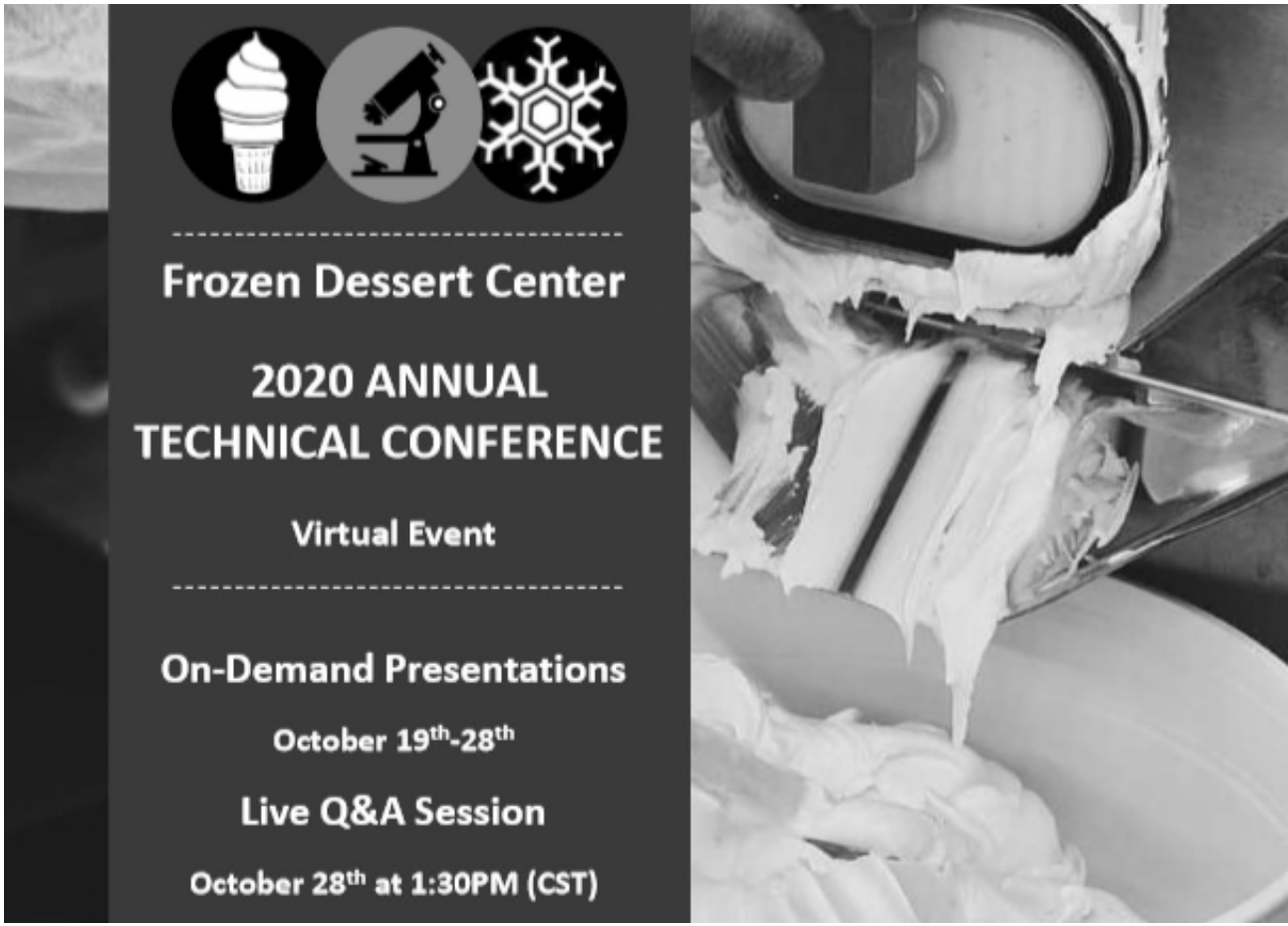
SPXFLOW

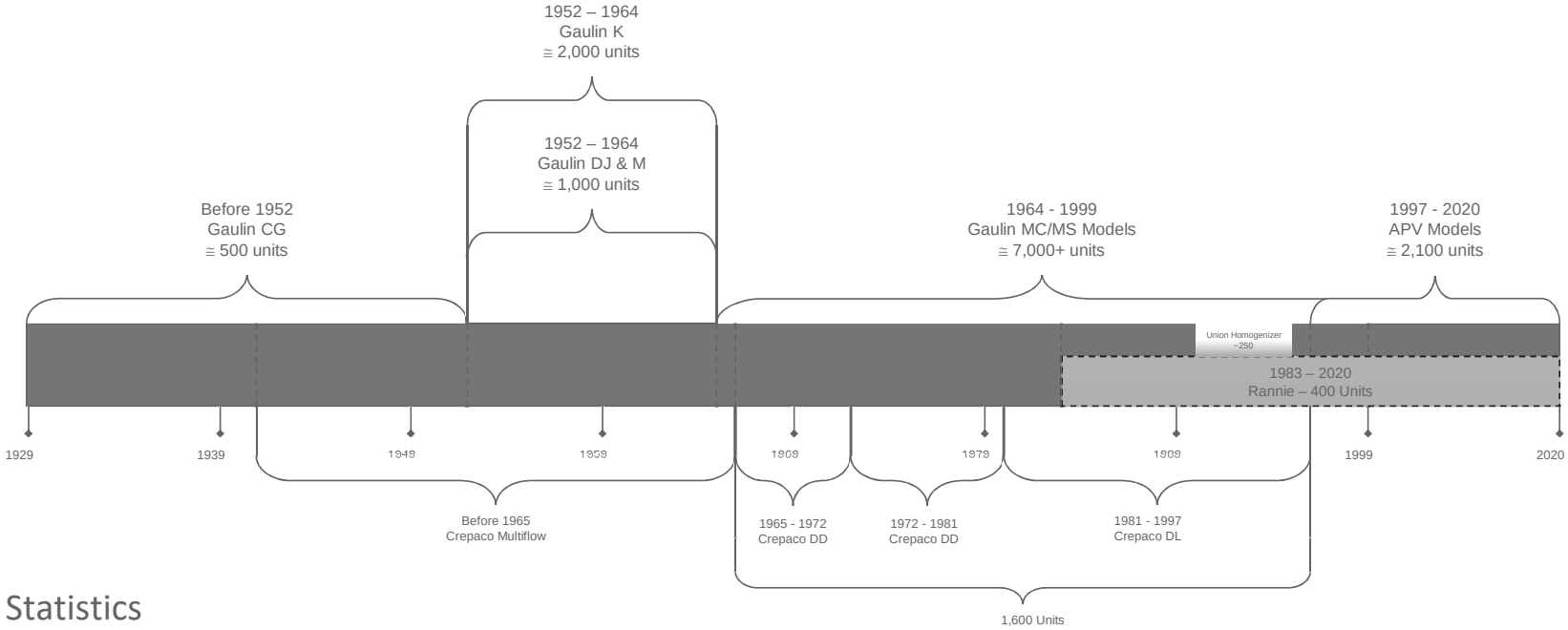
Homogenizer Theory and Basics



Training Goals

- After this session, I hope you know how homogenizers work.
- Why different products are homogenized.
- What the benefits of homogenization are.
- Some of the more common applications for homogenizers.

Homogenizer Timeline
North America



- Facts & Statistics
  - 23,000 Gaulin Units produced in the USA since the 1940's
  - 2,500 Crepaco Units produced in the USA since 1955
