A review on cascade system using different refrigerant pair and on freeze drying

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ABSTRACT

This study is presented a cascade refrigeration system for different refrigerant pair for high temperature cycle(HTC) and low temperature cycle(LTC). Different pairs are R404-R23 , R744-R717 , R404-R22 etc for low and high temperature cycle and also review on freeze drying application that is performed using cascade refrigeration system. Comparing the moisture content , vitamin C content and other properties of different fruits before and after freeze drying. Various condition of different paper used like freeze drying temperature , sample size , different operating condition etc are also listed.

Keyword : - *freeze drying , cascade system , different refrigerant pair , drying temperature , operating condition*

1. Introduction

In this paper a various parameters are studied like superheating , sub-cooling , evaporating temperature , condensing temperature , Vitamin C content in guava, mango, papaya and pineapple for fresh state and freeze dried state , Drying time for various pressure and various freezing rate , Sugar content and water content of apple , melon and pear etc. various paper discussed below has a various above operating parameter studied and concluded according to that various thing and conclusion are shortly discussed in below literature review.

The reference number should be shown in square bracket [1]. However the authors name can be used along with the reference number in the running text. The order of reference in the running text should match with the list of references at the end of the paper.
Eg1: As per Kong, the density of X increases with Y [3].
Eg 2: It is reported that X increase with Y [2].

1.1 Literature study

Umesh C. Rajmane et al[1] has presented a study on R404a-R23 cascade refrigeration system performance evaluation using R404a in high temperature cycle and R23 in low temperature cycle with operating parameter are superheating , sub-cooling , evaporating temperature , condensing temperature result shows that the cascade gives a better performance then normal VCR system has found a COP at very near to the actual result and getting a efficiency of about 0.2692.

Antonio messineo et al[2] has presented a study on R744-R717 cascade refrigeration system performance evaluation compared with HFC two stage refrigeration system using R717 in high temperature cycle and R744 in low temperature cycle with operating parameter are superheating , sub-cooling , evaporating temperature , condensing temperature and found that similar behaviour of two cycle within the range of condensing temperature 35°C to 40°C and similar behaviour of two cycle within the range of evaporating temperature -35°C to -40°C.

J. J. Fiori et al[3] has presented a study on theoretical experimental evaluation of a cascade refrigeration system for low temperature application using a pair R22-R404a R22 in high temperature cycle and R404a in low

temperature cycle with operating parameter are superheating , subcooling , evaporating temperature , condensing temperature and examined that increase in condensing temperature cause a decrease in COP, this behavior is easily explained by the increasing of compressor work of HT , COP varies as the compressor work varies.

A.Carapelle et al[4] has presented A study of vacuum freeze drying of frozen wet papers. Sample size = 246 X 150 X 36 mm. Vacuum vessel = 0.5 m^3 steel tank. Pump capacity = 30 m^3/hr.LN_2 in cold trap T type thermocouples. Studied parameter are Temperature inside the sample and Pressure inside the vessel. An experimental set-up was built to study the vacuum freeze-drying of frozen wet papers. Optimal parameters were determined to reduce the time and cost of freeze-drying. A simple model was developed to predict the evolution of the process and to help further investigations. Relative humidity inside the sample was only 5 % at 20°C.The blast-freezed paper had a better quality and better mechanical properties. An experimental set-up was built to study the vacuum freeze-drying of frozen wet papers.

Soren Carlsen [5] (1999) has presented Effects of freeze drying on paper. The investigation comprises three types of paper (ground wood paper, cotton paper, and coated paper) which have been freeze dried, air dried, and exposed to accelerated ageing. The effects of freeze drying on paper have been evaluated by the following indicators: moisture content, alkali reserve, folding endurance, tearing resistance, and zero span tensile strength. The results indicate that freeze drying primarily influences paper characteristic such as moisture content, folding endurance, and tearing resistance. Freeze drying particularly influences mechanical strength of paper with low initial strength, whereas the influence by freeze drying on paper with high mechanical strength is relatively small. The investigation shows that it is possible to determine changes in the mechanical strength of paper as well as in the ageing stability caused by freeze drying, and that mechanical strength and ageing stability is affected differently in different paper qualities. The study indicates that freeze drying particularly affects mechanical strength and ageing stability in ground wood paper and coated paper whereas the same characteristics are only affected insignificantly in cotton paper. The results particularly reveal that freeze drying reduces the folding endurance of ground wood paper and coated paper.

Luanda G. Marquesa et al[6] has presented study on Vitamin C Content of Freeze-Dried Tropical Fruits. Specifications are Circular tray : Diameter :- 125 mm, Height :- 15 mm, Frozen in LN_2,Pressure :- 0.13 mbar, Temperature :- -30° C. Studied parameter are Vitamin C content in guava, mango, papaya and pineapple for fresh state and freeze dried state. The vitamin C content of both fresh and freeze-dried guava, mango, papaya and pineapple was determined. Although losses have occurred during the process, the ascorbic acid content retained in the freeze-dried guava, mango, papaya and pineapple characterizes these products as a valuable source of vitamin C. Concerning to papaya, the use of conventional freezing led to higher vitamin C loss when compared with the cryogenic freezing.

Natalia A. Salazar et al[7] (2015) has presented Mango Lyophilization UsingVacuum-Induced Freezing. Specifications are Mango slices(6.5 g)Size : Height :- 0.006 m, Diameter :- 0.04 m, Temperature :- -2°C. Studied parameters are Drying time for various pressure and various freezing rate. Freezing rate and sudden reduction in pressure during freezing stage affect overall drying time and properties of dried products in mango lyophilization. The higher freezing rate (0.4°C/min) reduced the overall process time (and, consequently, the operational cost) up to 30%compared with the required for the lower freezing rate(0.1°C/min).

