USE OF LOW TEMPERATURE

The activities of food spoilage agents are very much dependent upon temperature. Enzymes require particular optimum for their activities. Even the rate of pure chemical reactions is influenced temperature for their catalytic reactions, so do the microorganisms by temperature, but these are not terminated as easily as enzyme-catalyzed reactions when temperature beyond the optimum range is encountered.

Temperature manipulation is a very useful tool for extending storage life of foods. When enzyme and microbial activities are undesirable in foods, temperature control may become necessary. Keeping food above the maximum temperature required for enzyme and microbial activity may mean encouraging chemical reactions as temperature is increased. Moreover, the nutritional quality of food is damaged if it is stored at a high temperature for a long time. The alternative procedure for checking the problems posed by enzymes and microorganisms is to hold food at temperature below the minimum for their activities. Low temperature also retards simple non-enzymatic chemical reactions in foods.

Normally enzyme activity and growth of food spoilage and pathogenic organisms best proceed at moderate temperature, i.e., in the mesophilic range. Progressive reduction in temperature below this initiates gradual decrease in the activity of food spoilage agents. Below a certain temperature, all life activities cease and so food is saved from deterioration and spoilage.

The choice of temperature usually depends upon the objective of storage.
If short-term storage is the aim, then the temperature could be decreased to near or slightly below the minimum e required for the enzyme and microbial activities. In case food is to be stored for a long period then the temperature has to be reduced far below the minimum at which any life activity can occur. The terms sold storage and freezer storage, respectively; describe storage under the two situations.

Cold storage refers to the storage condition where food is held at temperature above its freezing point.

Freezer storage, on the other hand, describes the situation whereas food is held in frozen state at temperatures lower than the freezing point, which incidentally corresponds to temperatures far below the minimum conducive for the activities of enzymes and microorganisms.

EQUIPMENT

The equipment required in low temperature installations is basically a refrigeration system whose- power may be-through non-mechanical or mechanical means. In mechanical

refrigeration systems, the liquid refrigerant that boils and vaporizes at very low temperature, circulates in a closed system,, It absorbs heat from its environment and is transformed to the gaseous state. The gaseous refrigerant is reconverted into liquid state through a suitable mechanism that may involve 'vapour compression cycle in systems using the vapour absorption cycle. Refrigerators using the vapour compression cycle employ a device, the 'compressor' to bring about the compression 'of the gaseous refrigerant. The electrical household refrigerators, freezers and common commercial equipment are of this type.(In its simplest form, a vapour compression mechanical refrigeration system • consists of four basic components—compressor, condenser, expansion valve and evaporator (Fig. 5.1).

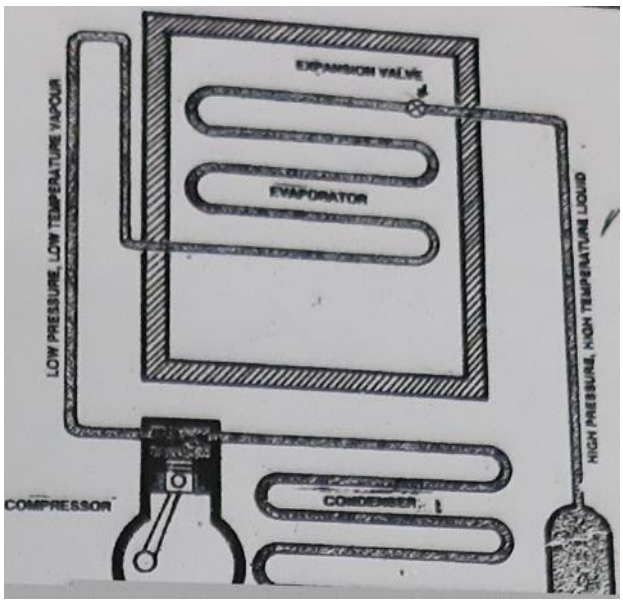

Fig. 5.1 Diagrammatic representation of a mechanical refrigeration system

The compressor is the heart of the system and provides energy for its operation. It compresses the gas circulating in the hermetically sealed refrigeration system and passes it to the condenser. Here the gas is Cooled and condensed to liquid form. The liquid refrigerant is passed to the evaporator at a high pressure through an expansion valve that results in changing the fluid refrigerant to an atomized vapour-liquid mixture at low

pressure. In the evaporator the refrigerant obtains heat from the surrounding atmosphere and vaporizes. The gaseous vapours again through the compressor and the cycle is repeated.

REFRIGERATION SYSTEMS

Refrigeration systems are generally classified into three groups based on the operating temperatures attainable: -

a. **High temperature systems** - used for air conditioning and cold storage equipment where temperatures between -3.9°C (25°F) to 7°C (45°F) or higher are needed.

b. Medium temperature systems- these are used for food storage and other applications requiring temperatures between -3.9°C (25°F) and -17.8°C (0°F).

c. Low temperature systems - employed where temperatures of - 17.8°C (O°F) or lower are needed.

