DESIGN AND DEVELOPMENT OF ONION PRESERVATION SYSTEM

Pavankumar R. Sonawane[1], Deepak Deshmukh[2], Nadeem Shaikh[3], Kaustubh S. Joshi[4], Junaid Abbas Mohammed S. Banikar[5], Bhushan R. Patil[6], Sandip Jadhav[7], Amar Gajbhiye[8], D M Mate[9], J A Hole[10]

Article History: Received: 19.03.2023 **Revised:** 04.05.2023 **Accepted:** 19.06.2023

Abstract:

India is the world's second-largest producer of onions. In addition to being a vegetable, the onion is among the fruits and vegetables that contributes significantly to foreign exchange earnings. Onions can rot or decay, however, as a result of the ongoing climate change. As a result, onions should be kept fresh by keeping the temperature suggested by Onions are kept in storage at a temperature of 0 to 4°C and a humidity of 60 to 70% in the ambient environment. Thus, the concept of onion preservation has emerged. In this project, we are creating an onion preservation system that keeps onions from spoiling. Sensors for temperature and humidity have been employed in this system to track the two variables. Carbohydrate for out-side onion in range 8.0- 8.7 mg and Carbohydrate for stored onion in range of 11.0-11.4 mg. Vitamin C for out-side onion in range of 4.5- 4.8 mg and Vitamin C for stored onion in range of 5.7-6.0 mg.

Keywords: Food preservation, Onion preservation, VCC cycle, controlled atmospheres, storage condition.

[1,9] Associate Professor, [7,8]Assistant Professor, [10]Professor, [3,4,5,6]UG Students, Department of Mechanical Engineering, JSPM's Rajarshi Shahu college of Engineering, Tathawade , Pune, India.
[2]Assistant Professor, Pravara Rural Engineering College, Loni, India.

Email: [1]coordinatoro.design@gmail.com, [2]deshmukhdm@gmail.com, [3]nadeemshaikh.info01@gmail.com, [4]kaustubh.joshi0122@gmail.com, [5]jbanikar@gmail.com [6]bhushan660315@gmail.com, [7]sajdeep9@gmail.com, [8]amargajbhiye24@gmail.com, [9]dmmate_mech@jspmrscoe.edu.in, [10]jahole_mech@jspmrscoe.edu.in

DOI: 10.31838/ecb/2023.12.s3.510

1. INTRODUCTION

Onion preservation system is most important in today's situation not only in India butalso for overall world. India is second largest onion development country and also known as country of farmers. As we known, onion is essential for every purpose, on as well as demand is very high. But as we seen, the demand and supply ration are mismatched from so many years as the production rises, the market demand gets decreases due to improper planning and some other reasons. Also, the demand and supply of growth in future. To focus on all these things, we require detail study about all over parameters related to this onion supply and demand. In our India onion is very regular crop that ever farmer try to doing onion farming. But there are some many crises related to this onion farming and supply.

For onion crop, the overall production of onion in India in between range of 7.1 to 7.9 billion per metric ton for 12-month evaluation. There are basically three seasons for onion crop decided for farming as following: 1.Kharip season:-between February to May which is very important season in India takes overall production up to 65 to 68% of onions.2.Late Kharif season:-between August to November, which takes 8 to 11 % of onion production.3.Rabbi season:-between October to January, which takes production up to 15 to 25%.In seasons, production of onion also depends on market ratio and environmental conditions, onion farming is not so costly in India, but proper innovation and planning also requires for that onion farming. Hence, we introduce the project mechanism that is useful for farmers as, this system is good for 12 month of storage purpose. As farmers take onion crop in any season, if there is no demand for onions in market, then with the help of natural process the onions get router because of the decrease in moisture, sprouting and growth of the onion. So, as we need a mechanism, that helps in maintaining onion physical properties for their life cycle and habitat.

The cold storage system is very essential for purpose of onion preservation by maintaining temperature and humidity of system as we want according to the season. In these projects, we design and build a model for onionpreservation useful for market as we overcome problem happens every year with import and export of onion due to shortage and heavy demand.

Table No. 1 Onion physical condition in all seasons (In India)

Season	Temperature in °c	Relative Humidity %
1.Summer	Present: 33 to 42. Required:10 to 0.	Present: 55 to 59. Required: 65 to 70.
2.Monsoon	Present: 21 to 29. Required:5 to 2.	Present:67 to 75. Required: 66.
3.Winter	Present: 9 to 22. Required:8 to 2.	Present:61 to 65. Required: 66.

