Practical Investigation and Study of Banana Ripening Chamber

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Abstract— This paper discusses the application of cold room approach to design a well-defined ripening room for banana storage and produce effective air flow around the banana crates. Recent days the fruit storage is important factors according maintain fruits quality, flavour and texture of banana i.e. mainly fulfil by harvest and storage it effectively which is developed and design a well-insulated ripening room for climacteric fruit. High performing cold rooms gives exact efficiency of cooling effect by proper investigation and designing a ripening chamber. A cold room or ripening chamber is a refrigeration system or building designed for storage of foods stuffs, fruits, vegetable, dairy products, sea products and meat within well-defined temperature range and relative humidity (RH). It is also an application of air conditioning, that air is cooled by passing around a cooling coil of refrigeration system and supplied back to cold room. These cold storage facilities are usually built to store perishable fruits. The fruits storage may vary according to size. The scope of the project is to design a well-defined ripening chamber for banana harvesting under controlled temperature and relative humidity. There is a loss of moisture due to low temperature humidification. For moisture control using evaporative humidifier which leads to maintain the product quality and increasing shelf life. And also obtain refrigerant effect and cop of chamber.

Keywords: Design Layout, Air Flow Rate, Cooling and Humidification Process, Storage Condition

I. INTRODUCTION

Ripening chamber plays a vital role in ripening the banana under controlled commodity. The Banana harvesting is the major source of production and including along with major part of proteins and vitamins factor in it which is consume by people living in the world; it is a major harvesting fruit of India which is very old from Indian civilization. It is one of the important fruit crops of many tropical and sub-tropical regions in India. It is harvested in India in an area near 830.5 thousand of hectare which is approximate 29,779.91 thousand tons in scale of production. For storage we required a large storage and ripening chamber for harvesting banana. A cold room or ripening chamber is a refrigerated room or building like structure for storage of foods stuffs, fruits, vegetable, dairy products, sea products and meat within well-defined temperature range and relative humidity. The Cold storage is also an application of air conditioning; in a way that the air is cooled by passing over a cooling coil of refrigeration plant and supplied back to the cold chamber.it is also known as walk in chamber. These cold storage facilities are usually built to store perishable products vary in size and storage requirement of fruits. Ripening is a process by which fruits obtain their desirable flavour, quality, taste, colour, palatable nature and other textural phenomenon. The process of ripening is associated with change in characteristics i.e. change of starch to sugar phase. On the basis of ripening behaviour, fruits are classified as climacteric and non-climacteric fruits. Generally, fruit becomes sweeter, less green (reddish), and as soft as completely ripens. Even though the nature of acidity of fruit increased as further ripens, the higher level of acidity not making the fruit sour to be seem. The whole process of ripening carried out in insulated chamber which takes 3-4 days of ripening. And design and installed 3 consecutive ripening chambers for same temperature and relative humidity.

II. LEARNING OBJECTIVES

- Study of banana ripening chamber.
- Problem occurred while ripening
- Behaviour of banana under preservation.
- Humidifier selection and effect.
- Refrigerant used.
- Reaction of Ethylene exposure on banana.
- Air flow around and inside the chamber.

III. METHOD AND MATERIAL

A. Description of the Ripening Chamber:

The ripening room was 6.m long, 3.5m wide and 3m high, which gives an overall volume of 72m3. The overall room which is made up of puf panel insulation made up cyclopentane having density 40kg/m3. The refrigeration system having 2.5mt of capacity which is fin coil evaporator (3000 btu). And a VRF condenser unit Humidifier installed for better control of moisture which is having 3kg/lit capacity. Inside this room, 6 layers of 8 rows crates per crate 12-13kg of banana (i.e. a total of 600 crates) were stored to obtain a filling pattern representing current industrial practice (Fig.1). We are using crates instead of stacks and avoid pallets which hold the moisture leads to free space according to the height between two consecutive crates was 2 cm. As our interest in was the better air flow between crates inside the room and not the heat and water transport arise from the interaction between the banana and their surroundings, we replaced stacks 10 cm in diameter and 4.4 cm high, i.e. inert objects presenting the same resistance against air circulation.

