OOO “Center of ultrasonic technologies”

ULTRASONIC INDUSTRIAL DEVICES

www.u-sonic.ru

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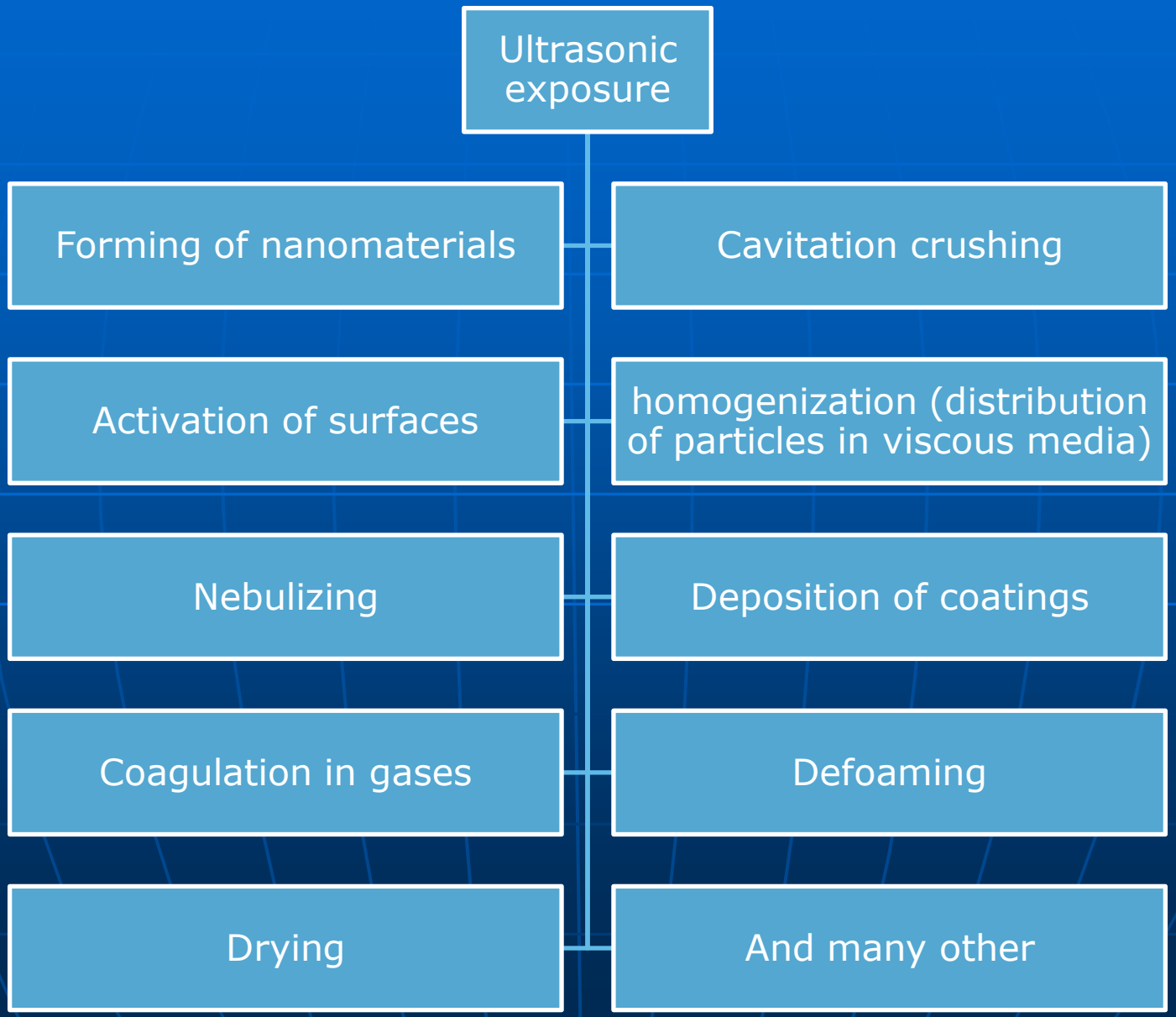
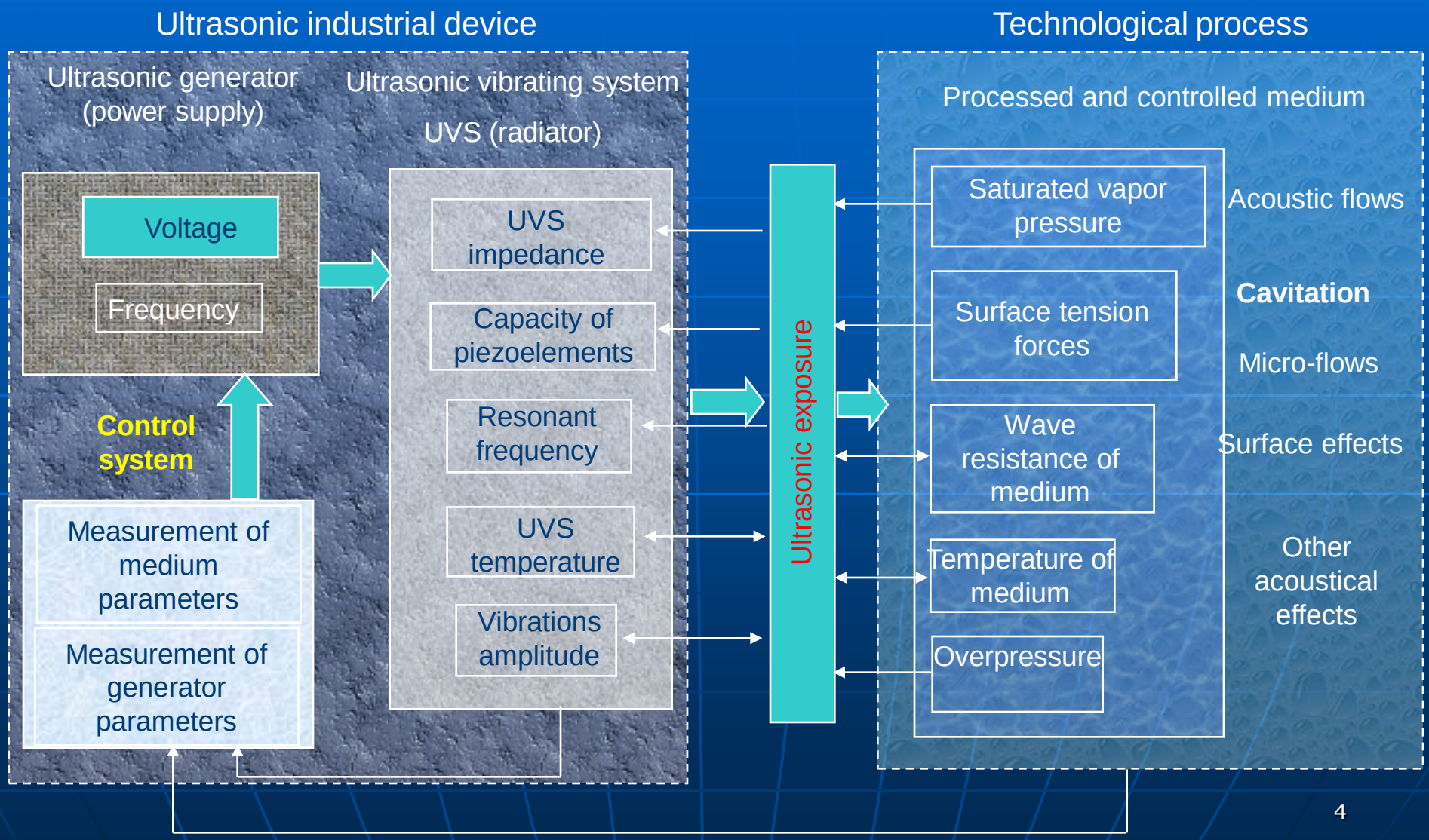
