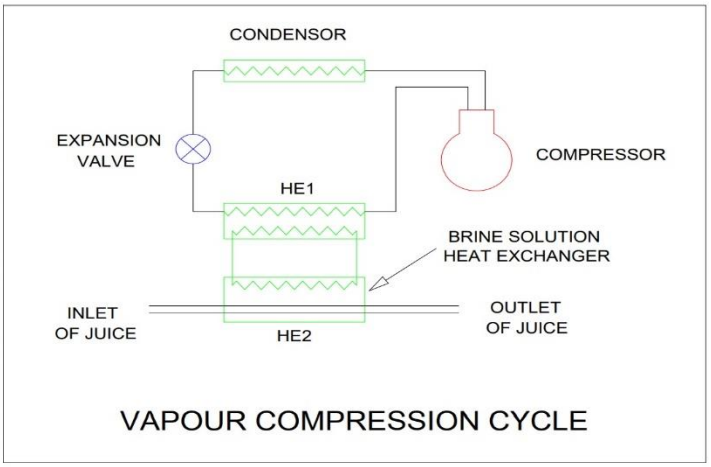


Fig – Experimental Setup

Component & Specifications-

1. **Compressor -** BTU 900 R134a
   Specifications – 220V – 240V ~ 50Hz
   Refrigerant – R134a (Hydro-Carbon)

Fig.1.2 Compressor

2. Condenser – Condenser with Fan

The Condenser we are using is air cooled condenser with help of fan.

An air cooled condenser (ACC) is a direct dry cooling system where steam is condensed inside air-cooled finned tubes. The cool ambient air flow outside the finned tubes is what removes heat and defines the functionality of an ACC.

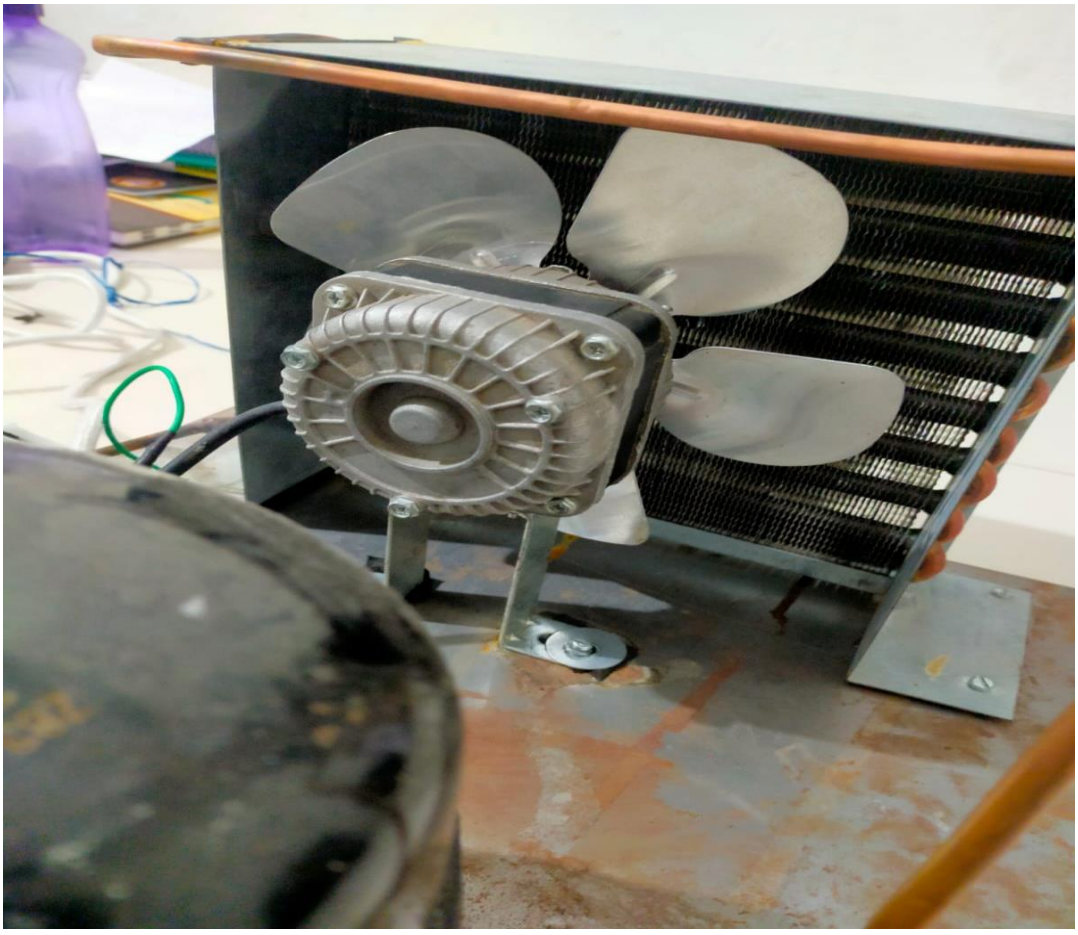


Fig.1.3 Condensor

3. Evaporator –

The Evaporator used is stainless steel food-grade container of 5-liter capacity.

The first Heat exchanger is to store the brine solution & to circulate the brine solution in the other heat exchanger which is used to chill down the juice.

What is the function of an evaporator?

