

Energy Efficient Ethanol Distillation

23rd Annual International Fuel Ethanol
Workshop & Expo
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Feed-Stocks



Leading To E-85



HOWEVER

Questions are Continually Raised
Concerning Energy Balances of Biofuels

Positive?

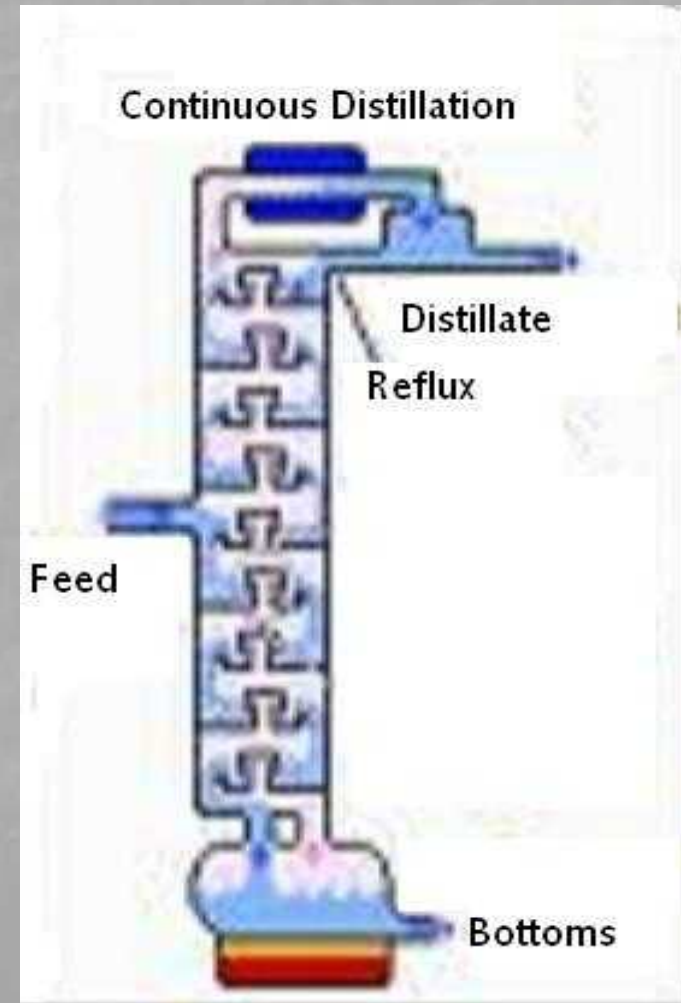
Negative?

670,000 Hits - Google

Major Energy Consumer is the
Distillation Process

Standard Distillation Column

- Boiling Technology
- Minimal Energy Reuse

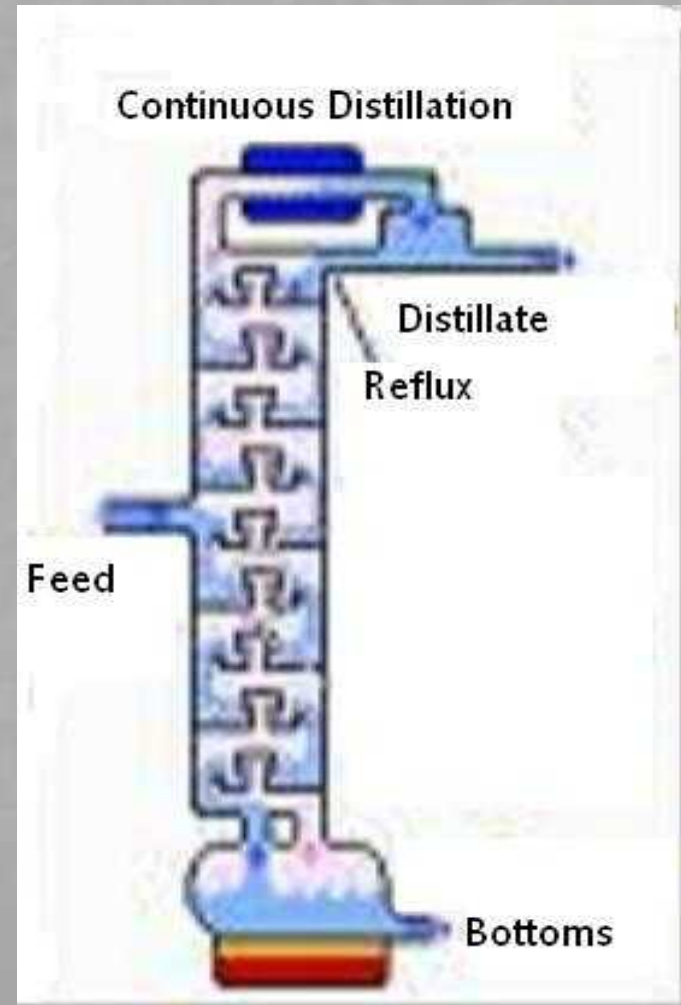


Search for Energy Reuse Distillation

Must Capture Heat Released
During Condensation

HOW?

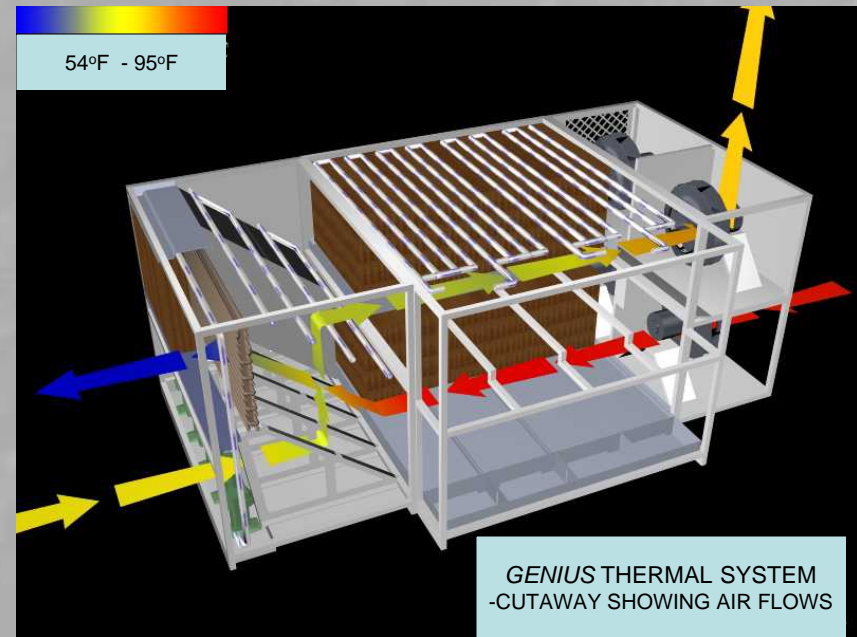
Column Requires
Stripper at Higher
Temperature Than
Rectifier



