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by Umi Fathanah

Purification of Sugar Cane Juice by Ultrafiltration Membrane

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Abstract
Separation technology of membrane can be used in the separation and purification of sugar cane to produce a good quality juice. The process of this technology safely because without use of chemicals and can be done at room temperature so it has lower operating costs than conventional separation technologies. On refining sugar cane, ultrafiltration membrane process replaces sulfitation stage. Specifications cellulose diacetate membranes used are flat with a pore size of 67 kDa and the membrane surface area of 12.56 cm^2. Conducted prior separation of heavy impurities from sugar cane using a cloth filter and then sugar cane carried by bulk filtration using a membrane with a transmembrane pressure variation (TMP) of 60, 120, and 180 kPa at a flow rate of 7.4 x 10^{-3} L/m2.hr. The performance of membrane flux is obtained around 36-165 L/m2.hr in the range 60-180 kPa in the TMP. Turbidity reduction about 40% and suspended solid decreased 95.65%. Changes in pH, Brix, and the degree of polarization is not too big as there is too much damage to sugar sucrose inversion.
Keywords: membrane technology, cellulose diacetate membrane, purification of sugar cane juice.

Introduction

Sugar is one of society needs generally. In Indonesia, the needs for sugar has increased every year and is expected to reach the needs of 5.2 million per year by 2020 (Murdiyatmo, 2002). Because the production of sugar in Indonesian is still below the needs of domestic sugar, therefore the estimated Indonesia still has to import sugar of about 3.4 - 4 million tons per year (Wulyoadi, S. *et al*, 2004). It is very important to make an effort to enhance the efficiency of sugar production of Indonesia.

Most of the sugar factories in Indonesia using the sulphitation process in stage of clarification of raw juice with lime and sulfur. The process is considered to be the cheapest, but there are some drawbacks such as inverting sucrose to glucose and fructose, the corrosion of equipment, quality of sugar sulphitation process is still low, the color of changes very quickly especially if the packaging performed at high temperatures, and produces large quantities of waste (Istadi, 2000; Wulyoadi, S. et al, 2004; Piotr Regiec, 2004).

The quality of the sugar crystals mainly depends on the effeciency of clarification. Separation of impurities from sugar cane juice as early as possible should be done to avoid sucrose inversion, increasing color, etc (Aziz, A. *et al*) Membran technology is one of such step in this direction and have been investigated by several researchers (Balakrishnan, M. *et. Al.* 2001; Gosh, A.M and M. Balkrishnan, 2003). They recomended that membrane technology has potential to improve productivity and efficiency in the sugar production process. Characterized in membrane operation of the flow are permeate and retentat while the performance is determined by the parameters of the membrane flux and rejection.

This study aims to investigate: (1) The effect of trans-membrane pressure (TMP) on permeate flux and (2) Characterization the quality of raw sugar cane juice compared with membrane purification of sugarcane juice.

Materials and Methods

Procedure

There are three steps in experiment: (1) Making Cellulose acetate (CA) membrane using by the phase inversion methode. Solution of CA was prepared by dissolving in dimethyle formamide (DMF) as polar solvent with precence poroging agent polyethylene glycol (PEG) 1450 Da in 30% of PEG/CA ratio. The membrane morphology was examined using a Scanning Electron Microscope (SEM) JSM-5310 LV, Jeol-Japan. Cellulose acetate was found from acetylation process of cellulose pulp sengon (*Paraserianthes falcataria*) by earlier researcher (Rosnelly, C.M. *et al*. 2010), (2) Before entering the purification process using a membrane, after milling the cane, raw sugar cane juice was filtered using 50 micron filter cloth to separate the contents of the floating particles, and (3) Furthermore the clarification process of sugar cane juice using membrane filtration is done by circulating sugar cane juice for 60 minutes using a pressure variation transmembran 60, 120, and 180 kPa at room temperature. Stream of permeate through the membrane pores are accommodated in the product tank, while retentat rejected by the membrane pores is circulated to the feed tank.

