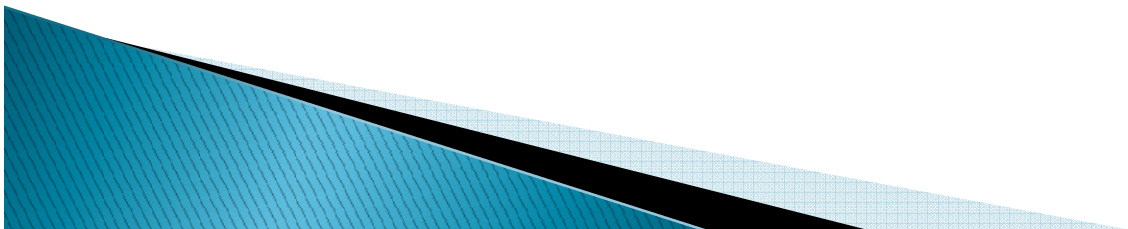


PRESERVING FOOD BY COLD TECHNIQUE

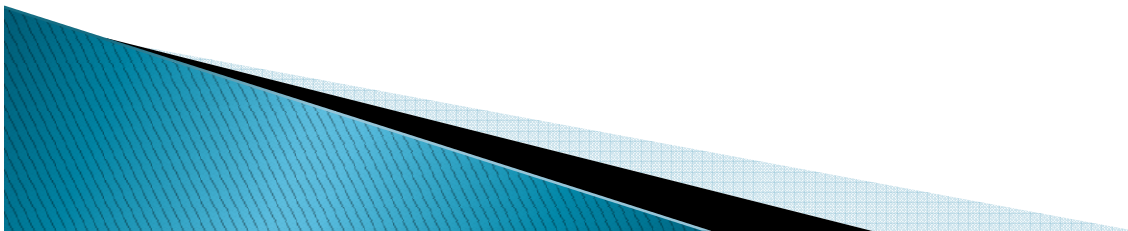
- ▶ The storage of foods under cold conditions has tremendous advantages in terms of both suppliers and consumers. The main scope of cold technique is to provide the storage of food for a longer time period without losing their nutritional value and sensory characteristics. The applied cooling or freezing decreases the enzymatic and microbial activity.



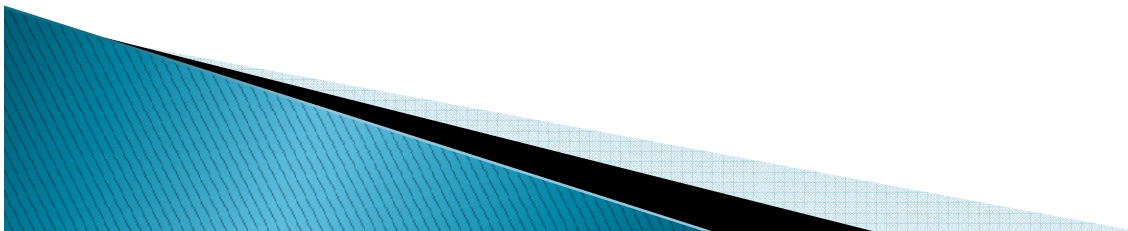
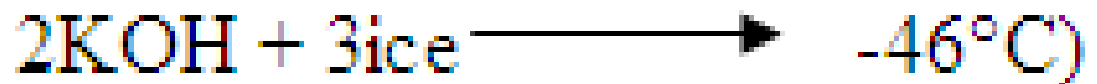
How to obtain cold?

There are three basic ways for the obtainment of cold.

- ▶ Mixing materials
- ▶ Expansion of compressed gases
- ▶ Evaporation of liquids

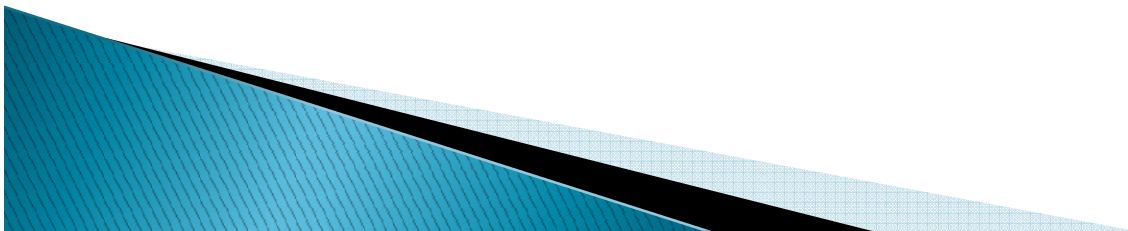


- ▶ **Mixing materials:** Whenever, you mix some materials which are at room temperature, due to specific endothermic reaction between them, they absorb the heat around and cause the decrement of temperature

