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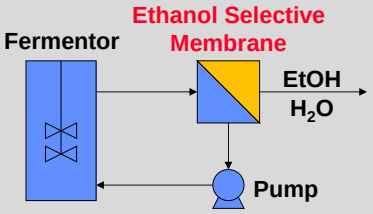
Sandia National Laboratories

Pervaporation Membranes for Biofuel Production

Reducing the cost and complexity of ethanol separation



Problem Statement:

Batch distilling ethanol from fermentation broth to produce biofuels increases overall capital and O&M costs significantly. Continuous fermentation-separation where ethanol is continually siphoned out of the reactor can reduce batch costs, but requires pervaporation membrane technologies. Currently, there are no viable membrane materials to separate ethanol. Sandia is working to develop pervaporation membranes for continuous ethanol separation in biofuels production.

Approach:

Sandia is working to develop separation membranes that exceed a minimum total flux of 150 g/(m^2·h) with a permeate stream containing 55% ethanol by mass. We propose to use hydrophobic polymers and hybrid inorganic-organic materials for use as ethanol selective pervaporation membranes. Sandia has extensive experience with membrane separations and has a large library of polymers including anion exchange, cation exchange, and high free volume polymers which are being evaluated for ethanol permeation. Testing is leading to modified formulations in a continuous fermentation-separation system.

Impact:

Continuous ethanol production would have the benefit of reducing fermenter capital costs by 75% and reducing annual distillation costs by 61% (See figures). In addition, the fermenter volume required to produce an equivalent amount of ethanol in a pervaporation process versus batch is reduced by 91%, leading to a smaller plant foot print. The distillation column is also significantly smaller and there is better nutrient utilization compared to batch production.

Membranes allow for continuous ethanol production, reducing capitol and annual distillation costs.

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Batch Production Plant (50 mil gal/yr)

16 x 250,000 gal reactors

Distillation:
87 disc & donut trays
28 sieve trays

Fermentation-Pervaporation Plant (50 mil gal/yr)

1 x 330,000 gal reactor

Distillation:
30 sieve trays

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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