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The First International Conference on "Green" Polymer Materials
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Chaired by PROF. DR. ANTONIO PIZZI and PROF. DR. FRANK WIESBROCK
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Fabrication of Cellulose Acetate Membrane using Cyrene as Green Solvent

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Abstract: : Forward osmosis technology is promising molecular separation processes employing osmotic pressure difference of two solutions separated by a membrane. Membrane for forward osmosis application has a semipermeable property which selectively passes the certain molecules while reject others. Cellulose triacetate and cellulose acetate are common polymers that are often used in the fabrication of forward osmosis membranes. However, the solvent used in the fabrication of forward osmosis membrane is a toxic organic solvent. Cyrene™ ($C_6H_8O_3$) is a solvent derived from cellulose and is an environmentally friendly solvent because it does not leave sulfur and nitrogen emissions. This work is investigating the fabrication of forward osmosis membranes based on cellulose triacetate and cellulose acetate via phase inversion method, by using Cyrene as solvent. Various composition of the polymers and the green solvent were evaluated. The properties of forward osmosis membranes were characterized by its morphology by scanning electron microscopy and its performance based on water flux and reverse solute flux.

Keywords: green membrane; cellulose triacetate; cellulose acetate; Cyrene™; forward osmosis

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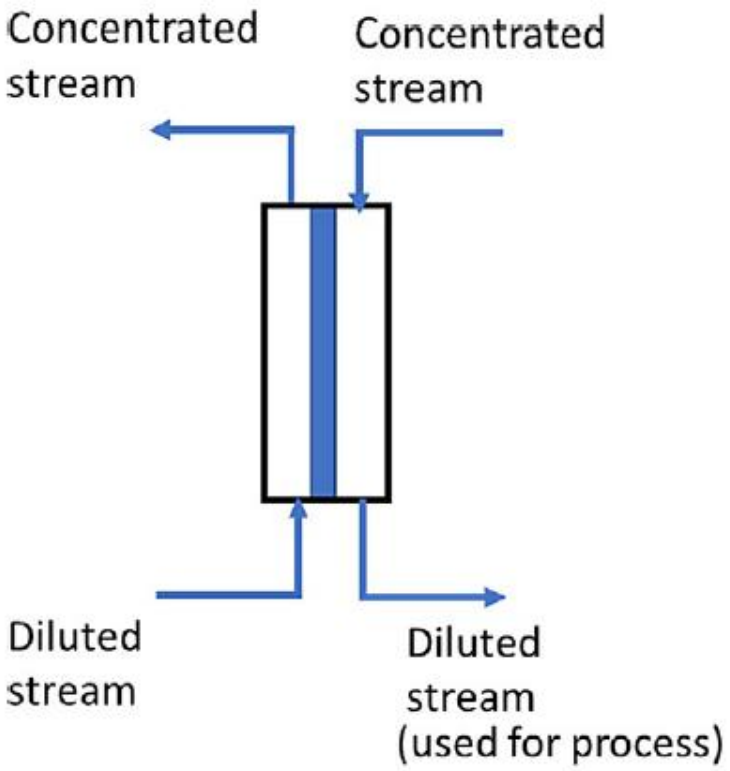
Introduction



Wibisono, *et al* (2020)

Forward Osmosis

- Energy efficient
- No hydrostatic pressure needed
- No membrane compaction

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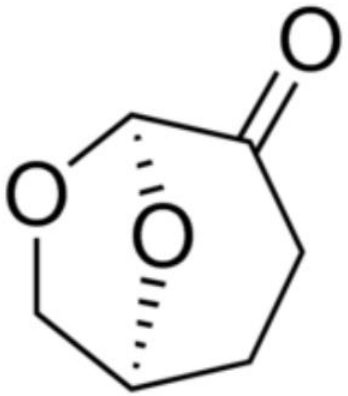
Introduction : Cyrene™ as Green Solvent



Dihydrolevoglucosenone (Cyrene™)

- Absence of NO_x and SO_x emission during combustion, environmental risks can be mitigated
- Its sustainable nature including its production and chemical cultivation from biomass
- Same level of dipolarity with solvents such as NMP. DMF, sulpholane and DMA
- High stability from oxidation and degradation

Properties	Cyrene™	NMP	DMF	DMA
Boiling point (°C)	227	202	153	164.5-166
Miscibility with water	complete	complete	complete	complete
δd (MPa0.5)	18.8	18.0	17.4	16.8
δp (MPa0.5)	10.6	12.3	13.7	11.5
δH (MPa0.5)	6.9	7.2	11.3	10.2

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Methods: Membrane synthesis

No.	Concentration			
	Cellulose Acetate		Cyrene	
	%	gram	%	mL
1	9	1.23	91	10
2	12	1.7	88	10
3	15	2.2	85	10

All materials are mixed and stirred using a hot plate stirrer for 4 hours.