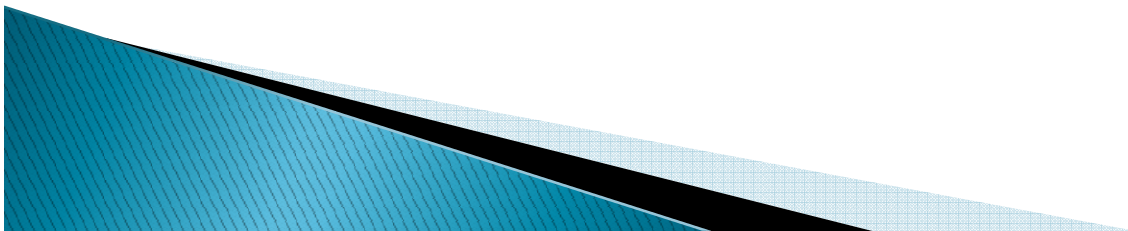


- ▶ Expansion of compressed gases:
As the temperature of gases which are compressed increases, whenever you cause the expansion of these compressed gases, their temperature will decrease similarly. ($PV=nRT$)

This technique is frequently used nowadays in cooling technology.

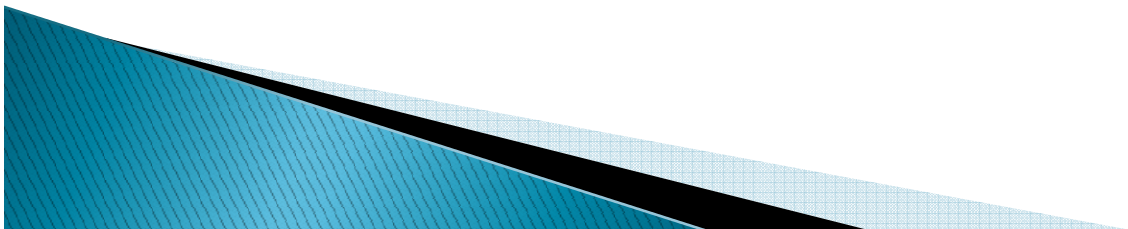


- ▶ **Evaporation of liquids:** As all we know liquids absorb heat from their surroundings during evaporation. This technique is based on this principle. For application, the liquids with a high evaporation temperature are preferred to be used such as NH_3 , CO_2 , Freon, Methyl chloride.

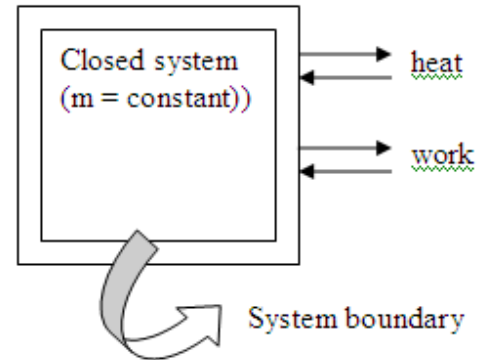


THERMODYNAMIC ASPECT OF COLD TECHNIQUE

- ▶ The zeroth law of thermodynamics states that if two bodies are in thermal equilibrium with a third body, they are also in thermal equilibrium with each other. By replacing the third body with a thermometer, the zeroth law can be restated as “two bodies are in thermal equilibrium if both have the same temperature reading even if they are not in contact”.