In refrigeration, an evaporator is the heat exchanger where the refrigerant circulating inside the refrigeration circuit absorbs the thermal energy from the environment, which is then cooled. This is how the state of the refrigerant changes from liquid vapor, giving it its name

Fig.1.4 Evaporator

4. Touch-sensitive temperature controller subzero control –

The touch-sensitive temperature controller subzero control is used to connect the various circuits such as the compressor condenser & also to the motor.

The controller has a set low/high temperature when the system goes below the set temperature then the system will be cut-off same for high temperature

Fig.1.5 Subzero Controller

5. Accumulator & Capillary Tube –

Capillary Tube – 0.040 ø

As per the Image shown below you can see the capillary tube is wounded around the accumulator. This helps in better heat transfer rate between the capillary tube & accumulator

The accumulator can act as a receiver during the heating and defrost cycles when system imbalance or an overcharge from field service could result in excessive liquid refrigerant in the system. The accumulator can store the refrigerant until needed and feed it back to the compressor at an acceptable rate.

A capillary tube is a type of metering device that is primarily used in refrigeration equipment and HVAC systems, designed to maintain the temperature of the system

Fig.1.6 Accumulator and Capillary tube

6. Filter Drier –

This device is to control & maintains the required humidity of the refrigerant

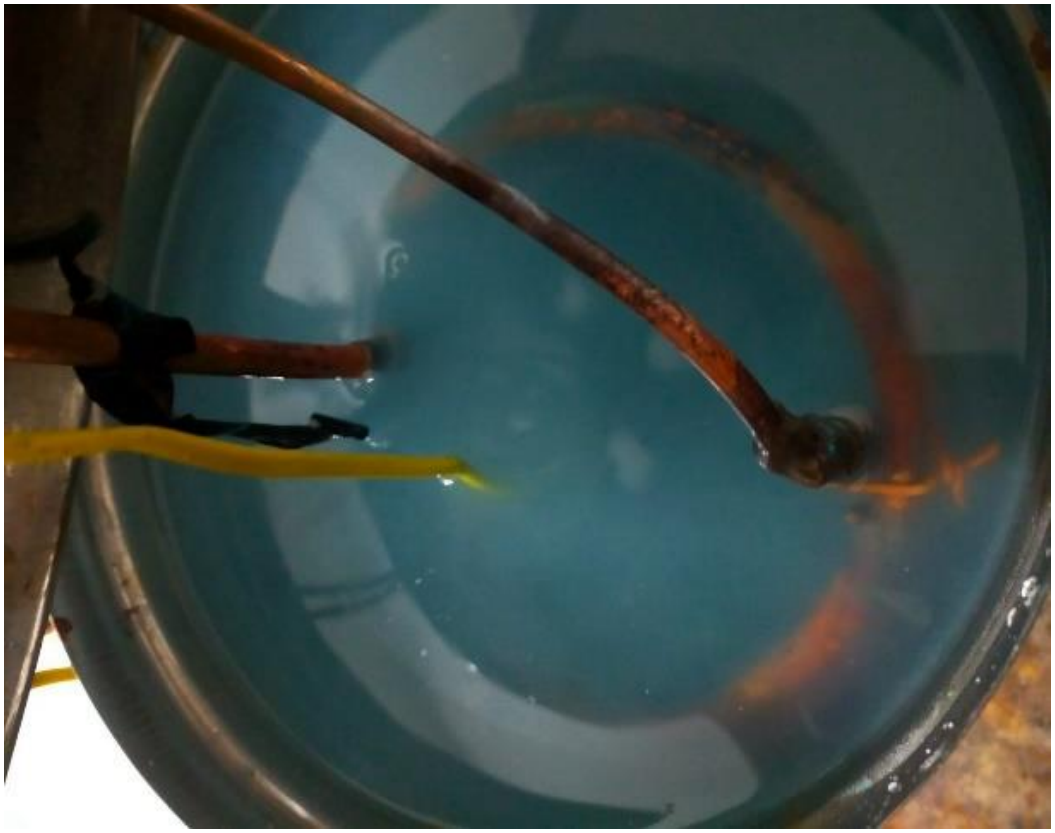
A filter-drier in a refrigeration or air conditioning system has two essential functions: one, to adsorb system contaminants, such as water, which can create acids, and two, to provide physical filtration. Evaluation of each factor is necessary to ensure proper and economical drier design**.**

Fig.1.7 Filter Drier

7. Brine Solution –

The Brine Solution which we are using is a mixture of NaCl & Water in such a way that for 1 liter of water, we are adding 135 gm. of NaCl.

Brine is a high-concentration solution of salt (usually sodium chloride) in water. In different contexts, brine may refer to salt solutions ranging from about 3.5% (a typical concentration of seawater, on the lower end of solutions used for bringing foods) up to about 26% (a typical saturated solution, depending on temperature). Lower levels of concentration are called by different names: freshwater, brackish water, and saline water



Brine is used as a secondary fluid in large refrigeration installations for the transport of thermal energy. Most commonly used brines are based on inexpensive calcium chloride and sodium chloride. It is used because the addition of salt to water lowers the freezing temperature of the solution and the heat transport efficiency can be greatly enhanced for the comparatively low cost of the material. The lowest freezing point obtainable for NaCl brine is −21.1 °C (−6.0 °F) at the concentration of 23.3% NaCl by weight. This is called the eutectic point.

Sodium chloride brine spray is used on some fishing vessels to freeze fish. The brine temperature is generally −5 °F (−21 °C). Air blast freezing temperatures are −31 °F (−35 °C) or lower. Given the higher temperature of brine, the system efficiency over air blast freezing can be higher. High-value fish usually are frozen at much lower temperatures, below the practical temperature limit for brine.