Alternative: Evaporation/Condensation



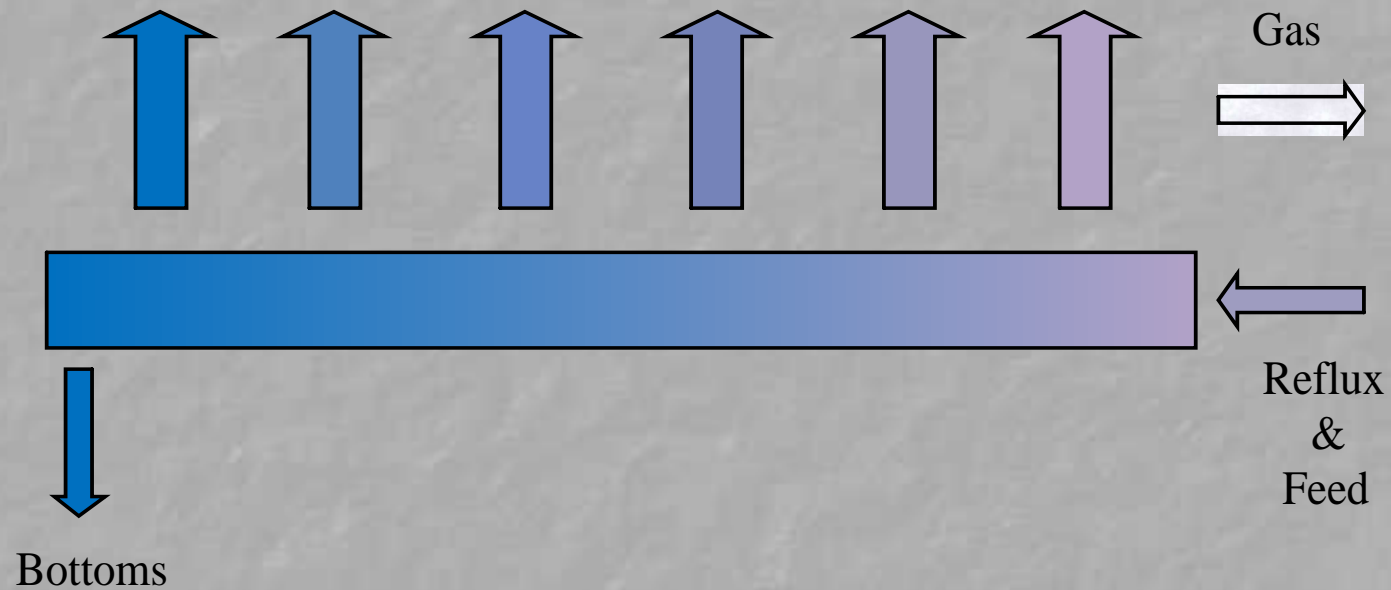
Evaporation and Condensation Development



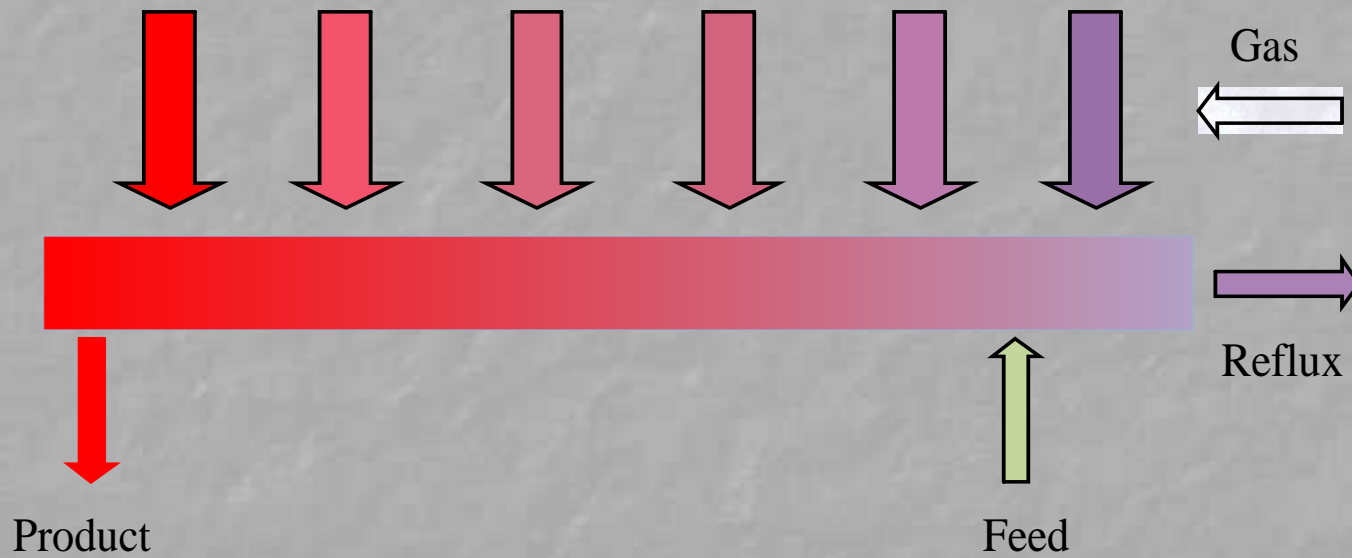
Ethanol and Water have Significantly Different Boiling Temperatures