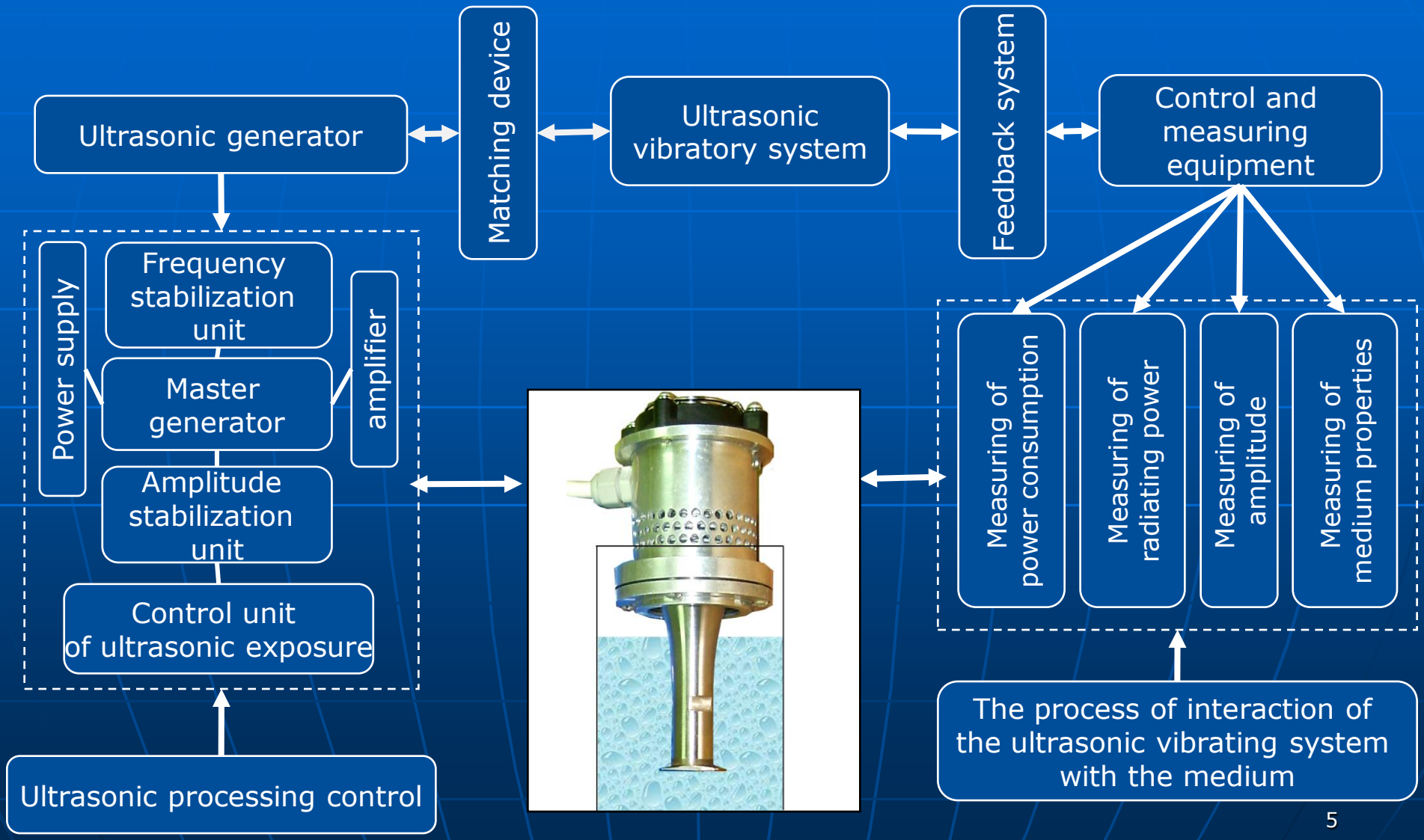
Areas of ultrasonic devices application