System Achieving Desired Temperature –

In this Experimental setup, we have achieved -8º C temperature.

To achieve this temperature from 31ºC to -8º C system took approx. 30 minutes of time.

Once the system reaches the desired temperature range the system is automatically cut-off by a Touch-sensitive temperature controller.

1.1 Problem Statement -

The fresh juice is often chilled by adding ice to it. Adding ice not only dilutes the juice but may also add impurities to the juice as the commercial ice-making process is always under question mark about hygiene.

The other way of chilling the juice is by storing it in a refrigerator which consumes time and affects the freshness of the juice. To overcome this, a novel instant juice chiller is Developed in the present project.

If we consume ice cubes which are present in juice then:

- Your teeth will become sensitive and may have pain.
- If ice/refrigerator is not of good quality, you may end up in sore throat.

If we take a survey in market then we know that the ice bar that the juice vendor purchase from factory is look little bit dirty and when they put that ice bar in the trolley or box which they use to transport the ice from one place to other is also add a layer of dirt on it.

For human body around 10 to 15 degree temperature is suitable without any harm.

So that's why we are developing a model which instantly cool the juice from normal temperature to 12 – 15 degree temperature without any addition of ice.

Due to which there is no dilution of juice.

Design & experiment Calculation.

For Heat Balance equation

Heat Exchanger 2 Design calculation [Brine → juice]

Heat rejected by the Sugarcane juice = Heat gained by the brine solution

Considering 3 liter per min discharge of juice

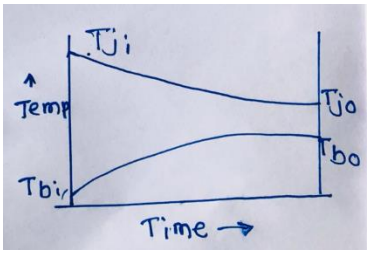
Initial temp of Juice = 25°c

Final temperature of juice to be achieved. = 12°C

ΔT_j = 13°C

$Mj \times cp(j) \times \Delta Tj = mb\ cp(b)\ \Delta Tb$

By considering the total volume of Brine as Five times more than the juice to achieve instant cooling.
For Cooling 1 litre of juice 5 litre of brine is kept.
For designing the tubes of the juice flow
The following equation can be considered.



Qj = UA x (LMTD)

LMTD is given by

$$LMTD = \frac{(Tji - Tbi) - (Tjo - Tbo)}{\log_e\left(\frac{Tji - Tbi}{Tjo - Tbo}\right)}$$

From this equation Qj can be calculated
Qj = mj.cpjΔT

From this mj , no. of tubes and tube diameter is selected.

Analysis of Condenser = Heat loss by refrigerant to the surrounding

$\because Q_c = hA\Delta T = m_r = (h_3 - h_4) = m_r Cp_r (T_3 - T_4)$

h = Heat transfer coefficient from condenser to atmosphere

ΔT = Temperature difference in ºC

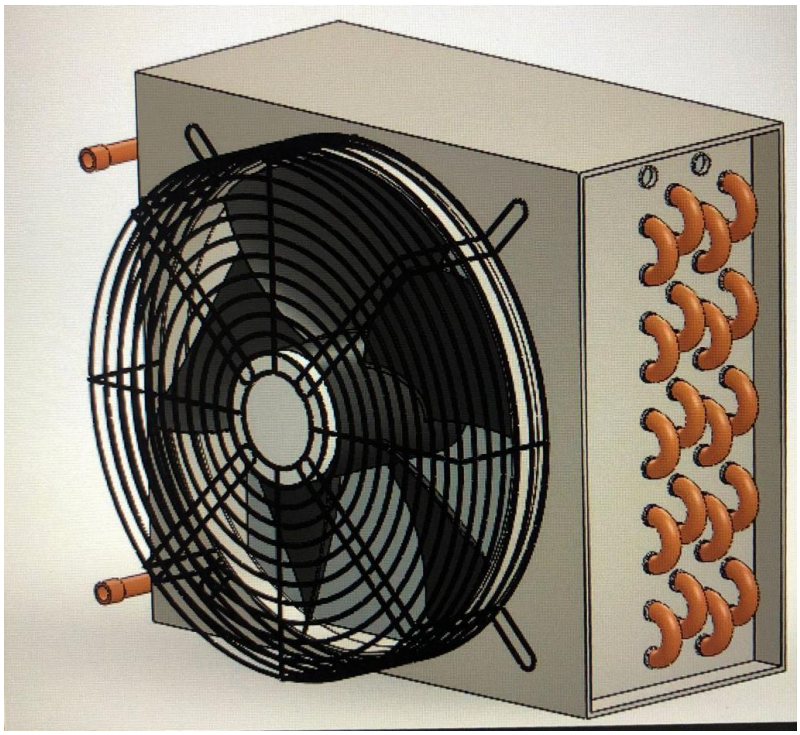
$\because Q_c = UA_s(LMTD)$

$$LMTD = \frac{(T3-Tai) - (T4-Tao)}{\log_e\left(\frac{T4-Tao}{T3-Tai}\right)}$$

Where T_3 is saturated temperature of refrigerant at condensing pressure (P_2) As it is surface area of condenser.

$$\therefore \frac{1}{U} = \frac{1}{hi} + \frac{1}{ho}$$

H_i and h_o= inside and outside heat transfer coefficient of tube.
By selected the standard condenser from market with required area.