An air conditioning system comprising of two fans and two fan coil unit motor and installed in a space located attached to the ceiling of the ripening room controlled the temperature and flow rate of the air blast into the room. Too little airflow tends to charge the system properly not possible. Low air flow may ice up the coil and allows liquid refrigerant to flood the compressor. Too much airflow and the system and high humidity levels may be a problem in the home. Both of these conditions drastically affect system performance and may damage the compressor. The balancing the air flow there must a primary condition to operate at proper air flow through the system.

The airflow rate was determined from height and depth and the amount of air passing through evaporator coil

and it is measure in cfm (cubic feet per minute). For proper air conditioning operation the required cfm around 350 to 400 per ton of cooling. Likewise, the evaporator is 2.5 ton of capacity, after calculating capaicity and cfm value which is taking the air flow required is 3700 CFM.

Inside the banana ripening room, the ventilation system was designed to imitate a common industrial configuration, namely an air conditioning system placed at the end of the room, extracting air in its lower part and blast the conditioned air through the fcu unit in its upper part. This system was composed of a 22 mm blowing evaporator made of aluminum material and a 67mm suction duct (Fig. 1).

The evapoartor running attached to the ceiling at half-width in the room was fitted just back to the humidifier will raises the moisture around room and flowing with the help of fcu unit. After air being blown into the room, the air was throwing at 18 feet from the ground (Fig. 1). The suction duct was connected to the space located above the ceiling of the ripening room in which the fans were installed. The full airflow rate blown into the room was 6200 m3h-1, i.e. an air change rate of 5 volumes h-1, which corresponds to normal industrial practice.

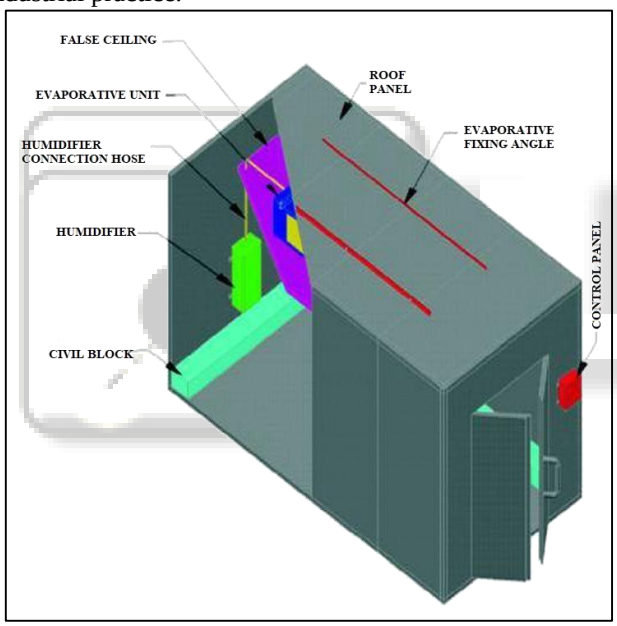


Fig. 1: Standard Ripening Chamber

IV. PROPOSED DESIGN

The layout design which is allocated on Autodesk education tool design software which is used for implementing a layout design plan for which a whole system installed. The purpose of designing a whole system according to consumer.

The primary work is to be done on mainly designing by calculating cooling load estimation. By this configuration and result the best air conditioning system to be installed at allocated area.

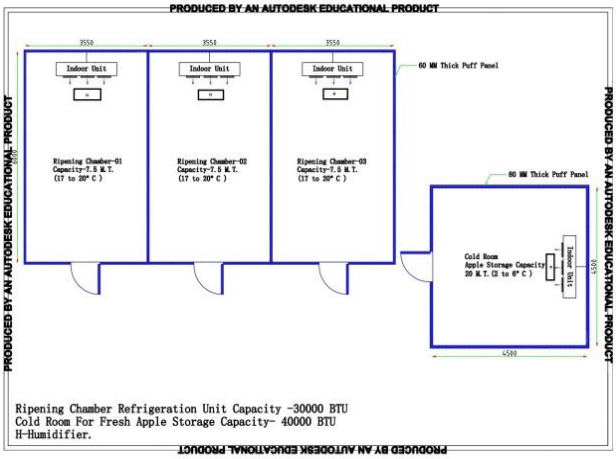


Fig. 2: Basic layout of ripening chamber

V. PUF INSULATION

A. Comparison of Insulation with Conventional Insulation:

Sr.No.	Particulars	HCFC-141b	Cyclopentane-ne (c5)
1	Density	35-37	37-40
2	Compressi-ve strength	1.5-1.8	1.6
3	Closed cell content	>90	>90
4	K- value (w/m°k)	0.0195	0.022
5	GWP	630	11
6	ODP	0.1	0
7	Fire retardant property	Self-extinguishing	Self-extinguishing