Lina M. Agudelo-Laverde et al[8] (2013) has presented Proton mobility for the description of dynamic aspects of freeze-dried fruits. Specifications are Sample(apple ,melon and pear) size of : Diameter = 0.025 m, Thickness = 0.005 m, Frozen temperature = 4 °C, frozen with liquid nitrogen at temperature = 20 °C. Sugar and water content in g/100 g dry solids Sugar content :Apple = 17.1±0.6,Melon = 36.5±1.2, Pear = 18.3±0.5.Water content :Apple = 4.7±0.01,Melon = 4.6±0.13, Pear = 6.3±0.1.

P.N. Ezhilarasi et al[9] (2013) has presented Freeze drying technique for microencapsulation of Garcinia fruit extract. System specifications are Sample= G. Cowa Quantity = 1 kg, freeze drying at -40 to -30 °C, Drying time = 20 hours, Three different wall material = whey protein isolate (WPI), maltodextrin (MD)and combination of whey protein isolate and maltodextrin (WPI + MD).Average percentage moisture content of freeze dried for WPI = 15.65% , MD = 12.56% and WPI+MD = 11.53%.

Marla Mateus de Lima et al[10] (2016) has presented Vacuum impregnation and drying of calcium-fortified pineapple snacks. System specifications are Sample size of pineapple : Thickness = 0.005 m, Diameter of =

0.085-0.090 m, Freeze drying temperature= -60°C,Frozen time = 4 hours,Freezing pressure = 20 ± 5 Pa,Freeze dryig time = 24 hours. Studied parameter are Moisture content for Non impregnated samples (N) , Atmospheric pressure impregnation (AI) , Vacuum impregnation (VI) , Vacuum impregnation by drainage pulses (VI-P1) , Vacuum impregnation by drainage pulses (VI-P2). Moisture content in g/100 g For N = 7.90 ± 0.80,AI = 9.10 ± 0.17,VI = 9.10 ± 0.69,(VI-P1) = 8.60 ± 0.52(at pressure 6.7 kpa),(VI-P2) = 8.80 ± 0.67(at pressure 13.33 kpa).

Beate Schulze et al[11] (2013) has presented Stability of quercetin derivatives in vacuum impregnated apple slices after drying (microwave vacuum drying, air drying, freeze drying) and storage. System specifications are Sample(apple) size : Thickness = 6 mm, Surface area = 0.00399 $m^{2,}$ Frozen in liquid nitrogen, Freeze drying time = 72 hours. Studied parameters are Moisture content in freeze drying(FD) ,microwave vacuum drying(MVD) ,air drying(AD). Moisture content in g/100 g FD = 6.8, MVD = 9.0, AD = 12.7.Freeze drying give the best result.

Yujing Sun et al[12] (2014) has presented Effects of drying methods on physical to chemical compounds and antioxidant activity of physiologically dropped un-matured citrus fruits. System specification are Sample(citrus fruits) size Thickness = 0.005 m, Pressure = 12 Pa, Drying time = 12 hours, Freezing temperature = -6°C. Studied parameter are Phytochemical compounds and antioxidant activity. freeze-drying is good for retaining phenolic compounds, synephrine and antioxidants; hot air-drying is good for retaining flavonoids; and all three methods can be used for retaining limonoids.

Abdullah Alhamdan et al[13] (2015) has presented Cryogenic freezing of fresh date fruits for quality preservation during frozen storage. System specifications are Sample(Fresh yellow dates cv. Barhi) size :Thickness = 0.0081 m, Freezing temperature = 5°C,Freezing time = 6 hours, Drying temperature = 70°C, Drying time = 45 hours. Studied parameter Moisture content and water activity. Moisture content and water activity Moisture content = 9.8 g/100g,Water activity = 10.1 %.

Stanisław Rudy et al[14] (2015) has presented Influence of pre-treatments and freeze-drying temperature on the process kinetics and selected physico-chemical properties of cranberries. System specification are Sample(cranberries) size :Diameter = 0.010 m, Thickness = 0.006 m, Drying temperature = 70°C,Drying time = 48 hours, Pressure = 52 pa. Studied parameter are Drying time and antioxidant. Pulping of cranberries before freeze-drying approximately halved drying time and produced a product with a higher redness and a higher antioxidant activity in comparison to dried whole fruits.

Rui Wang et al[15] (2010) has presented Effects of vacuum and microwave freeze drying on microstructure and quality of potato slices. System specifications are Sample(potato) size Thickness = 0.004 m, Diameter = 0.040 m, Freezing temperature = 4°C,Drying temperature = 105°C,Drying time = 48 hours. Studied parameter are Moisture content , vitamin C content , sugar and starch. Concluded that Moisture content In (g/100g) =3 ± 0.5,Vitamin C in (g/100g) = 0.153 ± 0.0076,Sugar in % = 6.57 ± 0.32,Starch in % =73.41 ± 2.12.

2. CONCLUSIONS

From the above study of cascade and freeze dried product there is a different quality of fruits , moisture content will be different for different fruits. Different temperature for freeze drying is achieved. Freeze drying with help of cascade refrigeration system to achieving low temperature that is required for freeze drying has a higher quality of product compare to other.

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