Ethanol	172°
Water	212°

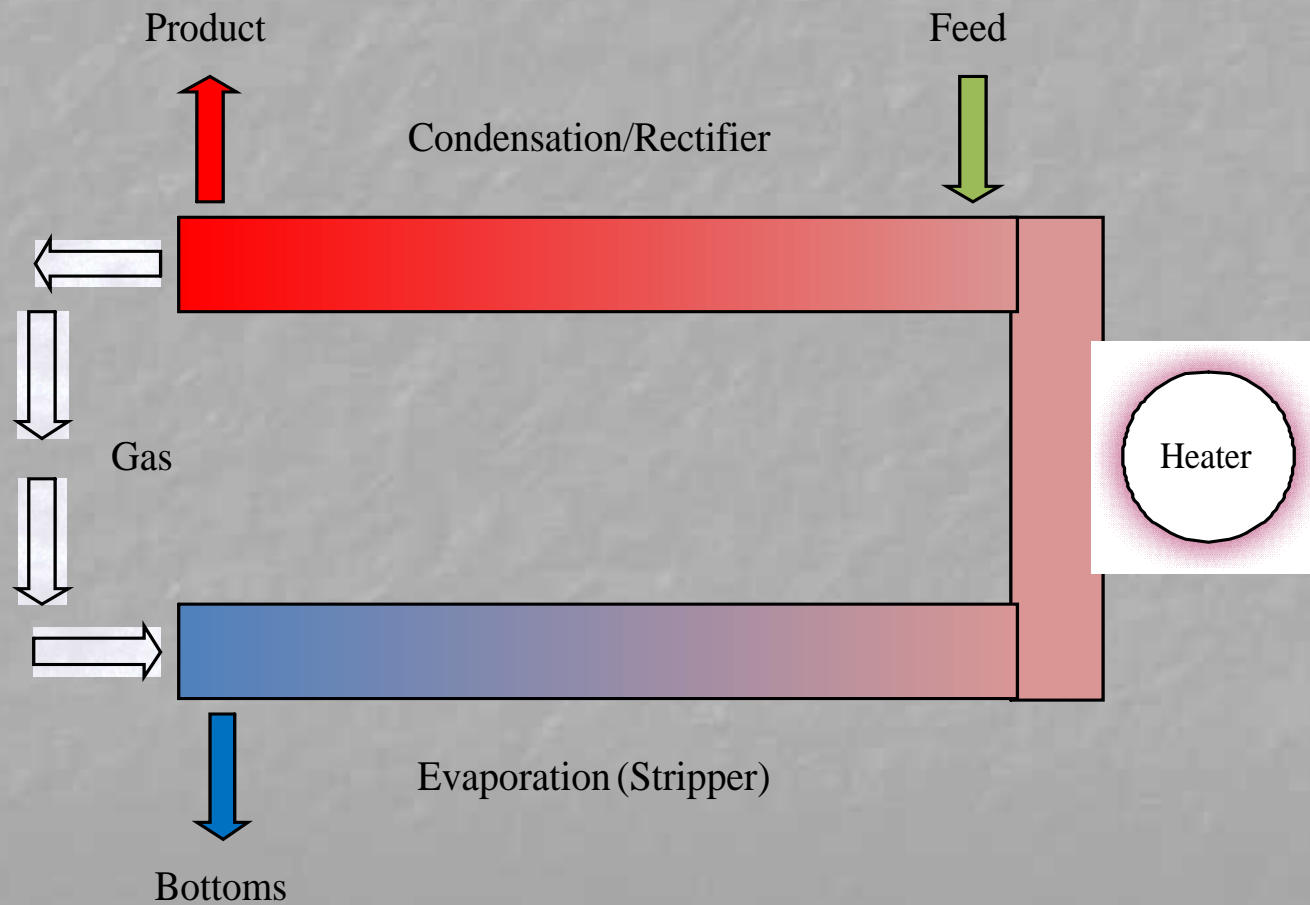
Preferential Evaporation



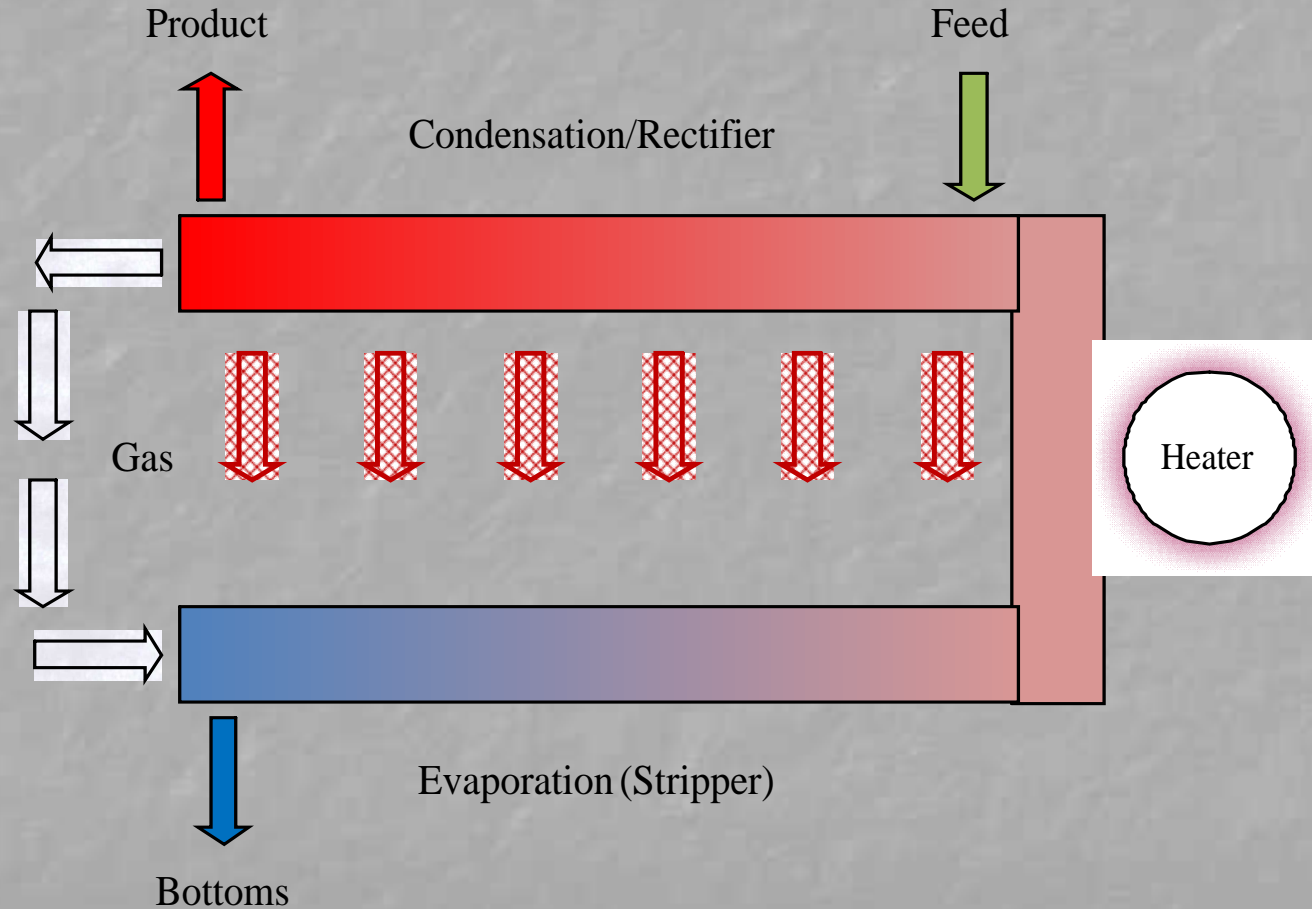
Preferential Condensation



Distillation Flow Diagram



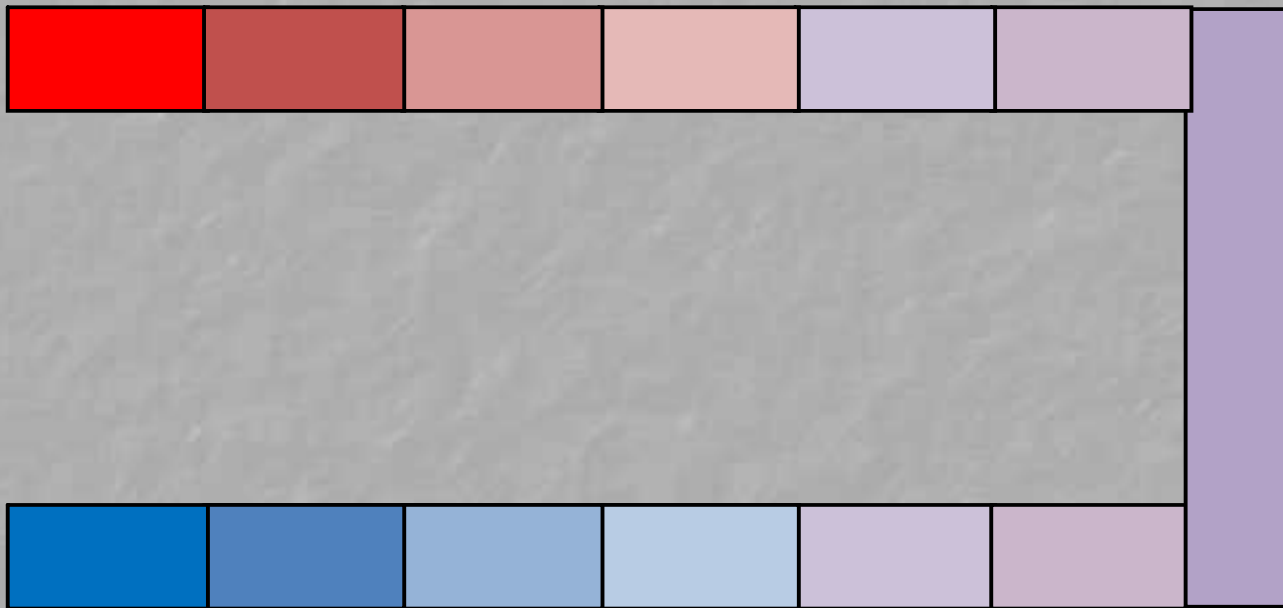