  - Confirmed installed base of Gaulin homogenizers in 2009 was at least 8,800
  - Total Number of SPX FLOW APV active machines in North America – as many as 9,000

SPX FLOW has unprecedented experience with homogenization

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Homogenizer

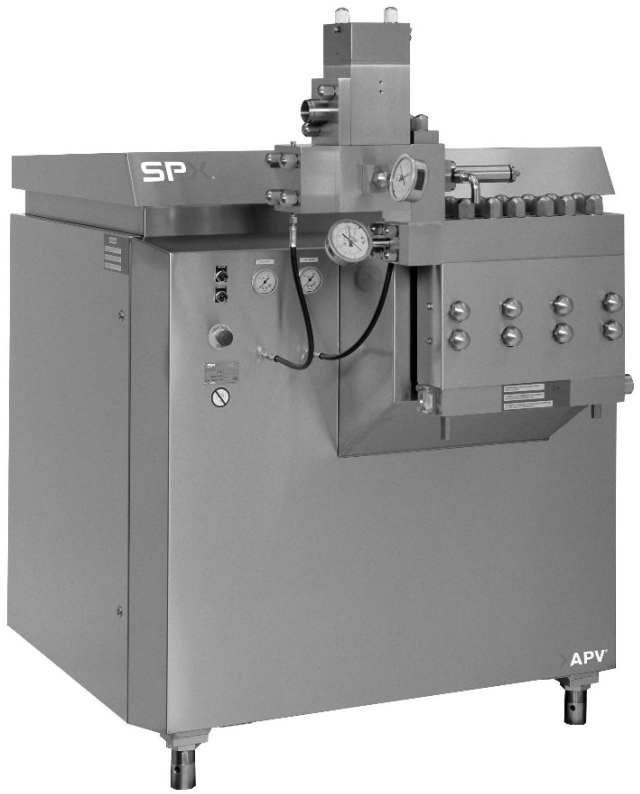
Basic Training

What is a Homogenizer?

- Homogenizer Basic Training

Homogenizers

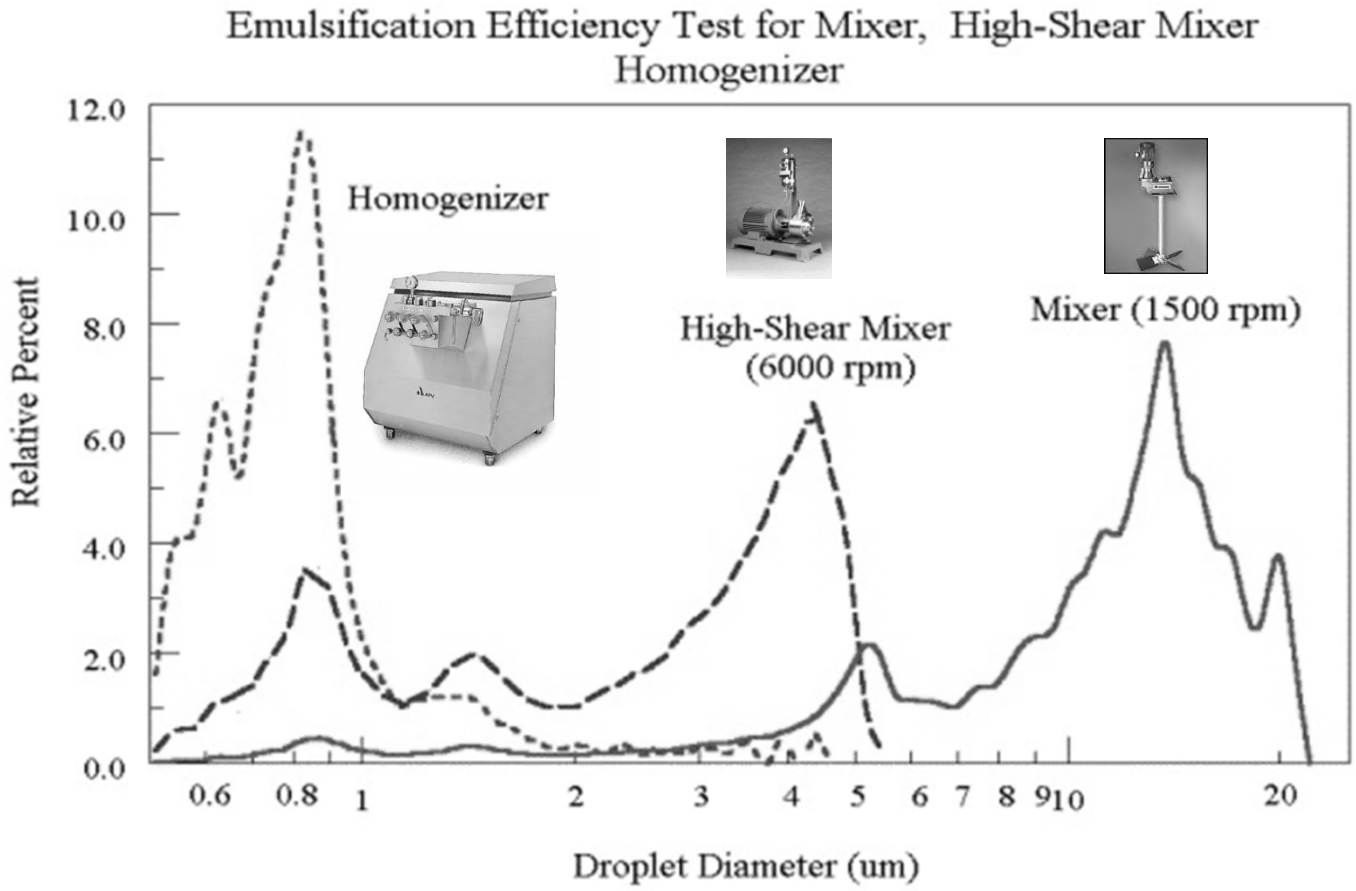
- Tank Mixers
- Inline Mixers
- High Shear Mixers
- Colloid Mills
- Cavitator
- High Pressure Homogenizers



