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## Research Article

# Polysulfone Membrane for Concentration Rise of Sugar Juice by Ultrafiltration Process

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**Abstract:** The membrane can be defined essentially as a barrier, which separates two phases and restricts transport of various chemicals in a selective manner. In some cases, especially in anatomy, membrane may refer to a thin film that is primarily a separating structure rather than a selective barrier. Ultra filtration has been demonstrated as a potential technology to separate the sugar from their mixtures and can be applied to remove sugars from juice. Ultrafiltration (UF) is basically a pressure-driven separation process, governed by a screening principle and dependent on particle size. The filtration studies are going to carry with the aim of retaining the solids except the sugars compounds present in juice as well as maximizing the flux. The aim is to develop a process for the direct production of sulphur-free, refined quality sugar without going through conventional sugar refining. The objectives of present work to study effects of various parameters such as pressure, concentration, selected membranes, on permeate flux and retention characteristics & flux decline analysis.
**Keywords:** Sugar Recovery; Retentate; Permeate; Ultrafiltration; Sugar Retention; Permeate Flux.

## INTRODUCTION

### Membrane

A membrane can be defined as a barrier separating two fluids. The barriers considered here do not prevent the passage of all species but are permeable to some and impermeable to others. Such membranes are termed semi permeable and usually are in the form of thin sheets of polymeric material. Since the amount of a species transported across a membrane is inversely proportional to the thickness, it is advantageous to have the thinnest membrane possible [1-3]. In practice, considerations such as mechanical strength usually determine the lower limit of membrane thickness. In many cases synthetic polymers are used and many have been developed specially to provide the required semi-permeable characteristics [4-5].

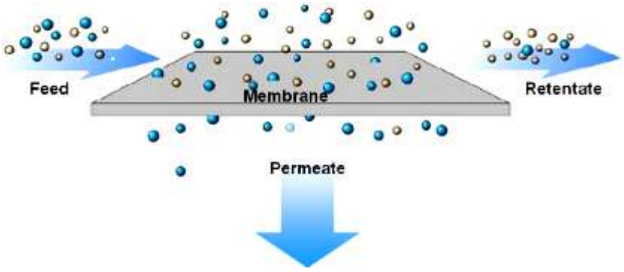


**Fig. 1: Membrane Separation Process** [20]

### Sugar Recovery by Ultrafiltration:

(UF) is a promising alternative to the liming-sulphitation process for the purification of sugarcane juice in the manufacture of plantation white sugar [1]. Sugarcane juice is a multicomponent feed, which apart from 10–21% sucrose, contains up to 2.5% of nonsugar impurities such as dextrans, proteins, fats, gums, and waxes ( Treatment by UF, on the contrary, produces a superior juice with a better clarity, much lower viscosity, and noticeable color removal we presented a broad overview of the application of UF for juice quality improvement in the cane sugar manufacturing process[6]. The field tests were further continued to investigate the effect of operating parameters on the UF of fresh mixed juice obtained from the milling station [7].

## PROCESS FOR MANUFACTURING OF SUGAR

### Washing and cutting

The sugar cane stalks are loaded onto conveyer belts and subjected to hot water sprays to remove dirt and other field debris. Then, they are passed under rotating knife blades that cut the stalk into short pieces or shreds [8-9].

### Extracting the sugar juice

In the sugar cane processing plant, extraction can be accomplished in one of two ways: diffusion or milling. By the diffusion method, the cut stalks are dissolved in hot water or lime juice. In the milling process, the stalks are passed under several successive heavy rollers, which squeeze the juice out of the cane pulps. Water is sprayed throughout the process to facilitate the dissolving of the juice [10-11].

### Clarifying the juice

The extracted juice is clarified by adding milk of lime and carbon dioxide. The juice is piped into a decanter, heated and mixed with lime. The juice passes through carbon filters, producing a mud-like substance. Called carb juice, this mud is pumped through a heater and then to a clarifying machine. Here the mud settles to the bottom and the clear juice is piped to yet another heater and treated again with carbon dioxide. Once again the mud is filtered out, leaving a pale yellow liquid called thin juice [12-13].

### Evaporating and concentrating the syrup

The juice is pumped into an evaporator that boils the juice until the water dissipates and the syrup remains. The syrup is concentrated through several stages of vacuum boiling, a low temperature boil to avoid scorching the syrup. Eventually, the sugar crystallizes out of the syrup, creating a substance called massecuite. The massecuite is poured into a centrifuge to further separate the raw sugar crystals from the syrup. In the centrifuge, the sugar crystals fall away from the syrup that is being spun at a significant force. This remaining syrup is molasses, and it is forced out through holes in the centrifuge [14-15].

## MATERIAL AND METHOD

### Materials for membrane casting and experimentation

Polysulphone (Udel-P1700) was provided by Amoco. The molecular weight of PS was 45000 g/mol (Mw = 45000). Polyvinylpyrrolidone (PVP), Acetic Acid, Acetone, Formamide and *N,N'*-dimethylacetamide (DMAC) were obtained from Merck. The molecular weight of PVP was 25000 g/mol (Mw = 25000). All these chemical are analytical graded .Sugar cane juice purchased from local market and distilled water.

