TREATMENT OF BIODIESEL AND BIOFUELS MANUFACTURING WASTEWATER

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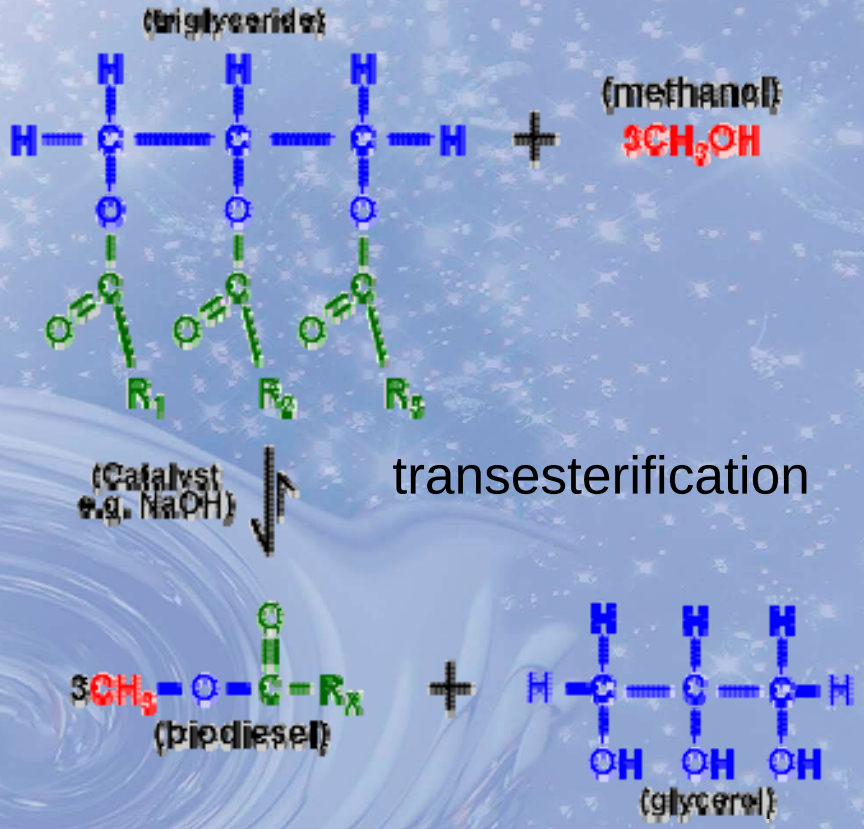
BIOFUELS

- Supplies of petroleum hydrocarbons limited
- Sustainable sources of fuels needed
- Less dependence on imported fuels needed
- Biofuels can help:
  - » Biodiesel
  - » Bioethanol

BIOFUELS AND WATER

- National Water Science and Technology Board
- Meeting and book published:
- Water Implications of Biofuels Production in the US (2008) (National Academy Press)
- For each gallon of biodiesel up to 2 gallons of water used
- For each gallon of bioethanol 4-6 gallons of water used

BIODIESEL MANUFACTURING



BIODIESEL WATER WASHING

SOURCES OF WASTEWATER

- Cooling towers
- Boilers
- Washing facilities
- Biodiesel washing water:
  - Emulsified oil (biodiesel residual)
  - Glycerine
  - Methanol
  - Soaps

WASTEWATER TREATMENT

- Stream segregation
- Cooling tower and boiler blowdown:
  - RO for salt removal
  - Prefiltration useful to prevent RO fouling