Heat Released During Condensation



Rectifier Temperature Higher Than Stripper Temperature

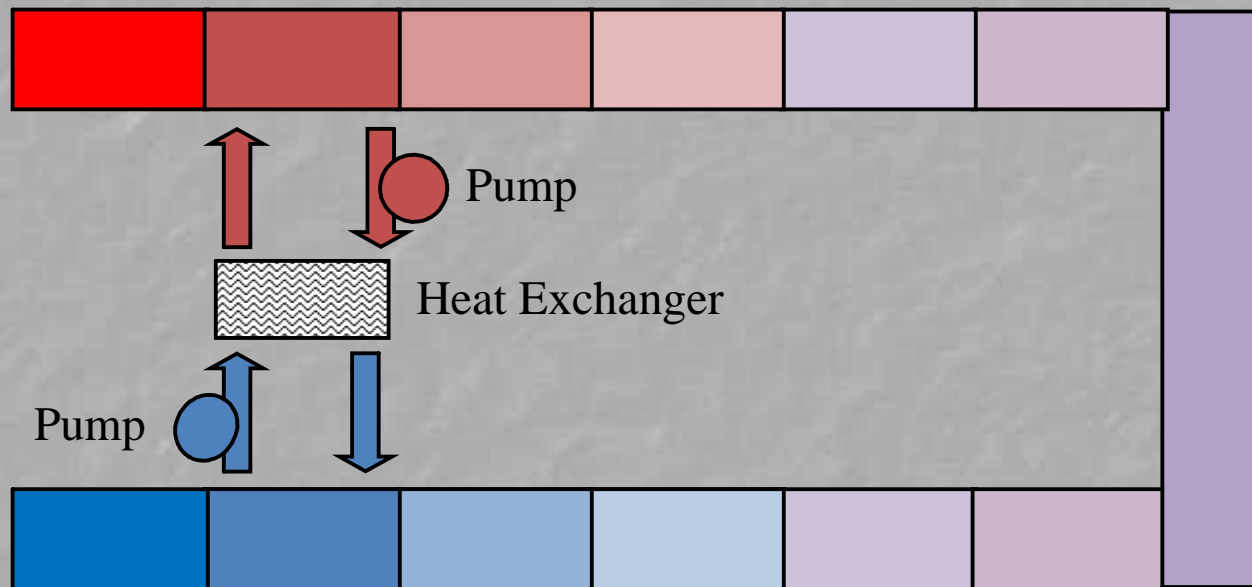
Staged Separation of Temperature and Concentration

Condensation (Rectifier)

