Stability of emulsions

Emulsion Characteristic Analyser

Droplet sizes in emulsions

Migration– and stability analysis of high concentrated dispersphased emulsion and suspension with insitu sensors in lab and pilot plant
Stability of emulsions

Emulsion Characteristic Analyser

Application:

**ECA- Sensor** allows measuring of size changing in original formulas of suspension and emulsion under *in situ* conditions with a minimum distance of 1 µsec between two droplets.

Therefore the formulation can be detected in streaming dispersed phase in real time.

*Fig. 01*: Results of replicated measurements on a 20 % o/w emulsion demonstrate that *in situ* particle size analysis highly reproducible.

Particle size was measured with an ECA. In parallel, we prepared freeze fractured replicas of the samples and examined the specimens by TEM.

The results are shown in fig. 02 to 04:

*Fig. 02*: Volume distribution and corresponding TEM micrographs of o/w emulsions with 20, 40, 60, and 80 % oil content; bar: 5µm.
Stability of emulsions

Emulsion Characteristic Analyser

For this experiment the ECA Sensor will directly insitu placed in undilluted original concentrated dispersed phase. For instance in a beaker or mini reactor for formulation of new products.

![Fig. 03*](image1)

![Fig. 04*](image2)

Emulsions with 20 % oil phase revealed the most shallow size distribution. By increasing the oil content the spread broadens and the mode of the distribution moves towards smaller values. 80 % emulsions gave almost the same particle size distribution as the 60 % emulsions. Only a small but reproducible peak in the size range from 50 to 80 µm indicated the inhomogeneity of this preparation. However, this is not sufficient for a quantitative characterization of the system.
Stability of emulsions

Emulsion Characteristic Analyser

![Graph](image)

**Fig. 05**: Particle size of the model emulsions after preparation, 6 months, and 27 months storage emulsions containing 20 % oil.

**Fig. 06**: Particle size of the model emulsions after preparation, emulsions containing 60 % oil.

The measurement enables to monitor coalescence in 60 % emulsions as well as Ostwaldt ripening which occurs in 20 % emulsions.

From these results, we conclude that 3D ORM technology is able to in situ characterize emulsions with up to 60 % oil content. The method is sufficiently sensitive to monitor severe changes due to coalescence as well as to trace small changes produced by Ostwaldt ripening. Emulsions with 80 % oil could not quantitatively be characterized.

However, we must bear in mind that these emulsions are susceptible to dilution. Thus, reliable results can only be expected when the samples can be analyzed without extensive dilution. Thus, this challenging problem cannot be solved by currently existing methods. The results of the ORM-Measurement, however, can be taken as a fingerprint which is characteristic for this sample and allows to identify changes which occur during manufacturing or storing.
Stability of emulsions
Emulsion Characteristic Analyser

Detecting with **ECA - Sensor**: 

- Agglomeration of products,
- Stability of dispesphased systems,
- Dissolution processes of substances

**No sample taken and preparation**.

**Fig. 07**: Comparison of the required steps for particle size analysis.

*)Fig. 01 to 07 and 13+14, kindly provided by Prof. Rolf Daniels, Lehrstuhl für Pharmazeutische Technologie, Eberhard Karls Universität Tübingen.

**Mode of operation:**

ECA- Sensor–technology based on Time of Flight Technology (TOF) and Optical back Reflection Measurement (ORM) and is a further development of the well known 3D ORM technology. Particles and droplets and their structures were detected and measured by a laser beam with higher energy as 3D ORM and with <10mW. At crossing the particles and droplets the laser beam detected their geometric expansion. This time periods in µs will displayed in a statistic of all counted events.
Stability of emulsions

Emulsion Characteristic Analyser

The patented measuring method of the optical visibility of the particles works in a band of wavelength of 680 nm. So 300 nm will be the deepest detection limit for diffuse dispersphased systems. Clear dispersphased systems can also be detected with a laser power more than 10 mW.