BIODIESEL WASHING WATER TREATMENT

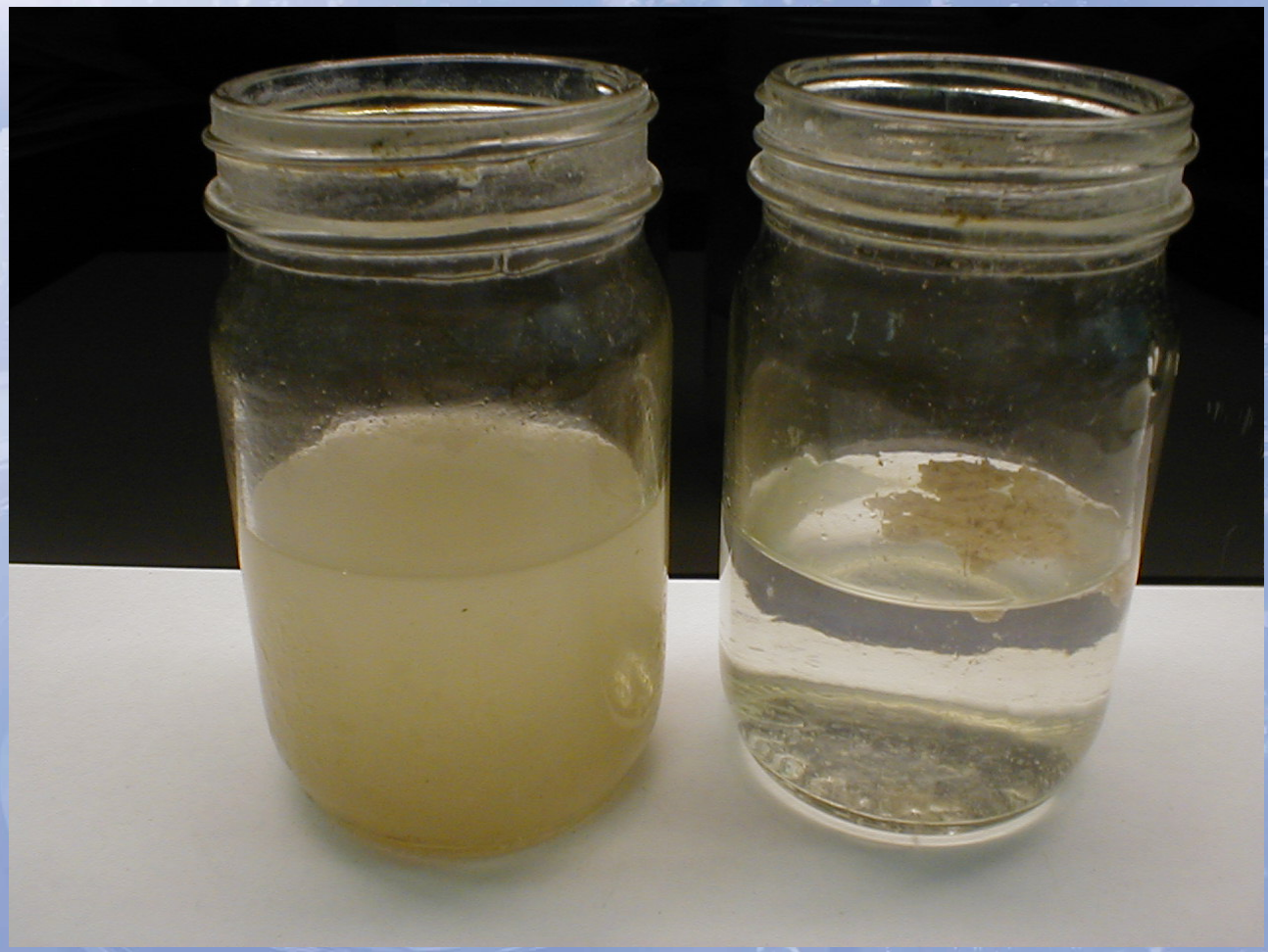
- Very strong, complex and variable
- TSS, FOG, glycerin, methanol, soaps
- TSS between 100 and 25,000 ppm
- COD between 1,500 and 55,000 ppm
- FOG between 25 and 4,000 ppm

- Multistep treatment needed
- Advanced equipment needed for such challenges

MULTISTEP TREATMENT

- Screening (rotating drum self cleaning screen)
- In situ flocculation – flotation
- Advanced anaerobic bioreactor treatment
- Membrane bioreactor polishing