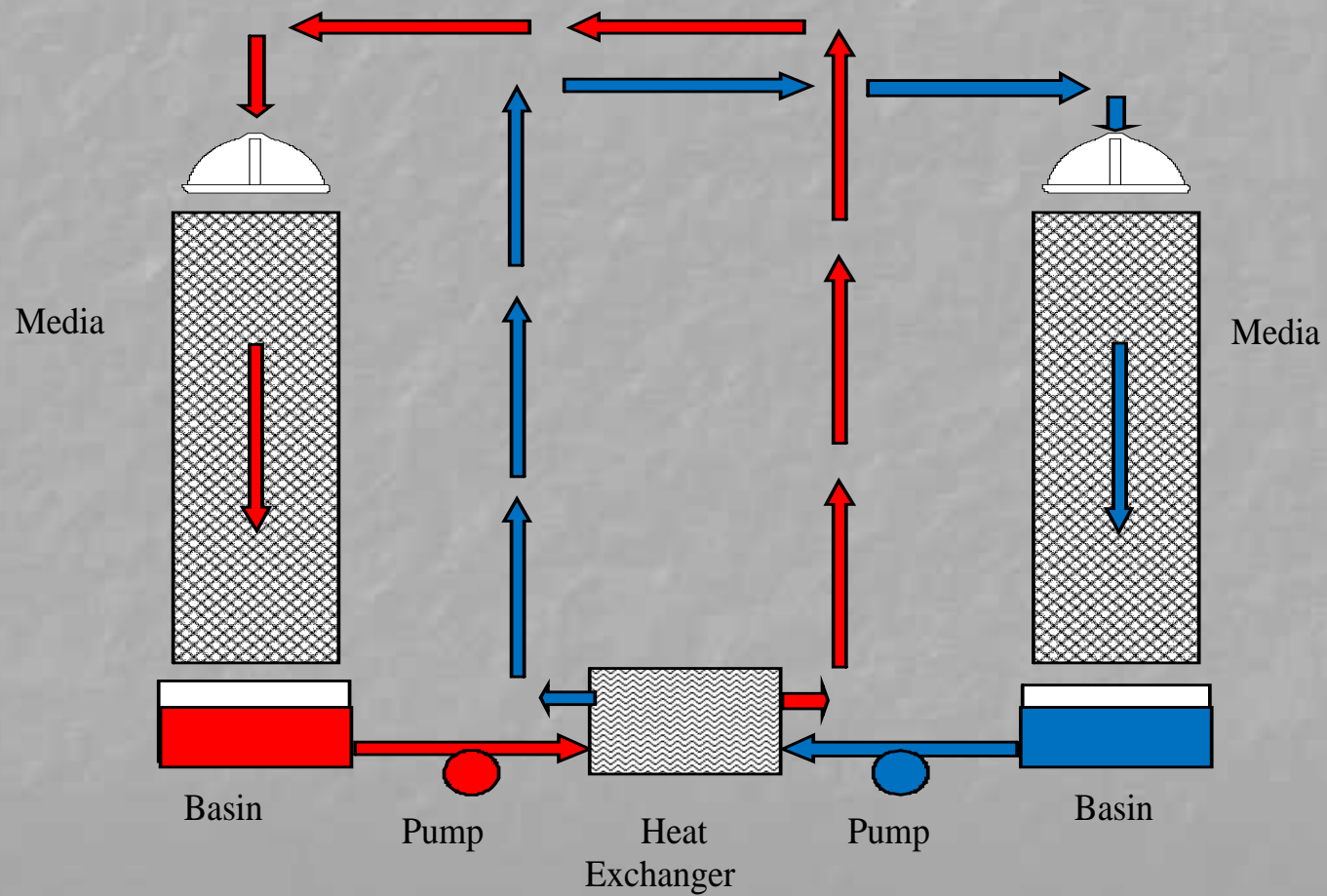


Evaporation (Stripper)

