

# Application of Controlled Flow Cavitation in Oils & Fats Processing

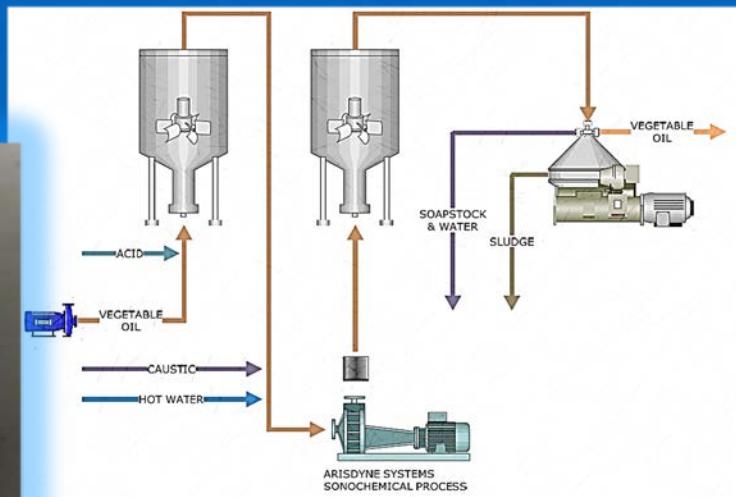
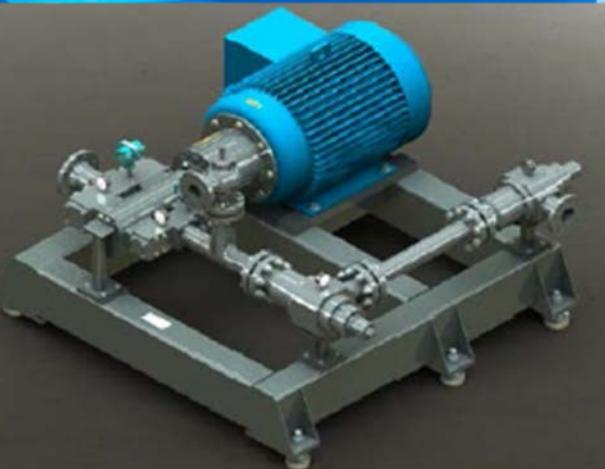
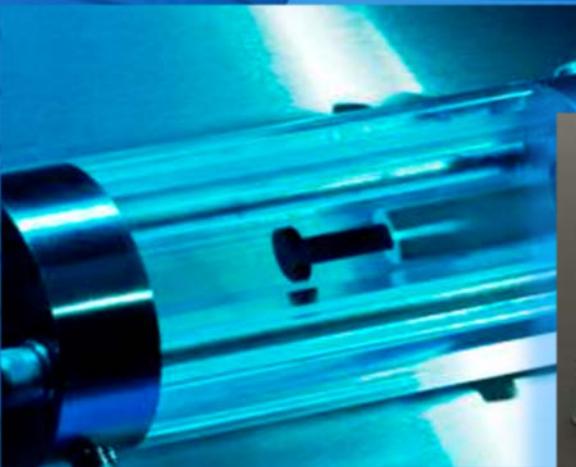


Figure 1 - Arisdyne Systems degumming/neutralization application

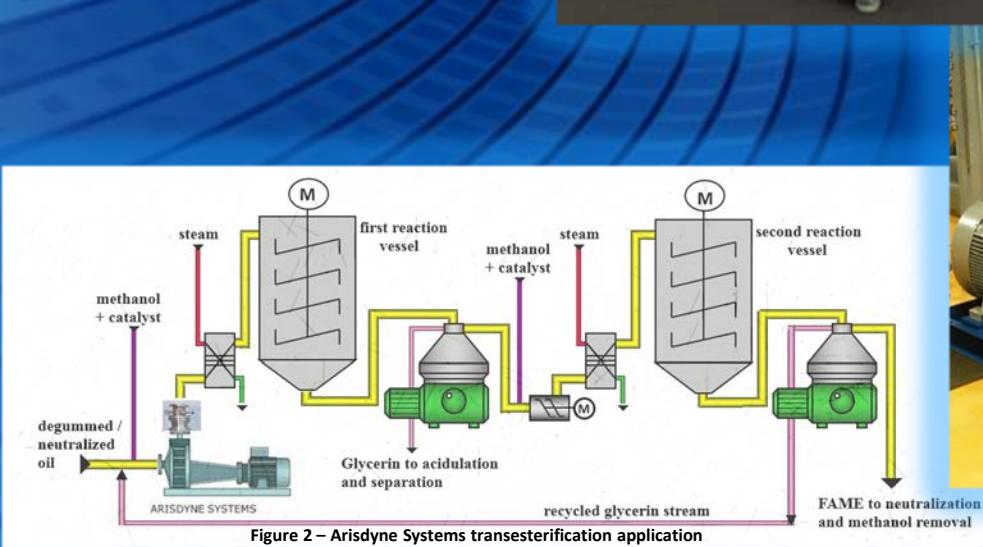
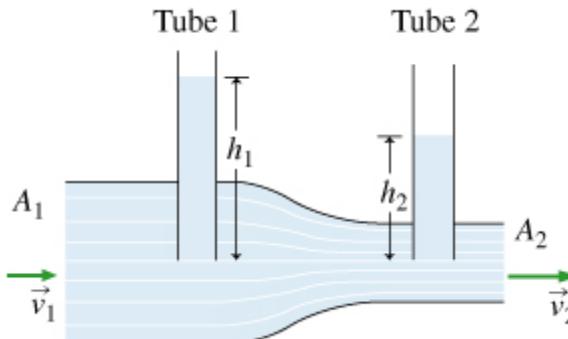


Figure 2 – Arisdyne Systems transesterification application



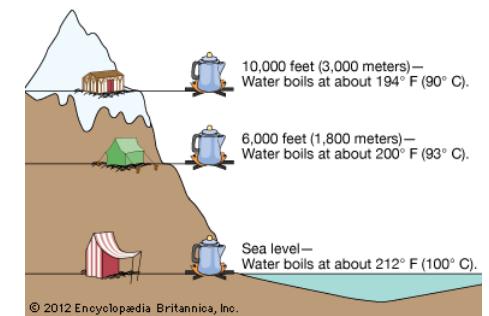
# Hydrodynamic Cavitation



Increase of speed leads to pressure reduction

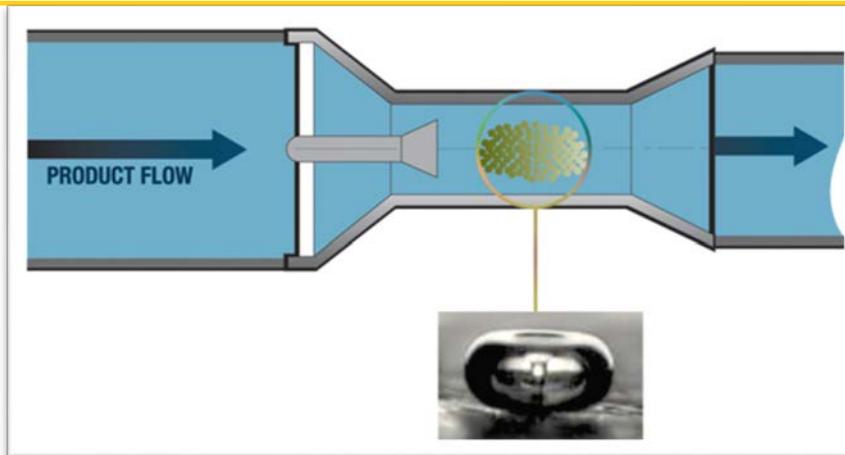
Reduced pressure leads to evaporation and vapor bubbles

Atmospheric pressure alters the boiling point of water



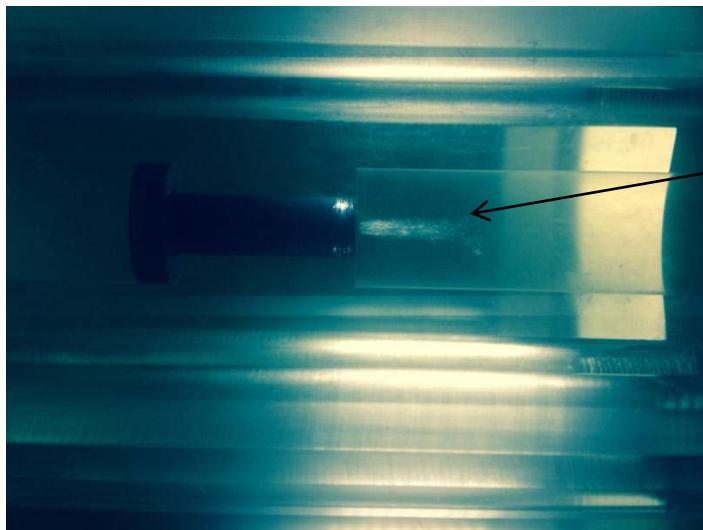
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# CFC™- cause & control cavitation