JAR TESTS OF BIODIESEL WASHWATER



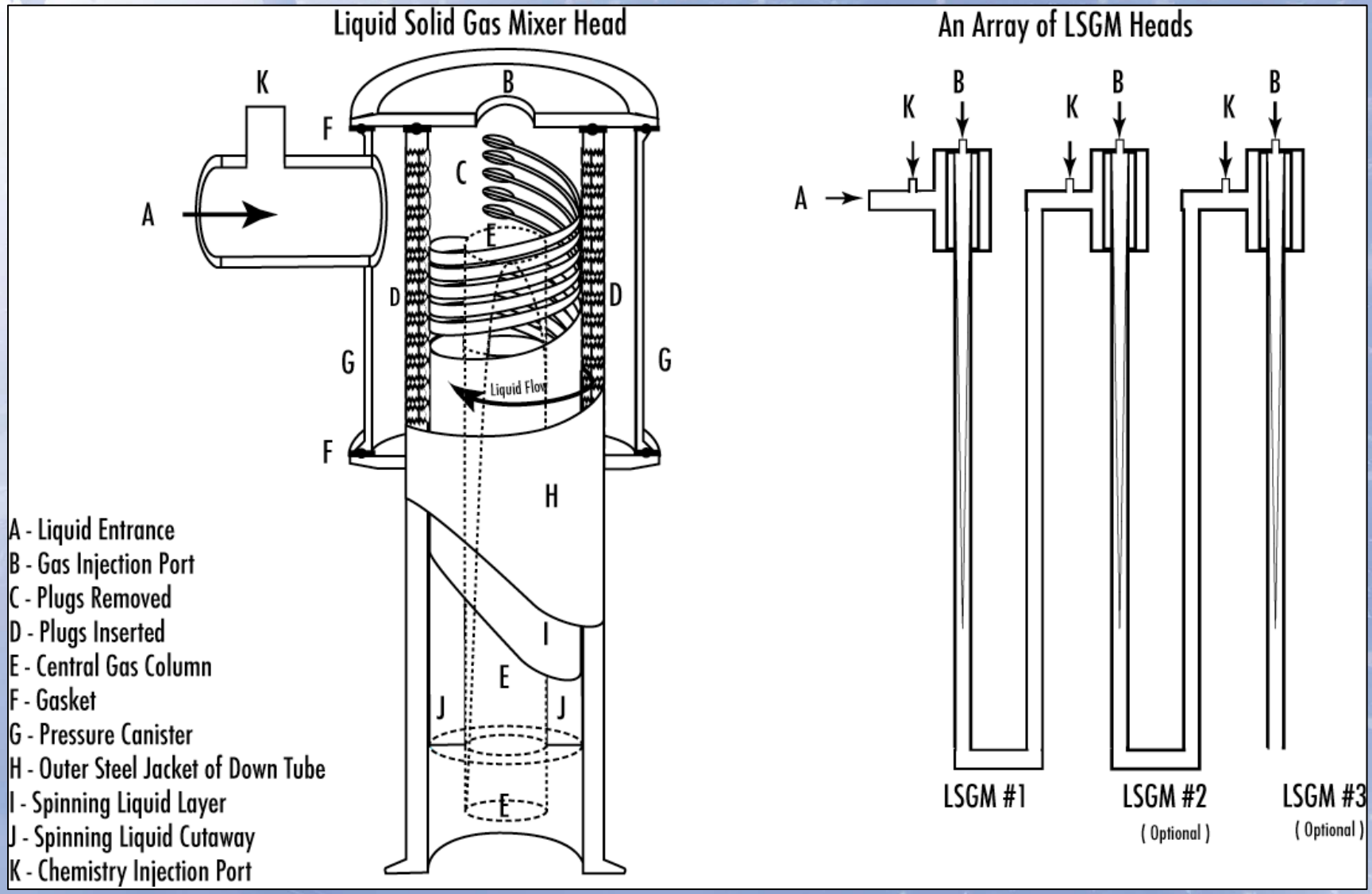
RESOURCE RECOVERY/REUSE

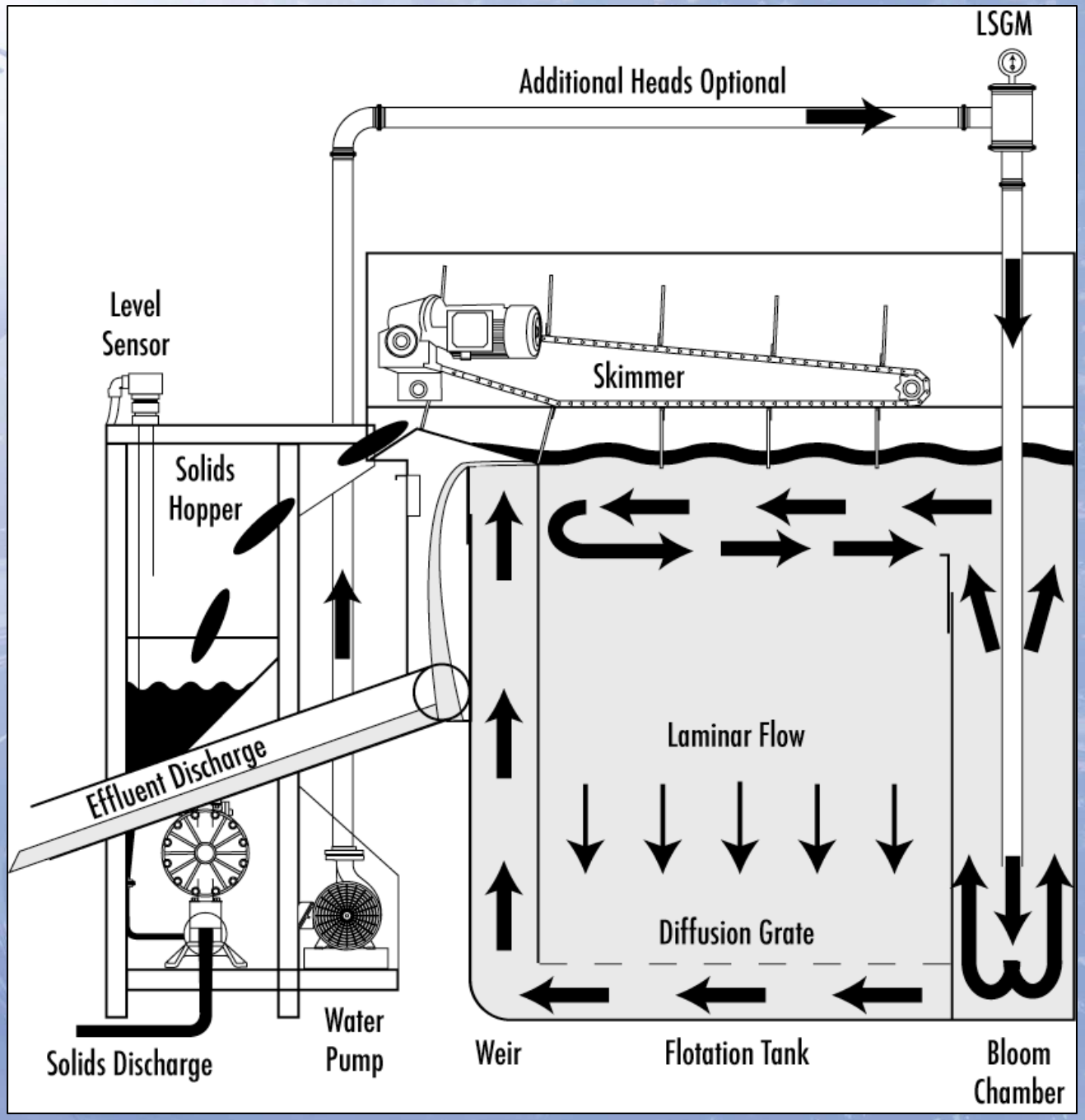
- Oil recovery and reuse from sludge
- Anaerobic reactor produces methane: energy
- Water reuse

In - Situ Flocculation Flotation

- GEM system unique in design
- Floc and bubble nucleation occur at the same time creating large porous, fast rising flocs
- Centrifugal swirl flow inside liquid cyclone cylinder efficient in activating polymer and promoting gentle flocculation - less polymers needed than in DAF
- 100% of flow is aerated, no recycle
- Solid-liquid separation occurs inside cyclone cylinders, tanks just used for skimming, small footprint

HYBRID DISSOLVED AIR – CENTRIFUGAL FLOTATION SCHEMATIC




LSGM
Additional Heads Optional
Level Sensor
Skimmer
Solids Hopper
Effluent Discharge
Laminar Flow
Diffusion Grate
Solids Discharge
Water Pump
Weir
Flotation Tank
Bloom Chamber