Analysis of Evaporator

The brine/Ethylene glycol is cooled by refrigerant
$\therefore Q_c$ = Heat gained by refrigerant = Heat lost by brine

Design of compressor

The displacement volume of compressor is given by

$\frac{\pi}{4}D^2L*\eta_v*\frac{N}{60} = m_r * V_{s2}$

D = Compressor Bore Diameter [m]

L= Stroke length of compressor [m]

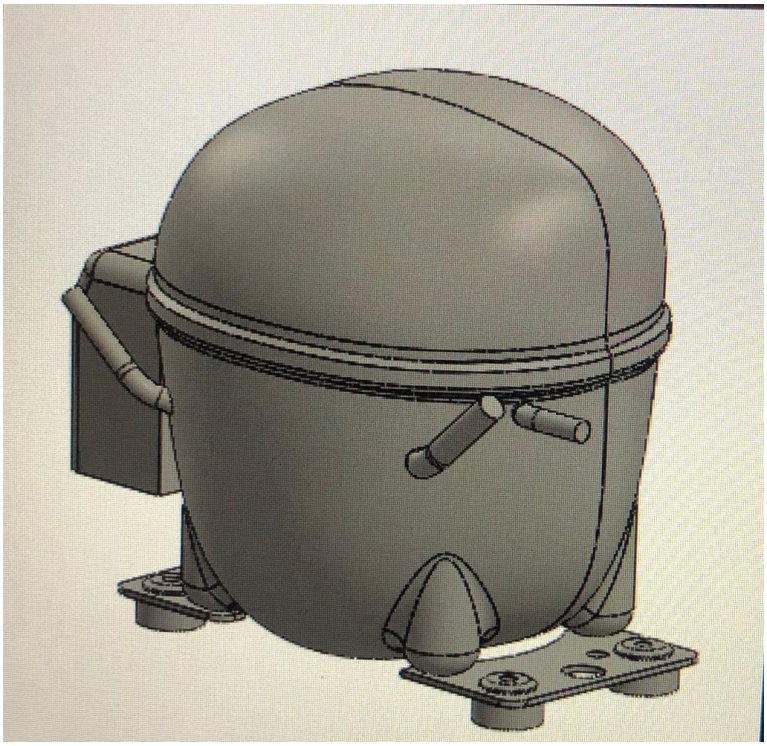
η_v = Volumetric efficiency of compressor (80% assume)

N = rpm of motor

M_r = mass of refrigerant [kg/s]

V_{s2} = specific volume of refrigerant at suction

∴ D & L are selected from standard compressor available



CHAPTER 2
LITERATURE REVIEW

There are several research papers have been published regarding various topics related to Instant juice chiller using refrigeration cycle they have been reviewed as follows

The fresh juice is often chilled by adding ice into it. Adding ice not only diluted the juice but may also add impurities to the juice as the commercial ice making process is always under question mark about hygiene. The other way of chilling the juice is by storing it in a refrigerator which consumes time and affect the freshness of the juice. To overcome this, a novel instant juice chiller is developed in the present project work using Peltier modules based on the concept of Thermo-electric refrigeration. The cooling chamber design integrates thermoelectric modules which operate on the Peltier effect to cool juice down. To make the chilling process more economical a solar PV panel is integrated for input energy provision.This unit provides a low energy and affordable solution to a conventional way of drinking cold juice.

A refrigerator is a common house hold appliance that consists of a thermally insulated compartment and a heat pump that transfer heat from the inside of the refrigerator to its surrounding so that the inside of the refrigerator is cooled to a temperature below the ambient temperature of the room. Thermoelectric Cooling (TEC) solar refrigerator runs on energy provided by sun, which includes photovoltaic or solar thermal energy. Peltier Jean (1834) discovered the Thermoelectric (TE) property about two centuries ago; thermoelectric device have commercialized during recent years. The applications of TE vary from small to large refrigerators. The Thermoelectric module refrigerator work on the principle of Peltier effect. Recently, the application of TEC modules in an industry is dramatically increased. The main objective of our project is to design & make analysis of a Heating & Cooling system which utilizes non-conventional energy source (i.e. Solar Energy) with the help of Thermoelectric Module which works on the principle of the Peltier effect. This will be a suitable & affordable system for the people living in remote part of India where load-shading is a major problem. The major difference between the existing system & our system is that, our project works without use of mechanical device & without

refrigerant too. As the module is compact in size one can design (i.e. shape, capacity) the system according to his requirement. In this paper an attempt has been made to conduct an experimental study on small scale solar operated thermoelectric Heating & Cooling system. Refrigeration is a basic method of food preservation. All the refrigeration methods for food preservation are based on Reverse Carnot cycle, which explains Adiabatic and Isothermal Expansion and Compression. Basic components used in these cycles are Evaporator, Compressor, Condenser and Expansion Valve. Generally used cycle is Vapor Compression Cycle. Other cycles are Vapor Absorption Cycle, Gas Cycle. Other new methods of Refrigeration are Thermoelectric and Magnetic Refrigeration. Various types of refrigerants are used in these cycles based upon their properties. Commercially Refrigeration is used as preservation method in various food industries like Dairy and Meat Processing industry.