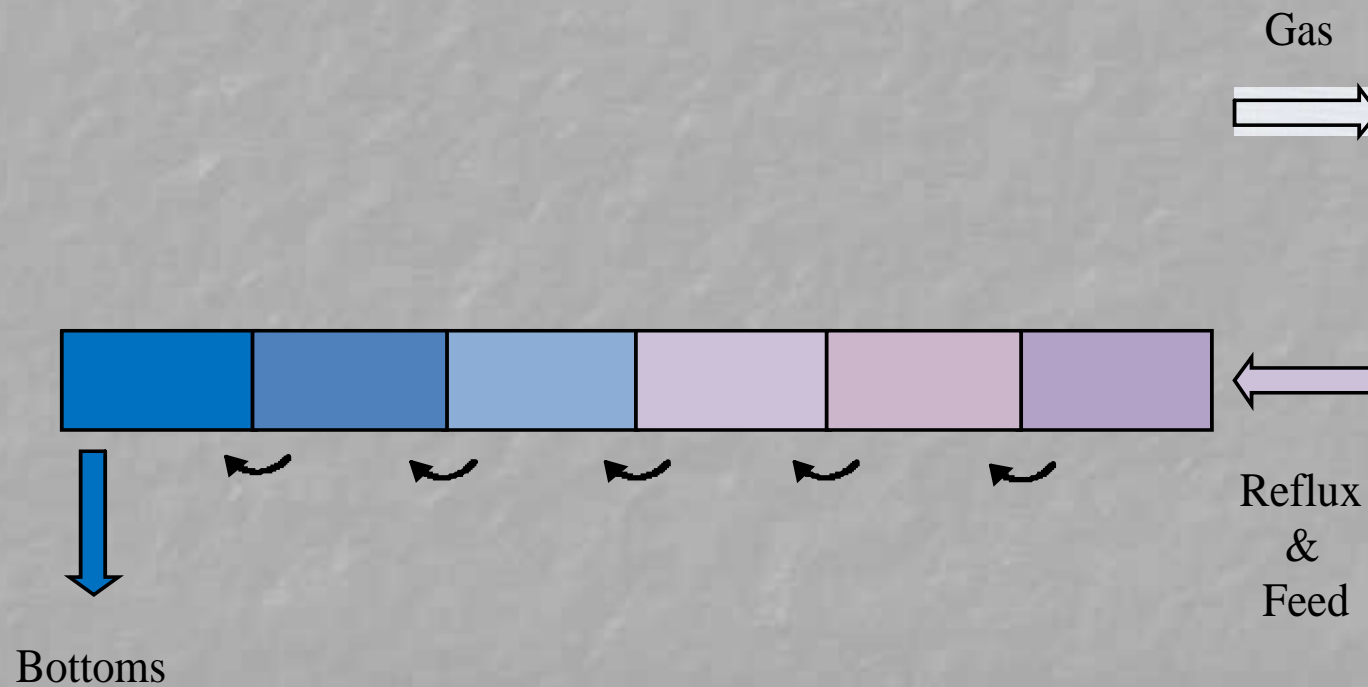
Heat Exchange Means



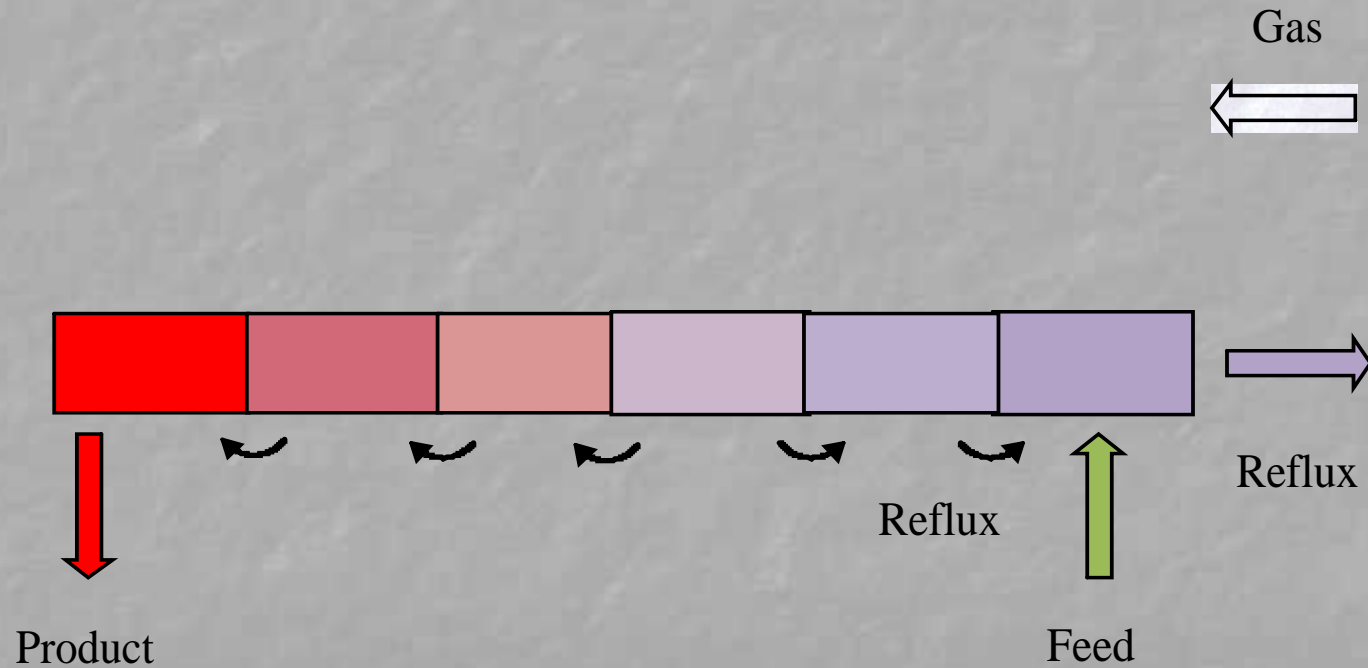
Staged Liquid Flows



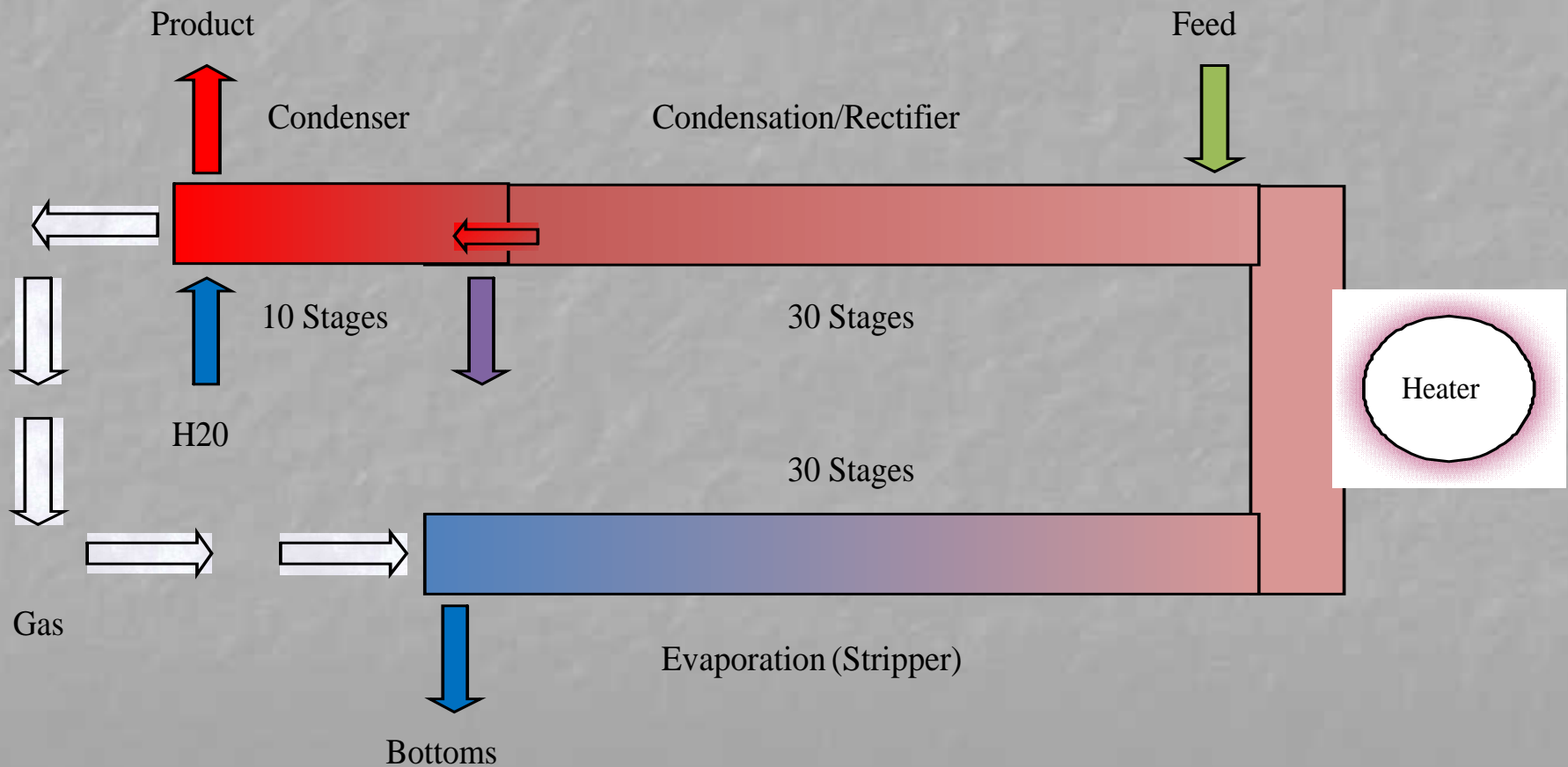
Staged Flow - Evaporation