All are considered homogenizers, what differentiates them are the energy levels.

A homogenizer is a very poor mixer

Energy Level of Mixers



How small is a Micron?

- **1 Micron is 1 thousandth of a millimeter**

  Human head hair averages
  0.1 mm or 100 microns

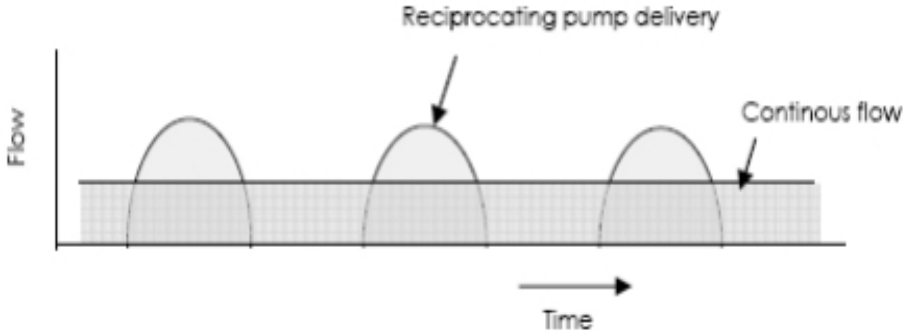
- **1 Micron is equal to .00004 inch**

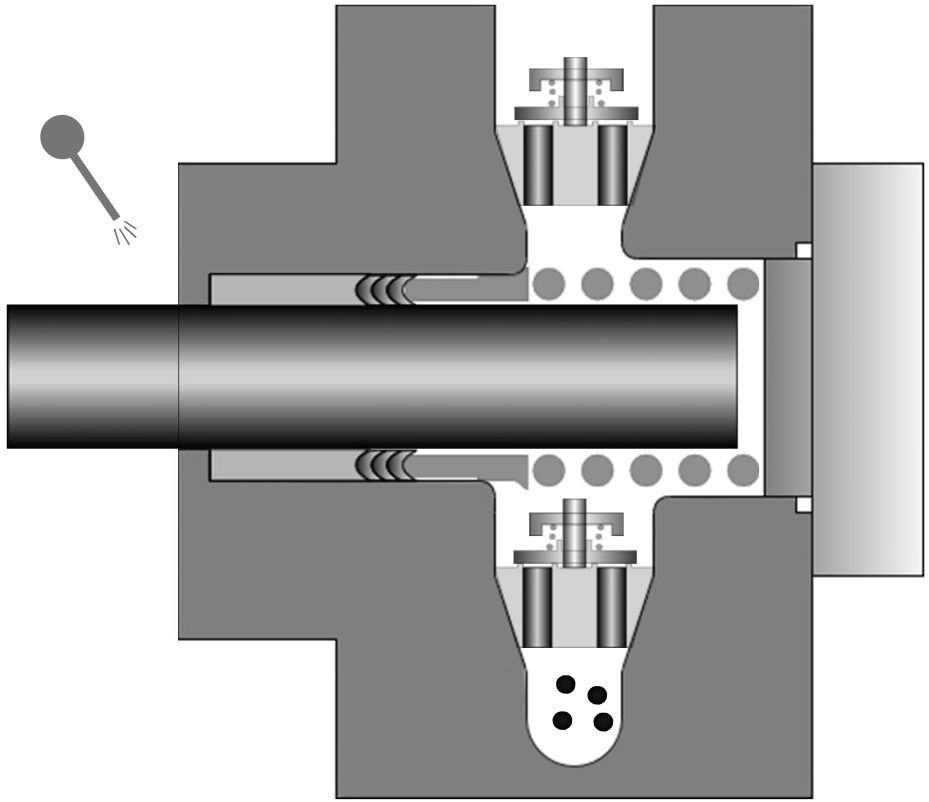
  Four (4) 100,000 thousandths of an inch

What is a High Pressure Homogenizer?

