



A Review on Design and Performance Enhancement of Cold Storage by CFD Analysis

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Abstract— Preservation by Refrigeration has been the principal known method of successful storage of fresh fruits and vegetables to retain their freshness and test. As harvested, they are cut off from their source of water and nutrition and soon start to deteriorate. They lose weight, texture, flavor, sweetness and nutritive value. Both time and temperature distribution are important factors in post-harvest product deterioration. The warmer the temperature, the faster the deterioration and the shorter the storage life; conversely, the cooler the temperature, the slower the deterioration and the longer storage life. This paper deals with different aspects of design of cold room and includes all standard refrigeration principles and heat load calculation which are normally considered in a cold room design. Evaporator arrangements in cold storage plays major role in Case of Efficient and rapid rate of cooling as well as the Ripening of the stored fruit. Streamlined flow prediction by using CFD tool can get better results in case of temperature distribution.

Keywords— Cold storage, Evaporator, Temperature distribution, streamlined flow

I. INTRODUCTION

Agriculture sector in India has moved from traditional agriculture in the 1950s to a highly capital-intensive sector. In agriculture 95% of the research investments during the past 30 years were reported to have focused on increasing productivity. There is only 5% directed towards reducing losses. Wastage is 17.9% in fruits and vegetables which causes anaerobic digestion of wasted food causes environmental pollution in addition to waste of resources where as their preservation is only 0.39% in India. Food loss is estimated to be equivalent to 6%-10% of human-generated greenhouse gas emissions. 2017 In case of perishable produce and others with lower holding life the surplus when not procured, tends to go waste. India witnesses nearly, 4.6% to 15.9% wastage in products and, 5.2% in inland fish, 10.5% in marine fish, 2.7% in meat and 6.7% in poultry product. Scheme that provides financial assistance to setup cold storage

1. Mission for Integrated Development for Horticulture (MIDH).
2. Pradhan Mantri Krishi Sampada Yojana (PMKSY).

In chart-1 we can clearly see that maximum percentage is wasted in fruits and vegetables where as cold storages in India for fruits is occupied 0.39% which is shown in chart-2

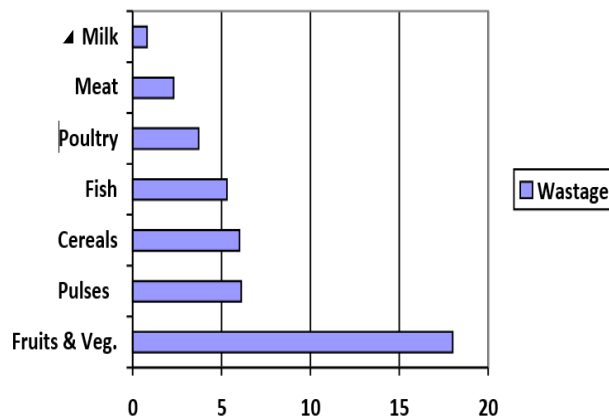


Chart -1: Commodity wise wastage in percentage.

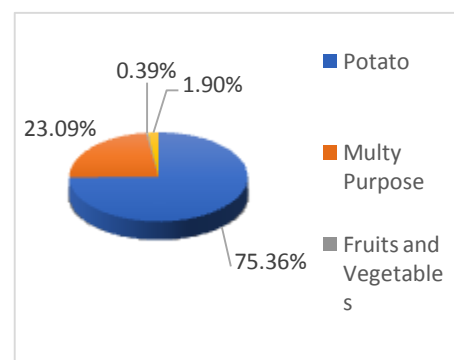


Chart -2: Commodity wise cold storages in India.

II. LITERATURE REVIEW

Ramesh Babu 2019 Designed the refrigeration thermal insulation and equipment for healthy ripening of mangoes and banana without using harmful chemicals. The study deals with concept of the necessity of ripening process the ripening can be done artificially too, by use of cold storage but the temperature ranges are to be kept within the precise limits. Therefore, the temperature of cold storages is very much necessary for the storage as well as the ripening process. If the fruits are ripened naturally then it will get softened that might get damaged due to travel at long distances.it is also given that the design procedure cold storage of 30MT.

Dr Parag B Jadhav 2019 Investigated the effect of the cold storage on the weight loss and storage life of pomegranate (Anar-Dana) at agricultural laboratory. The test was conducted at 7°C and 95% relative humidity, within this precise temperature and relative humidity limit the conclusion was carried out that after 22 days 2.63% of weight loss was observed and 7.5% was found after 30 days and also investigated the post storage life of fruits which is found to be 3 days and 2 days for 22



days and 30 days respectively. Proper boxing with CFB and shredded paper can increase shelf life of stored product.

Priyanka 2014 has designed cold storage of potatoes. it's one commodity cold storage within which preserved commodity will keep fresh throughout the year. The proposed design parameters may be adopted to fulfill the necessity of egg, fruits, flowers etc and got heat load calculations for 2700 cum. Size. during this article the principle of refrigeration also are explained all right. it concludes that a well-qualified and experienced person is required for the design of the cold storage. The cold storage also gives an honest guidance for the planning of his or her own cold storage.