Problem Statement

The current methods of onion storage have limitations in preserving the quality of onion bulbs over extended periods. This has led to the exploration of alternative storage techniques such as the use of

Vapor Compression Cycle (VCC) technology. However, limited studies have been conducted on the application of VCC technology for onion storage, leaving a research gap on the feasibility and effectiveness of this technique. Therefore, there is a need for further research to store onion, improve the quality and shelf-life

A. Objective

- To develop storage system for onions preservation.
- To design monitoring system for, temperature, relative humidity.
- To maintain the quality attributes of onions, including flavours, texture, colour, and nutritional content.

B. Scope

The scope for onion storage by VCC (Vapors Compression Cycle) technology is significant. VCC technology offers an efficient and effective method for onion storage, as it maintains a consistent temperature and humidity level, which are critical factors for preserving the quality of onions. VCC technology also reduces the risk of post-harvest losses due to spoilage or sprouting, which can occur in traditional storage methods. Furthermore, VCC technology offers the potential for increased shelf life and reduced energy consumption, making it a cost-effective and sustainable option for onion storage.

LITERATURE REVIEW

The authors then describe their experimental methods, in which they stored onions at four different temperatures (0°C, 5°C, 10°C, and 15°C) and three different relative humidities (60%, 70%, and 80%) for a period of four months. The results showed that storage temperature and humidity significantly affected onion quality changes during storage. Onions stored at lower temperatures (0°C and 5°C) and higher relative humidities (70% and 80%) showed less weight loss, sprouting, and decay, and maintained higher TSS levels compared to onions stored at higher temperatures (10°C and 15°C) and lower relative humidities (60%) [1].

Provide an overview of the physiological and biochemical changes that occur in onions during storage, including changes in texture, color, flavors, and nutritional content. The paper goes on to examine various factors that can affect onion quality during storage, such as temperature, humidity, packaging[2].

The importance of onion storage due to its significant impact on the postharvest losses and food security. Onions are a highly perishable crop, and their storage can be challenging due to various factors, including physiological changes, pathogenic attacks, and external damage. The effects of temperature, relative humidity, and gas composition on onion storage [3]. Importance of onion storage in reducing postharvest losses and ensuring food security. The quality of stored onions is affected by various factors, including cultivar, maturity, harvesting and postharvest practices, and storage conditions [4]. Focuses on optimizing onion storage conditions using response surface methodology (RSM) to improve onion quality and reduce postharvest losses. The importance of onion storage and the factors that influence onion quality changes during storage. Optimizing storage conditions, such as temperature and relative humidity, can help maintain onion quality and reduce postharvest losses [5].

Onion storage and the various factors that affect onion quality changes during storage, including temperature, relative humidity, cultivar, and maturity at harvest. Proper postharvest handling and storage practices to maintain onion quality and reduce postharvest losses. The physiology of onions during storage, discussing the various physiological processes that occur in onions, such as respiration, transpiration, and changes in sugar and organic acid content [6]. Three different onion varieties: Red Onion, Yellow

Onion, and White Onion. The onions were stored at three different temperatures: 0°C, 5°C, and 10°C, for a period of 180 days. The onions for various quality attributes, including weight loss, sprouting, decay, and bulb firmness. The onions stored at 0°C had the least weight loss and sprouting, while those stored at 10°C had the most [7].

Three different onion varieties: Red Onion, Yellow Onion, and White Onion. The onions were stored at two different storage conditions: normal air (control) and controlled atmosphere (CA) storage. The CA storage conditions were set to 1% O2 + 1% CO2, and the onions were stored for a period of 60 days [8]. Stored under ambient conditions for a period of six months. The researchers measured various quality parameters such as bulb weight loss, bulb firmness, total soluble solids (TSS), and pyruvic acid content during storage. The results showed that planting dates and plant spacing significantly influenced the quality of onion bulbs during storage [9]. Importance of postharvest quality in onions and the challenges associated with maintaining quality during storage. Onions to various pre-storage treatments, including hot water treatment, ultraviolet irradiation, and calcium chloride treatment, and then storing the onions under different storage conditions [10].

The post-harvest behavior of five onion varieties (Red Creole, Yellow Granex, Red Globe, Super Star, and Texas Grano) under ambient storage conditions. The onions were stored for four months and evaluated for changes in quality attributes, such as weight loss, sprouting, decay, and bulb firmness [11].