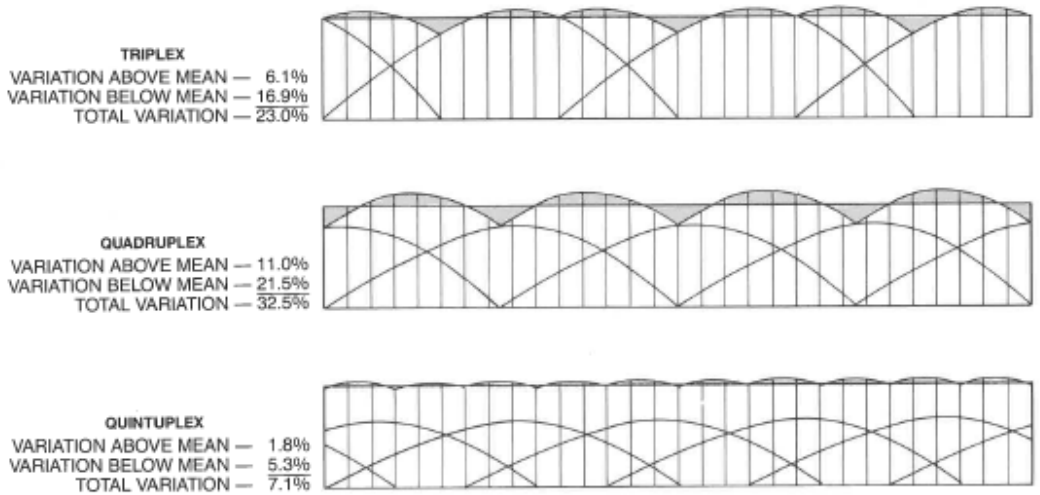
- A homogenizer consists of a positive displacement pump and a homogenizing valve assembly designed for a specific application. The pump forces the product under pressure through a small adjustable gap between the valve seat and the valve, causing turbulence and intense mixing.

Reciprocating plunger pump





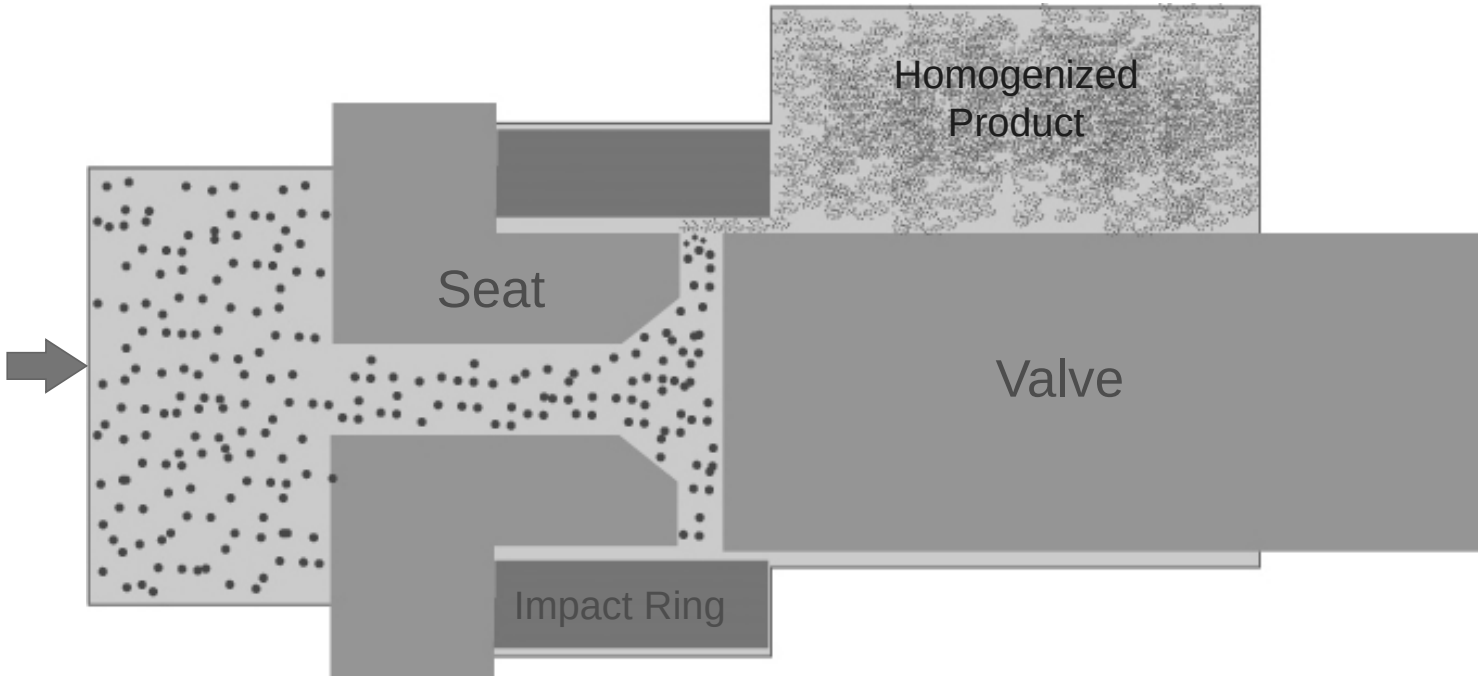
Reciprocating plunger pump
Triplex and Quintaplex Flow Variations



