**Introduction**

**Vaccine Adjuvants**
- Vaccine adjuvants enhance the efficacy of vaccines.
- Most new adjuvants are emulsions or liposomes with particle sizes below 200 nm.
  - Effective: Enhance both Th1, Th2 and MHC responses\(^1,2\)
  - Well tolerated
  - Biodegradable

**Microfluidizer® Technology**
- High pressure is used to pump multi-phase fluids through the microchannels of an interaction chamber, exposing the fluids to high shear.
- Velocities of over 400 m/s in micron channels result in shear rates of up to \(10^8\) s\(^{-1}\).
- Parallel arrays of identical microchannels ensure linear scalability to tens of liters per minute.

**Key Production Requirements & Challenges**
- Process efficiency.
- Sterile production.
- Repeatability & scalability.

**Case Study**

**Production of Squalene Nanoemulsion Adjuvant**
- Microfluidizer® technology:
  - Fixed geometry interaction chamber
  - Constant pressure profile
- High pressure homogenization:
  - Variable geometry valve
  - Dynamic pressure profile
  - Constant volume

**Pressure Profile**

**Method**
- Oil-in-water emulsion formulation with 4 wt% squalene oil and 1 wt% surfactant.
- Pre-emulsion was prepared using a rotor-stator mixer (Quadro HVO).
- Parameters varied during processing: pressure and number of passes through the processor.
- Particle size analyzed using a dynamic light scattering instrument (Malvern Zetasizer Nano-S).

**Results**

**Percent Increase in Average Particle Size When Using HPH vs MF**

**Conclusion**

- Microfluidizer® processors are well suited for manufacturing nanoemulsion vaccine adjuvants.
- Microfluidizer® processor consumed **7.5 times less** power than the high pressure homogenizer.
- Microfluidized emulsions were **18-55% smaller** than the homogenized emulsions with the same energy input.
- Emulsions created by Microfluidizer® were **17-91% less polydisperse** than that created by high pressure homogenizer.
- The standard deviations of Microfluidized emulsions (0.1-2.6) were much lower than that of the homogenized emulsions (3.8-14.8).


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**Power Consumption to Achieve A Particle Size at A Given Flow Rate**

<table>
<thead>
<tr>
<th>Homogenizer</th>
<th>Particle Size (nm)</th>
<th>Process Pressure (psi)</th>
<th>Number of Passes</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPH</td>
<td>178</td>
<td>30,000</td>
<td>5</td>
</tr>
<tr>
<td>Microfluidizer®</td>
<td>182</td>
<td>10,000</td>
<td>2</td>
</tr>
</tbody>
</table>

- HPH consumes as much as **7.5 times** power to achieve similar particle sizes.

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**Uniformity of Distribution**

**Repeatability**

**Contact Information**

BY: DR. YANG SU AND STEVEN MESITE
Microfluidics International Corporation, An IDEX Material Processing Technologies Unit
90 Glacier Dr. Suite 1000, Westwood, MA 02090, USA