### Membrane casting procedure:

Homogeneous solutions of the polymer dissolved in DMAC were prepared using various additives by stirring for 4 h at room temperature. The stirring was carried out at low speed (50 rpm). The solution was cast on a smooth glass plate by film applicator at room temperature. The membrane thickness was maintained at 100 μm. The film was immediately immersed in the coagulation bath containing a mixture of distilled water and 2-propanol (30/70 v %) at room temperature. In order to guarantee complete phase separation, the membrane was stored in the coagulation bath for 24 h. This allows the water soluble components in the membrane to be leached out. As the final stage, membrane was dried by placing between two sheets of filter paper for 24 h at room temperature. [16] For casting of 1$^{st}$ membrane the 86 gm of DMAC, 2gm of PVP, 8gm of PS and 4 gm of Formamide and for 2$^{nd}$ casting the 20 gm DMAC, 0.5 gm PVP, 4 gm of PS and 0.5 gm of Acetic Acid.

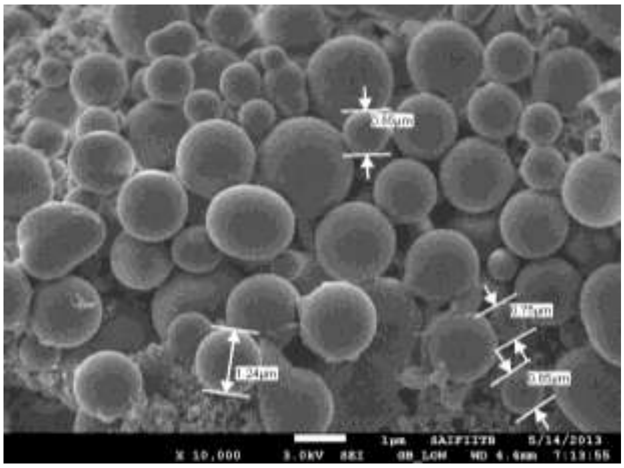

**Fig.2: Polysulfone Membrnae by formamide as additive**

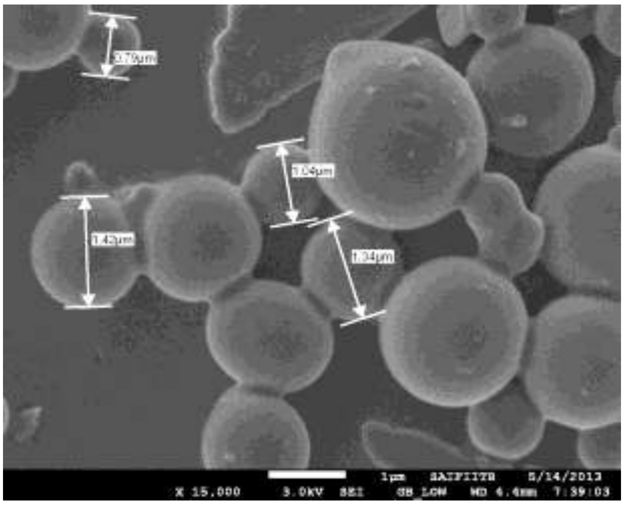

**Fig 3: Polysulfone Membrnae by acetic acid as a additives**

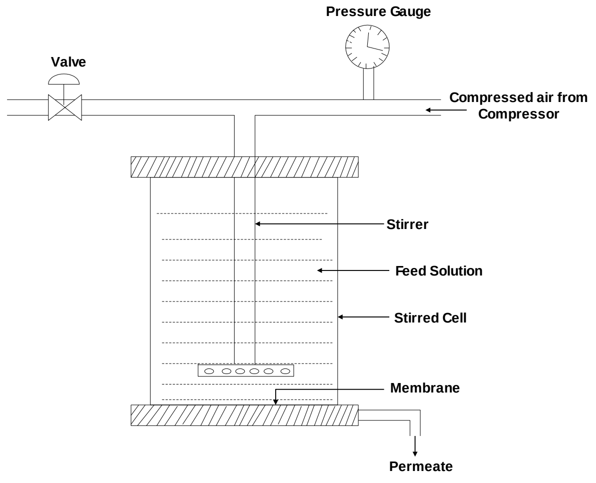


**Fig 4: Experimental Set Up**

**Ultrafiltration of Sugar**

This work presents a systematic study of the UF characteristics of sugarcane juice streams encountered in the production of plantation white (mill white) sugar. The manufacturing process generates four different juice streams viz. mixed juice, raw juice, rotary vacuum filtrate (RVF), and clarified juice. The UF of each of these streams is investigated. Further, the suitability of different polymeric membrane materials for this application is used (eg. Polysulfone, cellulose acetate). The quality of the UF permeate was consistently superior when compared to that of the conventional clear juice. The UF filtrate was sparkling clear in all the experiments and was lighter in color. The clarity was typically over threefold higher and the color was over five times lower than that of the conventional clear juice [9]. This was in spite of the fact that sulphitation was avoided with the raw and mixed juice feed prior to UF. Thus, it should be possible to produce low color sugar crystals while eliminating juice sulphitation altogether. An additional benefit is the lower CaO content of the ultra filtered juice. On an average, the UF permeate had a CaO content in the 950–1250 ppm range in contrast to 1300–1400 ppm with the clarified juice from the conventional process. This would lessen the evaporator fouling that, in turn, would imply reduced downtime for cleaning, in addition to savings on the cleaning chemicals. As the permeate from the UF process would be directly taken to the evaporators for concentration, it is essential to maintain the permeate pH near neutral (6.95–7.05) as required in the manufacturing scheme. Because all the feed streams tested (except for the conventional clarified juice) were originally at acidic pH, the juices were appropriately limed prior to UF as described in the experimental method. Liming the permeate is not a preferred option, as it may adversely affect the clarity of the juice. However, a pH drop of up to 1.1 units was observed across the membrane during UF [10].