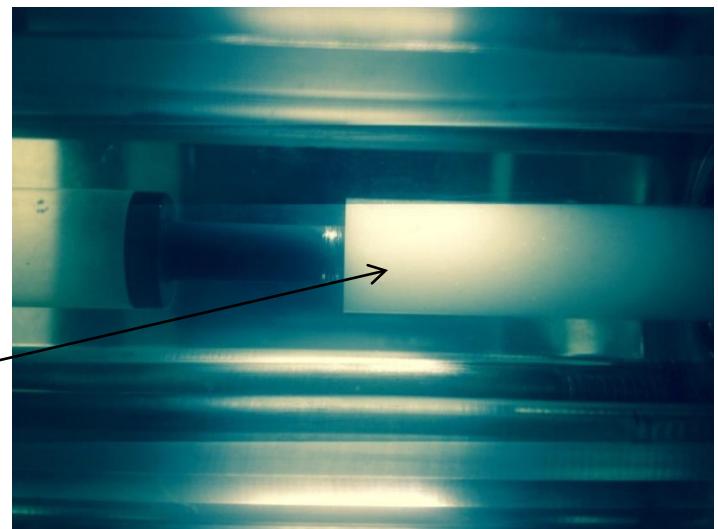


Compare  
'Controlled' vs.  
'Uncontrolled'  
Cavitation Demo  
at  
[www.arisdyne.com](http://www.arisdyne.com)

# CFC™- extreme energy peak



controlled bubble collapse –  
energy dissipation in small volume  
extreme energy peak



uncontrolled bubble collapse

# CFC™- extreme energy peak



# CFC™- a platform technology

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Liquid/Liquid	extreme small droplets in emulsions
Liquid/Powder	dispersions
Liquid/Solids	particle size reduction/ - disruption homogeneous particle size distribution
Liquid/Gas	extreme fine bubbles
Hot Spots	free radicals generation
Heating	instant, non scaling, highly efficient
Degassing	removal of low boiling components at low temp

# CFC™- over 20 successful years

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- Developed by Dr. Kozyuk with Five Star Technologies (est. 1995 in Cleveland, OH, USA)
- First Applications: Reaction enhancement, Nanomaterials synthesis
- Strong IP: 40+ issued patent families, 250+ patents and patent applications
- Blue Chip Customers:



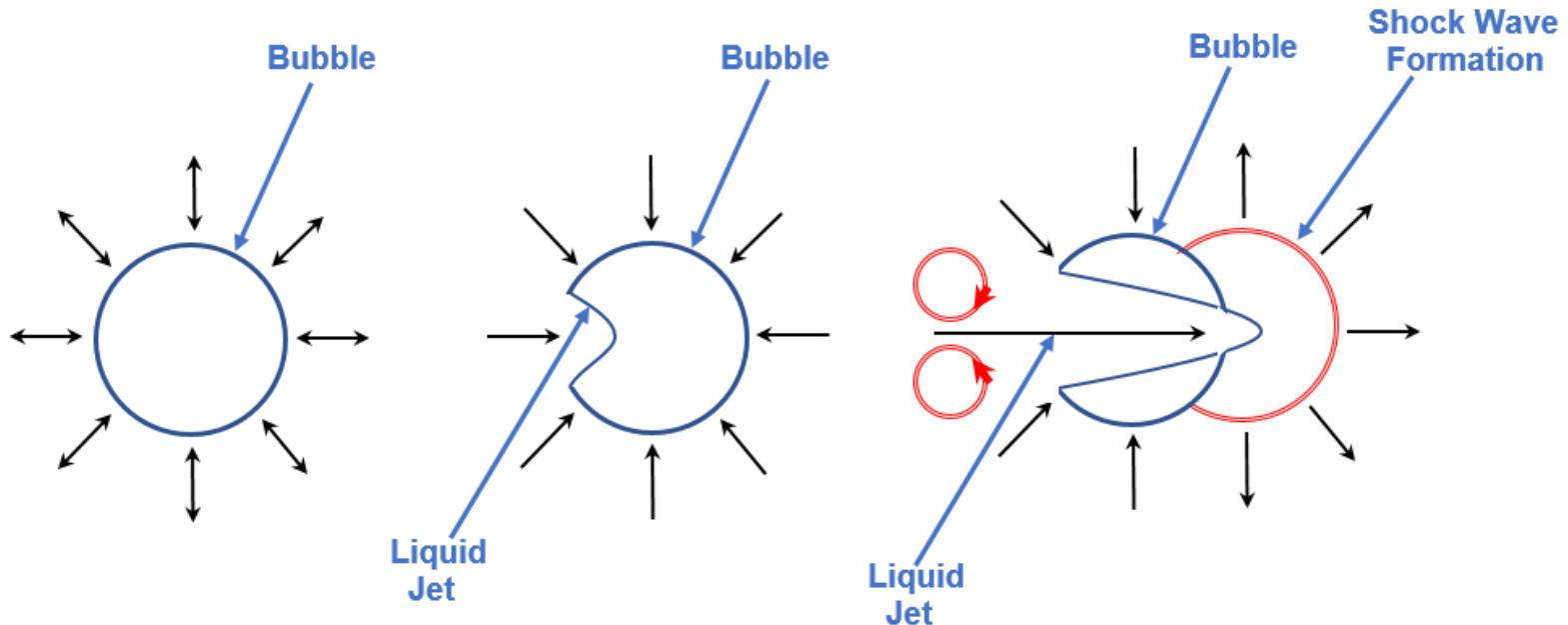
# Arisdyne Overview

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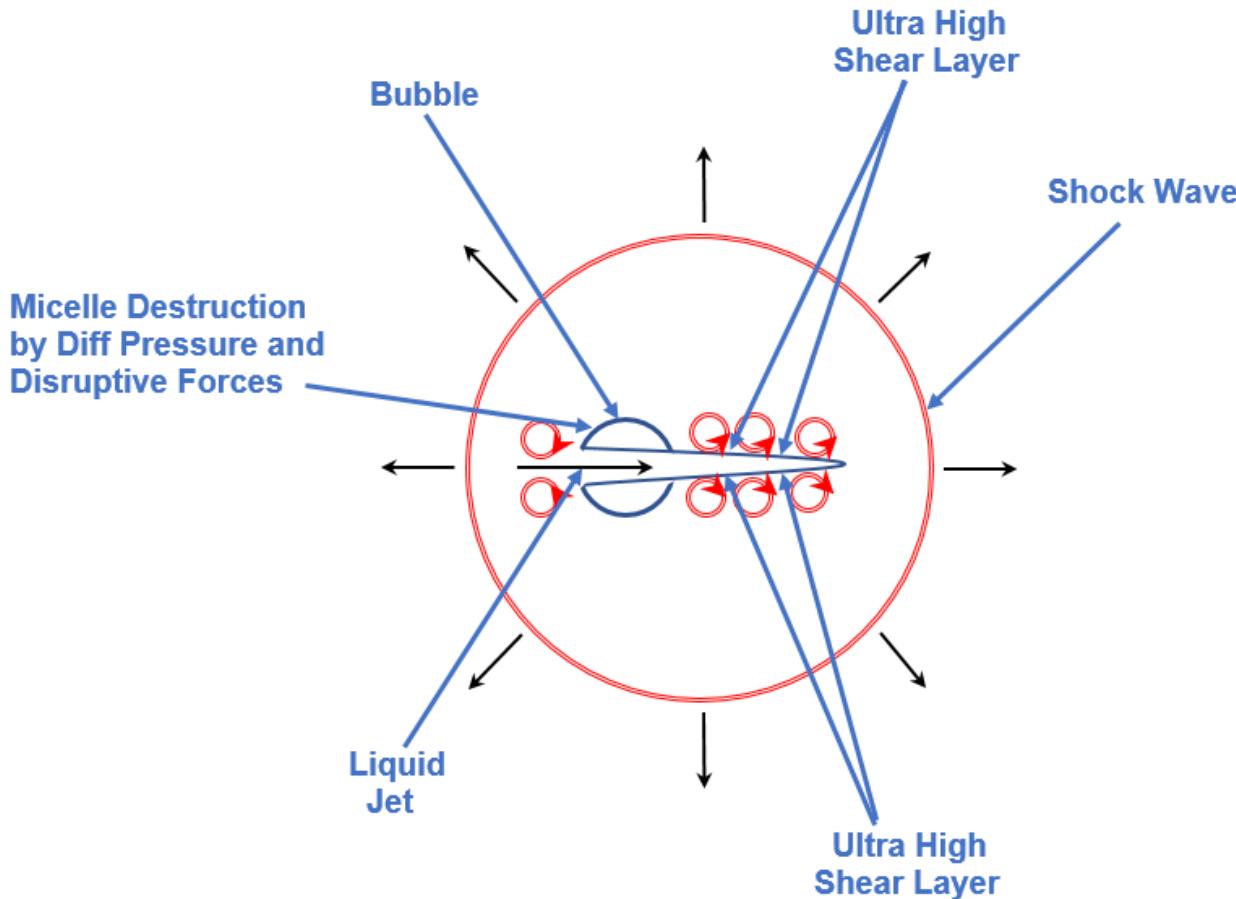
- Founded in 2008 – spin off of Five Star Technologies
- Mission: applying cavitation technology for process intensification
- Core Technology: Controlled Flow Cavitation (CFC™) produces powerful shock waves, ultra-high shear forces, high-temperature “hot spots”
- Strong oils & fats IP: 6 degumming patent families, 4 BioD patent families
- Currently more than 10% of all soy, canola and sunflower oil is produced with CFC™