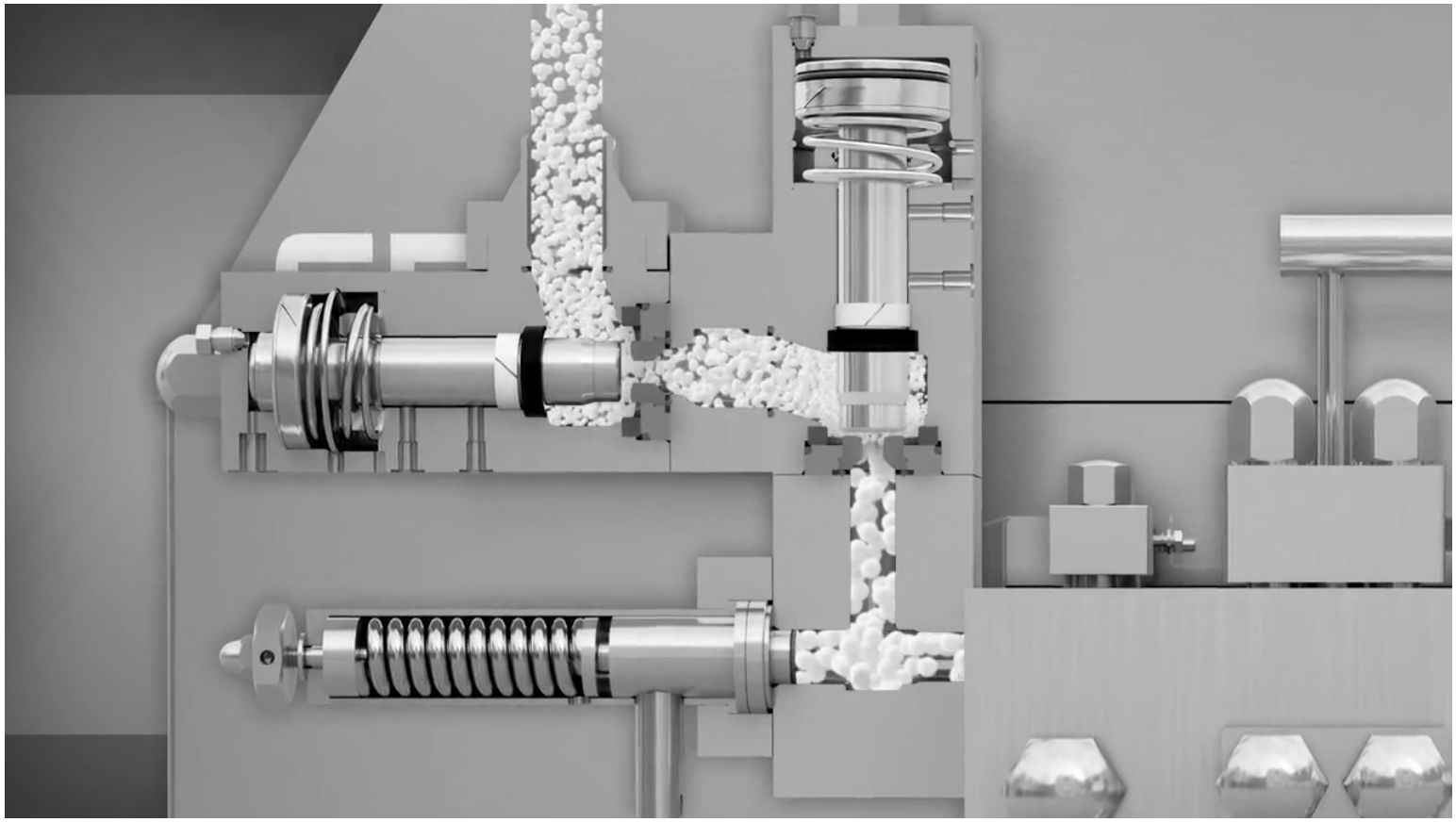
Cameron Hydraulic Data
18th Edition (3rd Printing).

- More plungers – Less pulsation
- Five (5) plungers provide a better flow profile than three (3) plungers.
- Odd number of plungers provide a better flow profile than an even number of plungers.

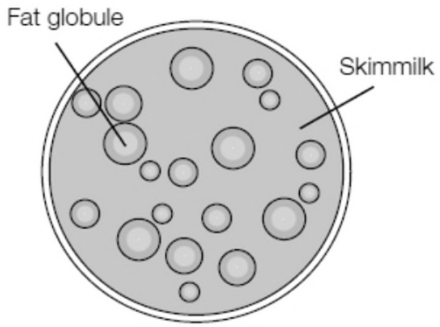
Homogenizing Valve



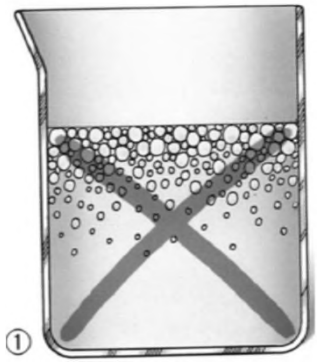
Homogenizing Valve



What is High Pressure Homogenisation?



Milk and cream are examples of fat-in-water (or oil-in-water) emulsions.
The milk fat exists as small globules or droplets dispersed in the milk serum.
Their diameters range from 0.1 to 20 µm (1 µm = 0.001 mm).
The average size is 3 – 4 µm and there are some 15 billion globules per ml.



If milk is left to stand for a while in a vessel, the fat will rise and form a layer of cream on the surface because fat globules are not only the largest particles in the milk but also the lightest density.

