The status and future of fine bubble technology in Russia

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Fine bubble technologies in Russia

- Metal ore enrichment
- Metal separation in complex ores
- Salt separation
- Waste water rectification
- Yeast production

... and other industrial fields
Bubble formation mechanisms

Mechanochemical disturbance of water surface layer

- Wind – water interaction
- Saturation of the surface layer by a suspended particles
- Electrothermodiffusion under Kolmogorov dissipation of a kinetic energy

Biogenic ways

- Subcell structures formed after death of unicell organisms
- Extinction of multicellular organism tissues
- Nucleoprotein complexes

Chemical processes

- Oxidation processes
- Ionization of molecules of atmosphere gaseous part
### Measurement base in VNIIFTRI (Russia)

<table>
<thead>
<tr>
<th>Method</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser diffraction</td>
<td>50-1000 nm</td>
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<tr>
<td>Dynamic light scattering</td>
<td>1-5000 nm</td>
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<tr>
<td>Liquid particle counters</td>
<td>500-20000 nm</td>
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<tr>
<td>Zeta potential measurements</td>
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<tr>
<td>pH measurements</td>
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<tr>
<td>Mass spectroscopy measurements</td>
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<tr>
<td>Chromatography</td>
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</tbody>
</table>

- **Measurement methods of particle disperse parameters**: (Uncertainty 6-10 %)
- **Measurement methods of liquid media parameters**:
Present and future main work goals

• Measurement processes – affect the measurement uncertainty
• Development of the method for particle size unit traceability in water over the range from 1 to 30 nm
• Creation of the generators for fine and ultrafine bubbles production with stable size and concentration

There are works carried out it in this field by VNIIFTRI research group in Russia.
Thank you for your attention
Speaking Notes: The status and future of fine bubble technology in Russia

In the Russian Federation, as also in other countries, fine bubble technologies are used for a nonferrous, rare and trace metal ore enrichment, metal separation in complex ores, salt separation, wastewater rectification (in particular, for oil drops extraction) and in the yeast production (as concentration method). Trace metal ore deposits are involved in manufacturing due to flotation, and complex use of mineral resources is provided in the Russian Federation. Factories produce up to five concentrate types. In some cases flotation remains are not considered as waste products and used as construction materials, fertilizers, etc. Flotation is the leading process in nonferrous metal ore enrichment.
The use of circulating water is adopted, so the water pollution is reduced. The fine bubble technologies are also used in the other industrial fields, such as pharmaceutical, food, electrical, agriculture, new functional materials production. However, the influence mechanisms of fine and ultrafine bubbles on different objects, especially biological, are studied insufficiently.

It should be noted that fine and ultrafine bubbles in natural waters and in the near-ground (near-water) atmosphere layer influence considerably on the atmosphere and hydrosphere condition. These bubbles are produced by the following mechanisms:

1) Fine and ultrafine bubbles generation as the result of interaction between water and wind and other types of mechanochemical disturbance of the surface layer (bubbles destruction, saturation of the surface layer by a suspended particles, electrothermodiffusion under Kolmogorov dissipation of a kinetic energy).
2) Biogenic ways dealt with secretion of metabolic products, subcell structures and special substances by living organisms. The sufficient part of biogenic fine and ultrafine bubbles is subcell structures formed after death of unicell organisms (bacteria, algae, protozoa) and extinction of multicellular organism tissues: from proteins and lipoprotein complexes to fragments of cell wall proteins. Separate fraction of fine and ultrafine bubbles is a nucleoprotein complexes.

3) Chemical processes of fine and ultrafine bubbles formation connected with well-known mechanisms of colloidal systems formation, which often coupled with oxidation processes in natural environments and require condensation cores, primers while polymerizing or any other heterogeneities in a conventionally homogeneous environment volume. Such heterogeneities also can arise under ionization of molecules of atmosphere gaseous part.
In technological environments (distilled water, water solutions of drugs and medicines) fine and ultrafine bubbles appear due to either decay processes of package and device walls or insufficient purification of natural water. The Russian Federation has measurement techniques and devices capable to determine the composition of dispersed liquid phase which contains fine and ultrafine bubbles, such as laser diffraction, dynamic light scattering, liquid particle counters technique for measurement of particle disperse parameters in range from one nanometer to tens micrometers with uncertainty from six to ten percents and zeta potential, pH, mass spectroscopy and chromatography for measurement of liquid media parameters.

However, it is necessary to take into account that a liquid environment with fine and ultrafine bubbles is unstable system. This instability is caused by kinetic and dynamical processes into this system.
This problem play a certain part in both processes of dispersed parameters measurement by different methods affecting the measurement uncertainty, and creation of generator for fine and ultrafine bubbles production with the stable size and concentration which required for measurement devices calibration, especially in the range from one to thirty nanometers. There are works carried out it this field by VNIIFTRI research group in Russian Federation.