**RESULTS AND DISCUSSION:**

**Water Flux Measurement**

The membrane was washed by approximately 100ml of distill water before recording the water flux. There were two Polysulfone membrane of 17% & 22% (wt %) was used for the experimentation .For a single coupon of each membrane water flux was calculated at different pressure. The membrane of 17% & 22% was cut into desired size for fixing up in the dead end ultrafiltration set-up of effective membrane area 1.11 x $10^{-3}$ $m^2$.The membrane coupons was placed in dead end ultrafiltration cell & initially pressurized by distilled water at different pressure .The applied pressure was increased by increment of 0.2 $Kg/cm^2$ till constant permeate flux of the membrane obtained. The permeate flux was calculated by equation:

$$J= V/AT------------- (1)$$

Where J is the permeate flux in LMH, V is the permeate volume in liter, A is the effective membrane area in $m^{2,}$
T is time required to collect permeate in hrs.

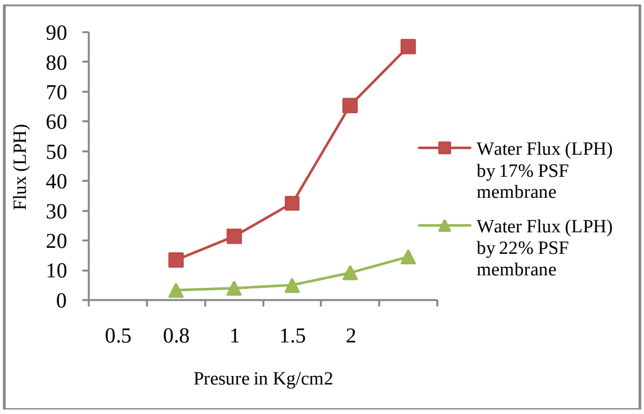


**Fig.5: Water flux (LPH) by 17% & 22% PSF membrane for 2 ml permeate volume at different pressure)**

**Effect of Time on Membrane Performance at Constant Pressure**

It is clear that in case of sugarcane juice. For making 100ml solution of sugarcane juice and water with concentration (25 ml juice) as the time goes on increasing the flux goes on decreasing at constant pressure for collecting the same amount of permeate. This is due to fouling on the membrane surface as the results are shown below.

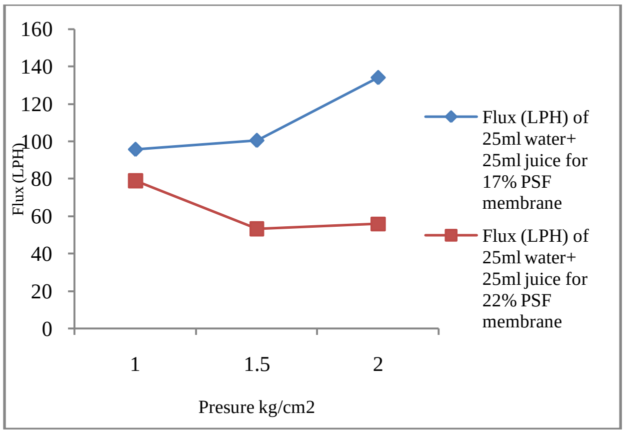


**Fig.6: Flux for the mixture (25ml water+25ml juice) of 1 ml permeate volume at different pressure**

## CONCLUSION

The behavior of flux with varying time at different pressures, Is denotes that the flux is simultaneously decrease with Increasing the pressure both for polysulphone membrane 17 & 22%. On the basis of experiments we have observe that the flux is initially high at the start of the run but it will simultaneously decrease with the time due to membrane fouling at constant pressure. As the pressure is increase the flux is also increase in PS17% but if the pressure remains constant the flux is decreased. On the basis of experiments we have observe that the flux is initially high at the start of the run but it will simultaneously decrease with the time due to membrane fouling at constant pressure. As the pressure is increase the flux is also increase in PS22% but if the pressure remains constant the flux is decreased. The rate of flux in PS 17% is greater than PS22%. Ultra filtration is effective technique which would be Use in sugar factory. Without using chemicals this UF system is produced Sulphur free, refined quality sugar. Ultra filtration process removes nearly 50% color, suspended solids, and inorganic compounds from sugarcane juice.

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