Staged Flow - Condensation

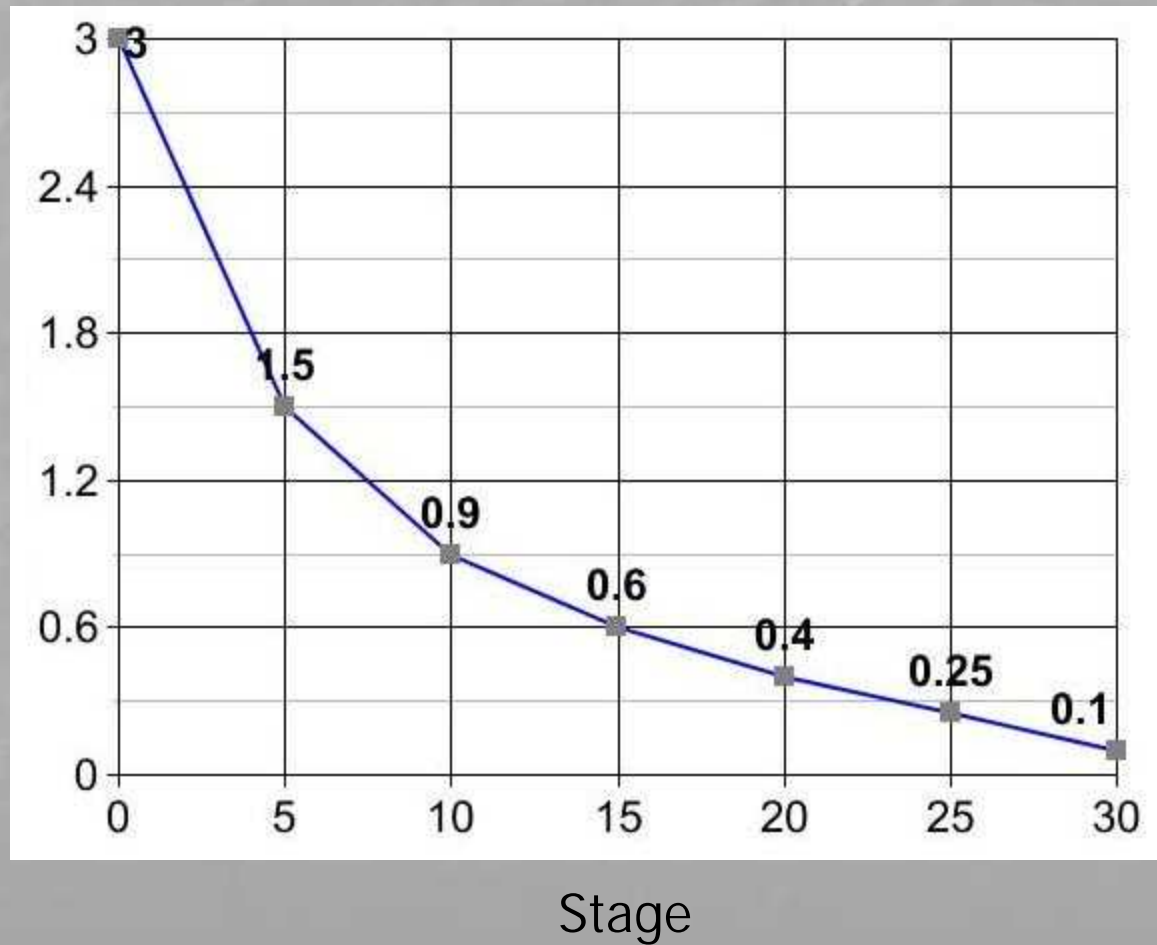


Prototype Flow Diagram



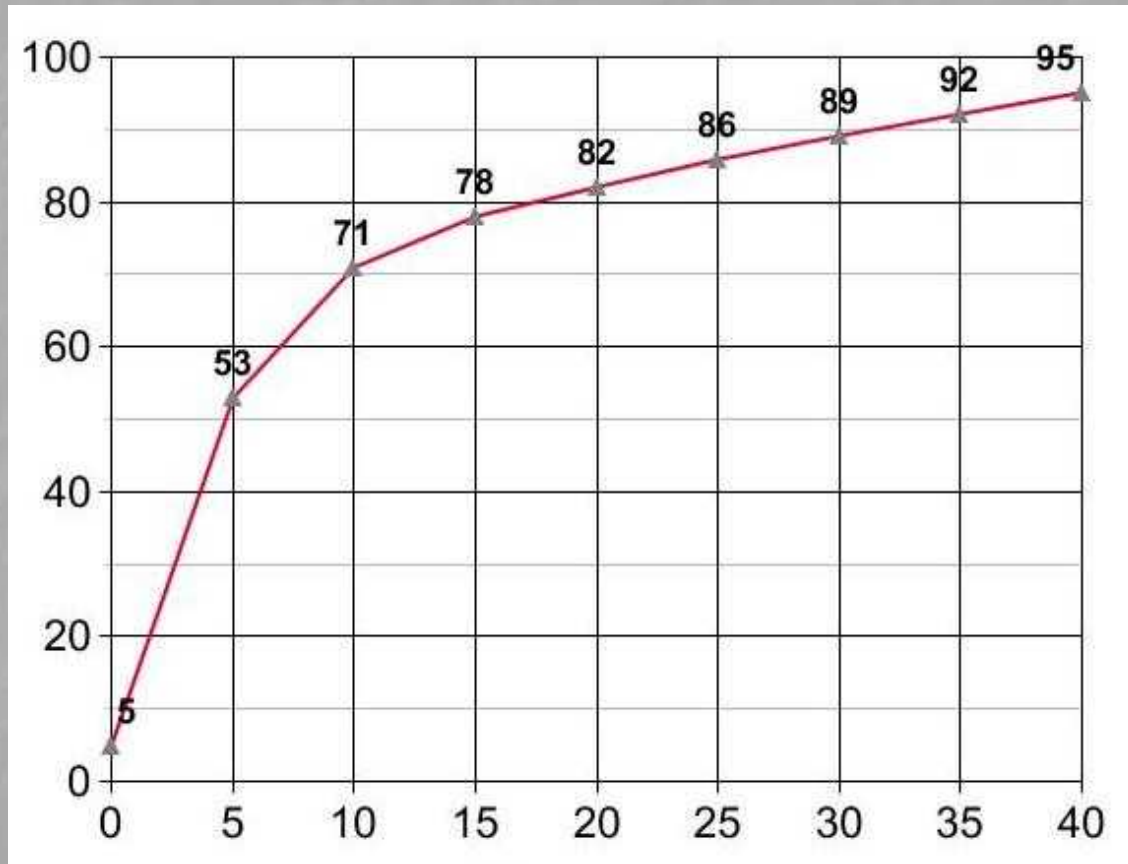
Evaporator (Stripper) Ethanol Composition Profile

