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Vacuum Evaporator Design Liquid Ring Vacuum Pump Method

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Abstract

The evaporation process in the nira with vacuum evaporator using barometric condenser requires considerable energy, to save energy, it is necessary to design a vacuum evaporator that can decrease the point also energy-saving by replacing the barometric condenser into Liquid Ring Vacuum Pump method where the vapor has been condensed in the condenser is flown to the vacuum pump to draw steam in the evaporator chamber so that vacuum conditions occur. This type of vacuum pump uses a small energy when compared with using a steam jet ejector and is expected to use the vacuum evaporator with the Liquid Ring Vacuum Pump Method will be able to save electrical power. Vacuum Pump vacuum design with Liquid Ring Vacuum Pump method can reduce the evaporation temperature to 76 °C with a level of vacuum reaching 200 mm Hg against pressure 760 mm Hg. The results of vacuum evaporator design is expected to be used in industries that use the evaporation process of a solution that is sensitive to high temperatures, by making the vacuum condition will decrease the boiling point which will automatically save costs in the evaporation process.

Keywords: liquid ring vacuum pump, vacuum evaporator

INTRODUCTION

Energy demand in Indonesia in 2016 continues to increase while in 2014 the need for energy has reached 3.06% growth of energy needs in 2013. The largest use of energy use in industry sectors where the need is 42.12% of the total national energy demand (Kencono at al., 2014). For energy saving, energy saving steps needed to meet the needs of the industry to increase energy demand can be withheld.

The use of energy in the sugar industry based on sugarcane juice or industrial-based refineries that require considerable energy for electricity needs and for the manufacture of steam boilers. To meet the demand for electricity and steam, the sugar industry uses a burning furnace using gas and coal (Hasan et al., 2014)

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Differences in sugar production process made from raw sugar cane and refined raw materials lies in the use of fuel where the use of sugar cane fuels are used in the process of sugar production made from raw sugar cane while the production of refined sugar is refined using gas or coal in combustion in the boiler.

Research Model Vacuum Evaporator Liquid Ring Water Pump method aims to produce Evaporator model which can produce vacuum pressure by using minimum heating energy (Novikov et al., 1983). In the process of production of sugar that requires a lot of energy is evaporator, the function of the evaporator is to evaporate the juice of water until it becomes viscous before entering the vacuum pan on crystallization process. In the evaporator is done evaporation of water juice from 12 brix to level 65 Brix by using steam heater. Energy consumption in most evaporators is required from steam. To save energy use in the pressure evaporator is attempted in vacuum where the boiling point of the solution will be low. Differences in sugar production process made from raw sugar cane and refined raw materials lies in the use of fuel where the use of sugar cane fuels are used in the production process of sugar made from raw sugar cane while the production of refined sugar made from gas or coal in combustion in the boiler. The purpose of the Vacuum Pump Vacuum Evaporator method is to create vacuum pressure on the evaporator, with the vacuum pressure in the evaporator is expected to decrease the boiling point of the solution. Making vacuum conditions with Liquid Ring Vacum Pump method uses less heating energy when compared with the method of Steam jet ejector. The process of making sugar that requires a lot of energy is on the evaporator system where the function of the evaporator is to evaporate the juice until it becomes viscous before entering the process of crystallization. In the evaporator, the evaporator is evaporated from the water content of 12 ^{0}brix to the level of 65^{0} Brix by using steam heater, to save the use of energy in the pressure evaporator cultivated in vacum conditions where the boiling point of the solution will be low.

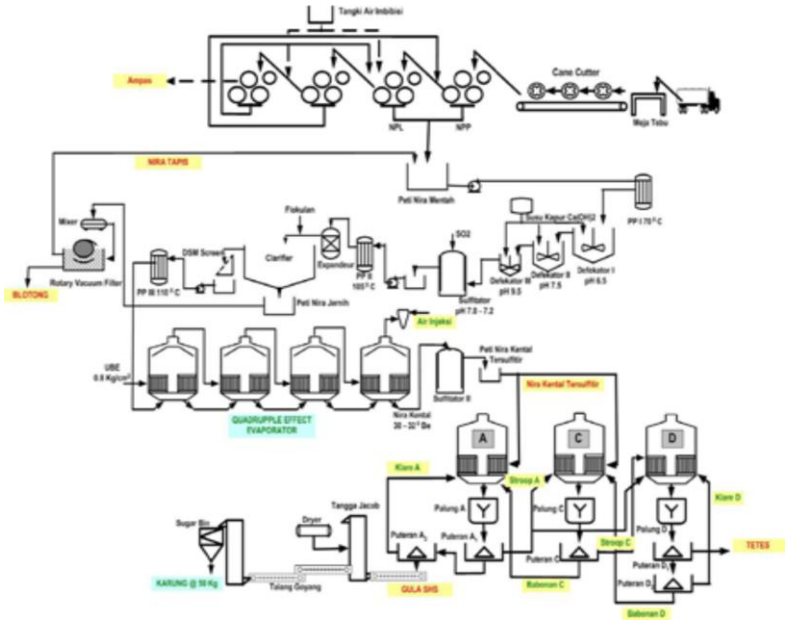

Figure 1. Flow of energy utilization at sugar factory

In the vaporization process the vapor is cooled in the condenser to convert the vapor to condensate, if the steam is continuously condensed, the pressure in the evaporator will become vacuum. The vapor from the evaporator enters from the top side of the condenser and then condensates as a result of heat uptake by cooling water. The steam cooling process is carried out at the condenser, when using a steam jet ejector can produce a vacuum pressure between 0.13 - 0.03 bar. Research conducted by Pottker and Hrnjak (2012) using Vacuum Evaporator on the manufacture of liquid sugar can save energy because the evaporator used can produce vacuum pressure so as to