The solution is poured on the glass plate and casted using a casting knife with an initial thickness setting

Immersed it in a coagulant bath filled with aquades for ± 10 minutes

Membrane sheet is dried using nitrogen gas

Green membrane

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Methods: Properties

1. Physical properties
    - Structure
    - Membranes thickness
    - Pore size
2. Mass transport properties
    - Flux

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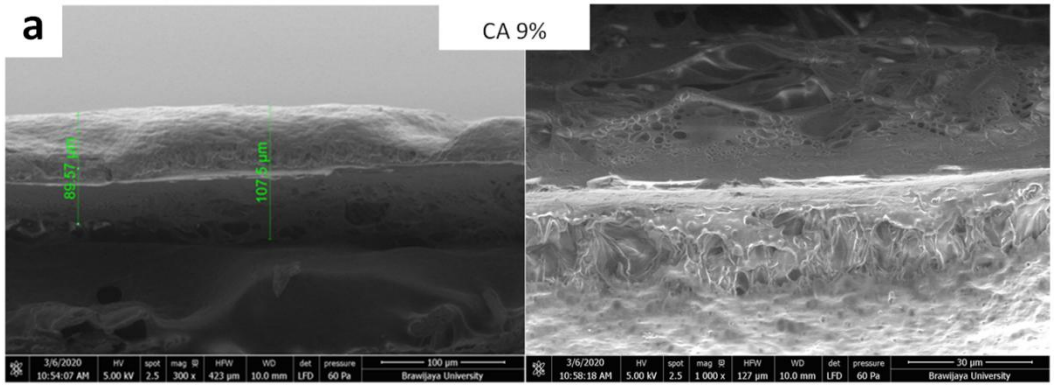
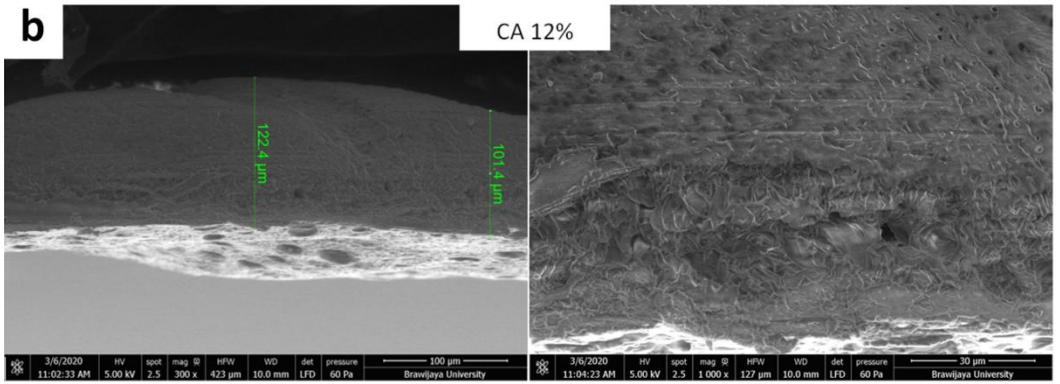
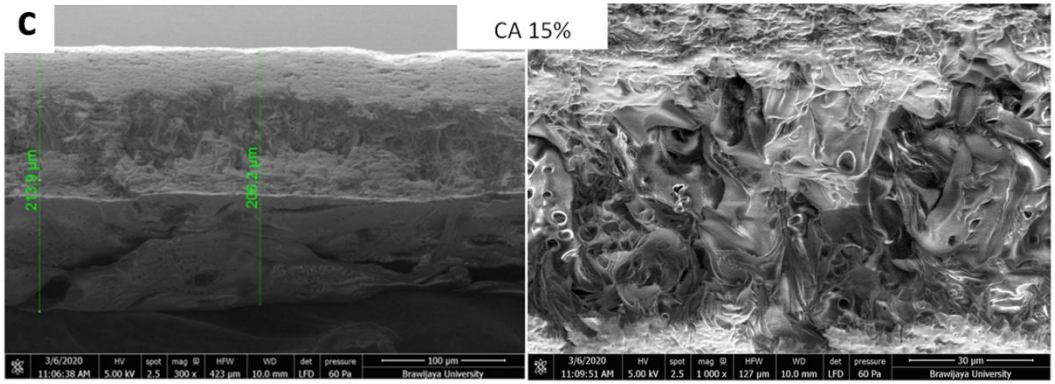
Results: Physical Properties