DESIGN CALCULATION

Mathematical/Numerical Analysis: -

❖ Capacity= 0.1ton.
❖ Suction Temperature =-30 ºC = 273-30 = 243°K
❖ Condensing temperature =35 ºC = 308°K

1. COP of Refrigeration Cycle: -COP = T2/(T1-T2)

=243/(308-243)COP = 3.73

Hence refrigerating effect of our system is find by using COP and refrigerant capacity;

2. Refrigerating Effect: -

R.F. = COP * Compressor work

= 3.73*0.1 = 0.373 TR

Hence Refrigerating effect if 0.373 TR respectively.

3. Total Heat consumption by system: -Where system has dimensions;

➢ Length=725mm
➢ Breadth=525mm
➢ Height=350mm
➢ Ti =-2

ºC = 273-2 = 271°K

➢ To = 30 ºC = 273+30 = 303°K

Q = Area * (To-Ti)

= (0.725*0.525) * (303-271)

= 18 watts.

Hence, we find above parameters related to our system.

EXPERIMENTAL SETUP

The selection of materials for the Vapor Compression Cycle plays a crucial role in the overall efficiency and performance of the cycle. Various components in the VCC, such as the compressor, condenser, evaporator, and piping, require different materials to ensure optimal functioning and durability. Starting with the compressor, which is responsible for compressing the refrigerant vapor, materials with excellent strength and corrosion resistance are essential. Commonly used materials for compressor components include stainless steel or aluminum alloys. These materials possess high tensile strength and can withstand the high-pressure conditions encountered during compression. Moving on to the condenser, where the refrigerant releases heat and condenses into a liquid state, materials with good thermal conductivity and corrosion resistance are desirable. Copper and aluminum are widely used in condenser construction due to their excellent heat transfer properties and resistance to corrosion from the refrigerant and external environmental factors.

The vapor compression cycle is the most common refrigeration cycle used in various cooling systems, including air conditioners, refrigerators, and heat pumps. It involves the circulation of a refrigerant through a closed loop, where it undergoes phase changes and heat transfer processes. The following are the main components involved in a typical vapor compression cycle:

- **Compressor:** The compressor is the heart of the vapor compression cycle. It is typically an electric motor-driven device that increases the pressure and temperature of the refrigerant vapor. The compressor draws low-pressure, low-temperature refrigerant vapor from the evaporator and compresses it to a high-pressure, high-temperature state before sending it to the condenser. The compressor is the heart of the vapor compression cycle.
- **Condenser:** On the system's high-pressure side, the condenser is a heat exchanger. Its main purpose is to return the hot refrigerant vapour to a liquid condition by releasing heat from it. The condenser coils conduct the high-temperature refrigerant as it is cooled by air or water. As a result, the refrigerant undergoes a phase shift from a vapour to a liquid and emits heat into the environment.
- **Expansion Valve or Throttle Valve**: Between the condenser and evaporator is a little component called the expansion valve. It serves as a metering mechanism that regulates the flow of liquid refrigerant from the high-pressure side of the system into the low-pressure side. The liquid refrigerant enters the evaporator as a low-pressure, low-temperature mixture of liquid and vapour after its pressure and temperature are reduced by the expansion valve.
- **Evaporator:** The system's low-pressure side contains the evaporator, another heat exchanger. The refrigerant absorbs heat from its surroundings (such as air or water) and evaporates into a low-pressure vapour during the heat transfer process, which is made easier by this. The refrigerant can absorb heat and chill the surrounding surroundings or the product being preserved since the evaporator coils have a high surface area for efficient heat exchange.
- **Refrigerant:** The working fluid that goes through phase shifts and heat transfer activities during the vapour compression cycle is the refrigerant. Like R-134a, common refrigerants include them. The efficiency and performance of the system are determined by the refrigerant's features, such as pressure-temperature relationship and heat transfer characteristics.

The system operates as follows:

1. The low-pressure, low-temperature refrigerant vapour is drawn from the evaporator by the compressor,

which then compresses it to raise its pressure and temperature.

2. The high-pressure, high-temperature refrigerant vapour then enters the condenser, where it condenses into a high-pressure liquid and discharges heat to the environment (air or water).

3. The expansion valve reduces the pressure and temperature of the high-pressure liquid refrigerant as it passes through, resulting in a low-pressure, low-temperature mixture of liquid and vapour.