# Stages of Bubble Pulsation, Microjet Formation and Collapse



# Effects on Chemical Reaction in the Cavitation Bubble Zone



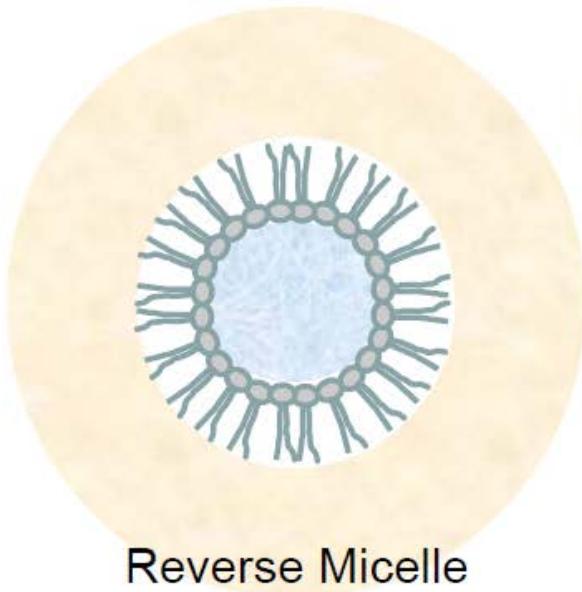
# Phospholipids in w/o emulsion

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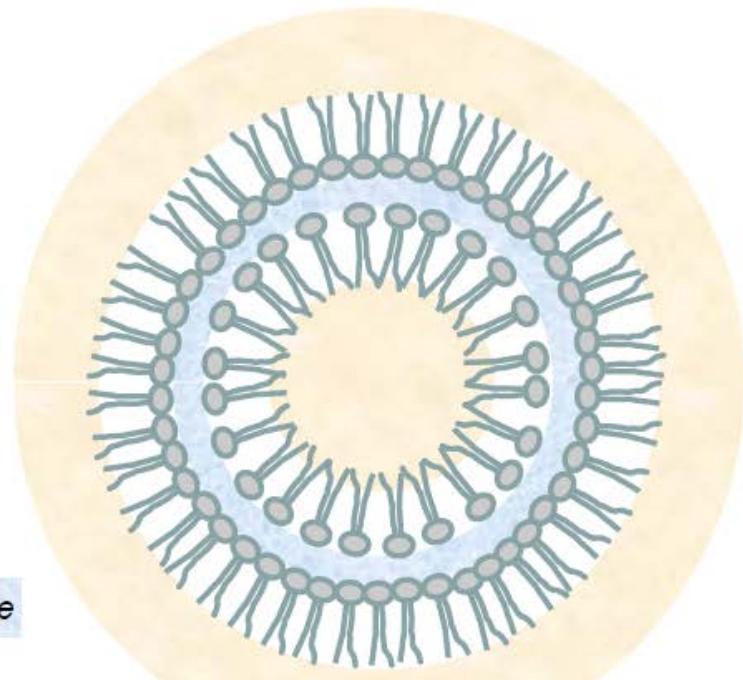
Polar head

Hydrophobic tail



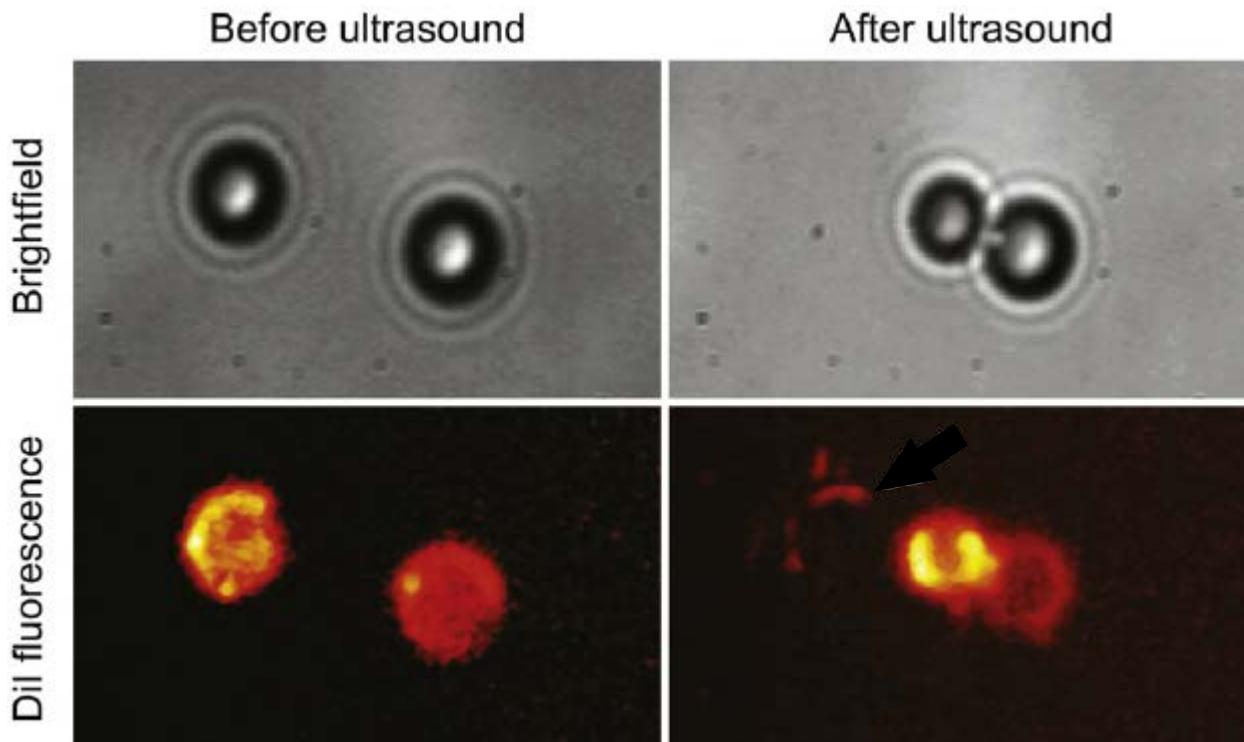
Reverse Micelle

aqueous phase



Reverse Liposome

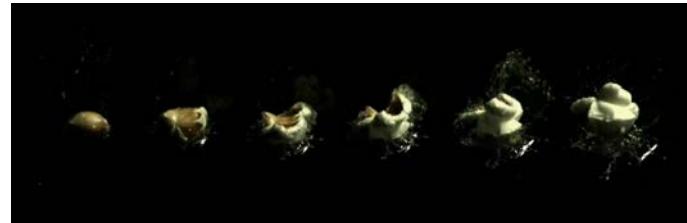
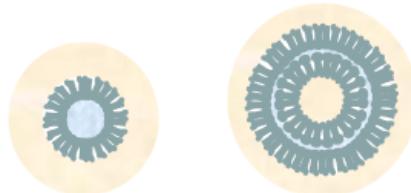
# CFC™- accelerated reaction



accelerated reaction due to attraction of lipid to bubble due to Bjerkenes floatation effect