Membranes Structure – Cross Section View







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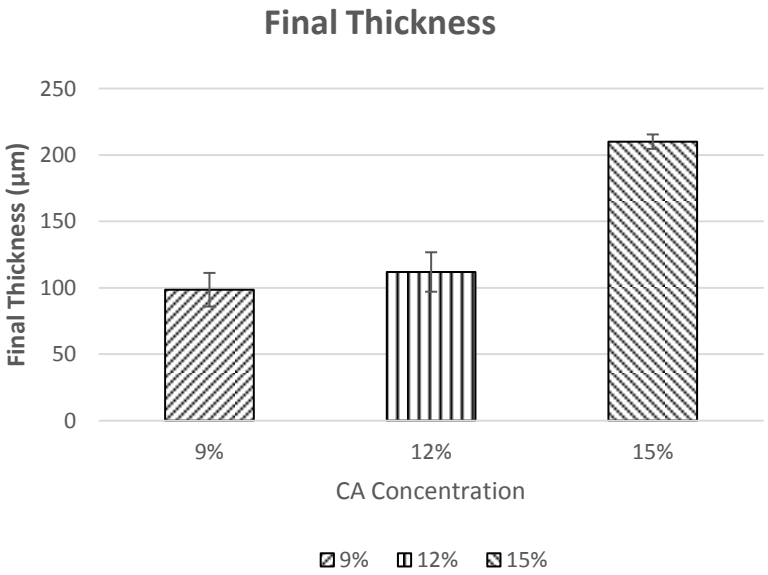
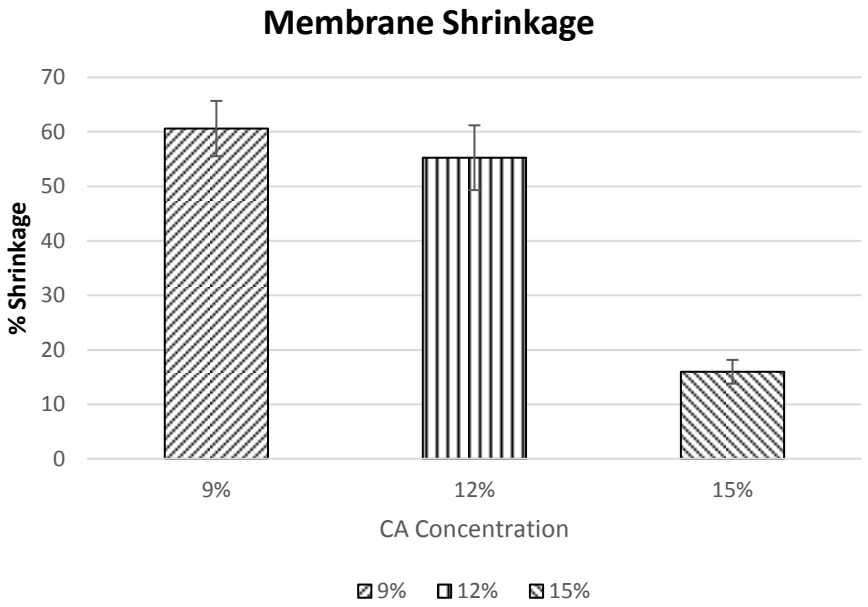
Results: Physical properties