Wt. %
Ethanol



Condenser (Rectifier) Ethanol Composition Profile

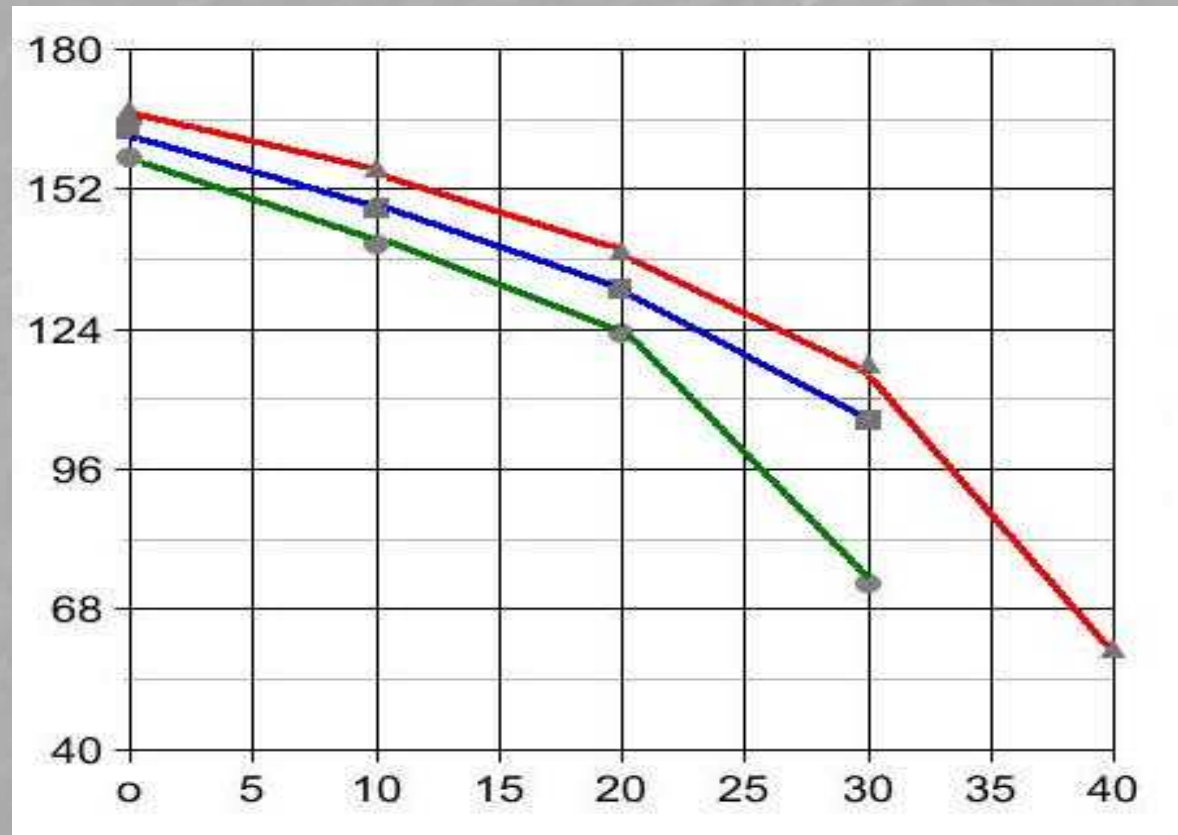
Wt. %
Ethanol



Stage

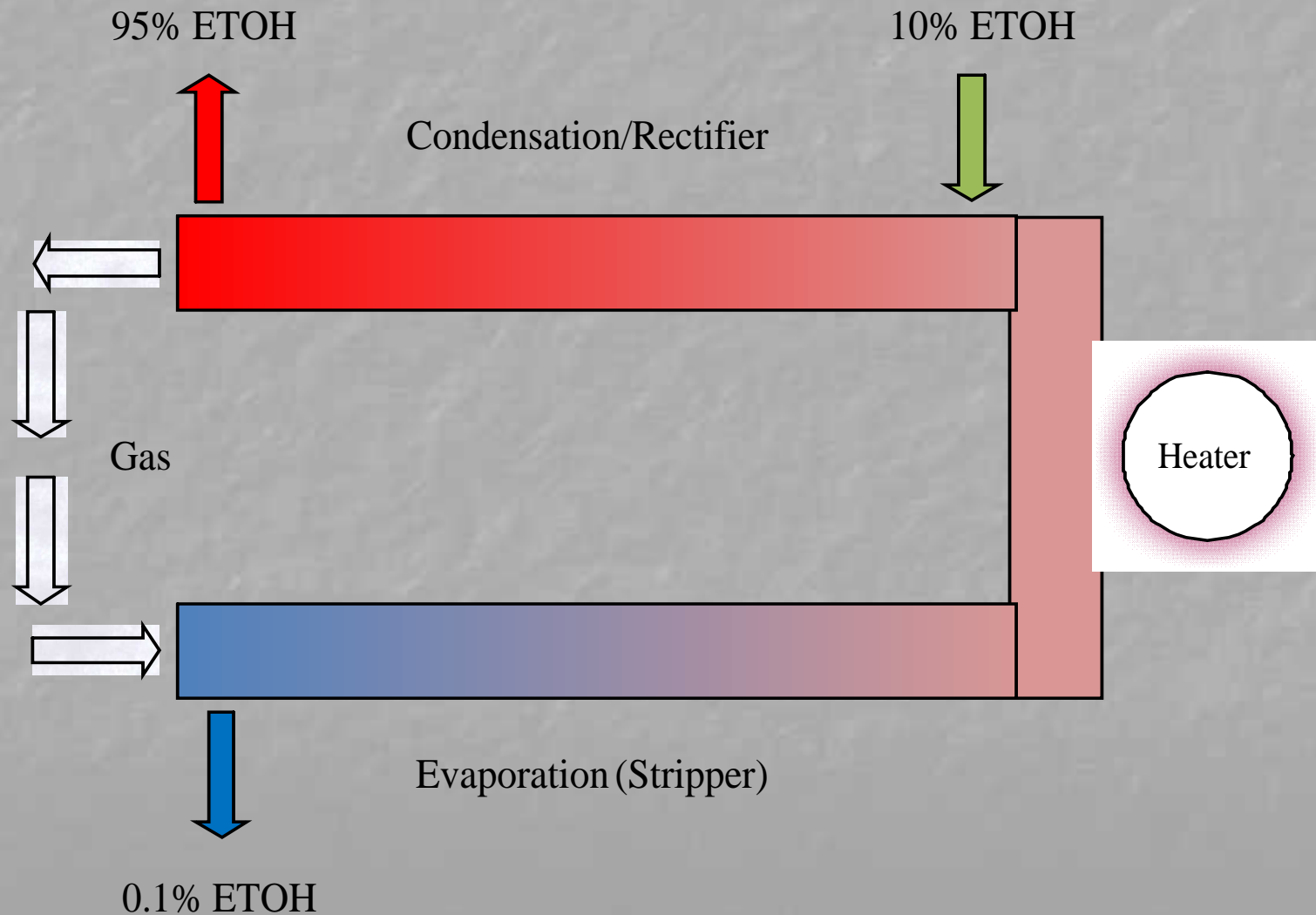
Temperature Profile

Temperature
(°F)



Stage

Liquid Concentrations



Energy Usage

One Gallon 95% Ethanol

- Thermal (Measured) 4,100 BTU's
- Thermal (Theoretical) 2,900 BTU's
- Liquid Pumping 150 watts
- Gas Movement (CO₂) 3 CFM

**Energy Savings Approaching
80%**

Compared With Many Standard
Distillation Columns

THANK YOU

**THE HEAT AND MASS TRANSFER
TECHNOLOGY IS UNIQUE**

Patents have been issued, filed,
or are in progress related
to the subject matter discussed.