Fig. 08: Display of a signal orgination

Fig 09: instabile formulation of a sun lotion
Stability of emulsions

Emulsion Characteristic Analyser

Results of inline stability analysis

**Fig. 10a:** instable formulation of a cleaning lotion

**Fig. 10b:** stable perfect formulation of a cleaning lotion
## Stability of emulsions

### Emulsion Characteristic Analyser

### Dynamic in situ ECA - Sensor

<table>
<thead>
<tr>
<th><strong>Hardware</strong></th>
<th></th>
</tr>
</thead>
</table>
| **Electronic** | cabinet IP 44; optionally IP69  
Data connection RJ 45 Bus  
voltage 230V, when required 110 V |
| **Optical fiber** | 2 m cable between sensor and electronic |

<table>
<thead>
<tr>
<th><strong>Automation</strong></th>
<th></th>
</tr>
</thead>
</table>
| **Software** | SeQuip ORM–Software  
Microsoft Windows 2000 and XP compatible without PC |

### Installation and conditions

| **Installation and Training** | 1 day at the customer |
| **Documentation** | Manual in English available |
| **Requirements** | Fitting of the in situ ECA Sensor:  
Inline Sensor configuration for lab reactors  
100 – 240 Volt AC; 5 Amai PS, earth cable needed  
Electrical connection  
Dust free environments with controlled temperature for the PC |
Stability of emulsions

Emulsion Characteristic Analyser

**Fig. 11:** Inline installation in a homogenizer

**Fig. 12:** Inline installation between mixing machine and homogenizer

### ECA - Sensoren

<table>
<thead>
<tr>
<th>Typ</th>
<th>Measuring range in µm</th>
<th>Max. concentration Cv in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 ECA</td>
<td>&lt; 0,5 – &lt; 40</td>
<td>80</td>
</tr>
<tr>
<td>60 ECA</td>
<td>&lt; 0,8 – &lt; 60</td>
<td>75</td>
</tr>
<tr>
<td>125 ECA</td>
<td>&lt;1 - &lt;125</td>
<td>70</td>
</tr>
</tbody>
</table>

**Sensor dimensions:**
- diameter 14 mm; length 300 mm
- diameter 18 mm; length 255/478 mm

**Conditions:**
- Pressure: optionally vacuum up to 6 bar
- Temperature: optionally 5 up to 85°C
- Out of action in situ sterilizable up to 165°C!
Stability of emulsions

Emulsion Characteristic Analyser

Fig. 13*: Comparison of volume distribution and span of model emulsions containing different amounts of ethanol obtained from ORM measurement or laser diffraction.

Fig. 14*: Volume distribution of a w/o type lotion and a o/w cream which have identical composition and use both ethylcellulose as polymeric emulsifier but they were prepared at different temperatures (15 or 30 °C).
### Stability of emulsions

**Emulsion Characteristic Analyser**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Material of the Sensors:</strong></td>
<td>1.4571 (SS 316) for all parts which are in contact with the medium – other materials as required</td>
</tr>
<tr>
<td></td>
<td>Electrochemical polished sapphire window at the sensor head optical grade: MIL– PRF-1383B 10-5</td>
</tr>
<tr>
<td></td>
<td>Sealing: Hifluor – O-rings (other materials as required)</td>
</tr>
<tr>
<td><strong>Max. operating pressure:</strong></td>
<td>Vacuum up to 3 bar, Optional 16 bar</td>
</tr>
<tr>
<td><strong>Working temperature:</strong></td>
<td>Plus 5°C - 85°C, optional minus 20 - 165°C</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td>300 m – max. distance between measuring device and PC</td>
</tr>
<tr>
<td></td>
<td>Max. 4 sensors, which can be connected with the PC</td>
</tr>
<tr>
<td><strong>Validation</strong></td>
<td>Option: Validation and 21 CFR Part 11</td>
</tr>
<tr>
<td><strong>Software</strong></td>
<td>Sequip ORM</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>15 kg (Sensor + Electronic)</td>
</tr>
</tbody>
</table>

**Fig. 15:** By pass Installation of the sensors in a recirculation pipe
Stability of emulsions

Emulsion Characteristic Analyser

Sequip provides for you

Rental systems
Measuring by order
Consulting
Sale of used and new systems

Contact:
Sequip S+E GmbH
Angermunder Str. 22
D-40489 Düsseldorf
Germany

Tel. +49(0)203 / 7421 40
Fax: +49(0)203/ 7421 444
Email: info@sequip.de

Internet: www.sequip.de