Membranes Structure – Thickness and Shrinkage





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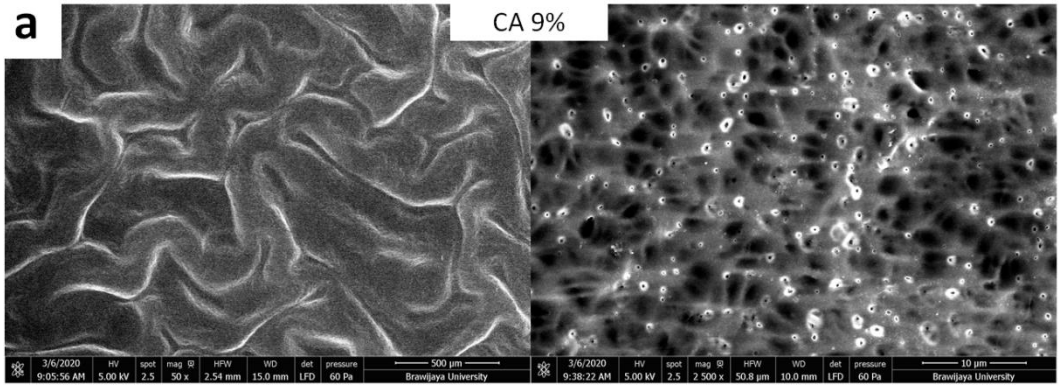
Results: Physical Properties

Membrane surface overview and pore size



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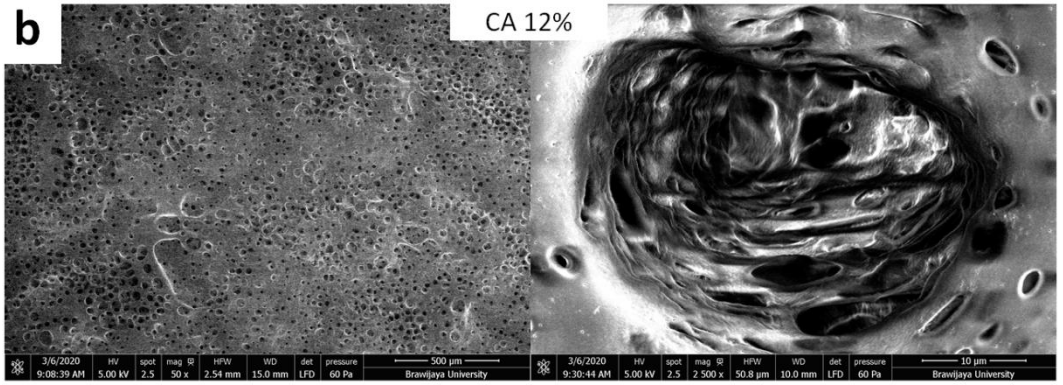

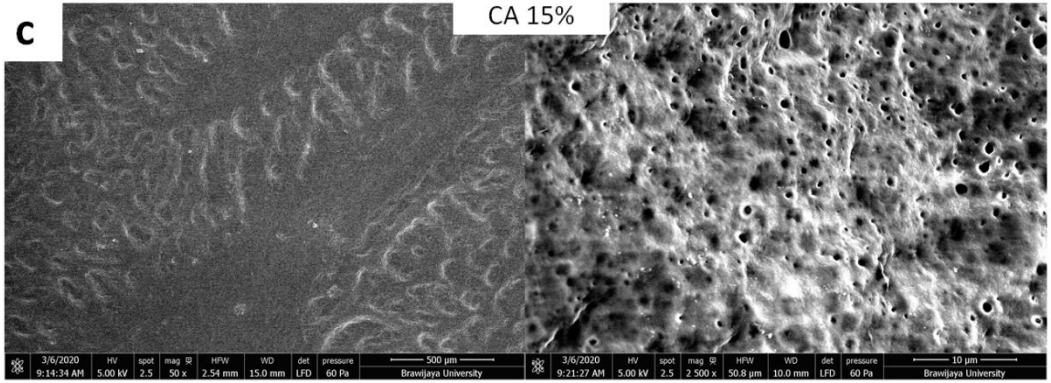

the 15% CA membrane has the smallest membrane pores that ranges from 0.3430 µm to 0.363 µm.