Study of instantaneous cooling effect on water using LPG gas as a refrigerant in today's life. A refrigerators serves many and useful purposes such as cooling water, storing food items, medicines, beverages, and other such materials. Among this all the consumption of chilled or cold water is more. The household refrigerator that we use in our homes and hotels requires opening and closing the door several times and also we have to fill the bottles or containers each time they are emptied. This reduces the efficiency or performance of the refrigerator. the refrigerant use in our refrigerator has an adverse effect on environment and also the power consumption is huge. So, to solve this problem out making just a water cooler or chillier that will give you chilled and cold water in the minimum time (instantaneous) as compared to our daily refrigerator by using LPG gas as a refrigerant. This system will be atomized with Automatic filling arrangements, Temperature controlling sensors, leakage detecting device. LPG(liquefied petroleum gas) as refrigerant used for supportive way to contribute towards our environment. LPG is easily available gas stored in the cylinder for household purposes. which consists of 24.4% propane, 56.4% butane and 17.2% isobutene . It is cheaper and eco-friendly towards global warming. It works efficiently when used instead of R134a to obtain good cooling effect and this may be a small step towards power saving, supporting towards environment.

Sultan Salahuddin Abdul Aziz Shah [POLiTEKNiK MALATSIA (Instant Drink Chiller)] : An instant drink chiller is a new product that's been designed overseas. According to our research, Malaysians are still using the traditional way to chill their drinks by using a fridge or an ice bucket, although this is an efficient way it is still very much time consuming and not economical. The main issue in the process of cooling is the time taken to cool a drink to optimum temperature. Traditionally, we use a fridge or otherwise we throw a can/bottle into a bucket of ice to chill our drinks but this process takes approximately 54 minutes to reach 11.5 o C which is the optimum temperature for most drinks. The objective of our project is to be able to chill a drink within a minute. To have a machine that is portable to have chill drinks instantly anywhere. Spinning is the main method in our project in order to achieve the chillness in the beverage. The spinning moves the warm liquid in the middle of the bottle or can to outer wall. This cools the liquid in the bottle or can as it bathes in ice water. As it continuously spins for 1 minutes it speeds up the cooling process. As a conclusion for our abstract, we can make this product better by adding more features via enhancing its performance function. Therefore, the findings and research that we have conducted for this study would bring a lot of benefits to people from all categories.

LOH WING LIONG Performance of refrigerator operating with and without liquid-suction heating. UNIVERSITI MALAYSIA PAHANG JUNE 2012

A modern refrigeration system consists of four main components which is a compressor, a condenser, an evaporator and a throttling device. There are many researches which have been conducted in order to achieve good performance of the refrigeration system such as two stage refrigeration system, energy systems and suction heating. Suction heating is based on the concept of heat transfer between the capillary tube and suction tube. Suction heating is applied in order to absorb heat and thus lowering the temperature if the refrigerant at the capillary tube. The main purpose of this project is to investigate the performance of refrigeration operating with and without liquid suction heating in order to investigate how much the suction heating influence the performance of the refrigeration system. The project is based on experimental study on refrigeration system test rig and two setup of experimental studies which is the experimental setup for refrigeration operating with suction heating and experimental setup for refrigeration operating without suction

heating. Both sets of system configuration will be run until it reaches steady operating condition before data is collected in order to calculate the coefficient of performance (COP). Results show that the refrigeration system operating with liquid suction heating has the highest value of COP which is 2.14 compare with the system operating without suction heating which is 1.8. The percentage difference in COP is about 15.89 percent.

XUE Xing, WEI Fenglan, LI Sheng. Progress of Air Cycle Refrigeration Technology School of Architecture and Transportation Engineering, Guilin University of Electronic Technology, Guilin, 541004, China.

In response to the global call of environmental protection, a kind of environment-friendly air circulation refrigeration system is analyzed . Working principle of air cycle refrigeration system is introduced.The advantages of air refrigeration system are summarized, and main research achievements and progress in related fields at home and abroad are briefly narrated. The application in the field of the research of air cycle refrigeration are introduced as a clean and environment-friendly refrigeration way, in addition, the future development direction and the prospect of air cycle refrigeration technology are also predicted. Air cycle refrigeration technology will take up an important position in the future air conditioning field according the analysis.

Mohammed Khalfan, Mohammed Sameer Baig Free Cooling Without Refrigeration Cycle Asian Journal of Applied Science and Technology, 2019 ASHRAE Handbook 2000 Systems and Equipment, Chapter 36, Chapter 38, ASHRAE, 2000 : In the present scenario free cooling system is one effective solution for reducing the power consumption of air conditioning systems. Various free cooling methods are available for data centers and commercial buildings that eliminate or reduce the need for mechanical cooling by utilizing outdoor air under certain conditions. It is evident that climate conditions affect the performance of free cooling modes. It also affects the performance of main components of the cooling infrastructure indirectly due to inefficiencies caused by the part load operation during free cooling modes. Hence, modeling key components of cooling infrastructure in an essential element for reliable assessment of these methods. Most of the studies assessing energy saving potential of free cooling methods in the existing literature follow simpler approaches that do not consider the off design performance of cooling equipment.

