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A Review on Feasibility Analysis of Single Effect Vapour Absorption System in Milk Processing Plant

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Abstract **-Milk is one of the best food available due to its nutrition values. For production of processed milk and other dairy products, quality Milk processing plants are required. Milk processing includes pasteurization, homogenization, evaporation, drying etc. In this study, system of a milk pasteurization process assisted by VAR is thermodynamically modelled. The whole energy requirement of the pasteurization system was supplied from Single Stage Libr VAR was used for both heating and cooling purposes. The heat exchangers were modelled with energy balances, based on the streams inlet and outlet enthalpies and mass flow rates. Therefrigerationunitwasbasedonasimplevapourcompressioncycleusing LiBr as a refrigerant. The energy analysis of the model was based on the 1st law of thermodynamics. An EES code has been developed using computer simulation program for simulating the cycle and validation of results with experimental one. This paper presents the review of the past studies done in the similar topic.**

Keywords-**Milk processing plants, Single Stage VAR, EES code, COP, exit temperature, pasteurization, dairy products.**

I.INTRODUCTION

Absorption refrigerator is a chemically driven refrigeration system which uses an absorbent refrigerant combination as the main working pair. In case of LiBr+water combo, LiBr solution works as absorbent whereas water works as refrigerant. The outstanding features of LiBr+water system is the non-volatility of the absorbent i.e. LiBr. This eliminates the use of rectifier as used in Ammonia+ water based absorption refrigeration system. Another advantage is the high heat of vaporization of refrigerant i.e. water. But the use of water as refrigerant also restricts the use in low temperature applications. The COP of these kinds of refrigeration system is higher than the ammonia + water based refrigeration system. The thermodynamic analysis of the system involves finding important parameters like enthalpy, mass flow rates, coefficient of performance (COP), heat and mass transfer and crystallization in LiBr + Water system[2]

A dairy is a type of farm devoted to raising and tending cattle in order to use them for milking. After the milk is collected, it goes through a process of clarification and separation, after which it is fortified with vitamins. Once fortified, the milk must be pasteurized and homogenized, processes that kill bacteria and reduce the amount of fat content. Once these procedures are complete, the milk is ready to be packaged and sold. Raw Milk is obtained from the cow (or goat, sheep, or water buffalo) under sanitary conditions and cooled to 45°F (7°C) within 2 hours of milking. Milk is picked up by a handler who takes a sample and then pumps the milk from farm's bulk tank into the milk truck. A handler may pick up milk from more than one farm, so a truck load may contain milk from several farms when it is delivered to the processing plant. Before the milk can be unloaded at the processing plant, each load is tested for antibiotic residues. If the milk shows no evidence of antibiotics, it is pumped into the plant's holding tanks for further processing. Milk at the plant is stored at less than 45°F (7°C) and is usually processed within 24 hours, but can held for up to 72 hours (3 days) before processing. Longer holding time allows for growth of spoilage organisms that grow at refrigerator temperatures, called psychrotrophs.

II. LITERATURE REVIEW

Altun et al. (2020) investigated a solar-powered absorption cooling system was modelled using the TRNSYS software. The performance of the system using dynamic modelling under the weather conditions of Mugla, Trabzon, Izmir, Konya, Canakkale and Istanbul. The external catalog data file of the absorption chiller model was created to get more realistic results.

Jain et al. (2020) presented a novel structure of transcritical vapor compression-absorption integrated refrigeration system (TVCAIRS) based on its thermoeconomic viability. The integration of single effect vapor absorption refrigeration system (VARS) (with H2O-LiBr fluid couple) in transcritical vapor compression refrigeration system (TVCRS) (with R744 refrigerant) provides a subcooling of 5 °C in the proposed configuration.

Meraj et al. (2020) investigated performance analyses of interconnected N number of fully covered semitransparent photovoltaic thermal integrated concentrator collectors combined with single effect vapor absorption refrigeration system The proposed system was analyzed under the constant mass flowrate of collectors' fluid. Mathematical expressions have also been derived for generator temperature of the absorption unit as a function of both design and operating parameters.