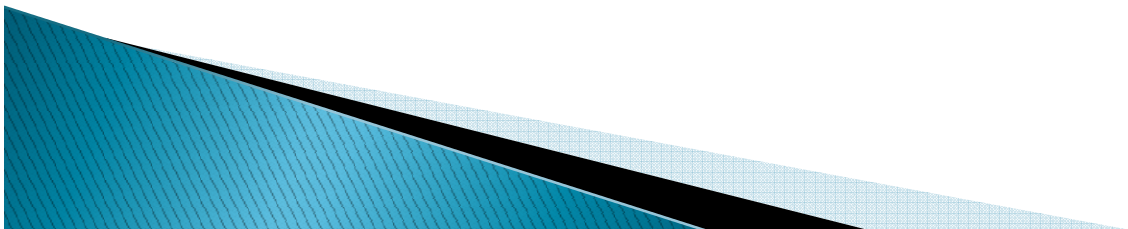


- ▶ The first law of thermodynamics can simply be stated as follows: during an interaction between a system and its surroundings, the amount of energy gained by the system must be exactly equal to the amount of energy lost by the surroundings. Energy can cross the boundary of a closed system in two distinct forms; heat and work.

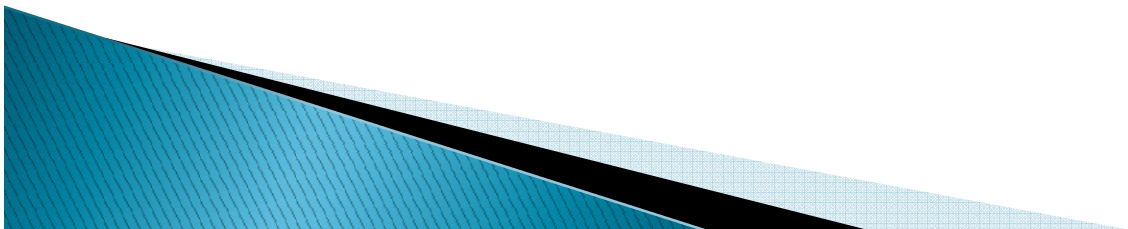


REFRIGERATION SYSTEMS

- ▶ Refrigeration is the process of removing heat from an enclosed space, or from a substance, and rejecting it elsewhere for the primary purpose of lowering the temperature of the enclosed space or substance and then maintaining that lower temperature. In other words refrigeration system is the system which transfers heat from low temperature surrounding to high temperature surrounding for the purpose of cooling.



- ▶ A *refrigeration cycle* describes the changes that take place in the refrigerant as it alternately absorbs and rejects heat as it circulates through a refrigerator.
- ▶ In terms of power which enables refrigerant circulate through the system, the refrigeration systems can be classified in two groups;
 1. Vapor compression refrigeration
 2. Vapor absorption refrigeration



Vapor compression cycle:

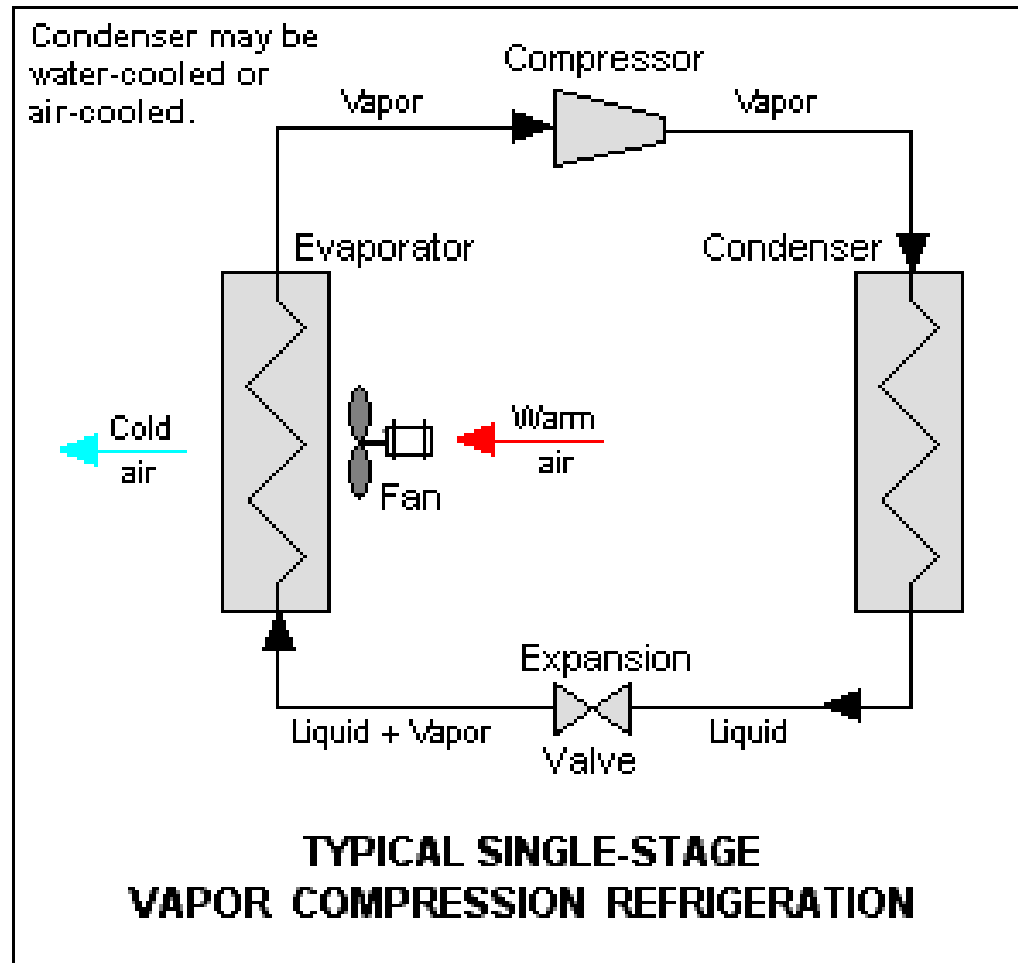
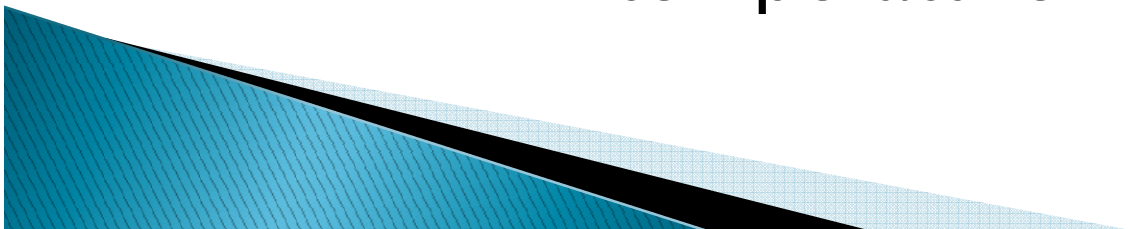
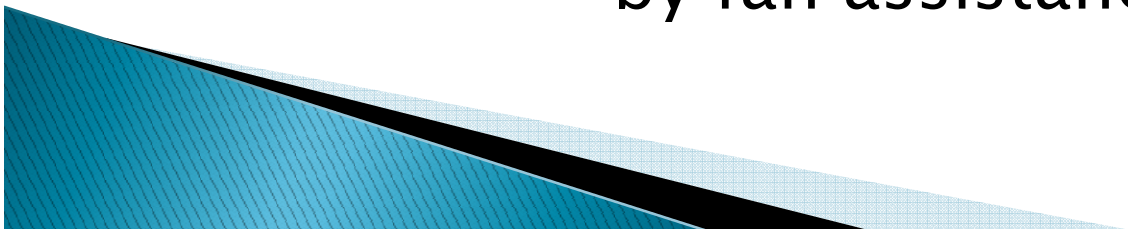


Figure 1: Vapor compression refrigeration

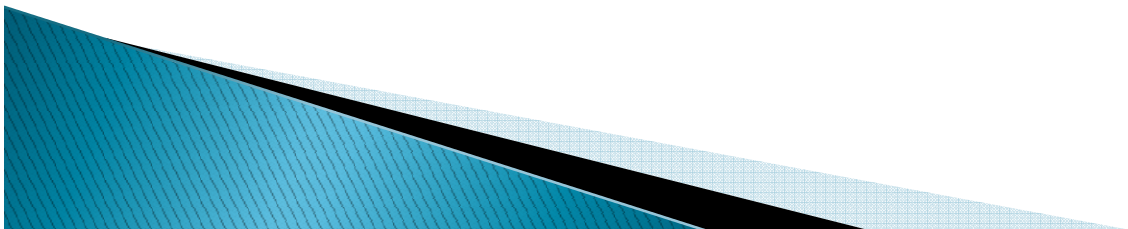
- ▶ The refrigeration cycle begins with the refrigerant in the evaporator.
- ▶ At this stage the refrigerant in the evaporator is in liquid form and is used to absorb heat from the product.
- ▶ When leaving the evaporator, the refrigerant has absorbed a quantity of heat from the product and is a low-pressure, low-temperature vapour.