# CFC™- accelerated reaction

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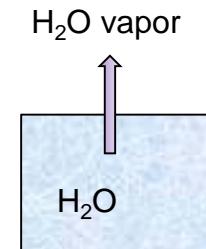
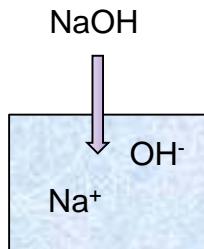


micelle destruction through water evaporation

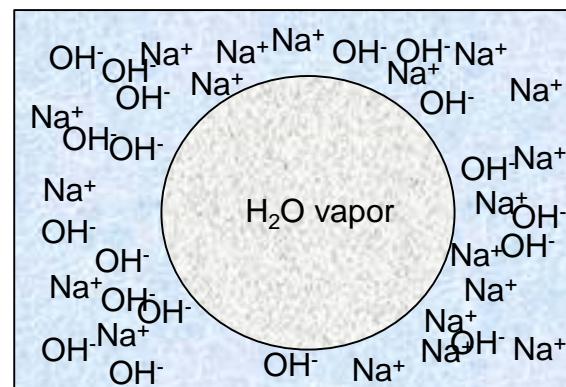
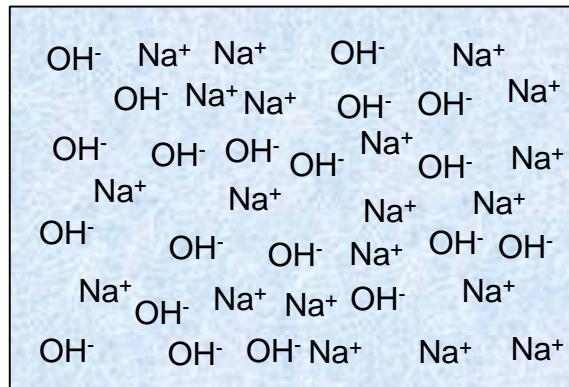


accelerated reaction through free phospholipids

# CFC™- accelerated reaction



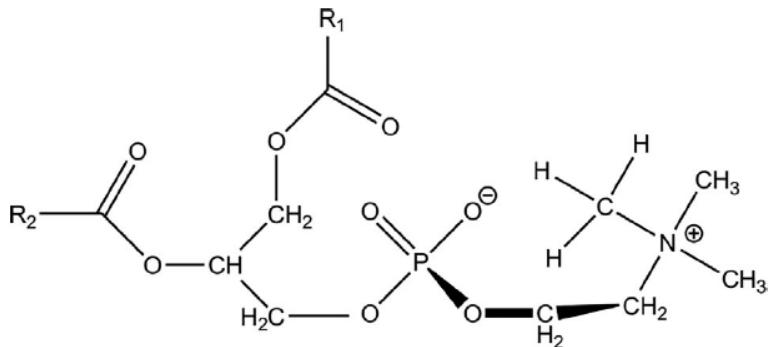
increase of NaOH concentration through water evaporation



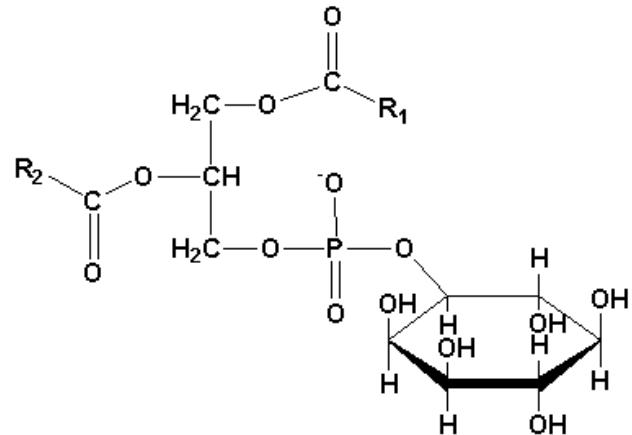
accelerated reaction due to increase of NaOH concentration in remaining aqueous phase

# CFC™- increased hydration

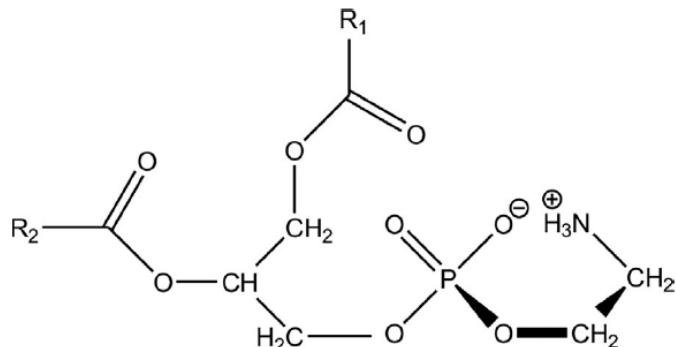
Phosphatidylcholine



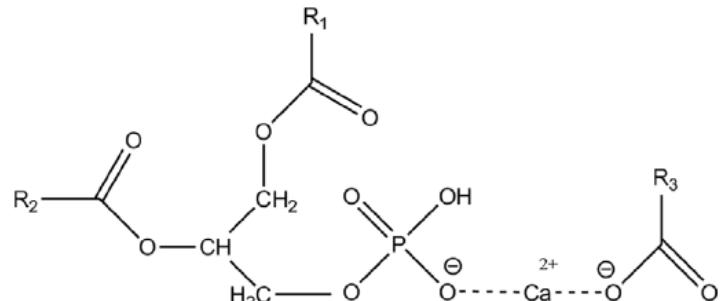
Phosphatidylinositol



Phosphatidylethanolamine



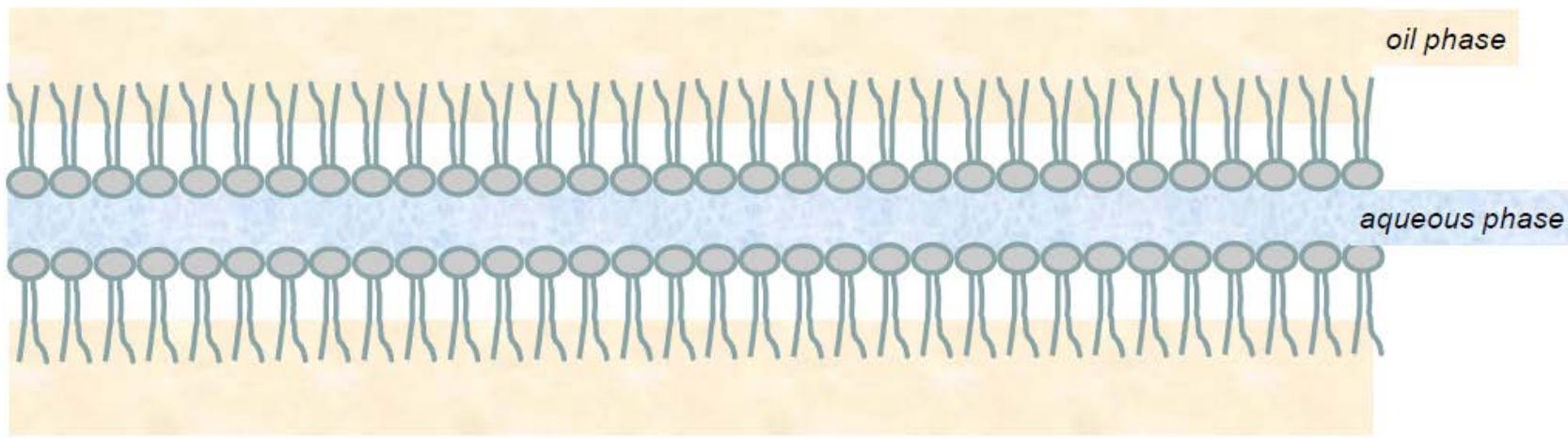
Phosphatidic acid



# CFC™- changes to heavy phase

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Higher yield due to lower oil entrainment