4. After entering the evaporator, the low-pressure refrigerant mixture absorbs heat from its surroundings (such as air or water) and evaporates into a low-pressure vapour.

5. As the low-pressure vapour is pushed back into the compressor to be compressed, starting a new refrigeration cycle, the cycle repeats.

3D MODELING USING CAE

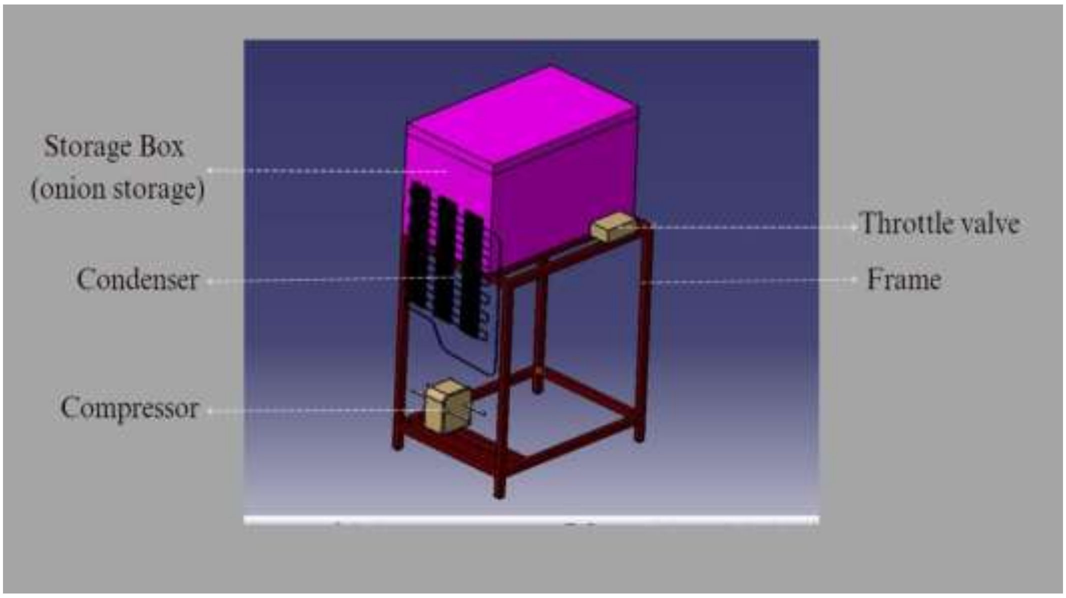

Fig. 1 Overall system

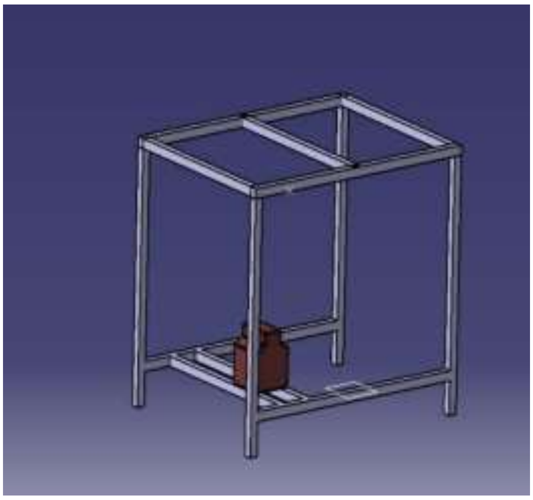

Fig. 2 Frame

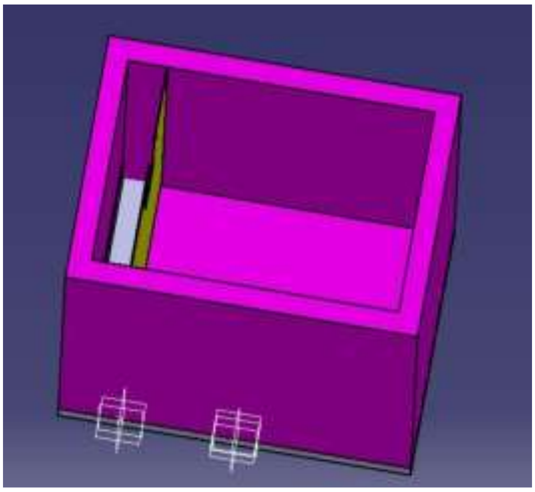

Fig. 3 Storage Box

2. RESULT & DISCUSSION

Table. 2 Test Result

Sr. No.	Test	Sample No.	Result
1	Carbohydrate for out-side onion	1	8.0 mg.
		2	8.7 mg.
		3	8.3 mg.
2	Carbohydrate for Stored onion	1	11.0 mg.
		2	11.1 mg.
		3	11.4 mg.
3	Vitamin C for out-side onion	1	4.5 mg.
		2	4.8 mg.
		3	4.5 mg.
4	Vitamin C for stored onion	1	6.0 mg.
		2	5.7 mg.
		3	5.9 mg.

- The provided information indicates the carbohydrate content and vitamin C content of onions from two different conditions: "oct-side" (presumably freshly harvested onions) and "stored" onions. Let's discuss the given ranges for each parameter and their implications.

Carbohydrate Content:
Oct-side Onion: The carbohydrate content of oct-side onions ranges from 8.0 to 8.7 mg. Stored Onion: The carbohydrate content of stored onions ranges from 11.0 to 11.4 mg.

- The carbohydrate content represents the amount of carbohydrates, including sugars and fibres, present in the onions. Generally, the carbohydrate content tends to increase during storage due to the breakdown of starch into sugars. The higher carbohydrate content in stored onions suggests that the starches in the onions have converted into sugars over time.

Vitamin C Content:
Oct-side Onion: The vitamin C content of oct-side onions ranges from 4.5 to 4.8 mg. Stored Onion: The vitamin C content of stored onions ranges from 5.7 to 6.0 mg.

3. CONCLUSION

In conclusion, the implementation of a vapor compression cycle-based onion preservation system offers several advantages for extending the shelf life and maintaining the quality of onions. Onion preservation system is to achieve prolonged shelf life, retain quality attributes, minimize losses, ensure cost-effectiveness, promote scalability and adaptability, prioritize sustainability, and contribute to foodsecurity.