CWT
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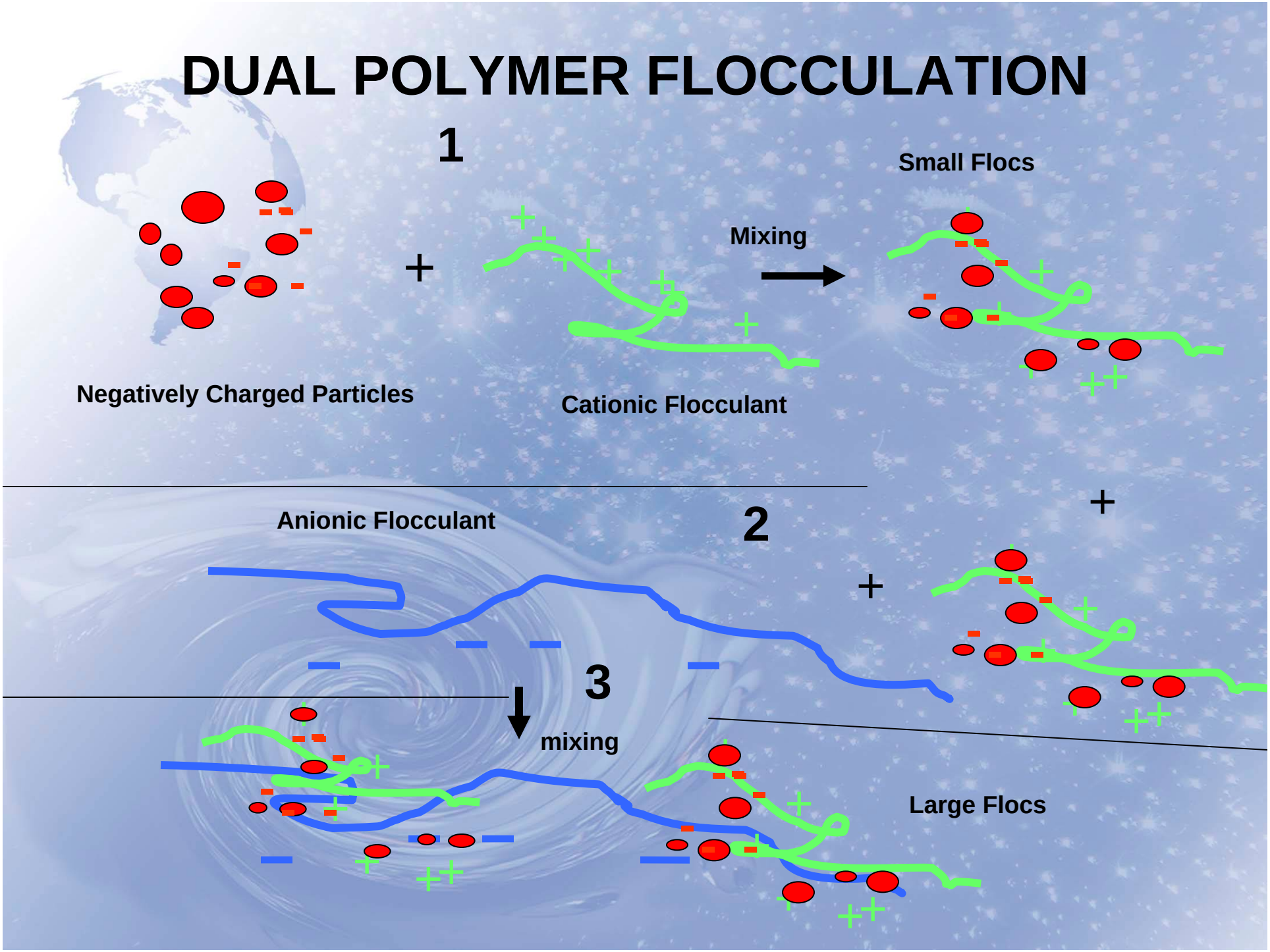
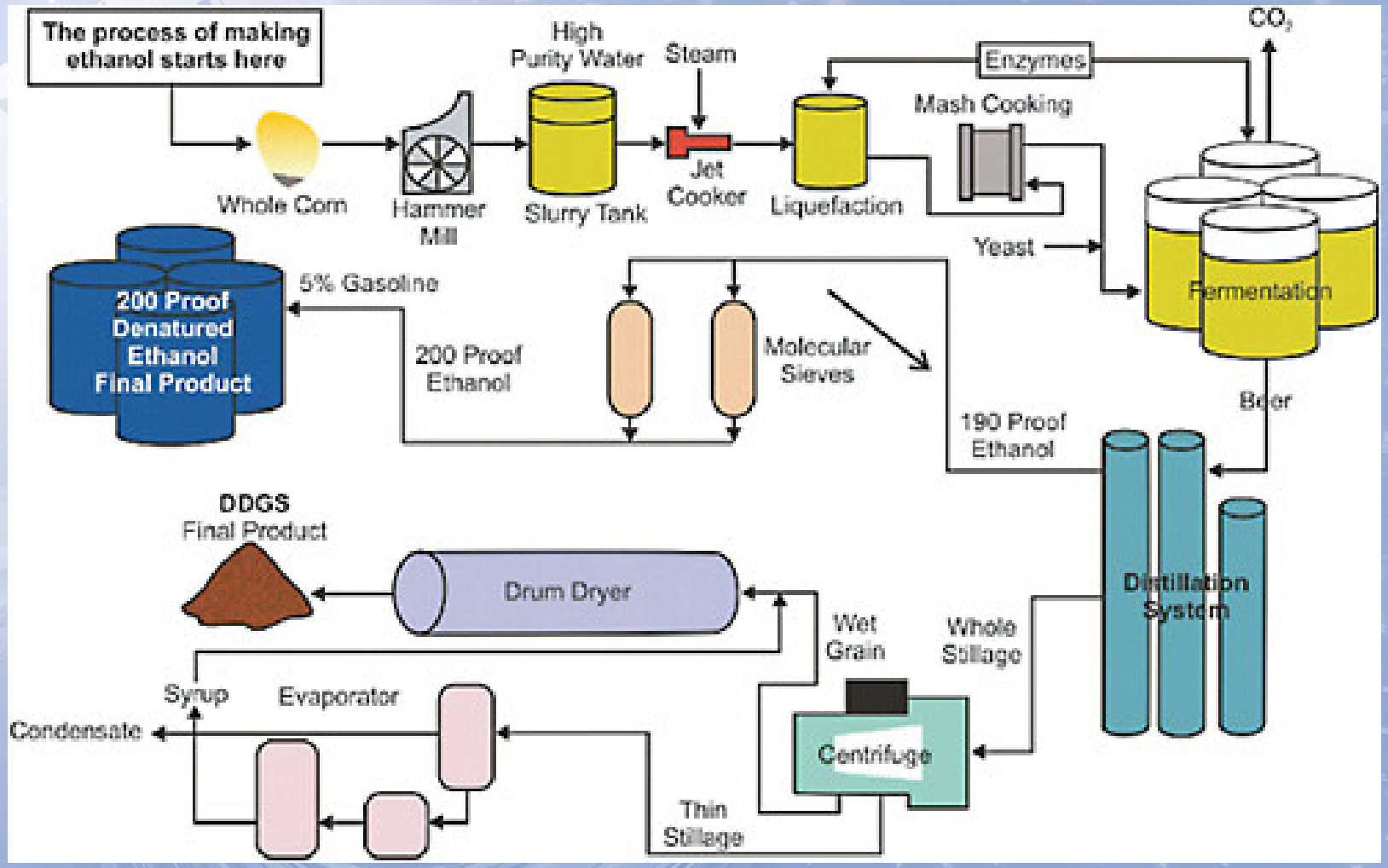
DUAL POLYMER FLOCCULATION



