Water Use in Bioethanol Production

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Types of Water

• Process Water
  – CO₂ Scrubber
  – Yeast tanks

• Non-Process Water
  – Cooling Tower
  – Boiler (RO water)
Input and Output: Water Balance

Emissions

Inputs → Ethanol Plant → Products

Effluent
Input and Output: Water Balance

Water Vapour

Corn
Water

Ethanol Plant

Ethanol
DDGS
CO₂

Effluent
Water Routing in Dry Grind Ethanol Plant

- Plant Feed
- Reverse Osmosis
  - RO Reject
  - RO Product Tank
- Deaerator
- Storage Tank
- MM/GS Filters
- Dry Grind Process
- Process RO
- Process Non RO
- Process Out
- Cooling Tower
- Cooling Tower BD
- Boiler
- Boiler Makeup
- Boiler BD
- Softner Regen
- Plant Output
Water Routing in Dry Grind Ethanol Plant

- Plant Feed
- MM/GS Filters
- Storage Tank
- Dry Grind Process
- Process Non RO
- Process Out
- Plant Output
- RO Reject
- Reverse Osmosis
- RO Product Tank
- Evaporation and Drift
- Cooling Tower
- Cooling Tower BD
- Process RO
- Deaerator
- Boiler Makeup
- Boiler
- Boiler BD
- Softner Regen
- Steam
- Dry Grind Process
- Process Out
Cooling Tower

- Circulation rate is set by process design
- Evaporation and drift is determined by heat load, circulation rate and design of tower
- Blowdown is calculated by cycles of concentration (permit requirements)
- Makeup is sum of evaporation and drift and blowdown.
• Steam load and condensate return is determined by process design
• Boiler blowdown is determined by the water chemistry
• RO reject is determined by RO design
Input and Output: Water Balance

- **Corn** → Ethanol Plant
- **Water** → Ethanol Plant
- Ethanol Plant → **Ethanol**
- Ethanol Plant → **DDGS**
- Ethanol Plant → **CO₂**
- Ethanol Plant → **Effluent**
- Water Vapour
Water Use in Other Industries

- Water used to produce
  - 1 can of fruit = 9.3 gallons
  - 1 lb of sugar = 14 gallons
  - 1 lb of synthetic rubber = 55 gallons
  - 1 gallon of paint = 13 gallons
  - 1 lb of cotton = 101 gallons
  - 1 Sunday newspaper = 150 gallons
  - 1 gallon of gasoline = 2 to 2.5 gallons

Source: USGC/USEPA
Sodium and its Effect on Fermentation

Source: Alcohol Textbook, Ingledew, 2003
Fermentation Profile

- Ethanol Concentration (% v/v)
- Glucose (% w/v)
- % Ethanol Produced

Graph showing the fermentation profile with SSF (hr) on the x-axis and Ethanol Concentration (% v/v) on the y-axis.
Conventional Dry Grind Process
Conclusions

- Conventional dry grind ethanol production requires
  - 4 gallons water/gallon of ethanol
  - 60-70% of this water is for cooling towers
- Water use in dry grind ethanol plants is small compared to other industrial processes
- New technologies can further reduce water requirement in dry grind ethanol process