Homogenizer Theory and Basics

Frozen Dessert Center

2020 ANNUAL TECHNICAL CONFERENCE

Virtual Event

On-Demand Presentations
October 19th-28th

Live Q&A Session
October 28th at 1:30PM (CST)
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.
• **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**
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

Emulsification Efficiency Test for Mixer, High-Shear Mixer, Homogenizer

![Graph showing relative percent of droplet diameter (um) for different mixers at various speeds.](graph.png)
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

- 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
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.
Why use High Pressure Homogenization?

Emulsions

- Oil or Fat Particle Size Reduction

Ice Cream, milk, dairy products, creams & lotions
Why use High Pressure Homogenization?

Dispersions

- Dispersion of Agglomerates

Whey, Nutritional powders, Dyes, inks, greases
Why use High Pressure Homogenization?

Fibrillation

- Micro-fibrillation of Fibers

Ketchup, mustard, cellulose
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.
The better the premix, the better the final result.
Homogenizing Valve Facts

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?
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
Dairy Applications

- 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
Ice Cream

Fat

- 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.

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rich, uniformly smooth and creamy texture
Non-Dairy Frozen Dessert (Ice Cream)

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
John Vancrey
john.vancrey@spxflow.com