Determination of sugar cane juice flux conducted to determine the ability of the membrane in passing a number of sugar cane juice volume per time unit membrane area. The best conditions are based upon consideration of the permeate flux is high. Flow diagram of process of purification sugar cane juice using membrane filtration can be seen in Figure 1.

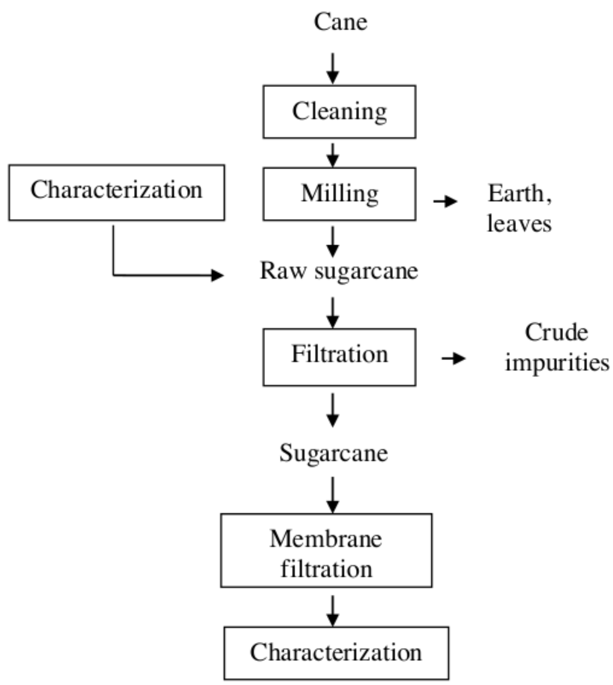

Figure 1. Flow diagram sugar cane juice purification using membrane filtration

Characteristics of sugar cane juice and permeate done by analyzing the pH, % Brix, % polarization, turbidity, and suspended solid. Measurements of pH made with a pH meter, pol (polarization) is measured with a polarimeter, Brix is measured with a refractometer, and turbidity measured with a spectrophotometer.

Results and Discussion

By analyzing of SEM the morphology of membrane showed an asymmetrical structure with two layer. The top-layer more dense than the bottom-layer (Figure 2) and the specifications of the membrane as listed in Table 1.

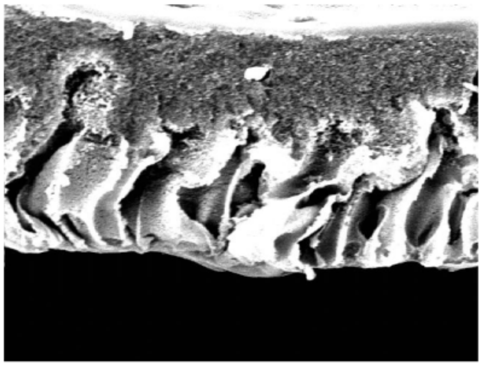

Figure 2. Asymmetrical structure of membrane

Table 1. Specification of membranes

Spesification	Note
Configuration	Flat
MWCO	67000 dalton
Membrane material	Cellulose acetate
Effective area of membrane	12,56 cm^2
Process type	Ultrafiltration

Sugar cane juice contains sucrose and impurities substances such as sugar reduction, colloidal substances, suspended impurities (dyes, proteins, waxes, carbohydrate, and organic and inorganic compounds) (Aziz, A.A *et. al*., Wulyoadi, S. *et.al*. 2004). Grinding the sugar cane juice greenish-brown because it still contains many impurities, cloudy, and slightly thickened. In general, the parameters of raw sugar cane juice can be seen in Table 2.

Table 2. Constituent parameters of raw sugar cane juice *

Parameters	Composition of raw sugar cane juice
Brix (%)	13,16-14,98
Pol (%)	9,69-11,03
Turbidity (ppm)	60-634
Suspended solid (ppm)	621-1005
Sucrose (%)	10,74-11,67
Sugar reduction (%)	1,04-1,25
Ash (%)	0,48-0,6
Inorganic non-sugar (%)	0,2-0,6
Organic non-sugar (%)	0,05-10
Water (%)	77-80

*Wulyoadi *et al*. (2004)

Purification of fresh sugar cane juice using cellulose acetate membranes produced an average flux in ultrafiltration operation for 60 minutes to three variations of transmembrane pressure (TMP) can be seen in Figure 2.