Table 2.1: Research Gap from Literature Survey

Author	Parameter Investigate	Major Finding
Abhilash Dafare, Akshay Taikar, Alok Thakre, Apurv Shende, Golden Patil, Prashant Kurhade, Shubham Dhande	It contains description how the instant juice chiller works	Solution for which parameters should we consider for design this project
Mahesh P. Gotte, P. R. Walke	It explains Experimental Analysis on Solar Operated Thermoelectric Refrigeration System.	Solution for how refrigeration cycle can work on solar energy
Poonam Dhankhar	A Study on Refrigeration & Other new methods of Refrigeration	In this explained about how the refrigeration cycle works and also learned about new refrigeration methods
Sumeet Prakash Baviskar, Ajinkya Prabhakar Bairagi	Analyzed research work of the last ten years and has presented the details of grippers, adopted sensors and grasped strategies.	Introduced both the still open issues and the present and future trends in gripping technology.
Tharrshan th a/l sivagandi, Muhamma d akid bin mohamed nazri, Dhirren das a/l sivadass	Analyse the working of Instant drink chiller.	Learned about how instant drink chiller works which were developed overseas Analyzed the working

Sultan Salahuddin Abdul Aziz Shah [POLiTEKNiK MALATSIA]	Instant Drink Chiller	To have a machine that is portable to have chill drinks instantly anywhere.
LOH WING LIONG UNIVERSITI MALAYSIA PAHANG JUNE 2012	Performance of refrigerator operating with and without liquid-suction heating.	A modern refrigeration system consists of four main components which is a compressor, a condenser, an evaporator and a throttling device. There are many researches which have been conducted in order to achieve good performance of the refrigeration system such as two stage refrigeration system, energy systems and suction heating.
XUE Xing, WEI Fenglan, LI Sheng.	Progress of Air Cycle Refrigeration	In response to the global call of environmental protection, a kind of environment-friendly air circulation refrigeration system is analyzed .
Mohammed Khalfan, Mohammed Sameer	Cooling Without Refrigeration Cycle	In the present scenario free cooling system is one effective solution for reducing the power consumption of air conditioning systems.

2.2 Literature Outcome

From the above literature review it is seen that a lot of research work has been done in the field of Chilling of juice or water by using the refrigeration cycle by different researchers. The following work has been observed after analyzing all the literature work.

By studying the research papers we found the better and efficient way to chill the fruit juice.

By studying the various research papers we found different techniques to develop and Improve the project

CHAPTER 3

OBJECTIVE, SCOPE AND METHODOLOGY

3.1Objective

- To design and develop the low temperature chiller for food and beverage industry
- To analyze the performance of the refrigeration system at low temperature (@ -30ºC)
- To develop a commercial model of the system
- To carry out the infield testing with some local vendors for instant chilling of fruit juice
- To develop a model which will reduce the use of ice in juice
- Study the process of the Vapor Refrigeration Cycle using Brine Solution as a Refrigerant.
- Analyze Research Paper on Vapor Refrigeration Cycle.
- Make an affordable machine for vendors who can run their business.

3.2Scope

1) To provide fresh and hygienic juice and maintaining the freshness of juice.
2) It is beneficial for small vendors.
3) To make it compact and easy to use.
4) As of there are no affordable juice chillers there is a huge scope for this project.

3.3Methodology

The ideas begin with searching the various papers presented on instant juice chiller and by using different modern refrigeration systems. By different authors suggesting various solutions to the problems to be undertaken to increase productivity using automation techniques and finding their effectiveness in current problem.

- To collect various research papers that has made research regarding Instant juice chiller.
- To study these research paper and find solution to the current problem. If the solution is not found, then study different solutions that have been applied to different problems i.e., in our case study different refrigeration cycles and properties of brine solution.

Methodology.

3.4 Advantage and Disadvantage

Advantage

- Time required for cooling is very less as compared to other water coolers.
- Produce low noise and working is effective.
- It does not creating hazardous situation.
- Easy to use.
- Eco-friendly cooling and working.
- Reliability is much better.
- By designing effectively we can use it for high capacity applications.
- It saves electricity

Disadvantage

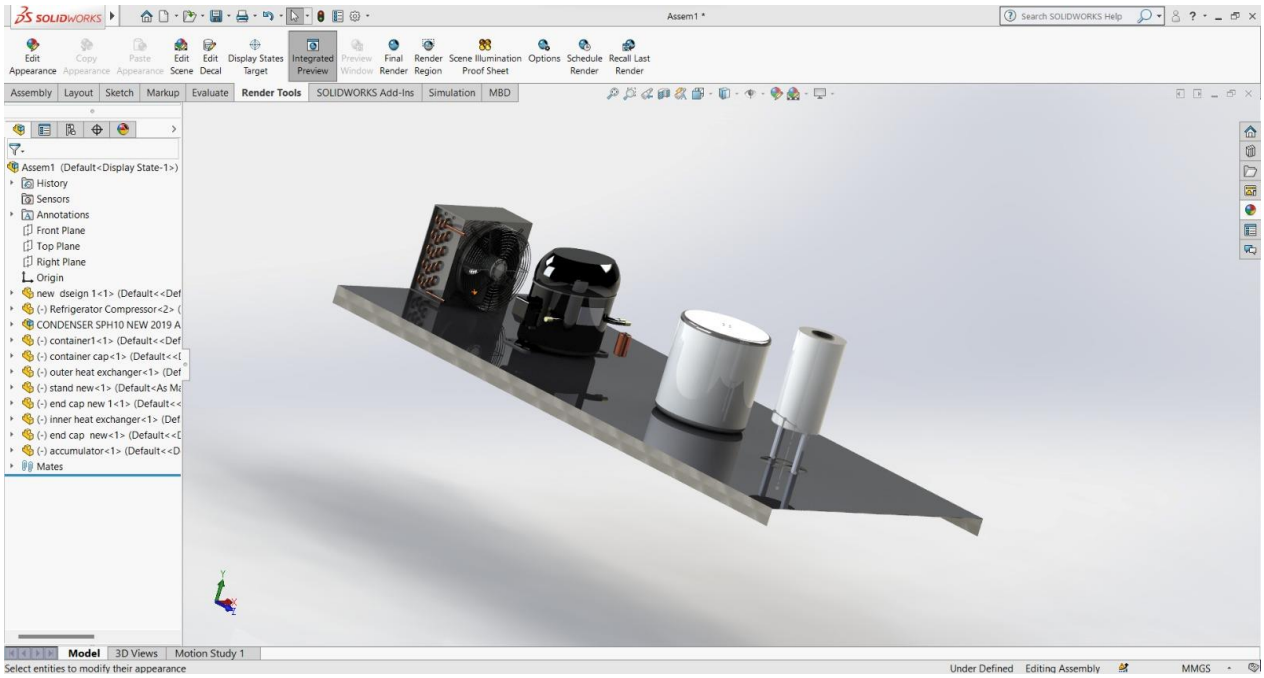
- Hydrocarbon is explosive
- Highly flammable gas
- Never heat more than 49ºC
- Costly
- Complicated design
- Any minor cut in system can lead to heavy pressure drop.

