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Dr. M. Dani Supardan (Indonesia)

Dr. Abrar Muslim (Indonesia)

Prof. Dr. Koichi Fujie (Japan)

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Chemical Engineering Department  
Engineering Faculty  
Syiah Kuala University



Graduate School of Environmental and  
Information Science  
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## WELCOME SPEECH FROM THE RECTOR

Assalamualaikum Wa Rahmatullahi Wa Barakatuh,  
In the Name of Allah, the Most Beneficent, the Most Merciful  
May the peace, the mercy, and the blessings of Allah be upon you.

Distinguished Participants, Ladies and Gentlemen,  
On behalf of Syiah Kuala University, I would like to welcome you all to the 7th International Conference of Chemical Engineering on Science and Applications 2013.

It is an honor for me to attend this conference, which is held at the seventh time, of course beginning with lecturers from Chemical Engineering Department of Syiah Kuala University. The conference event is unique in that it springs up from the thinking how to share knowledge based on our area of expertise. It is rewarded if Chemical Engineering lecturers would not only share their creative ideas in the Faculty but also in a forum such as this international conference. Because of the reason, this conference wants to provide the forum to gather the ideas to implement innovative knowledge into our daily activity successfully.

I sincerely hope this conference is inspiring and also one to be expected again next time. The organizing committee is committed to make this conference a success with its ready applications to not only university but government. Therefore, I extend my greetings to all parties who may benefit from the conference to apply it in managing activities in their areas.

Currently, the Chemical Engineering Department of Syiah Kuala University agree on topics: Food and Biochemical Engineering, Catalytic Reaction Engineering, and much more. The topics come from the belief to develop clean energy technology for community welfare. There is an argument put forward by many scholars that we approach an ideal society when we can combine ideas to support technology development. Therefore, this conference is just a trigger for us to get involve more towards local, national, and international development.

Last but not the least, my deepest gratitude goes to the Organizing Committee, institutions, and companies who have directly and indirectly supported the well-running of this seminar. Although we try to be professional, on behalf of Rector of Syiah Kuala University, please accept our sincere apologies for inconveniences that crop before, during, or after the event.

May God bless us all with the health to make this event a successful and enjoyable one!

Thank you.

Prof. Dr. Ir. Samsul Rizal, M.Eng  
Rector of Syiah Kuala University

## MESSAGE FROM THE CHAIRMAN

Assalamualaikum Wr. Wb.

Honorable Guests, Presenters, and Participants,

First of all, I would like to thank you for your valuable contributions to this conference that is conducted by Chemical Engineering Department of Syiah Kuala University. Our department is one of the largest department in Engineering Faculty. It was established in 1963 driven by a spirit to form a department to bring Acehnese to become educated, knowledgeable, and technocrate. Therefore, we try to give our best in contributing our ideas in the field of Chemical Engineering Science and Applications so that we can cooperate to improve our daily lives. We understand that it takes time to achieve the target; however, we believe one effort is much better than nothing.

I am also happy to inform that the committee is very lucky to have 5 Plenary Speakers, i. e. from Japan and Indonesia, who supported us from the very beginning with their capabilities to try and personally come and meet you all. Although there may be many other competitive International Seminars held with similar topics around the world, I am happy to report that the Chemical Engineering on Science and Applications manages to successfully attract more than 100 academicians to present their abstracts, i. e. from Iran, Japan, Malaysia, Taiwan, and Indonesia. So, I am proud to announce that the 61 abstracts accepted to be presented in this seminar has gone through a professionally selective process. For that reason, I personally congratulate you all as distinguished speakers to this event!.

This conference has collaborated with four international journals, i.e. Bulletin of Chemical Reaction Engineering and Catalysis, International Journal of Science and Engineering, International Journal of Renewable Energy Development, and International Journal of Waste Resources. All selected conference papers are then peer-reviewed to meet the highest standards of publication. The peer review of each manuscript is rigorous and concentrates on objective and technical concerns to determine whether the research has been sufficiently well conceived, well executed, and well described.

I also would like to give a special welcome to The Government of Aceh, Pertamina, PT. Medco E&P Indonesia, PT. Arun, Exxon Mobil, PT. Pupuk Iskandar Muda, Bank Mandiri, PT. Lafarge Cement Indonesia, Bank Mandiri, and individuals who sponsor this conference. We can never thank them enough for that! A way to express our gratitude would be to make every effort to make this conference a full success.

Finally, I expect all participants have memorable moment through this conference and enjoy your stay in Banda Aceh.

Thank you.

Sincerely,

Chairman of Committee

Dr. M. Faisal, S. T., M. Eng



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## Purification of Sugar Cane Juice by Ultrafiltration Membrane

Cut Meurah Rosnelly<sup>\*1</sup>, Umi Fathanah<sup>1</sup>

<sup>1</sup>Department of Chemical Engineering, Syiah Kuala University, Darussalam, Banda Aceh 23111, Indonesia

<sup>\*</sup>Corresponding author: cutnelly@gmail.com/ cut.meurah@che.unsyiah.ac.id

### 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<sup>2</sup>. 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  $7.4 \times 10^{-3}$  L/m<sup>2</sup> hr. The performance of membrane flux is obtained around 36-165 L/m<sup>2</sup> 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 are not too big as there is too much damage to sugar sucrose inversion.