Ibarra-Bahena, Jonathan et al. (2020) used a hydrophobic membrane desorber to separate water vapor from an aqueous LiBr solution. Influencing factors, such as the H2O/LiBr solution and cooling water temperatures, were tested and analyzed. With the experimental data, a solar collector system was simulated on a larger scale, considering a 1 m2 membrane.

De, Ramen Kanti et al. (2020) presented a comparative performance assessment of a single-effect and a double-effect vapor absorption system for the operation of a cold storage facility. The proposed cold storage is powered through a combination of a grid-interactive solar photovoltaic system and parabolic trough collectors.

Venkataraman et al. (2020) presented an up to date review of the heat driven absorption refrigeration/air conditioning systems specifically meant for transport applications. This is followed by a discussion on the major challenges involved in implementing such a technology for the transport sector, the ways in which such a technology can be developed further and why using heat driven refrigeration/air conditioning systems could be a game changer in the automotive industry.

Alhamid et al. (2020) presented A solar-gas fired absorption cooling installed and tested in a real environment at the University of Indonesia, Depok, Indonesia. The cooling system provides chilled water to the building of the Mechanical Research Center of the university. This system has a unique single/double-effect water/Lithium Bromide absorption chiller with a nominal cooling capacity of 239 kW. In addition, the system consists of evacuated tube solar collectors (~181 m2 total aperture area) and fan coil units installed in the building.

Liu et al. (2020) presented a LiBr/H2O absorption chiller and a Kalina integrated in cascade to achieve full utilization of low-grade waste heat. A parametric analysis has been conducted to investigate the effect of key operational parameters in terms of turbine-inlet pressure, turbine-outlet pressure, ammonia concentration, segment temperature and refrigeration temperature.

Azhar et al. (2019) presented exergy analyses of lithium bromide-water based single to triple effect direct and indirect fired vapour absorption systems. The analysis carried out by various investigators on exergy of the absorption cycles have been discussed. To fill the gap in the knowledge on exergy destruction rate in the absorption system, optimization of the single to triple effect direct and indirect fired absorption cycles have been conducted for a wide range of operating conditions. Hence optimum parameters in various components of the systems for maximum exergy coefficient of performance and minimum exergy destruction rate have been determined.

Mishra et al. (2019) developed an integrated solar refrigeration system where waste heat from different energy resources assists a combined vapour absorption compression system, and to analyze feasibility & practicality of that system of thermodynamically for improving its COP and exergetic efficiency by reduction of irreversibilities in terms of exergy destruction /losses occurred in the system components.

Mishra et al. (2019) analyzed solar assisted half effect vapour absorption refrigeration system cascaded by vapour compression refrigeration system using ecofriendly refrigerants and developed thermodynamic model to predict the variation of generator , absorber , condenser temperatures on first and second law efficiencies and to predict the solar collector area required.

Pandya et al. (2019) represented the detailed thermodynamic study to compare the performance of solar assisted double effect LiBr-H2O and LiCl-H2O vapour absorption refrigeration systems (VARS) coupled with several solar collectors. A 100 kW absorption cooling system is analysed at evaporator temperature 5 °C and two condensation temperatures 30 °C and 40 °C integrated with evacuated tube collector (ETC) and parabolic trough collector (PTC) connected with storage tank to operate the absorption system.

Sioud et al. (2019) investigated the feasibility and the eventual improvement in performance of an ejector powered water/lithium bromide double-effect absorption/recompression refrigeration cycle driven by high temperature heat sources.

Li, Zeyu, et al. (2019) presented The evaluation, performing by the dynamic simulation based on the monthly typical cooling demand and meteorological data, by the comparison of solar absorption-subcooled compression hybrid cooling system SASCHCS and the solar PV cooling which is thought to be the most economical solution recently.

López-Zavala et al. (2019) presents a novel LiBr/H2O absorption cooling and desalination system with three pressure levels which uses seawater as a cooling medium and is activated by solar thermal energy. This system helps counteract coastal populations' thermal conditioning and water supply problems.