Table 1: Comparison of Insulation Material

VI. WORKING GAS

The selection of gas charged is based on following factors that helpful for selecting gas to be charged to compressor.

- Environmental factors.
- Thermophysical properties.
- Technological issues.
- Economic aspects.
- Stability of operating condition.

Working gas properties
R-22 (HCFC22)
Critical pressure(p_c) = 4.936 MPa (49.36bar)
Critical temperature(T_c) = 96.2 °C (369.3 K)
Density (ρ)=3.5 kg/m^3 at 17 °C, gas
Molar mass= 86.47 g/mol
Odour = Sweetish
Colour code= Light Green

Table 2: Refrigerant Properties

VII. EVAPORATIVE HUMIDIFIER

Sr.no	Model	Fusion 700
1.	Particle size	5-10 microns
2.	Power supply	230 VAC/50Hz

3.	Operating temp	1-50°c
4.	Humidification capacity	3-8 ltr/hr
5.	Power input	90 W
6.	Water connection	0.5inch(<5kg/cm^2)
8.	Dimensions	370×370×480mm
9.	Weight	9 kg (dry)

Table 3: Cool mist humidifier

Fig. 3: Cool mist humidifier

VIII. STORAGE CONDITION

Sr.No.	Fruit(Banana)	Specification
1.	Storage temperature	17°c to 20°c
2.	Storage temp after ripening	13°c to 14°c
3.	Relative humidity	90 to 95%
4.	Ethylene concentration	100 to 150ppm
5.	Duration of ethylene exposure	24 to 48 hours
6.	CO2	< 1%

Table 3: Banana Storage Condition

IX. INDOOR OUTDOOR UNIT:

Capacity (Btu/hr)	30000
Power supply (vph/Ph/hz)	230/1/50
Airflow (CFM)	4500
Air throw (Feet)	25
No. of circuits (Nos.)	3
Overall dimensions (mm)	1710×645×720
Dry weight (kgs)	72

Table 4: Indoor unit

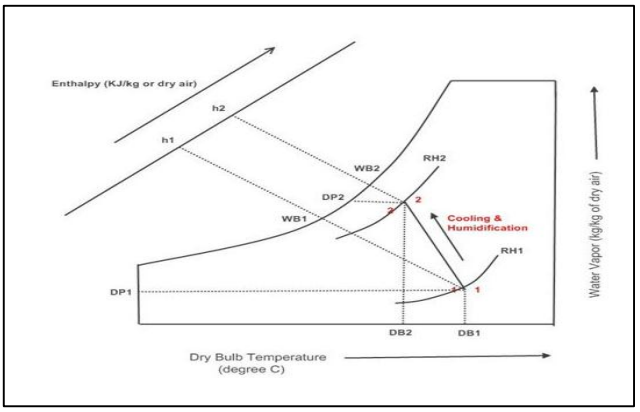
Compressor type	Hermetic scroll
Power supply (vph/Ph/hz)	415/3/50
Comp. quantity (Nos.)	3
No. of chassis (Nos.)	3
Each chassis overall dimensions (mm)	1100×444×1259
Each chassis dry weight (kgs)	125
Each chassis refrigerant per charged quantity (kgs)	3.5