reduce the evaporation temperature in the evaporation process. Preparation of liquid sugar can be done on evaporation using vacuum evaporator temperature 70 ^{0}C to produce liquid with the best content (Harvey et al., 2000). The use of vacuum evaporator by Liquid ring vacuum pump method can be used to make vacuum pressure in evaporator (Wikipedia.2015a). Characteristics The liquid vacuum pump is channeling energy from the impeller to the fluid pumped through the liquid ring, LRVP consisting of a single rotor with a set of propellers on the front. The working principle of LRVP is to increase the pressure of the gas by rotating the impeller vane in an eccentric casing cylinder, the liquid present in the gas output section is then separated and circulated in a separation system. (Santoso, 1995). LRVP has a capacity of between 3 - 27 m^{3}/hour and is generally used for pressure between 0.13-5.5 bar a can even be used up to 7 bar pressure.

METHODS

This research method is to operate Vacuum Evaporator with Liquid Ring Vacuum Pump method of prototype scale to sap solution. Raw materials in this study were sap or sugarcane as a material to be evaporated by various vacuum presses in which the juice or sugarcane water with initial concentration of 12 ^{0}Be.

Research variables performed at vacuum pressure (mm Hg) were: 100, 140, 160, 180 and 200, the amount of sap used was fixed as much as 6 liters with constant heating. The apparatus used for making vacuum pressure on the evaporator of the Liquid Ring Vacuum Pump method consists of the evaporator tank and its heater, condenser and vacuum pump as follows.

Figure 2. Equipment Set

Research Procedure

The experimental flow in designing a vacuum evaporator using LRVP can be seen in the following scheme.

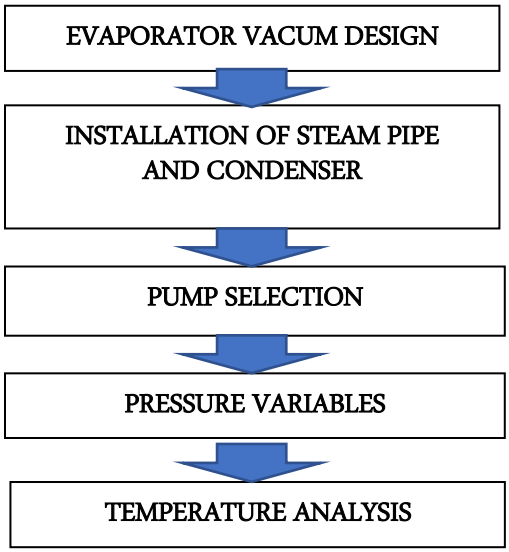

Figure 3. Block diagram of Research

RESULT AND DISCUSSION

By adjusting the pressure on the vacuum pump then the juice or sugarcane water will evaporate according to the varied vacum pressure. From steam table (Mc Cabe): for vacuum pressure 100 mm Hg = 100/760 x 14.7 psi = 1,94 psi where from steam table got boiling point = 125 °F = 51.6 °C. From the preliminary experiment when using pure water heated at vacuum pressure of 100 mm Hg, the boiling point of water = 145 °F = 62 °C. From the experimental results with sap or sugar cane materials using prototype vacuum evaporator by varying the vacuum pressure from 100 mm Hg to 200 mm Hg obtained the results listed in the following table.

Table 1. Vacuum pressure

Vacum Pressure (mm Hg)	Vaporizing Temp (°C)
100	94
140	91
160	88
180	84
200	76

Theoretically from steam table to pressure 100 mm Hg water will boil at temperature 51,6 °C and from reality exist in evaporation of pure water using prototype evaporator at vacuum pressure 100 mm Hg got boiling water at temperature 62 °C this is caused because less perfect designed equipment. When using sugars or cane juice with a degree of viscosity heated at 100 mm Hg vapor pressure at 94 °C, this corresponds to during Line graph (Mc Cabe,

Unit Operations 1968) in which the boiling point of a material will increase accordingly. Evaporative temperature has an effect on evaporation velocity. The higher evaporation temperature is faster evaporation but high temperature usage can cause some heat sensitive material to be damaged. To minimize the risk of damage, the evaporation temperature used should be low. The evaporating temperature can be lowered by decreasing the evaporator pressure.

CONCLUSION

Evaporation of water juice by using vacum evaporator method Liquid Ring Vacum Pump can lower the evaporation temperature up to 76 ^{0}C with a pressure vacuum 200 mm Hg so that this evaporator can be used for heat-sensitive solution.

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