Shukoor et al. (2019) presented performance of 11 kW solar-powered lithium bromide water absorption chillers in cogeneration mode is investigated. A 40 m2 solar parabolic dish of 19 kWth capacity is used for both processes heating and cooling. Extensive thermodynamic design and analysis, and the results obtained are validated. Parabolic dish and cavity receiver are sized for Chennai (13°N, 80.18°E), India.

Takalkar et al. (2019) presented thermodynamic analysis of novel ionic liquid 1 Ethyl-3-methylimidazolium ethyl sulphate (EMISE) as absorbent and water as green refrigerant for absorption refrigeration system (ARS) is performed. Thermodynamics excess properties like excess Gibbs free energy (GE), excess enthalpy (hE) and equilibrium Dühring's plot (P-T-x1) of EMISE-H2O binary mixture are assessed using non-random two liquid (NRTL) activity coefficient model for composition of 0.45–1.

Liu, Xiangyang et al. (2019) presented three new working pairs R1234yf/[HMIM][TfO], R1234yf/[HMIM][PF6], R1234yf/[HMIM][BF4] were proposed and new solubility data for them were determined. Two new absorption-compression hybrid refrigeration systems were proposed to improve the cooling performances of the single-effect absorption refrigeration system using R1234yf/[HMIM][TfO], R1234yf/[HMIM][PF6] and R1234yf/[HMIM][BF4] as working pair.

Shahboun et al. (2018) presented the improvement of the system is achieved by utilizing the potential kinetic energy of the ejector to enhance refrigeration efficiency. However, the first and the second law of thermodynamics are used to analyze the performance of a single-stage water-lithium bromide absorption refrigeration system (ARS), whereas some working parameters are varied.

Patel et al. (2017) presented a thermodynamic evaluation of a small cooling LiCl-H2O vaporizer carrier for the influence of 1 TR primarily based on the initial and 2d rules. Mathematical modeling is based on the concept of thermodynamics, which is employed in the engineering of equation solver to use mathematics.

Kumar et al. (2017) presented thermodynamic analysis and cooling efficiency of the aqua-ammonia system. The mathematical model is derived from the thermodynamic theory of integrating all the most useful computational circuits. The cut-off temperature to activate the gadget is available at many temperatures.

Ramesh et al. (2017) introduced the Absorption-Compression Cascade Refidgeation, which combines a VCR tool at a low temperature stage with a VAR machine in the overheating phase. CO2, NH3 and R134a were taken as refrigerants in the pressure phase and H2O-LiBr refrigeration in the input phase.

Pandya et al. (2017) presented a quantitative evaluation of the thermodynamic heating of a single cooling influence of the LiBr-H2O vapor cooling power plug of 1 TR mainly based on the initial and 2d rules. Mathematical modeling is based on the concept of thermodynamics, which is employed in the engineering of equation solver to use mathematics. A small generator temperature is required to run the air-conditioning gadget.

Imam et al. (2017) presented a thermodynamic evaluation of a single gadget for tumor suppression (Vars). LiBr-Water is used as a working fluid for further analysis. This experiment is performed to determine the impact of the final operating performance of the vapor spray system.

Modi et al. (2017) presented the power and advanced investigations of the refrigeration system (ARS) in LiBr - the H2O response generated and analyzed throughout the segment. The optimization measure is used at generator temperatures to correlate electricity with logical efficiency and, many external corrosion factors are also found.

Tiwari et al. (2017) presented an experimental system in addition to the small Vapor Absorption Reffiriation technologies. Also read about the fluids that are active in VAS, as well as promoting the Vapor Absorption method are discussed.

III. CONCLUSION

Energy, exergy and advanced exergy methods are used to analyse a milk powder production facility. The production of dairy products, such as milk powder and cheese, is a major industrial sector in India and other countries, It is also one of the most energy-intensive industries within the food sector . India has a high share of agricultural products in their overall exports, of which 20% of the agricultural exports are dairy products. Several scientific and engineering methods exist and are under continuous development, which target the determination, quantification and prioritisation of possible energy savings in complex and large-scale industrial processes. The energy analysis, focusing on the main components, was the first step in defining the system.

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