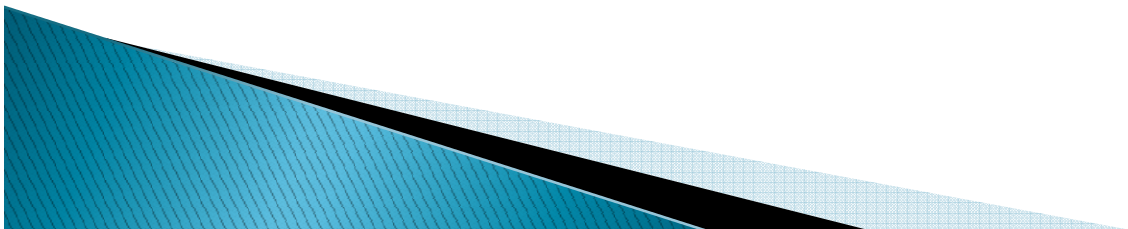
- ▶ This low–pressure, low–temperature vapour is then drawn from the evaporator by the compressor.
- ▶ When vapour is compressed it rises in temperature. Therefore, the compressor transforms the vapour from a low–temperature vapour to a high–temperature vapour, in turn increasing the pressure.
- ▶ This high–temperature, high–pressure vapour is pumped from the compressor to the condenser; where it is cooled by the surrounding air, or in some cases by fan assistance.



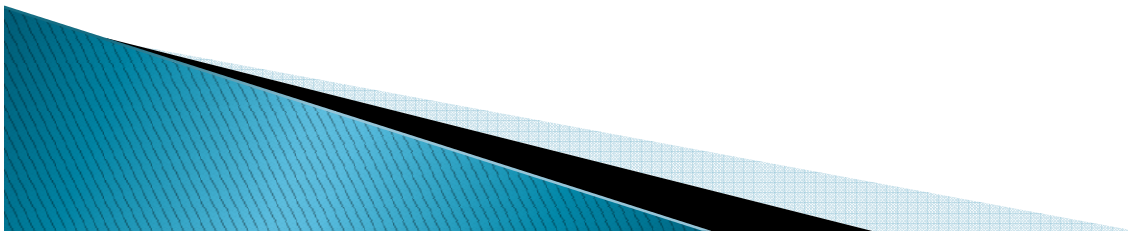
- ▶ The vapour within the condenser is cooled only to the point where it becomes a liquid once more.
- ▶ The heat, which has been absorbed, is then conducted to the outside air.
- ▶ At this stage the liquid refrigerant is passed through the expansion valve.



- ▶ The expansion valve reduces the pressure of the liquid refrigerant and therefore reduces the temperature.
- ▶ The cycle is complete when the refrigerant flows into the evaporator, from the expansion valve, as a low-pressure, low-temperature liquid.



- ▶ compression rate = the pressure after compressor / the pressure before compressor
- ▶ There is an optimum value for this compression rate. It should not be less than 8–10 but the less the compression rate the more economic the system.



The thermodynamic analysis of cycle:

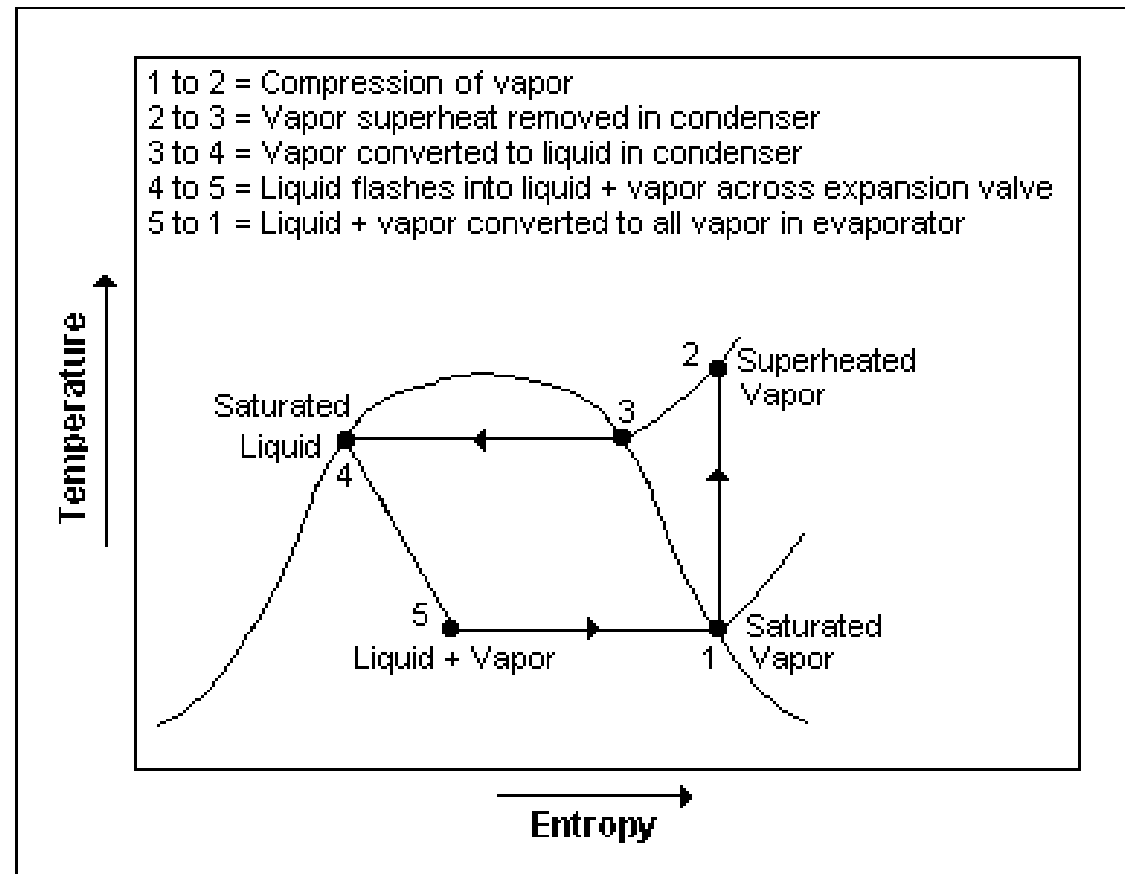


Figure 2: Temperature-Entropy diagram

COLD STORAGE OF FOODS

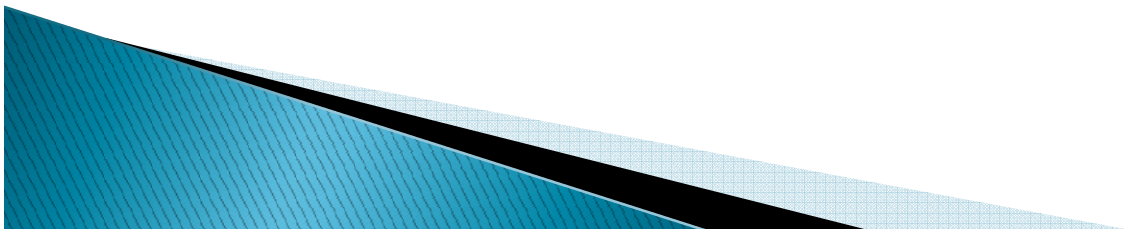
- ▶ As we have mentioned before, cold storage of foods means keeping food at a certain temperature which is its freezing point minimum.
- ▶ When we consider all foods to be stored the range of this storage temperature is mostly between -1 and 8°C .

e.g. between -1 and 1°C : fresh fish, meat, sausages, smoked meat and fish, garlic, onion

between 0 and 5°C : milk, cream, yoghurt, pizza, pasta, batter and some fruits and vegetables

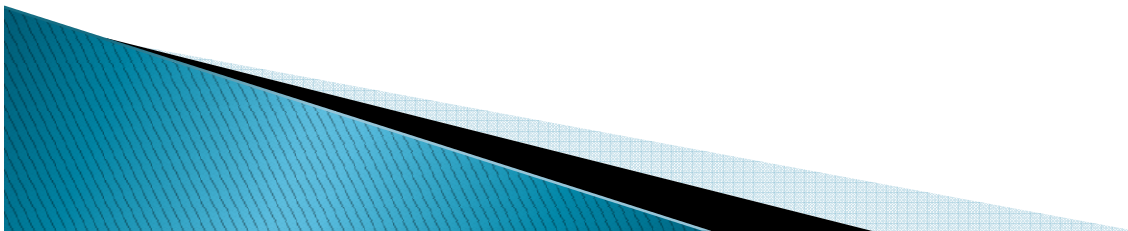
between 0 and 8°C : cheese, most of fruits and vegetables