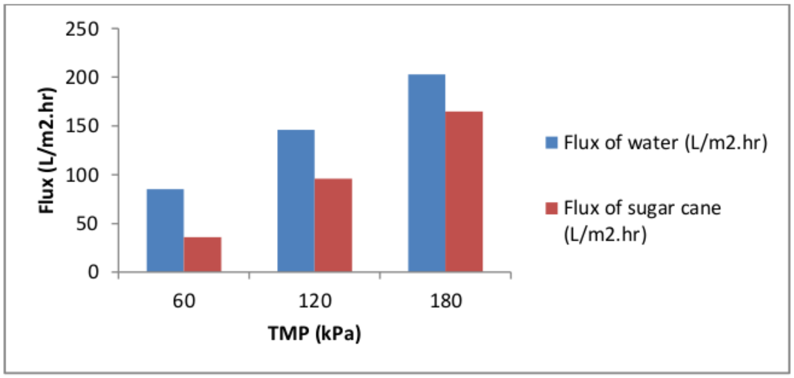

Figure 2. Effect of Trans Membrane Pressur (TMP) on permeat flux

From Fig.2, it can be seen that the steady state permeate flux is increased as the TMP is increased. This situation shows that not a second filter layer formed on the surface of the membrane filter so there is no barrier to the flux generated. The highest flux obtained at TMP 180 kPa at 165 L/m2.hr. Ultrafiltration membrane with a type of process is able to separate of compounds and solid suspendend macromolecules (proteins, polysaccharides). Parameters raw sugar cane juice and results of membrane operations of the raw juice at TMP 180 kPa can be seen in Table 3.

Table 3. Parameters of raw sugar cane and results of operations ultrafiltration membrane at TMP 180 kPa and room temperature of feed.

Parameters	Feed	Permeate
Turbidity (A)	90	54
Suspended solid (ppm)	813	35,34
pH	5,25	6,0
Brix (%)	14,07	11,98
Pol (%)	10,86	9,38

Turbidity in the juice of sugar cane caused by contaminant microorganisms in the sugar cane juice is left for some time without any treatment so that the sucrose reduction turns into glucose and fructose that can be besides acid content of suspended impurities (Mochtar et al., 1998). As can be seen in Table 3, there is a decrease in operating results of turbidity UF membrane .

Suspended Solid (SS) is a floating particles and difficult to settle. In this study, the SS content contained in crude sugar cane juice prior to the separation of pretreatment prior to membrane operations. But the content of SS remains were analyzed after passing through the membrane operation. Content of SS has decreased from 813 ppm to 35.34 ppm. This indicates that particles with large size cellulose acetate membrane was blocked by the size of 67 kDa.

Value of pH at 5.25 due to the feed of raw sugar cane juice is allowed to stand for some time will experience the process of fermentation and result in elevated levels of acid so that the pH tends to decrease. Membrane filtration to increase the pH of cane juice into 6 and close to neutral. For parameter % Brix and pol tend not to so great a change in value. This suggests that the sucrose content of the membrane tends to sap the operating results are not a lot of damage to sugar inversion. From the results obtained can be said that the refining of sugar cane juice using ultrafiltration membrane operation can be used as a substitute for defecation, sulphitation, and carbonatation in sulphitation process.

Conclusions

The purification of sugar cane juice using ultrafiltration membrane operation can be concluded: (1) The highest flux was obtained at a transmembrane pressure of 180 kPa at 165 L/m2.hr, (2) Turbidity reduction about 40% and suspended solid decreased 95.65%. Changes in pH, Brix, and the degree of polarization is not too big as there is too much damage to sugar sucrose inversion.

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