Ashwini Chapre 2019 Carried out the study that the life of fresh fruit is greatly affected by extrinsic and intrinsic environment of cold storage. Temperature and extrinsic parameters affect the proliferation of micro-organisms. MOs are not only responsible for spoilage of food but many of them are also harmful to the human body and if they are consumed by human, they also may cause the food poisoning. Psychrophiles MOs are maximum in the range of 15°C - 20°C. temperature ranges are also being discussed in this article.

R. Mishra 2020 experimentally designed small cold storage has been developed employing a domestic split cooling system. The developed solar-powered cold storage could be a low cost, simple and energy-efficient unit. Installation, operation and maintenance costs of the cold storage are less. The cold storage is integrated with IoT-based sensors for remote monitoring and controlling of temperature and humidity additionally as tracking of the stored items. It uses multiple sensors and a microcontroller to take care of and monitor the specified temperature and ratio. cost of cold storage can be recouped from the rent benefits within the first 2.1-year period where solar light available at least 6 h in a day

Abhinav rajan 2015 Carried out an experimental study by applying space between stacks with 10cm 20cm and 30cm respectively and concluded various result regarding temperature distribution and power consumption.

Amar Kood 2016 Investigated the flow pattern and thermal behavior in large refrigerated store by changing 8 different arrangement of the evaporator with help of Computational fluid dynamics tool. He used unstructured mesh with 5,54,000 meshing elements. He used k-e energy equation in the CFD tool for better accuracy. Article found staggered arrangement gives better flow pattern and minimize the dead zones and found that large number of evaporators give better flow filed and minimize the dead zones. It is not recommended to use too heavy evaporators in large cold storage because it gives low velocity field and high temperature also.

Serap Akdemira 2013 Has investigated the research was to determine temperature distributions of two different cold stores which have two different cooling systems. One of the cold storages which is called as Cold store-1, has classical cooling system such as compressor, condenser and evaporator. Second called Cold store-2, cold air ventilation. Cold store-2 has separate suction system of exhaust for air. He also concluded the temperature distribution is more sufficient in case of cold store-2.

Pankaj Mishra 2018 reviewed in detail for the selection of appropriate model in CFD analysis. there are number of mathematical models in CFD analysis according to their significant use. His literature provides good amount of knowledge in case of selection of appropriate model.

Prashant Jaiswal 2015 have analyzed cold storage with different evaporator arrangements with the help of CFD tool and carried out velocity and temperature distribution in cold storage. Literature also provides good amount of knowledge of standard mathematical model as well as the methodology must be required in a cold storage simulation with tool of CFD.

Zina Ghiloufi 2019 has carried out the analysis by CFD tool in case of providing deflector within the cold storage to streamline the flow and concluded that stream line flow can reduces precooling time by reenable amount of time which is beneficial in contras of perishable products.

III. SCOPE OF WORK

Taking the literature and various studies into consideration of improving cooling performance of a cold storage. It is clearly visible that the parameters like the Evaporator arrangement, packing material, stacking arrangement and product heat load can mainly affect on ripening as well as the shelf life of a product and temperature distribution. Methodology required to improve cooling performance is mentioned in this paper.

IV. METHODOLOGY

The following task must be carried out in order to achieve objectives.

Tasks must be carried out by using basic three steps.

STEP-A: Cooling load Calculation.

1. Colling load calculation is very important parameter that is taken in consideration.
2. All heat loads should be calculated based on designed Psychrometry data.
3. Designed Psychrometry data can be easily find out from ISHRAE handbook.
4. Calculate the m³ of air required per stack. It is shown in ASHRAE handbook.
5. 30% volume of cold storage should be free for batter air circulation.
6. Danfoss Cool selector is very good open access software to calculate cooling load.



STEP-B: Modelling and CFD Analysis

1. It is much costly to analyze the Cold storage by practical approach that is why we use CFD model.
2. Identify blank zones, Blank zones are the area which have not proper temperature distribution.
3. Once the heat load is calculated we can clearly identify our heat load capacity in TR (tone of refrigeration) or in kW.
4. Make a model in modelling software and further process in CFD in order to identify blank zone.
5. Make analysis with different orientation of evaporator, and find out the optimum orientation which have minimum Blank zone.
6. For good velocity distribution we can apply aerodynamically designed deflector in cold storage which streamlined the flow.
7. Make analysis with different different stacking arrangements.
8. Avoid to change the design of Stacks because they have standard design in the market, so that change their arrangement only

STEP-C: Implementation of above Steps.

1. Apply the same in Cold storage which is optimum in Step-B
2. Once the installation is completed it will be too much costly to change it again.

V. REMEDIAL MEASURES

However bigger the problem we can prevent it by using proper Strategy.

Remedial measures for freshness, weight loss and Temperature injuries are given below.

1. Humidity is a highly responsible factor for freshness and weight loss.
2. With lower humidity fruits and vegetables reduces their own water particles with considerable amount of nutrients.
3. With proper use of Humidifier, we can able to reduce Weight loss.
4. Avoid chilling injuries which can be seen maximum in the stacks which are near to the walls of cold storage.
5. Proper streamlined flow can reduce the Cold impact near to the storage walls by applying aerodynamically designed deflectors

CONCLUSION

The various parameters should be kept into considerations in order to design and performance enhancement of any cold storage is reviewed in this paper. By reading literature we can see that there is a lot of scope to streamline the velocity of air by using external device like deflector. The CFD simulation is

being analyzed by me on cold storage with proper shaped deflector will be published in upcoming journal.

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