The preservation system's ability to maintain the quality attributes of onions, such as flavour, texture, colour, and nutritional content, enhances consumer satisfaction and supports the market value of preserved onions. A well-designed and properly implemented onion preservation system based on the vapor compression cycle can effectively extend the shelf life of onions, maintain their quality attributes, minimize losses, and contribute to the economic viability of the onion industry while ensuring food security and promoting sustainability.

4. REFERENCES

1. Mohammed, A. T., et al. (2014). Effect of Temperature and Humidity on Onion Storage Quality. Journal of Food Processing & Technology, 5(11), 1-5.
2. Kang, S. S., & Kang, S. K. (2021). Factors affecting onion quality during postharvest storage: A comprehensive review. Horticulture, 58(3), 123-135.
3. Kaleemullah, M., Mahroof, R., & Khan, I. A. (2016). Onion Storage: A Review. Journal of Agricultural Science and Technology, 18(6), 1353-1366.
4. Singh, S. P., et al. (2014). Quality Changes in Onion during Storage: A Review. Critical Reviews in Food Science and Nutrition, 54(3), 321-330.
5. Shabani, M. R., et al. (2017). Optimization of Onion Storage Conditions Using Response Surface Methodology. Journal of Agricultural Science and Technology, 19(2), 315-327.
6. Mir, M. S., et al. (2014). Postharvest Physiology and Storage of Onion: A Review. Journal of Food Science and Technology, 51(12), 2837-2854. 2004.
7. Srinivasan, M. P., et al. (2015). Effects of Different Storage Temperatures on Onion Bulb Quality. International Journal of Agriculture, Environment and Biotechnology, 8(1), 165-172.
8. Grewal, N. S., et al. (2018). Effect of Controlled Atmosphere Storage on Onion Bulb Quality and Respiration Rate. International Journal of Agriculture and Biology, 20(1), 129-136.
9. Sadik, G. D., et al. (2016). Effect of Preharvest Factors on Onion Bulb Quality during Storage. International Journal of Agriculture and Biology, 18(6), 1197-1204.
10. Omoniyi, B. Y., et al. (2015). Influence of Pre-storage Treatments on Onion Bulb Quality during Storage. Journal of Agricultural Science and Technology, 17(5), 1125-1137.
11. Hussain, A., et al. (2014). Storage Studies on Onion Varieties under Ambient Conditions. Journal of Agricultural Science and Technology, 16(5), 1169-1181.