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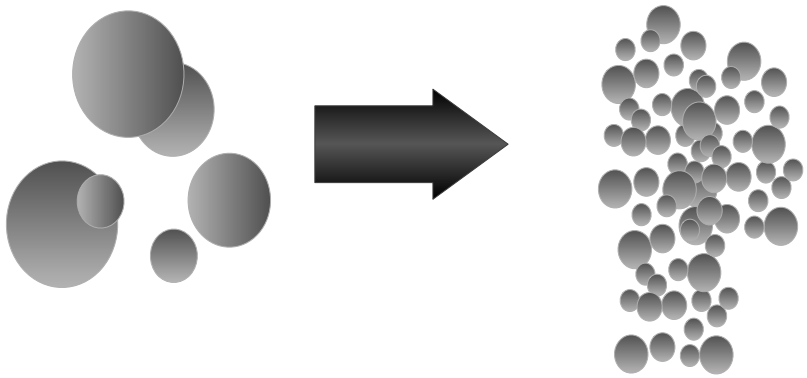
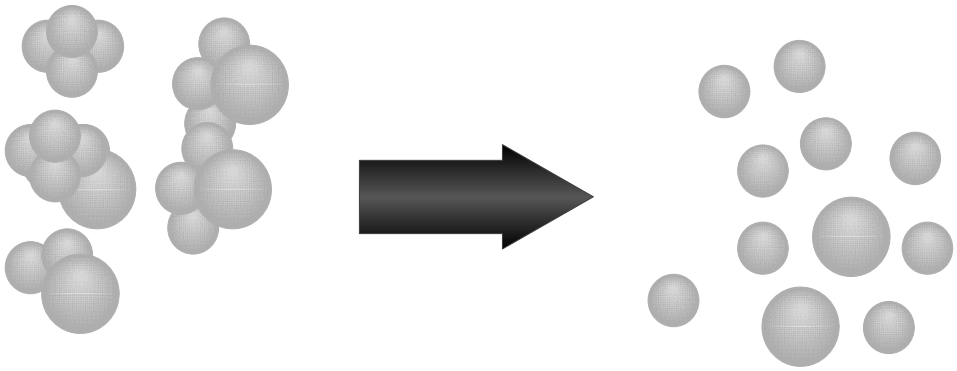
Emulsions



- Oil or Fat Particle Size Reduction

Ice Cream, milk, dairy products, creams & lotions

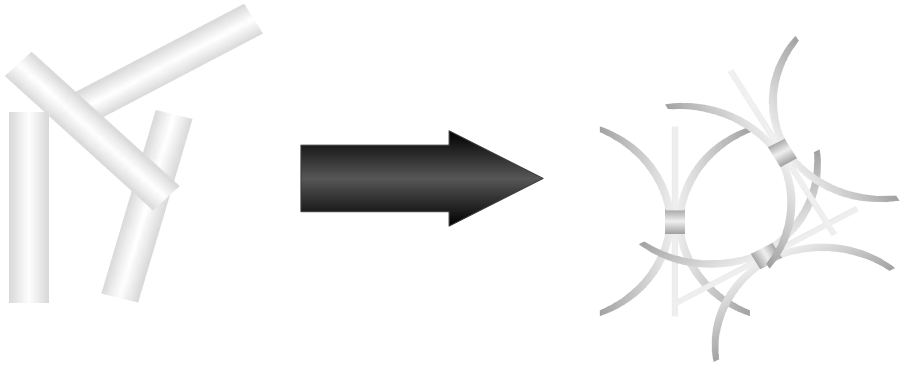
Dispersions



- Dispersion of Agglomerates

Whey, Nutritional powders, Dyes, inks, greases

Fibrillation

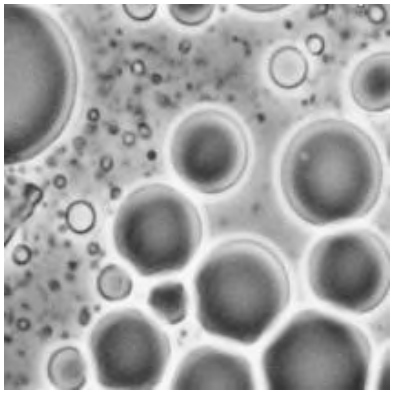


- Micro-fibrillation of Fibers

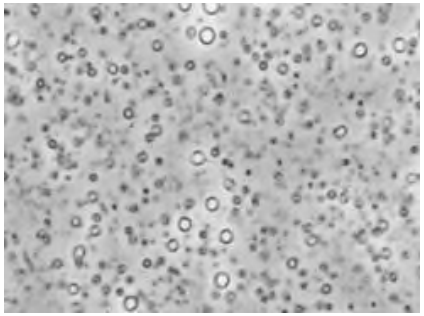
Emulsions

Oil-in-Water Emulsion

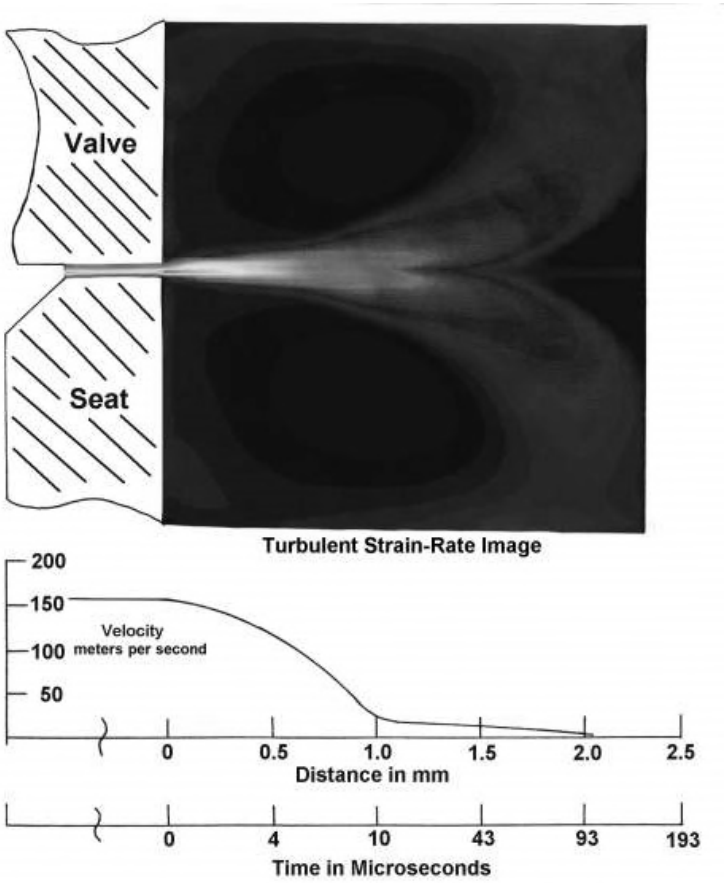
- **Oil and water emulsion before homogenization: average size 8 microns**