(but some tropical fruits should be stored above 8°C)



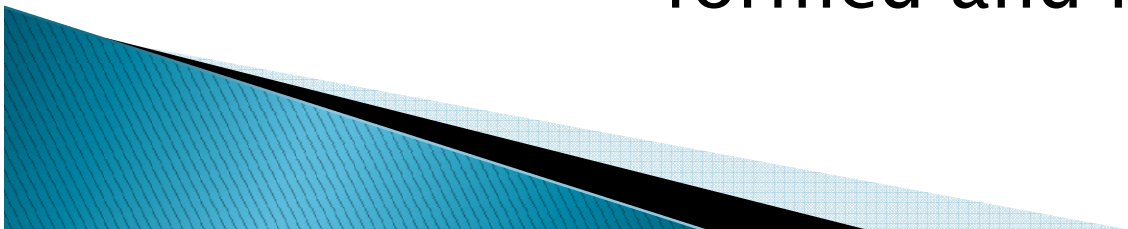
The cold storage can be classified in three groups:

- ▶ Storage under normal atmosphere conditions
- ▶ Storage under controlled atmosphere conditions
- ▶ Modified atmosphere packaging



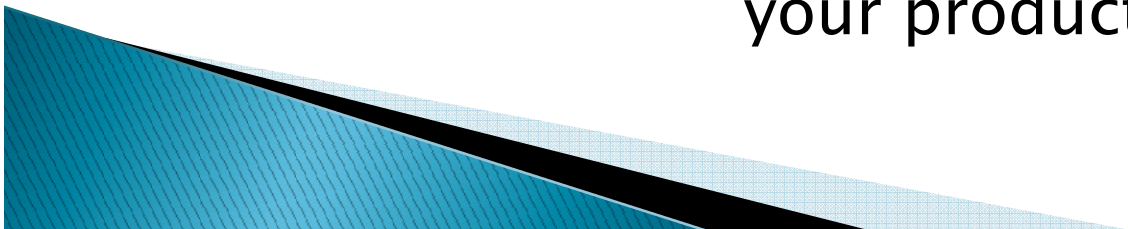
Storage under controlled atmosphere conditions: low O₂ concentration, high CO₂ concentration

Modified atmosphere packaging: this kind of an application is mostly for fruits, vegetables, meat, ready foods. The food is placed in a special package and covered with a synthetic film. This film provides the outlet of CO₂ formed and inlet of O₂ needed.



We can also classify modified packaging in two subgroups.

- **Passive modification:** It is applied to fresh fruits and vegetables. Since during maturation of fruits and vegetables ethylene release takes place, these kinds of films have some compounds which entrap ethylene.
- **Active modification:** It is applied to cut fruits and vegetables, poultry and meat, milk products. In this kind of modification the gas which can be needed by the product is injected to the film. And by the help of this gas the shelf life of your product increases.



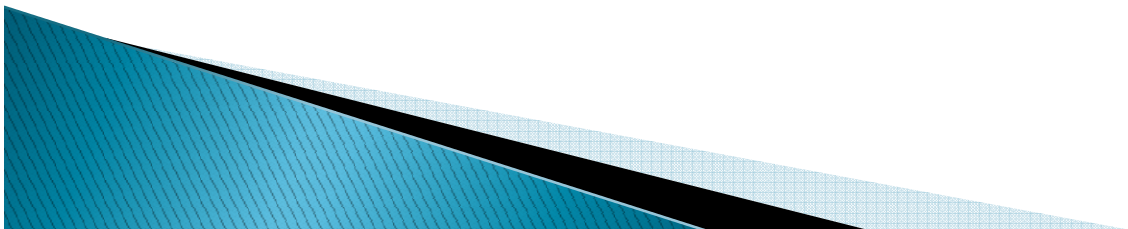
THE FACTS THAT SHOULD BE CONSIDERED WHILE PLANNING COLD STORAGE ROOMS

In order to have a good project for designing a cold storage room some basic factors should be considered;

- ▶ Optimizing the moisture loss in the product
- ▶ Good insulation
- ▶ Controlling the temperature of the room
- ▶ Arrangement of the charge of the room
- ▶ Maintaining the required heat removal



- ▶ The moisture loss causes some unwanted situations and reactions such as shrinkage, colour change, fat oxidation and protein denaturation.
- ▶ Similarly temperature waving in the room may cause damages on the product so providing constant temperature during storage is critical.