**Key words:** membrane technology, cellulose diacetate membrane, purification of sugar cane juice

### Introduction

Sugar is one of society needs generally. In Indonesia, the need 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 sulphur. 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 colour 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 efficiency of clarification. Separation of impurities from sugar cane juice as early as possible should be done to avoid sucrose inversion, increasing colour, etc. (Aziz, A. *et al*) Membrane 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 recommend 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 retentate while the performance is determined by the parameters of the membrane flux and rejection.

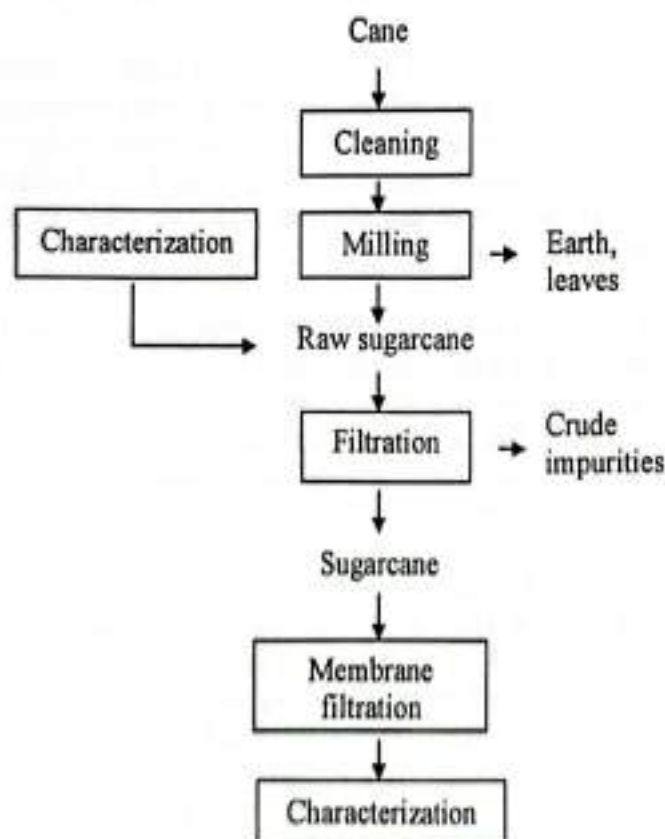
This study aims to investigate: (1) The effect of trans-membrane pressure (TMP) on permeate flux and (2) Characterization the quality of raw sugar cane juice compared with membrane purification of sugarcane juice.

## Materials and Methods

### Procedure

There are three steps in experiment: (1) Making Cellulose acetate (CA) membrane using by the phase inversion method. Solution of CA was prepared by dissolving in dimethyl formamide (DMF) as polar solvent with presence 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 trans membrane 60, 120, and 180 kPa at room temperature. Stream of permeate through the membrane pores are accommodated in the product tank, while retentate 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 analysing 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 analysing of SEM the morphology of membrane showed an asymmetrical structure with two layers. The top-layer denser than the bottom-layer (Figure 2) and the specifications of the membrane as listed in Table 1.



Table 1. Specification of membranes

Specification	Note
Configuration	Flat
MWCO	67000 dalton
Membrane material	Cellulose acetate
Effective area of membrane	12,56 cm <sup>2</sup>
Process type	Ultrafiltration

Figure 2. Asymmetrical structure of membrane

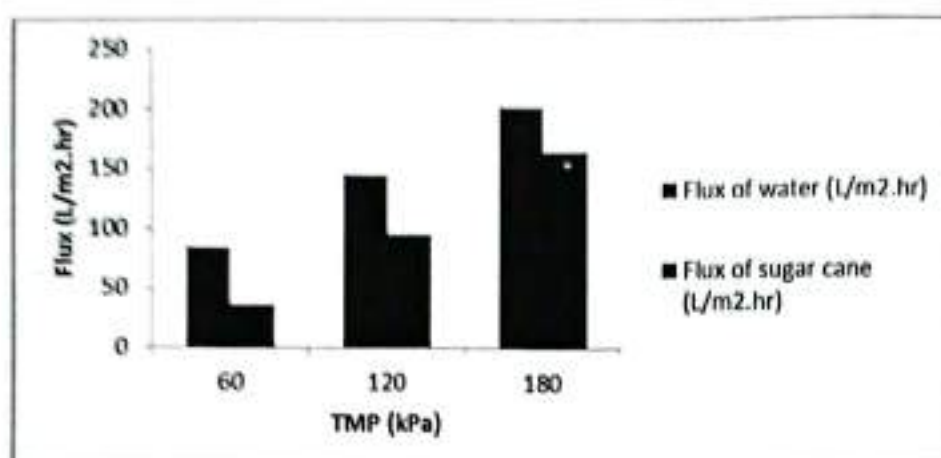
Sugar cane juice contains sucrose and impurities substances such as sugar reduction, colloidal substances, suspended impurities (dyes, proteins, waxes, carbohydrate, and organic and inorganic compounds) (Aziz, A.A *et. al.*, Wulyoadi, S. *et.al.* 2004). Grinding the sugar cane juice greenish-brown because 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 trans membrane pressure (TMP) can be seen in Figure 2.



**Figure 2.** Effect of Trans Membrane Pressure (TMP) on permeate 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 suspended 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 pre-treatment prior to membrane operations. But the content of SS remains were analysed 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 were 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 trans membrane pressure of 180 kPa at 165 L/m<sup>2</sup>.hr, (2) Turbidity reduction about 40% and suspended solid decreased 95.65%. Changes in pH, Brix, and the degree of polarization are not too big as there is too much damage to sugar sucrose inversion.

### Acknowledgements

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