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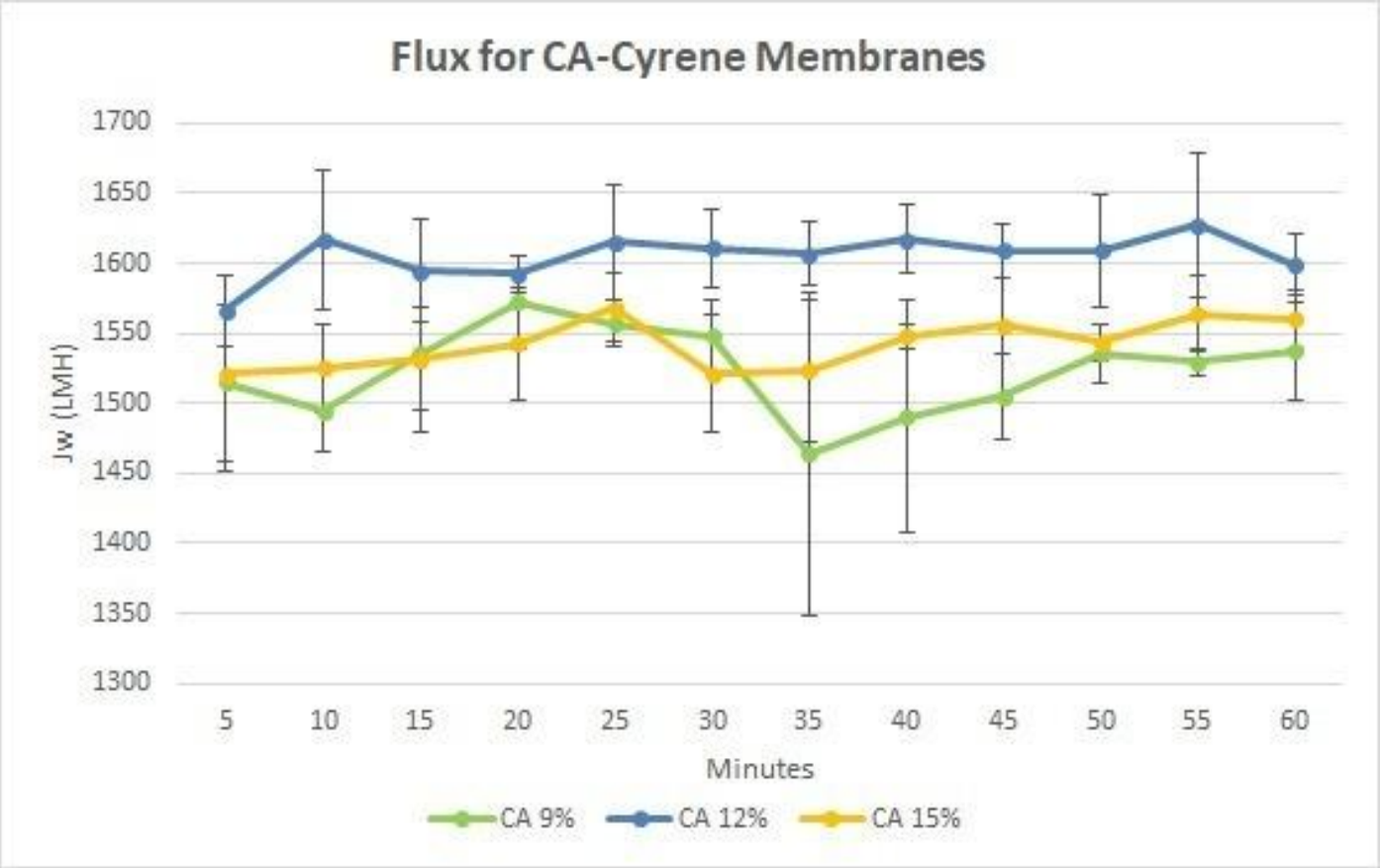
Results: Mass transport properties



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Conclusions

- The usage of green solvent cyrene in the fabrication of cellulose acetate membranes has resulted in a membrane with a dense top layer and a semi-porous middle layer with various pore sizes.
- As the concentration of the polymer increases, the pore size of the membrane tends to be smaller.
- The CA Cyrene membrane is more suitable when applied to MF technology due to its larger pore size.
- Further research is needed on how to reduce the pore size of the membrane with pretreatment or additive substances so the membrane could be applied in FO technology

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Thank you