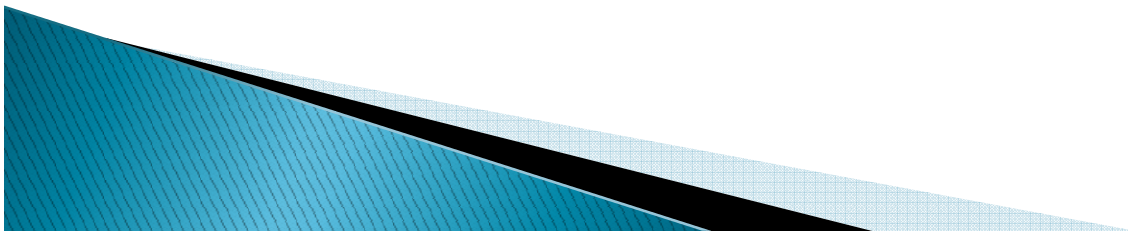


- ▶ In cold storage controlling heat flow has also a great importance. For example the air at -20°C can hold three times more moisture than the air at -30°C . This shows us that fluctuation of air temperature may cause drying of product. So the inlet and outlet of everything to the room should be under control.
- ▶ Mostly storage of frozen and unfrozen food together may lead to unwanted results.

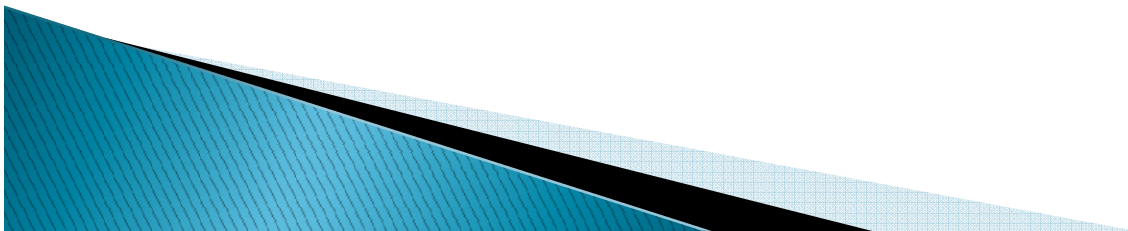


By considering all these, the most important factors which should be taken into account while preparing the project are:

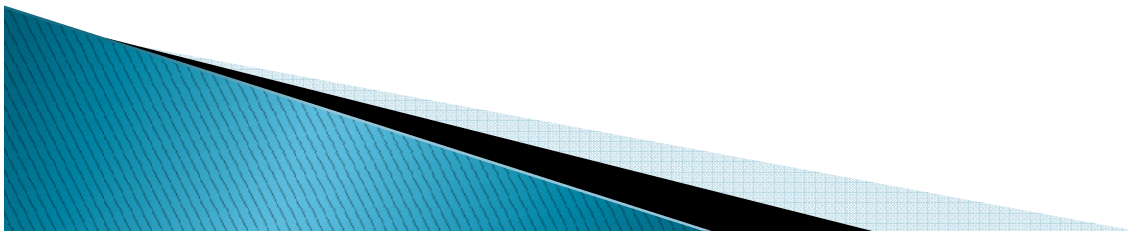
- ▶ low, homogeneous and constant temperature
- ▶ good air circulation
- ▶ minimum heat inlet to the room from the outside



- ▶ The difference between the product and the room temperature will cause a heat transfer between product and the surrounding causing product to warm, which is an unwanted case for us. If the temperature difference increases the heat transfer rate increases too.



- ▶ In cold storage in order to avoid the surface drying of stored product sometimes, they are let to be covered with ice or they are covered with a special material.



- ▶ In very small cold storage rooms or cold chain vehicles the most important heat loss occurs due to door openings. So some precautions should be taken against this situation first of everything.
- ▶ Since the heat transfer eventuate through the surfaces mostly, the insulation material, its thickness, the construction method of building, and the surface area gains quite importance.