Flocculation – Flotation: results

- Effluent TSS below 50 mg/l
- Effluent FOG below 10 mg/l
- Effluent BOD vary between 2,000 and 23,000 mg/l, mostly methanol
- Effluent fully biodegradable
- Oils can be recycled from sludge
- Sludge 15-22% solids, after drain up to 30% solids

BIOETHANOL MANUFACTURING PROCESS



BIOETHANOL THIN STILLAGE TREATMENT

- Corn fibers, oil and syrup
- TSS between 10,000 and 78,000 mg/l
- FOG between 500 and 24,000 mg/l
- BOD between 25,000 and 160,000 mg/l

- In situ flocculation – flotation
- Advanced anaerobic bioreactor
- Membrane bioreactor

JAR TESTS OF THIN STILLAGE

SAMPLE: thin stillage; pH 3.7, increased to 6 with 500 ppm of NaOH

	Before		After		% Reduction
TSS/ppm	55,000		7,000		85%
COD/ppm	140,000		48,000		71%
FOG/ppm	7,600		85		98%

Treatment at pH 6:
250ppm of GRAS CATIONIC FLOCCULANT;
60 ppm of GRAS ANIONIC FLOCCULANT

BIOETHANOL WASTEWATER TREATMENT

- Stream segregation
- Fermentation wastewater
- Washing and storm drain
- Cooling tower and boiler blowdown:
  - RO for salt removal
  - Prefiltration useful to prevent RO fouling

CONCLUSIONS

- Biofuels manufacturing consumes large amount of water and produces difficult to treat wastewater
- Multistep treatment yields best results
- Screening - Flocculation – flotation followed by anaerobic bioreactor and MBR produces water ready for reuse
- Sludge reuse: oil extraction valuable
- Anaerobic bioreactors produce methane: energy recovery