Reverse Bilayer

# Degumming and Neutralization of Lipids Using CFC™

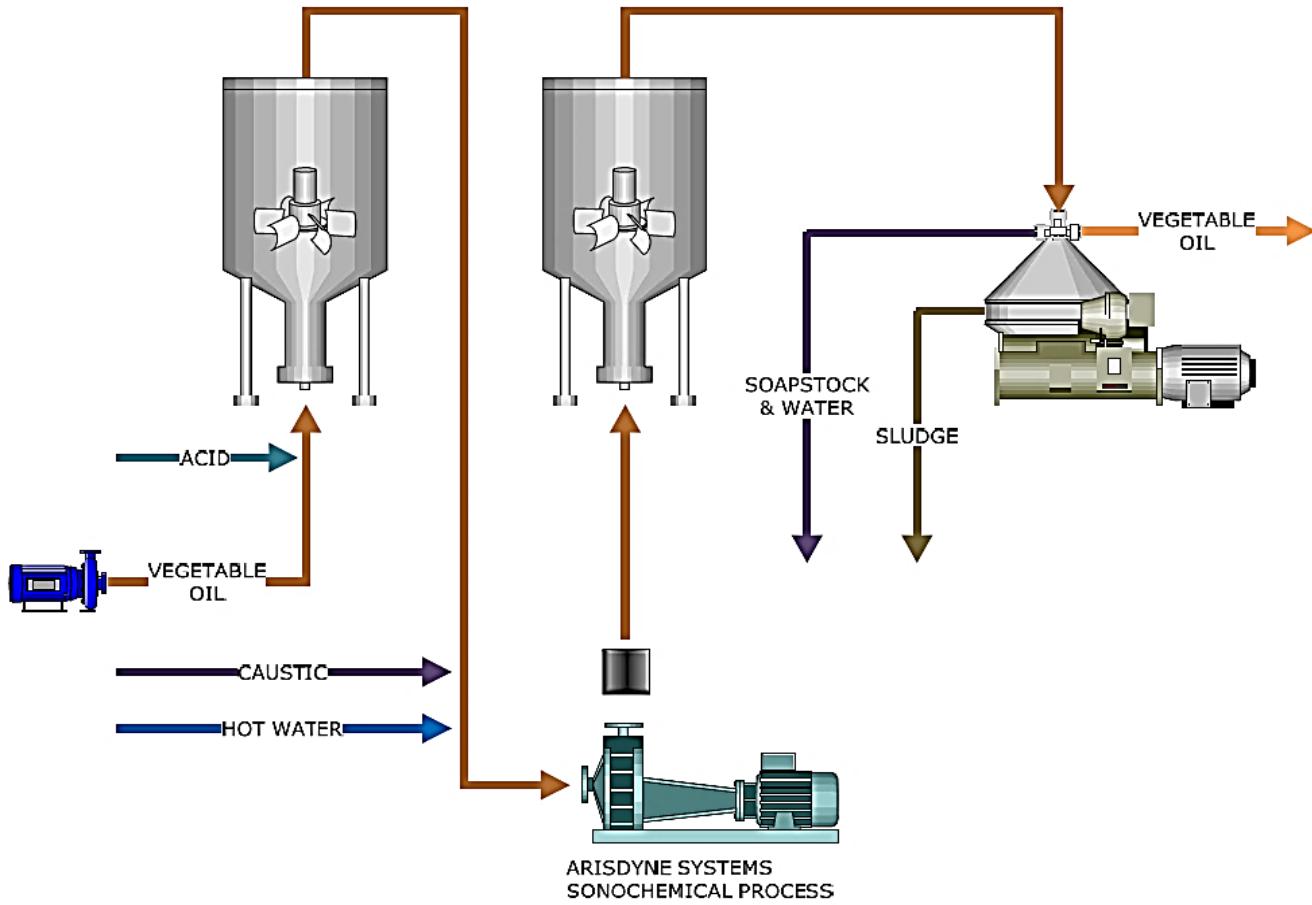


Figure 1 - Arisdyne Systems degumming/neutralization application

# Anticipated Improvements

## Refining With CFC™

- Oil Yield Improvement:

0.1-0.5%

- Reduction in

- Phosphoric Acid:

50-90%

- Caustic Usage:

15-50%

- Residual Soaps:

to <150 ppm

- Residual Phosphorus:

to <5 ppm

- Silica Usage:

40-100%

- Water Washing:

50-100%

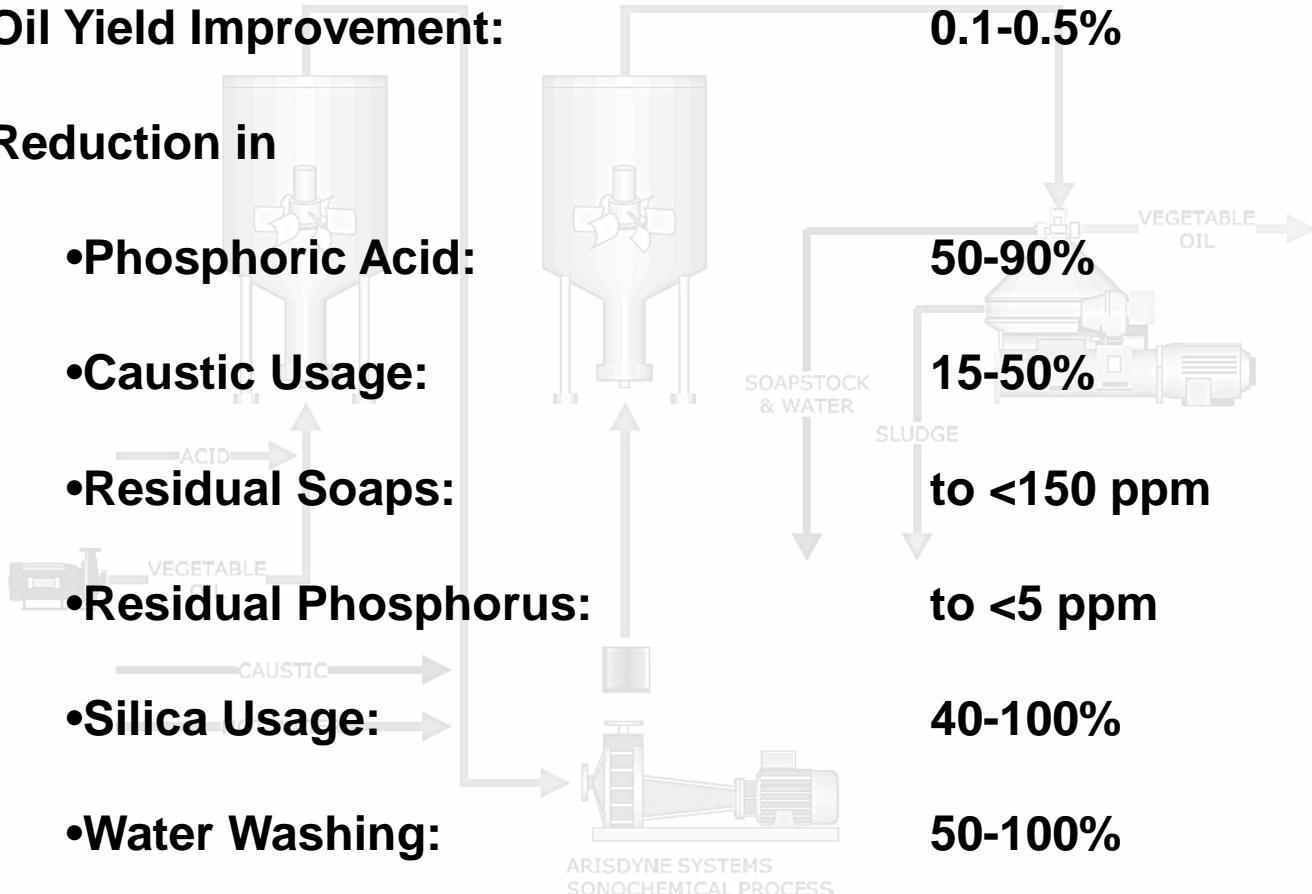


Figure 1 - Arisdyne Systems degumming/neutralization application

# Industrial Scale Example

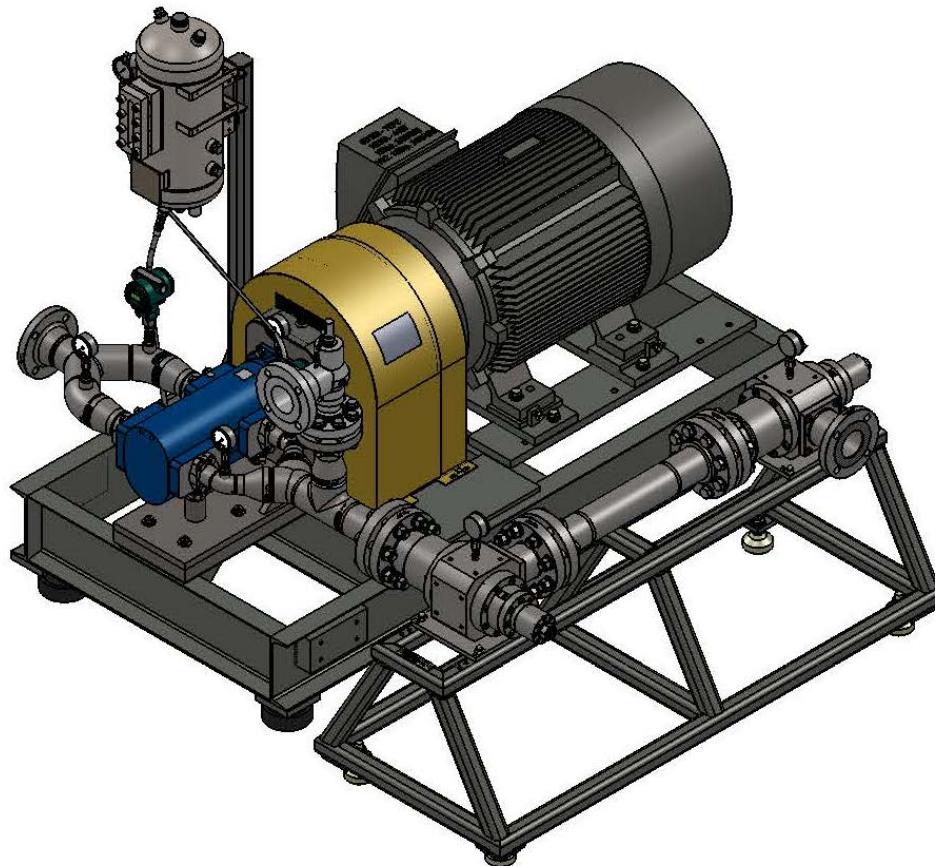
## Crude Canola Oil Test Results

	3 Month Average pre CAV	1 month post CAV	Amount Changed	\$ Cost/unit	Savings \$/MT	Savings \$/year 450 mt/d	Savings \$/year 600 mt/d
<b>Oil Loss %</b>	2.377%	2.180%	0.197%	1.15	2.27	356,816	475,755
<b>Caustic Usage (KG/MT)</b>	4.283	3.570	0.713	0.65	0.46	72,993	97,325
<b>Phosphoric usage (KG/MT)</b>	1.10	0.89	0.210	1.90	0.40	62,843	83,790
<b>Power increase (kWh/MT)</b>			-3.90	0.09	-0.35	-55,283	-73,710
<b>Soaps in Oil (PPM)</b>	180	146					
<b>Production (MT)</b>	13,757	15,920					
<b>Bleaching Clay Usage (KG/MT)</b>	11.07	9.470	1.600	0.500	0.80	126,000	168,000
			<b>Total Savings</b>		3.58	563,370	751,160

Production Rate (mt/d)	450	600
Production Rate (mt/h)	18.75	25
Production Rate (gpm)	92	122
Production Days per year	350	350
Annual Production (MT)	157500	210000

# Small Footprint, Simple Design

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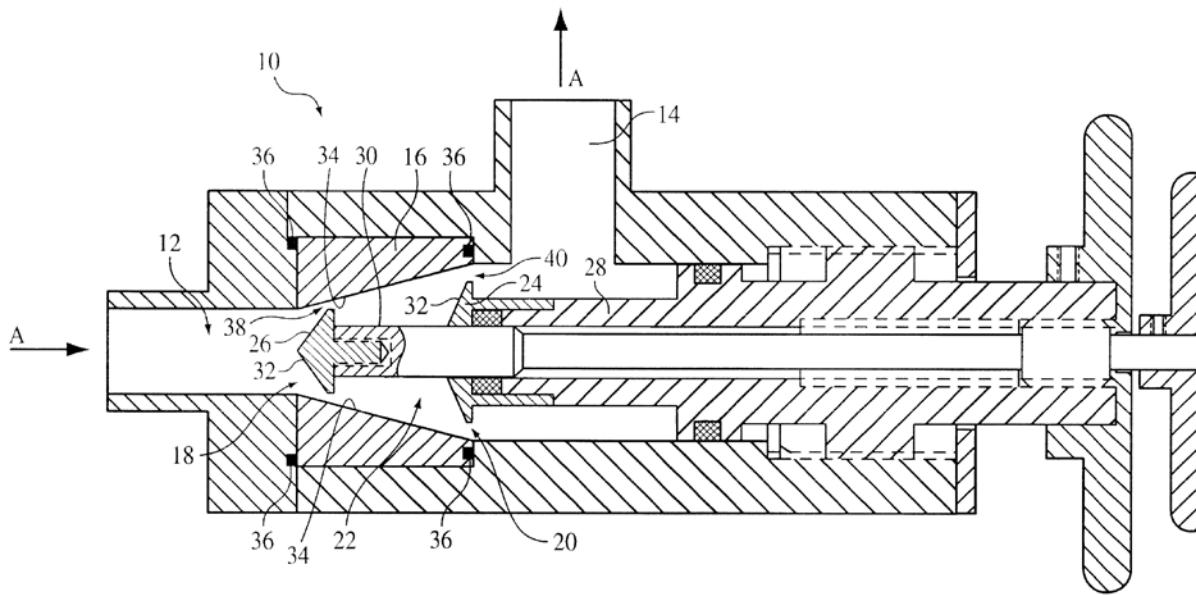


