Application Note

Microfluidizer® Technology vs other methods of creating nanoemulsions

INTRODUCTION

Creating a high quality nanoemulsion for use in beverages can be achieved with a variety of different methods.

Ultimately the choice depends on many parameters including time, budget and quality of product needed, and the characteristics of the active ingredients to be incorporated.

This paper compares Microfluidizer® technology to the commonly used Ultrasonication method.

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PREPARATION TECHNIQUES

To create a quality nanoemulsion, it is important to select the right emulsification method. Here we explore two typical methodologies:

Ultrasonication - a process using sound energy at high frequencies to break apart particles by cavitation. The expansion and implosion of the bubbles causes the particles to break (fig 1).

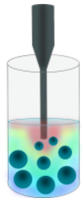

Fig 1

Whilst this is simple equipment, there are some inherent drawbacks of the methodology:

- Erosion of the probe, due to the cavitation effect, leads to the liquid being contaminated with metal particles (Fig. 3). This can cause difficulty with downstream processing, not to mention health & safety concerns.
- It is not suitable for continuous processing.
- Whilst it works well at the small scale, it is not scalable to industrial production scale.
- Temperature control is extremely difficult. Close to the probe tip there is a high heat, but then this reduces with distance, so it makes it hard to control temperature throughout the material batch (fig 1).
- Non-uniform processing means it requires a very long processing time to ensure all material has been treated.
- The probe tip is costly and needs to be replaced often which can result in a high cost of ownership after maybe a seemingly cheaper initial investment.

Microfluidizer® technology is a high energy method of creating nanoemulsions. It works by ensuring fluid pressure is efficiently & consistently converted to high shear forces (Figure 2).

The fixed-geometry Interaction Chamber™ ensures that all fluids are forced at constant pressures and with controlled temperatures through the chamber. All material experiences the same extreme shear forces, which yields precisely controlled particle size reductions and tight particle size distribution curves.

This technology is scalable linearly, from the lab through to pilot scale and on to production sized capacities. It also complies with various levels of regulatory requirements.

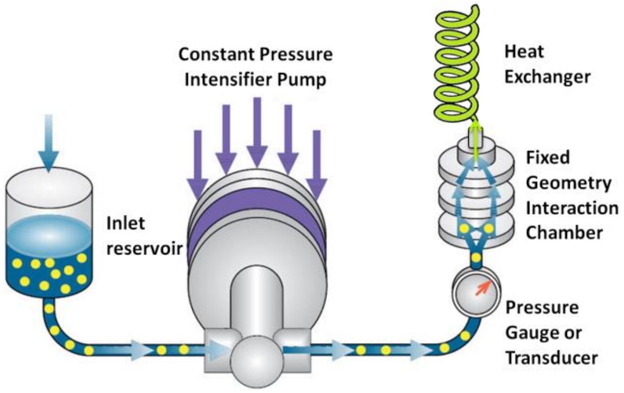

Figure 2 – Schematic of Microfluidizer Technology

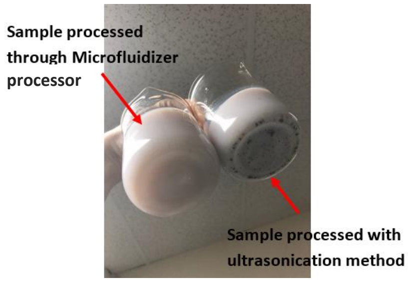

Figure 3 – contamination from ultrasonication processing

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CHOOSING THE RIGHT HIGH ENERGY TECHNOLOGY

The following is a direct comparison between Microfluidizer® technology and the commonly used Ultrasonic technology:

	Microfluidizer technology	Ultrasonic technology
Technology	Constant pressure + fixed geometry Interaction Chamber™ achieves uniform processing	High cavitational forces at the probe tips
Continuous	Yes	Not by design
Scalable	Yes – Guaranteed scalability	No – acceptable for very small batch sizes, but difficult to expand to production scale.
Optimal Temp Control	Yes – Effective and efficient cooling system integration	No –localized overheating as high heat/temperature generation near probe tip – makes it hard to control temperature throughout.
Contamination Free	Yes	No – Contamination issue with metal particles due to erosion of the probe. Additional filtration step required but difficult to remove contamination particles if they are the same size as the product particles
Constant Shear Rate	Yes – constant, high pressure system.	No – High forces near probe tips but decays quickly resulting in non-uniform processing, resulting in long processing times.
Maintenance	Robust system with regular preventative maintenance.	Probe has to be replaced often due to cavitation erosion which can be costly.

Manufactured by Microfluidics, distributed in the UK and Ireland by **analytik**.