- **Oil and water emulsion after homogenization: average size 1 micron**



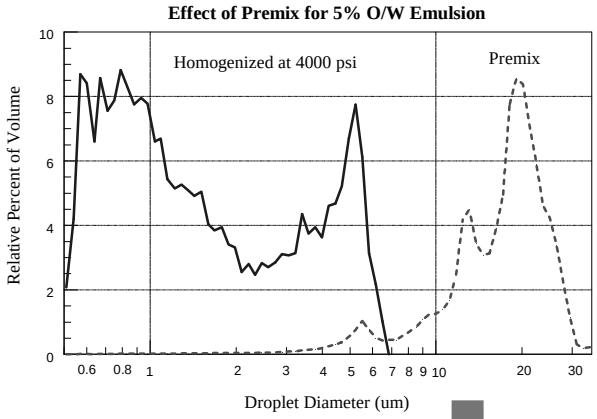
Turbulent Flow Profile

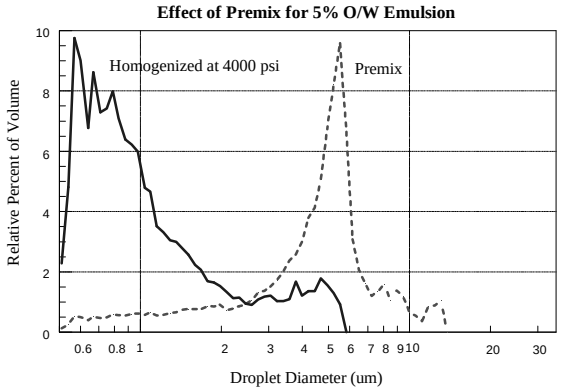


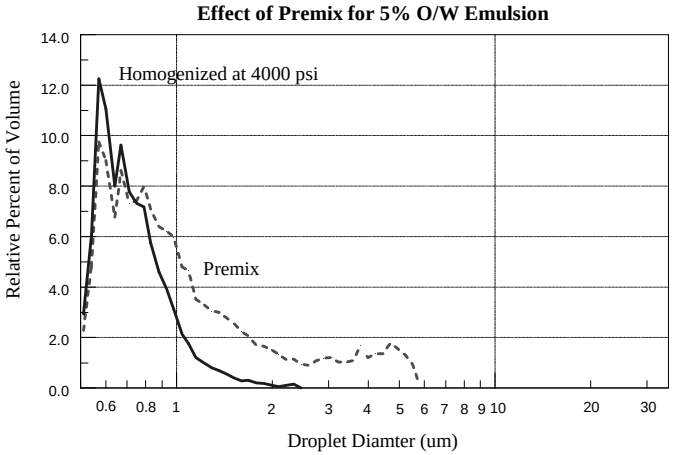
- 99% of all the working energy that is used in homogenization, is used within 0.5mm of the valve and within 3 microseconds.

- Since the mechanism of homogenization for an emulsion is turbulence, the land length of a valve only LOWERS the efficiency of a homogenizing valve.

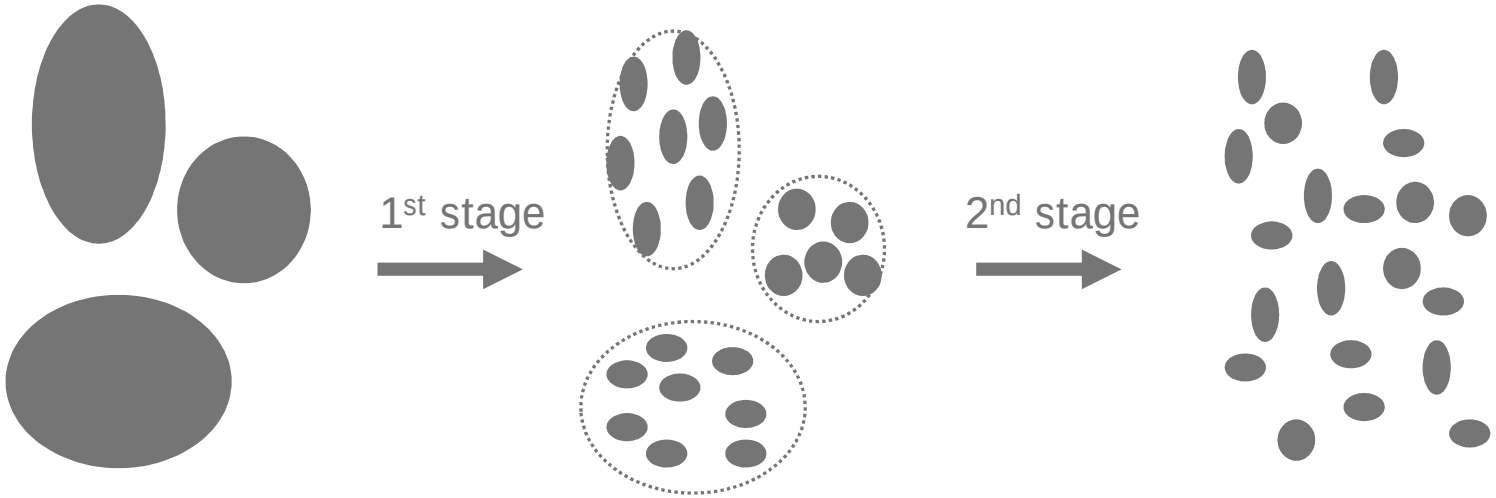
Effect of Premix







The better the premix, the better the final result.