USE OF ABOVE FREEZING TEMPERATURE

The simplest form of equipment available for storage of foods at above freezing temperature is the domestic refrigerator and food displaying cabinets installed in supermarkets. In this equipment, temperature is lowered by the use of vapour compression mechanical refrigeration system. The shelf life of food commodities is short in these than when the same commodities are stored in commercial cold stores equipped with other sets of controls.

The commercial cold stores operating in Pakistan are large insulated rooms equipped with a mechanical cooling system that lowers the temperature of the chamber. The controlled atmosphere storage facilities (CA storage) are equipped with other mechanisms whereby humidity, ventilation and composition of gases inside the chamber be regulated. These provide optimum conditions to the commodities ensuring long shelf life.

Pre-treatment of Food for Low Temperature

Storage Food raw materials get contaminated from different sources when they are gathered, harvested or slaughtered. Some contaminants such as microorganisms can be troublesome even under very ideal handling conditions. Food meant for cold storage is prepared according to the requirements for each particular commodity. Quite often the microbial load of fresh' destined for cold storage is reduced by washing, heat treatment, use of chemicals or irradiation.

Washing: Beef carcasses are washed, dewatered and then stacked in the chambers that are usually equipped with ultraviolet lamps. Fruits are sorted for over-ripe or under-ripe ones, while vegetables are washed, drained and then stored.

Heat Treatment: Peas are blanched for green color preservation. Lemons, papaya or nectarines are immersed in hot water at a temperature of 46 to 54°C for one to four minutes to pasteurize.

Waxing: Some fruits and vegetables such as cucumbers and root crops are waxed to improve their appearance and keeping qualities.

Chemicals: chemicals are very frequently employed in the treatment of the food materials prior to cold storage. Chlorine, sulpher dioxide and methyle bromide are commonly used to treat the fruits and occasionally for the vegetables to prevent the growth of microorganism. Mangoes are treated with 2,4,5 trichlorophenoxy acetic acid to preven the ripening.

Irradiation: irradiation has also been very helpful in cold storge of may commodities. Quite often chilled meat is irradiated to destroy the surface microflora and paracites.

Cold Storage Procedure:

At commercial level, The food is stored under the controlled conditions, which guarantee extension in the shelf life. Large capacity cold storages are employed for preserving fresh food materials. Examples; fruits, vegetables and tubers

Factors affecting the Cold Storage of Foods

The physiological phenomena in plants and animal tissues is required to be slowed down to prevent metabolic changes and increase the shelf life. All plants materials respire even after harvesting. The rate varies from one material to another. During the storage of fruits and vegetables, oxygen is taken up and carbon dioxide and water are evolved. Respiration in plant materials also results in heat generation and loss in the quality of the product. Animal tissues undergo anaerobic respiration.

The refrigeration requirements of plant and animal foods are dependent on several factors. These are temperature, relative humidity, composition of gases in storage room and ventilation.

1.Temperature:

The choice of temperature for refrigeration storage of foods depends primarily on the

a. Nature of the food
b. Estimated desired period of the storage
c. Composition of the storage atmosphere
d. Pretreatment of the raw material

The metabolic activities of some plant food materials are very high that result in the production of heat during storage. **For Example,** one tone of green beans, sweet corn okra or

green peas stored for 24 hours at 4.5°C, generate over 252 kilocalories of heat. In an atmosphere containing normal amounts of oxygen and carbon dioxide, oranges, pineapple and potatoes will be stored at 2 to 7 °C.

2.Relative Humidity:

Control over the relative humidity in the storage chamber isvital for extended storage. Too high relative humidity, above the optimum level, encourages microbial growth. Moulds grow in a relative humidity of 85% to 90%, yeasts require 90 to 92% . relative humidity below the optimum results in moisture loss, causing th wilting in fruits and vegetablesor damage to the appearance of animal tissues, a decrease of 3 to 6% moisture will result in a marked loss in quality.

The optimum relative humidity for al particular raw material depends upon the storage temperature.. In 2.2°C case of meat, the recommended relative humidity at 0°C is 92%, at 2.2°C 88 % and 75% at 4.4°C. Thus, whenever temperature for storage is specified for particular material, the relative humidity has also to be stated.

3.Composition of the storage atmosphere

In cold storage chambers, an atmosphere containing higher percentage of carbon dioxide and lower oxygen content than are found in air, is maintained to suppress the normal physiological processes in plant materials. Carbon dioxide content of above 10% significantly retards microbial growth on the food surface. Similarly, reducing Oxygen concentration from the normal 21 % to 10 % or lower decreases the rate of respiration.

The problem in manipulating the gas atmosphere lies in the difficulty of control. The storage process known as 'Controlled Atmosphere Storage' or 'CA storage' has technically solved this. In CA storage, machines including scrubbers control the amount of different gases in sealed and insulated storage atmosphere.

4.Ventilation

Ventilation in cold storage chambers is important to prevent the development of stale odors and flavors and remove them from the atmosphere. This is also helpful in maintaining a uniform temperature and relative humidity in case adequate ventilation or air circulation is not provided, then food in local areas of high humidity may undergo microbial decomposition. This, would also prevent maintenance of uniform product composition in the storage atmosphere.