Table 5: Outdoor unit

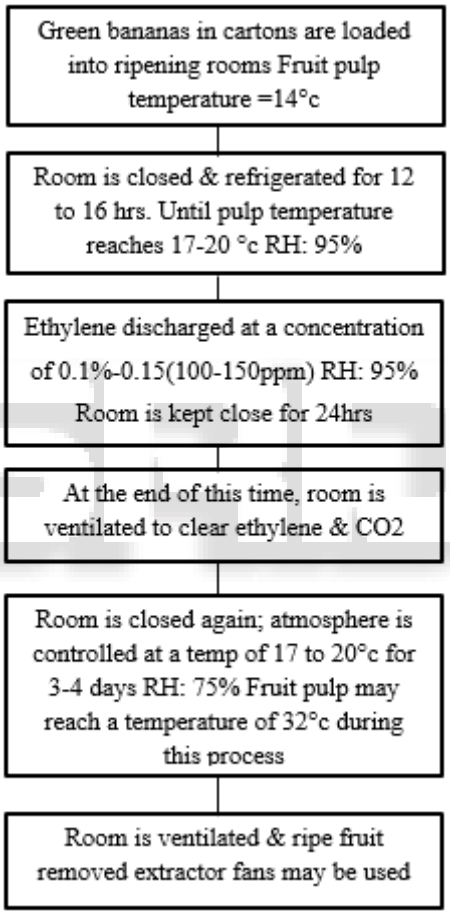
X. PROCESS OF COOLING

A. Cooling and Humidification:

The whole process of refrigeration system running on cooling and humidification at design DBT and WBT.



XI. FLOW PROCESS CHART OF DURING RIPENING



XII. CONCLUSION

The performance of cold store banana ripening chamber was investigated. In general, data were taken in good agreement with theoretical data. The bananas in ripening chamber may do not failing to chilling injury due appropriate cooling temperature and there is no delaying of banana ripening. The humidity is maintain during ripening and the marketability of produce get increased which is before lost due to low temperature humidification that cause the whole moisture lost from chamber will affect the product stores. Due artificial humidification after ripening great texture banana produced. The shelf life is increase with proper exposure of ethylene (100 to 150ppm). The cooling effect is maintaining

throughout the chamber with proper selection of cooling unit and great insulating material. Thus overall performance of the chamber is maintained. The temperature we set to obtained desired cooling that is 17°c to 20°c is more way sufficient to ripen the banana. The cop we have achieved that make the whole chamber efficient in terms of cooling thus overall chamber we design is cost effective.

REFERENCES

[1] Kimball, Dan (1991). The Brix/Acid Ratio. Citrus Processing. pp. 55–65.
[2] "Indian start-up offers ripening solution". Retrieved 7 Feb 2018.
[3] "Now, a safe powder to ripen your mangoes". Retrieved 17 Feb 2018.
[4] "Artificial Ripening of Fruits: ethylene gas- a safe fruit ripener" (PDF). Retrieved 17 Feb2018.
[5] Per, Hüseyin; Kurtoğlu, Selim; Yağmur, Fatih; Gümüş, Hakan; Kumandaş, Sefer; Poyrazoğlu, M. Hakan (2007). "Calcium carbide poisoning via food in childhood". The Journal of Emergency Medicine. 32 (2): 179–80.
[6] "Bet on it. Your mango is ripened using carbide". May 18, 2013. Retrieved 18 May 2013.
[7] "How to Ripen Fruit Faster". 2013-09-20. Prasanna, V.; Prabha, T.N.; Tharanathan, R.N. (2007). "Fruit ripening phenomena-an overview". Critical Reviews in Food Science and Nutrition. 47 (1): 1–19.
[8] Atwell, Brian J.; Kriedemann, Paul E.; Turnbull, Colin G.N., eds. (1999). "11.5.5 Colour and flavour". Plants in Action: Adaptation in Nature, Performance in Cultivation. Macmillan Education Australia.
[9] ^ Xuewu Duana; Guiping Chenga; En Yanga; Chun Yia; Neungnapa Ruenroengklina; Wangjin Lub; Yunbo Luoc; Yueming Jiang (November 2008). "Modification of pectin polysaccharides during ripening of postharvest banana fruit". Food Chemistry. 111 (1): 144–9.
[10] Medlicott, A.P.; Thompson, A.K. (1985). "Analysis of sugars and organic acids in ripening mango fruits (Mangifera indica L. var Keitt) by high performance liquid chromatography". J. Sci. Food Agric. 36 (7): 561–6.
[11] Bashir, H.A.; Abu-Goukh, A.A. (2003). "Compositional changes during guava fruit ripening". Food Chemistry. 80 (4): 557–563.