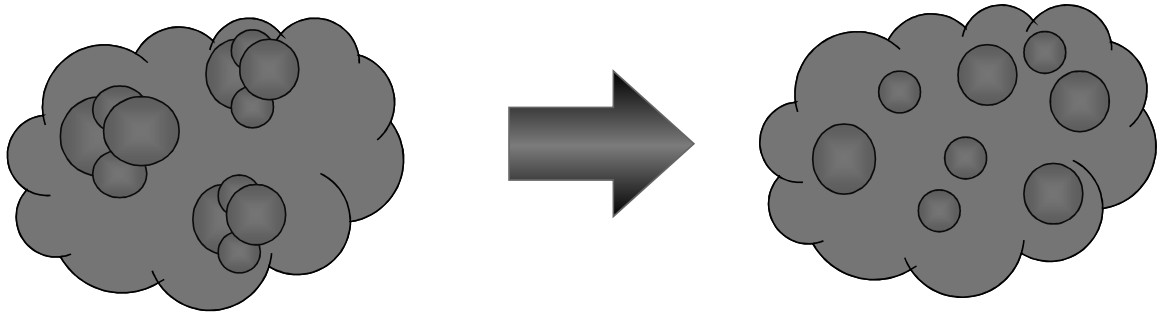


Cluster Effect in Fat Products

Dispersions

Definition of Dispersion

- The way it is used within this reference, a dispersion is a solid dispersed within a liquid, no matter what type of liquid.



- Examples:
  - Inks
  - Carbon Black for Toner
  - Waxes for Paper
  - Rosins
  - Paints

Operating Conditions for Dispersions

- Most can be processed via a single stage homogenizing valve
- Cavitation and Impact does have an effect on a dispersion
- Impact ring design and distance can help provide a better final dispersion
- Surfactant or final viscosity can provide the right conditions to make a stable dispersion.

Fibrillation & Micro-Fibrillation

Micro fibrillation

- Where is it used?
  - Plant fiber products, usually to build bulk viscosity
  - Paper products, to minimize the amount of pulp used in making paper.

- Products that currently use a homogenizer
  - Ketchup – Thickness and water separation, less tomato fiber needed
  - Mustard – water separation
  - Paper – build strength
  - Nanocellulose - build strength

Cell Disruption

Cell Disruption

- What market sectors use cell disruption?
  - BioPharm
  - Industrial BioTech
  - Pharmaceutical
- What is the product of cell disruption?
  - Enzymes
  - Proteins
  - RNA and DNA used for testing and drug manufacture
- Why do they use homogenizers?
  - Mechanical process, less post processing
  - Higher first pass yields
  - Cost – Production Costs are lower

Conditions For Optimizing Homogenization

- Feed homogenizer with good premix
- Avoid large amounts of air in the product
- Select the most effective and efficient surfactant
- Low viscosity means better homogenizing efficiency
- High oil or solids level reduces homogenizing efficiency
- Uniform droplet size distribution may require multi-passing
- Provide proper infeed pressure

Is this homogenized?

Any Questions?

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Homogenizer Applications

Why do our customers homogenize?

- Enhanced texture and taste
- Enhanced product color and gloss
- Particle size control and uniformity
- Increased shelf stability
- Controlled viscosity and yield
- Batch-to-batch consistency
- Improved reaction time
- Improved water-binding capacity
- Cell rupture / Release of important intercellular components

- Rannie and Gaulin homogenizers provide extended shelf stability, improved smoothness, body and color for a wide range of dairy applications including.

  - Milk
  - Ice cream
  - Cream
  - Yogurt
  - Desserts
  - Sour cream
  - Cheeses
  - Condensed milk
  - Dairy based Drinks

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Fat

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rich, uniformly smooth and creamy texture

- Homogenization
  - Reduce fat particle size
  - Fat particles evenly distributed
- Air introduced – fat clusters hold air pockets in place
  - Stable air pockets – creamier
- Homogenization
  - stable emulsion
  - Finer crystalline structure.

Non-Dairy Frozen Dessert (Ice Cream)

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Fat source to maintain creamy texture and mouthfeel and flavor

- Almond and Cashew Milk
- Coconut milk
- Soy milk
- Rice and Hemp Milk
- Oat milk
- Combinations of the above

Guar Gum and Locus Bean Gum

- Thickening agent
- Gelling additive
- Improves emulsification

Food and Beverage Applications

- Count on APV Homogenizers to deliver improved viscosity control, shelf stability and reduce ingredient costs for your food and beverage application.
  - Fat substitutes
  - Egg products
  - Nutritional supplements
  - Dressings
  - Liqueurs
  - Peanut butter
  - Flavors and fragrances
  - Fruit juices /concentrates
  - Sauces
  - Beverage emulsions
  - Baby foods and infant formulas
  - Vegetable juices
  - Tomato products
  - Reduced fat products

Healthcare and Cosmetics

- Count on SPX Flow Products to deliver improved viscosity control, shelf stability and reduce ingredient costs for your healthcare applications
  - Hair products
  - Conditioners
  - Skin creams
  - Lipsticks
  - Lotions
  - Nail polish
  - Shampoos
  - Liposome emulsions

Chemicals

- Benefits include smaller particle size, improved penetration properties, viscosity control, enhanced color, and improved stability.
  - Disinfectants
  - Silicone emulsions
  - Latex
  - Cellulose gum dispersions
  - Wax emulsions
  - Viscosity index improvers
  - Insecticides
  - Lubricants
  - Pigment dispersions
  - Specialty paints and coatings
  - Resins/Rosins
  - Inks

Biotechnology

- Benefits include particle size and viscosity control, enhanced color, uniformity or application and improved stability.
  - Bacteria (E-Coli, etc.)
  - Proteins
  - Yeast
  - Algae
  - Enzymes

Pharmaceuticals

- Improve stability and uniformity while achieving narrow particle size distribution and enhanced texture.
  - Antibiotics
  - Ointments
  - Veterinary preparations
  - Intravenous emulsions
  - Nutritional supplements
  - Creams
  - Liposomes
  - Antacids
  - Tablet coatings

Questions?

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