# Small Footprint, Simple Design



Adjustable device:  
No CIP  
No Recycle

# Adjustable Device



**Device and method for creating  
hydrodynamic cavitation in fluids**  
**US 6502979 B1**

# Continuous Biobiodiesel Production Using Controlled Flow Cavitation

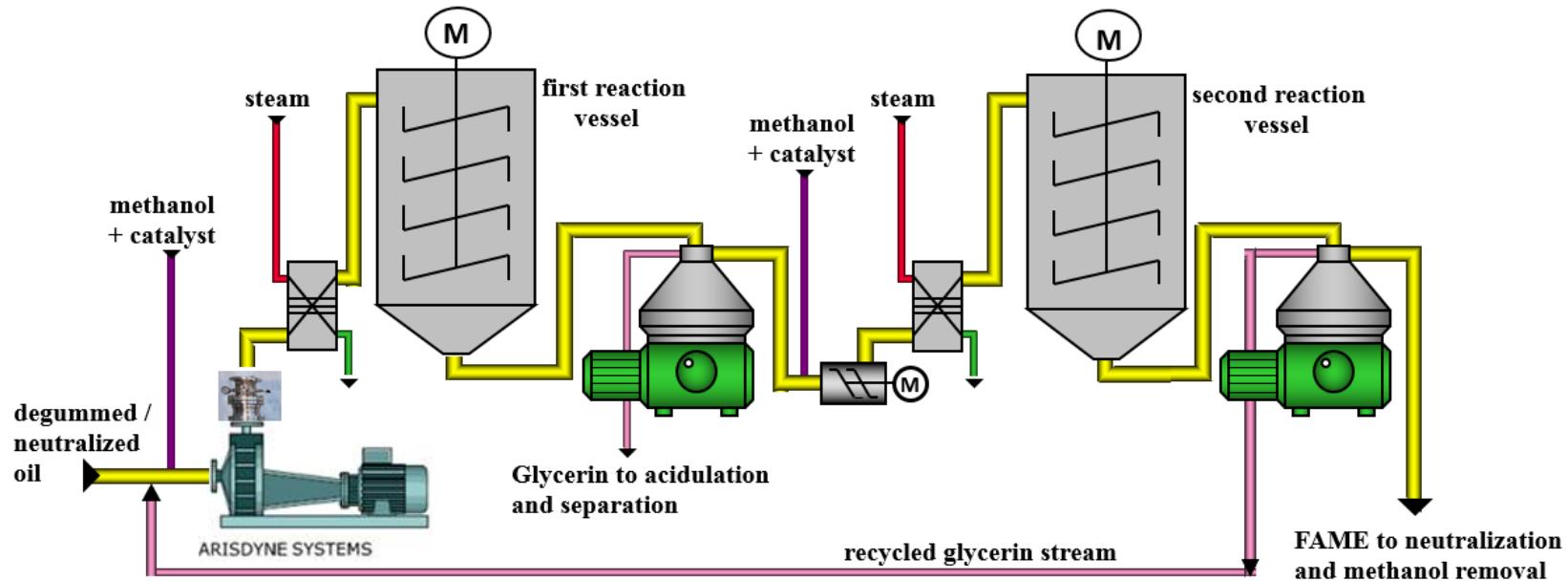


Figure 2 – Arisdyne Systems transesterification application

# Anticipated Improvements With CFC™ Transesterification

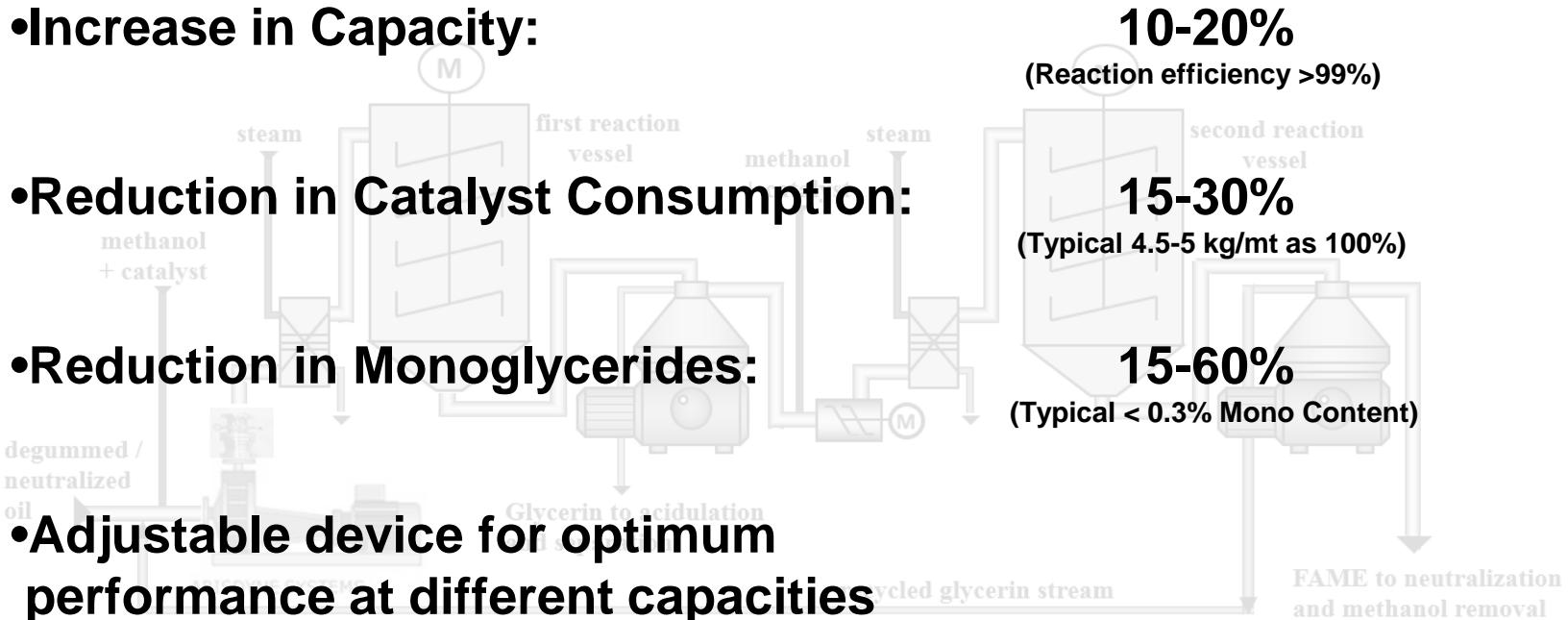
- Increase in Capacity:

- Reduction in Catalyst Consumption:

- Reduction in Monoglycerides:

- Adjustable device for optimum performance at different capacities

- No Production Downtime for Installation



# Industrial Scale Example

## Biodiesel Production

FEED	FFA (%)	Moist (%)	Catalyst Used
UCO, Tallows, Greases, SBO, CNO	< 0.15	< 0.05	30% NaOCH <sub>3</sub>
Transesterification	Feed Rate [lbs/min]	Catalyst Usage [%]	Mono Content [%]
Conventional	700	2.6	0.59
CFC™	800	2.1	0.28 (achieved at 600 lbs/min flowrate and 2.6% catalyst usage) Avg. < 0.45 (achieved at 800 lbs/min and 2.1% catalyst usage)

# Small Footprint, Simple Design

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# CFC™ Models

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Model (#)	Capacity (mt/h)	Power (kW)
CM 600	6-13	15-35
CM 1000	9-20	35-80
CM 1500	12-30	55-90
CM 1800	20-40	55-110
CM 2400	25-50	75-150
CM 3500	35-70	100-300
CM 4800	50-100	160-320

Overall Dimensions: 2m x 2m x 1.2m

# Conclusions

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## ■ CFC™ in Lipid Refining Applications

- More Efficient Removal of Phos/Metals/FFA
- Less Phosphoric/Citric Acid/Caustic Soda
- Less Silica/Bleaching Earth
- May Eliminate Need for Water Washing
- Increased Oil Yield
- Lower Operating Costs

## ■ CFC™ in Transesterification Application

- Less Catalyst Usage
- Reduction in Reaction Time
- More Complete Reaction (lower mono-, di-)

# Thank You For Your Time

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**Dir. of Techn. Sales – Oils & Fats & Biod.**  
**+1 (216) 389-0230**  
**[dlittle@arisdyne.com](mailto:dlittle@arisdyne.com)**

# ASI's Team

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- **Dr. Peter Reimers, President & CEO**
  - GM Oleochemicals & Biofuels at Archer Daniels Midland (ADM)
  - MD of Technology Strategy at ADM
- **Dr. Oleg Kozyuk, CTO**
  - Founder of Cavitation scientific field
  - Holds over 150 cavitation patents
- **Nick Berchtold, COO & CFO**
  - 26 years of CFO experience
  - 3 successful corporate divestitures
- **Paul Reinking, Dir. New Applications**
  - Production Manager IKA (high shear force mixers)
  - 18 years experience in CFC™
- **Darren Little, Dir. Sales Oils&Fats, BioD**
  - 26 years experience in fats & oils & biodiesel
  - Dir. Sales GEA Westfalia, NA
  - Dir. Sales Sud-Chemie Bleaching Earth, NA

# ASI's Business

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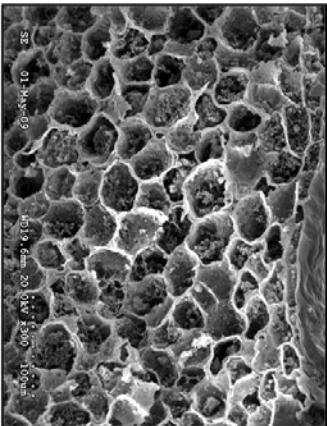
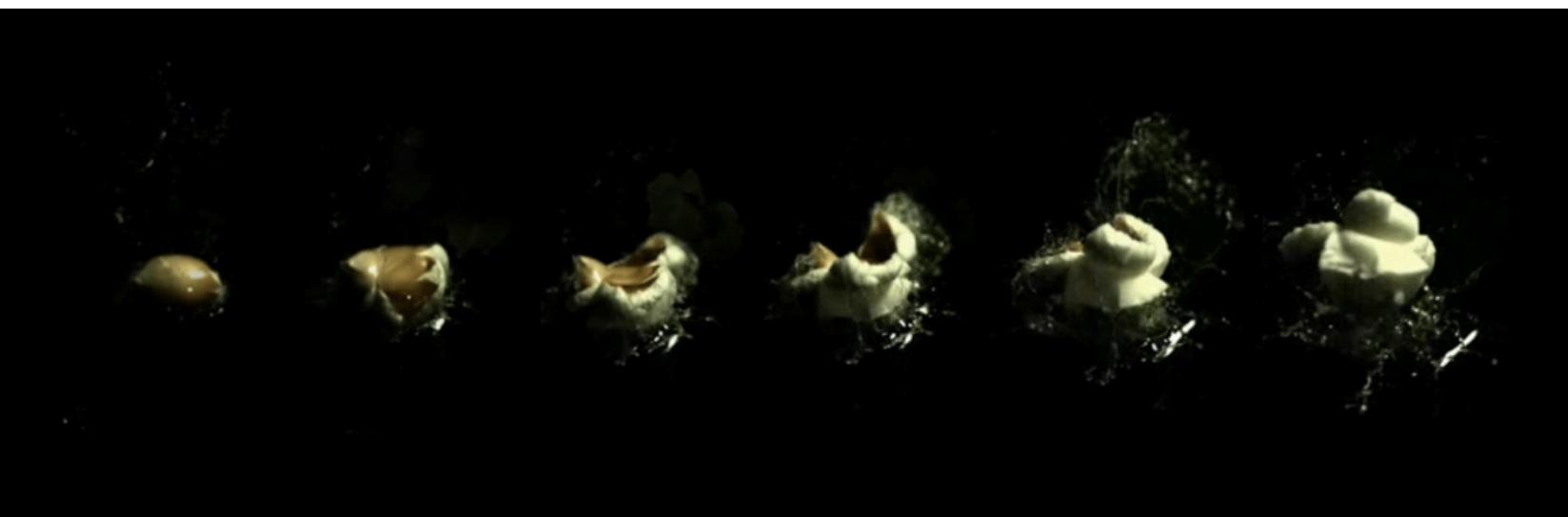
1. Manufacture and sell CFC systems
  - Vegetable Oil Refining
  - BioDiesel
  - Ethanol
2. Manufacture and sell conductive inks
3. Joint Development programs
  - ExxonMobil
  - ADM

# ASI Product History

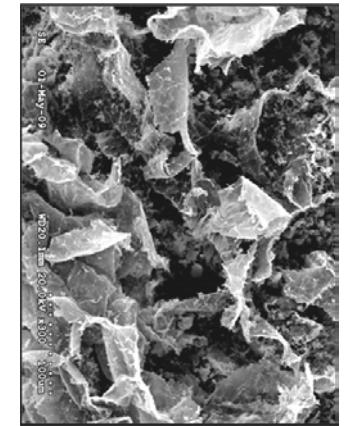
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- 2006 designed and sold small scale biodiesel reaction system
- 2009 Arisdyne began tests on petroleum crude oil
- 2010 first commercial ethanol system installation
- 2012 start of production of conductive inks
- 2012 first commercial municipal waste water treatment installation
- 2013 first commercial vegetable oil neutralization system installation