Chapter 4
Experimental Setup and Working

- The project system is going to work on vapour compression refrigeration cycle.
- In vapour compression refrigeration cycle there are 4 stages namely: Compression, Condensation, Expansion, Evaporation.
- Base plate, Compressor, Condenser, Heat Exchanger device, Accumulator, Capillary Tube, Piping pipe & tube, Dryer, Sub zero, pump, brine container.
- The above mention components where all present in our system.
- **Base plate :** Base plate is used as foundation on which our system is going to stand.
- **Compressor :** The compressor is the "heart" of our system. It circulates the refrigerant throughout the system and adds pressure to the warm part of the circuit, and makes the refrigerant hot. It's similar to when you are pumping air into a bicycle tube - you can sense a heat increase in the pump while you compress the air.
- **Condenser :** It is placed after the compressor. The refrigerant get cooled down and condenses, meaning it turns from a gas to liquid.
- **Heat exchanger:** A heat exchanger is a system used to transfer heat between a source and a working fluid. Heat exchangers are used in both cooling and heating processes. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact.
- **Accumulator :** The accumulator can act as a receiver during the heating and defrost cycles when system imbalance or an overcharge from field service could result in excessive liquid refrigerant in the system.
- **Capillary tubes :** The main aim of the capillary tube is to reduce pressure.
- **Piping Pip e & tubes :** Refrigeration piping involves extremely complex relationships in the flow of refrigerant and oil. Fluid flow is the study of the flow of any fluid, whether it is a gas or a liquid, and the interrelationship of velocity, pressure, friction, density, and the work required to cause the flow.
- **Dryer :** Separate lubricant from the refrigerant. Remove the moisture from the refrigerant. To maintain the level of the liquid refrigerant in the system**.**

- **Sub zero :** Subzero Temperature Controller is a single setpoint controller with a buzzer. This digital Temperature controller is specifically designed for refrigeration applications wherein the compressor cuts off at a set point and is restarted at a temperature of setpoint plus differential.

Cad Drawing of System



Working

- This experimental setup is based on a Simple Vapor compression Cycle
- The Refrigerant used in the System is Hydrocarbon
- Condenser used in the system is Air cooled condenser with fan
- The accumulator is used so that the evaporated Liquid refrigerant would not come in the compressor
- To maintain the Gas flow in the system capillary tube is used.
- The capillary tube is wounded to the accumulator for the better heat transfer rate.
- Due to sudden expansion in capillary tube the heat removal process gets start
- At the same time the heat from the brine solution get removed as per the requirements of -8ºC temperature
- The water pump is used to circulate the brine solution from one heat exchanger to other heat exchanger
- First in compressor our refrigerant get compress at high pressure and high temperature after compression it passes to condenser.
- In condenser our refrigerant got condense, means the gas convert into liquid.
- After condensing into condenser the gas is then pass to dryer in which the moisture that is present in refrigerant is separate.
- After dryer refrigerant pass through capillary tubes in which its pressure gets drop to a certain level.
- After capillary tube the low pressure and low temperature liquid refrigerant passes in heat exchanger in which the heat transfer takes place.
- The heat of brine is gained by refrigerant and then the refrigerant enters into accumulator.
- After accumulator the vapour refrigerant again get compress in the compressor and the cycle repeat again and again till the system get shut down.
- In 1st heat exchanger or we can say brine solution container the temperature sensor is present which can sense the temperature of brine and display all the temperature reading on sub zero.
- After that with help of pump the brine solution is pumped into the 2nd heat exchanger .
- In 2nd heat exchanger we pour the juice in 2nd heat exchanger.

- In brine and juice there is no contact so it is no harmful and there is no reaction.
- Our juice get instantly cool because the brine is already at very low temperature or below 0^{o} temperature.
- At last after 2^{nd} heat exchanger the brine is flow back to 1^{st} heat exchanger to cool and the cycle run continuously till the system get off.

