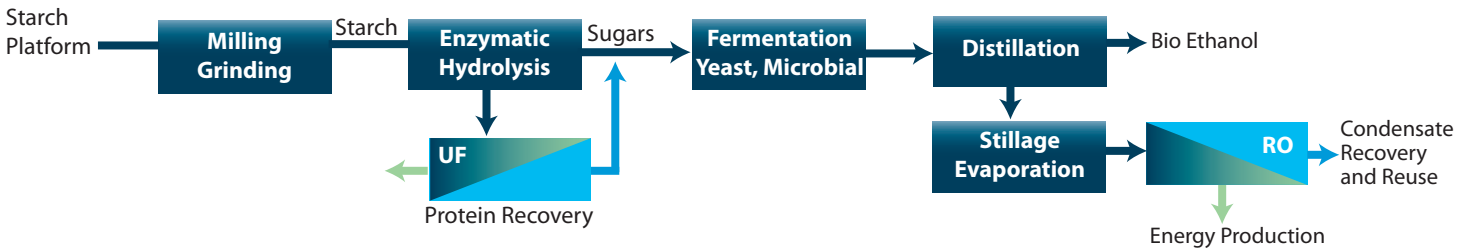




BUSINESS UNIT: Food and Life Sciences



# Application of Membrane Technology to the Production of Biofuels

## Overview

Membrane filtration technologies—microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO)—are proving to be effective ways to achieve optimum yields and reduce energy costs for biofuels production. In particular, membrane filtration technology shows promise to improve “second-generation” cellulosic ethanol processes.

Membrane use is rising in biodiesel processes where membranes facilitate water reuse, particularly in areas where water is scarce. Membrane technology shows promise for concentrating and purifying organic acids, commonly used as the base for a variety of new biodegradable plastics.

In addition, so-called integrated biorefineries are using a variety of membrane technologies, particularly those that facilitate continuous, rather than batch, fermentation. Membranes are poised to play a significant role in

this important advancement.

In the next few years, a number of cellulosic biorefinery pilot and demonstration plants will be placed online using membrane technology in parts of the production process.

## The Challenge

To improve bioprocesses, lower overall energy costs, and increase valuable product recovery.

## The Solution

Koch Membrane Systems (KMS) provides a comprehensive range of membrane filtration systems to provide manufacturers with cost-effective solutions for producing biofuels.

KMS’ MF and UF products can be used for clarifying the process stream after turning it into sugars during the saccharification process.

In processes that use acid/alkali, KMS’ NF products can be used to

recover and concentrate some of the useful sugars like hemi-cellulose, which also is used in the fermentation process.

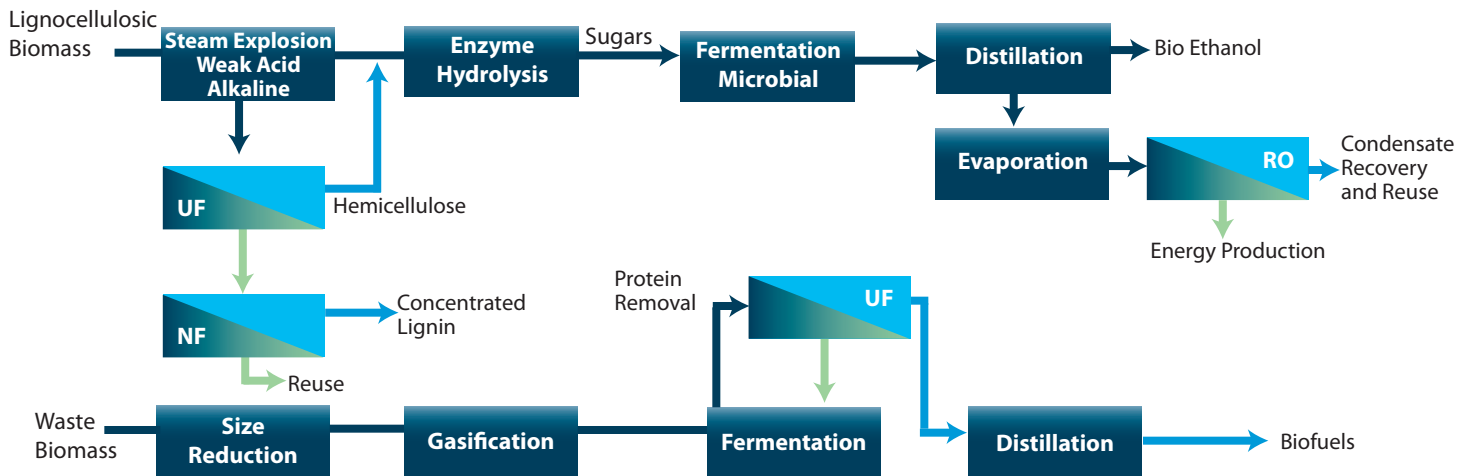
RO products from KMS are used for product concentration and water recovery for reuse.

## Customer Benefits

- Optimized valuable product recovery
- Reduced waste
- Reduced energy and operating costs
- Water recovery and reuse

## APPLICATION BULLETIN

### Membrane Technology in Biofuels



### Maximizing Efficiency

Using membrane technology in bioprocesses has the potential to greatly reduce operating costs compared to the traditional method of using an evaporator to recover or remove water, which requires very high energy use. RO can offer about 75 percent lower capital and operational costs compared to a 5 multi-effect evaporator with thermal vapor recompression. Nanofiltration allows the recovery of proteins, peptides, amino acids, and sugars, while allowing salts to pass the membrane.

On the wastewater side, anaerobic digestion is often used to remove BOD and COD from the waste stream. UF may be used to concentrate the biosludge, followed by a water recovery and reuse RO system. This is especially important in areas where water is limited.



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Membrane Filtration Uses	
Application	Membrane Type
<i>Upstream from the fermentation process</i>	
Clarification or fractionation of feed stock material going to the fermenter	Ultrafiltration Microfiltration
Protein recovery/removal from hydrolyzed prepared biomass	Ultrafiltration
Acid and alkali recovery and reuse	Ultrafiltration, nanofiltration
Separation of lignin from hydrolyzed biomass	Ultrafiltration, nanofiltration
Concentration of sugars to enable product yield enhancement in the fermentation process	Nanofiltration
Continuous enzyme reactors retain enzyme and substrate, permitting removal of reaction-inhibiting components	Ultrafiltration, nanofiltration
<i>Downstream from the fermentation process</i>	
Biomass/microbial cell retention that enables continuous recovery of the target product component or removal of fermentation inhibitor molecules	Ultrafiltration, nanofiltration
Concentration of organic acids with water recovery for reuse	Reverse osmosis
Amino acid concentration and desalting	Nanofiltration
Evaporator condensate treatment for water recovery and reuse enabling environmental compliance	Reverse osmosis