# “CFC™- Popcorn-Effect”

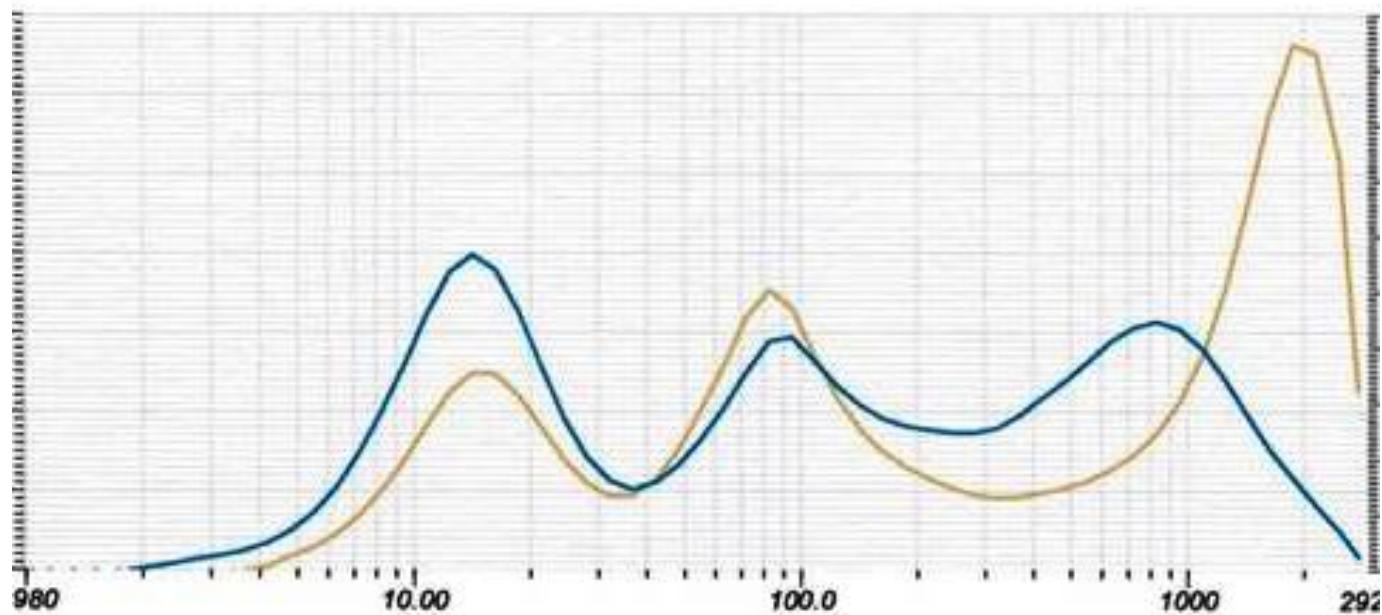


CFC™ creates low pressure zones, where corn kernel cell wall structure explode (“popcorn effect”) followed by the shock wave, which reduces particle size.



# Particle Size Reduction

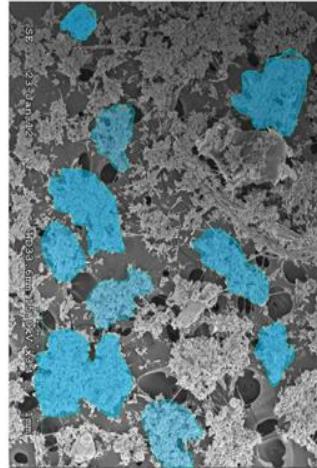
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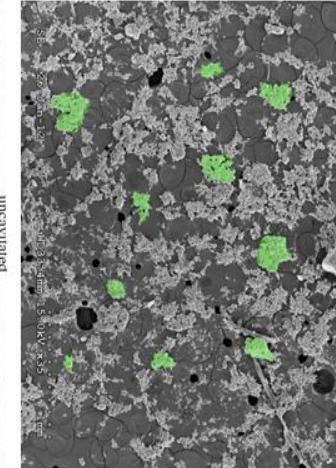
# CFC™- Extreme Energy Peak

Example WWTP

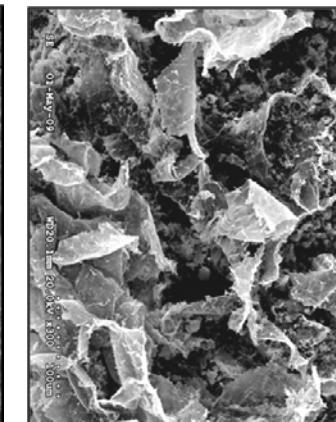
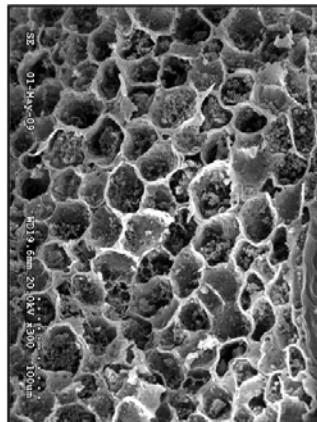
Pre



Post



Example Corn Slurry



# Crude Soybean Oil

FEED	FFA (%)	Phos (ppm)	Ca + Mg (ppm)
Soybean	0.6 – 0.8	400 - 650	65 - 120

REFINING	FFA [%]	Phos [ppm]	Soap [ppm]	(100%) H <sub>3</sub> PO <sub>4</sub> Reduction	(100%) NaOH Reduction
Conventional	0.015-0.03	< 20	250 - 400		
CFC™	0.01 – 0.02	< 10	90 – 150	60 – 85% (Avg 150 ppm)	20 – 40% (Avg 1300 ppm)

# Mixed Crude / Degummed Soybean Oil

FEED	FFA (%)	Phos (ppm)	Ca + Mg (ppm)
Soybean	0.3 – 0.5	400 - 550	50 - 90

REFINING	FFA [%]	Phos [ppm]	Soap [ppm]	(100%) H <sub>3</sub> PO <sub>4</sub> Reduction	(100%) NaOH Reduction
Conventional	0.02	< 20	200-250		
CFC™	0.02	< 10	120-150	25 – 50% (Avg 175 ppm)	15 – 40% (Avg 1600 ppm)

# Degummed Soybean Oil

FEED	FFA (%)	Phos (ppm)	Ca + Mg (ppm)
Soybean	0.5 – 1.2	100 - 200	45 - 80

REFINING	FFA [%]	Phos [ppm]	Soap [ppm]	(100%) H <sub>3</sub> PO <sub>4</sub> Reduction	(100%) NaOH Reduction
Conventional	0.02	< 5	200		
CFC™	0.02	< 5	125	50 – 80% (Avg 125 ppm)	30 – 60% (Avg 1100 ppm)

# Degummed Rapeseed Oil

FEED	FFA (%)	Phos (ppm)	Ca + Mg (ppm)
Rapeseed	0.6 – 0.75		

REFINING	FFA [%]	Phos [ppm]	Soap [ppm]	(100%) H <sub>3</sub> PO <sub>4</sub> Reduction	(100%) NaOH Reduction
Conventional	0.02	12	> 300		
CFC™	0.02	< 10	< 200	20 – 40% (Avg 220 ppm)	15 – 30% (Avg 1450 ppm)

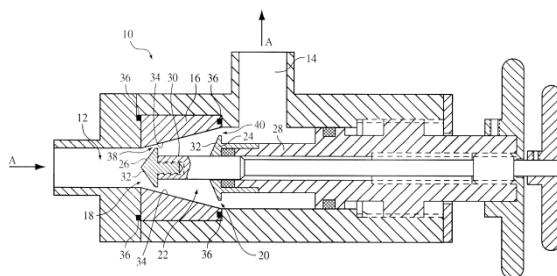
# Crude Canola Oil

FEED	FFA (%)	Phos (ppm)	Ca + Mg (ppm)
Canola	0.5 – 0.8	350 - 600	190 - 300

REFINING	FFA [%]	Phos [ppm]	Soap [ppm]	(100%) H <sub>3</sub> PO <sub>4</sub> Reduction	(100%) NaOH Reduction
Conventional	0.05	< 15	350 - 400		
CFC™	0.03	< 10	50-150	25 – 50% (Avg 550 ppm)	20 – 50% (Avg 1250 ppm)

# CFC™ versus Nano

## CFC™ Technology



## Nano Neutralization®



Adjustable Capacity?



One pass through

Recycle loop

Anti clogging

CIP

No dark material build up

Easy to control

Energy efficient