Chapter 5

Costing

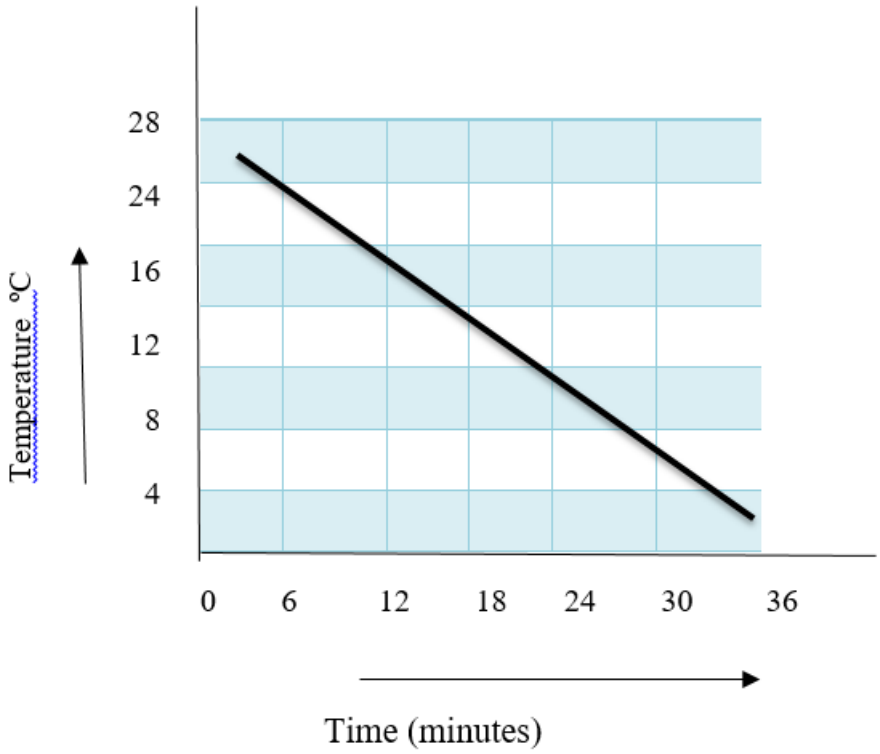
S. No	Item Head	Sep– Oct'22 (₹)	Nov-Dec'22 (₹)	Jan'23-Mar'23 (₹)	Total (₹)
A	**Non-recurring (Capital Items)**				
1	Permanent Equipment's with Specification	Thermocouple based 12 channel RTD meter with K type of sensors Rs= 4500.00 Energy meter, rotameter to calculate flow of refrigerant and brine and secondary fluid Rs= 6000.00 Other measuring instruments like flow meter = 2000.00	Compressor (hermetic sealed ½ Hp) Rs.=3500.00 Evaporator, condenser heat exchanger capillary copper tubing etc. Rs.=4000.00	-	Rs=20000.00
2	Plant cost /Fabricated systems/ demonstration models/civil works	Fabrication of the frame Rs= 8000.00	SS frame, enclose body frame for system Rs. =6000.00		Rs.= 14000.00
	Sub total (capital items)				
B	**Recurring Items (General)**				
1	Consumables	Refrigerant R134A, Hydrocarbon etc Rs.= 2000.00	Different fruit juices for testing , food items etc Rs.=1000.00		Rs.= 3000.00
2	Contingencies	Rs.= 2000.00	Rs.=2000.00		Rs. = 4000.00
3	Travel	Rs.=1000.00	Rs.=1000.00		Rs. =2000.00
4	Other Cost (Outsource work etc),if any	Miscellaneous Rs. = 2000.00	Miscellaneous Rs. = 2000.00		Rs. = 4000.00
	Subtotal (General)				
C	**Total cost of the project (A+B)**	**27500.00**	**19500.00**		**Rs. =47000.00**

Chapter 6
Result and Discussion

- In result we got instant chill juice at very less time.
- We had achieve brine temperature upto -8ºC
- Experimental result:

Time (minute)	Brine temperature (ºC)	Juice temperature (ºC)	ΔT (ºC)
35 – 40	-8	10 - 15	15 - 20

- **Flow Charts**



CHAPTER 7

EXPECTED CONCLUSION AND SCOPE FOR THE FUTURE

Conclusion

By fabricating this project of instant juice chiller, we conclude that the cooling of juice in heat exchanger is depend upon :

- Flow rate of incoming water in heat exchanger.
- Flow of refrigerant through copper tube.
- Quantity of water to be cooled.
- Capacity and performance and efficiency of overall components.

The temperature of juice after 2^{nd} heat exchanger is in temperature after which it will not affect on human teeths and throat.

Succession of this project will result in relatively very affordable price of instant juice chiller.

We can provide a hygienic and instant chilled juice.

By doing this project we can obtain more efficiency and effectiveness.

There will be reduction cost of ice.

Reduction in cost of transport.

From this project we can conclude that with the use of Compressor and the Refrigerant It is possible to cool the system. There are several different types of cooling devices available to remove the heat from industrial enclosures as well as medical enclosures, but as the technology advances , refrigeration cooling is emerging as a truly viable method that can be advantageous in the handling of certain small to medium applications.

Juice temperature at input side and juice temperature at output side gives much more differences. We conclude this we obtained desired output from this project experiment.

7.1 Future Scope

1. The succession of this project will result in less costly system for everyone who is in juice business.
2. We can provide lots of small businesses this system and by the effectiveness and quality will be increased.
3. As the efficiency and effectiveness of system increases in future this system is used to cool beverages also.

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