Production of Renewable Fuels using DYNAJETS® Cavitating Jets

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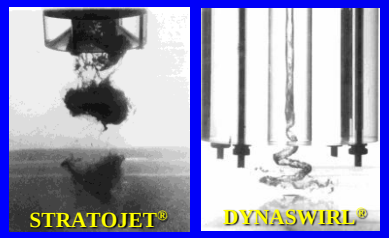
Cavitation

- Cavitation results form significant local pressure drop
- Collapsing bubbles produce large pressures & temperatures (~5,200 K, ~200 Atm).
- Water vapor dissociates into $OH^{\bullet}$ and $H^{\bullet}$ $\quad H_2O \rightarrow OH^{\bullet} + H^{\bullet}$
- Shear and pressure spikes break up biomass, lyse algae, create emulsions, speed chemical reactions
- DYNAJETS cavitating jet very efficient
- 1/10 – 1/100 energy required compared to ultrasonic cavitation
- Intensified cavitation using passive acoustic excitation or swirling flow.



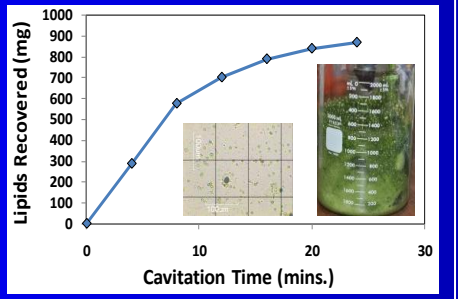
Photographs of cavitation regions produced by DYNAJETS® nozzles

Applications

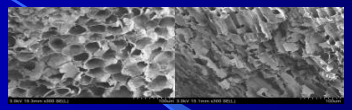
- *Cell lysis:* Cell membranes in dilute aqueous solutions ruptured
- *Biomass disruption*: Lingocellulose particles fragmented in solution
- *Mixing:* Multiphase fluids emulsified

Cell Lysis: Algae

- Cavitation lyses cell membranes : bacteria , algae, and zooplankton
- Algae can be lysed in dilute solutions and bio-products such as lipids can be recovered
- Physical separation processes such as solid phase extraction or foam fractionation shown to be effective.



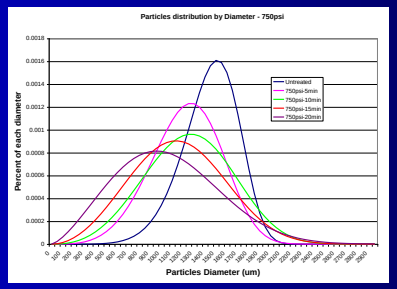
Recovery of lipids from 1% algae solution



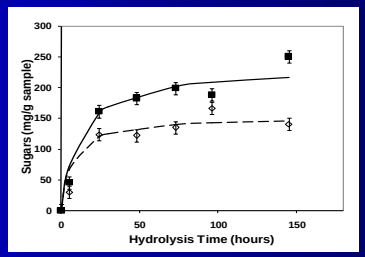
Scanning Electron Micrographs of corn cob before (left) and after (right)

Delignification

- Particle sizes of corn cob and pine wood reduced,
- Enzymatic hydrolysis rates increased
- Aqueous based reaction



Decrease in particle size of corn cob After cavitation treatment

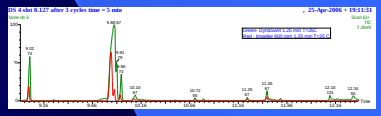


Increase in cellulose accessibility to enzymes after cavitation treatment

2-Phase Mixing Transesterification

- Rapid mixing of immiscible liquids such as Triglycerides and methanol
- Rapid transesterification reactions at room temperature & pressure

Rapid and complete mixing of immiscible liquids



Comparison of FAMEs from mechanical mixing and DYNAJETS® mixing

Conclusions

- Aqueous based reactions
- Free radicals can be formed from H_2O
- Room temperature and pressures
- Cavitation on particle surfaces
- Cell lysis of microorganisms in water
- Much better energy efficiency than ultrasonic devices