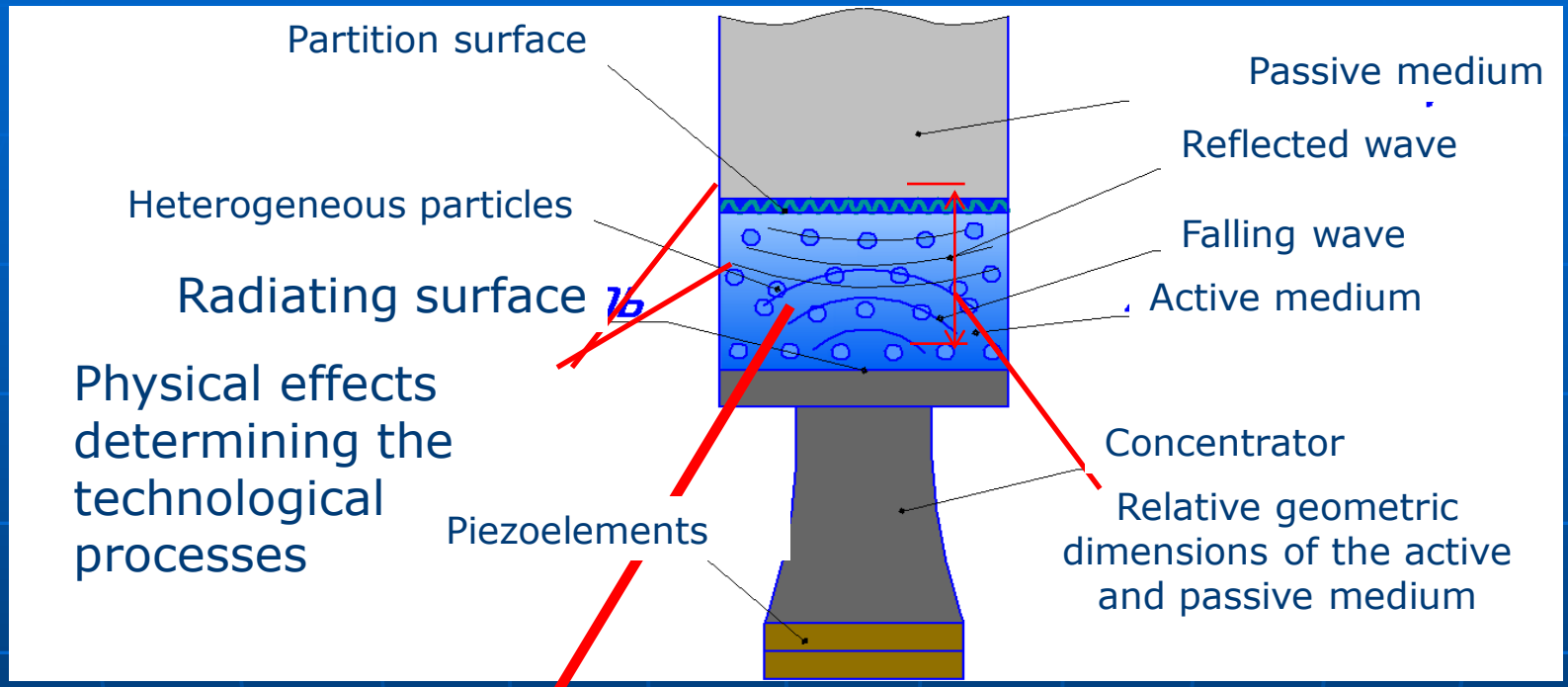
Ultrasonic exposure



Ultrasonic industrial device



Common scheme of ultrasonic device operating



Frequency and intensity of ultrasonic exposure

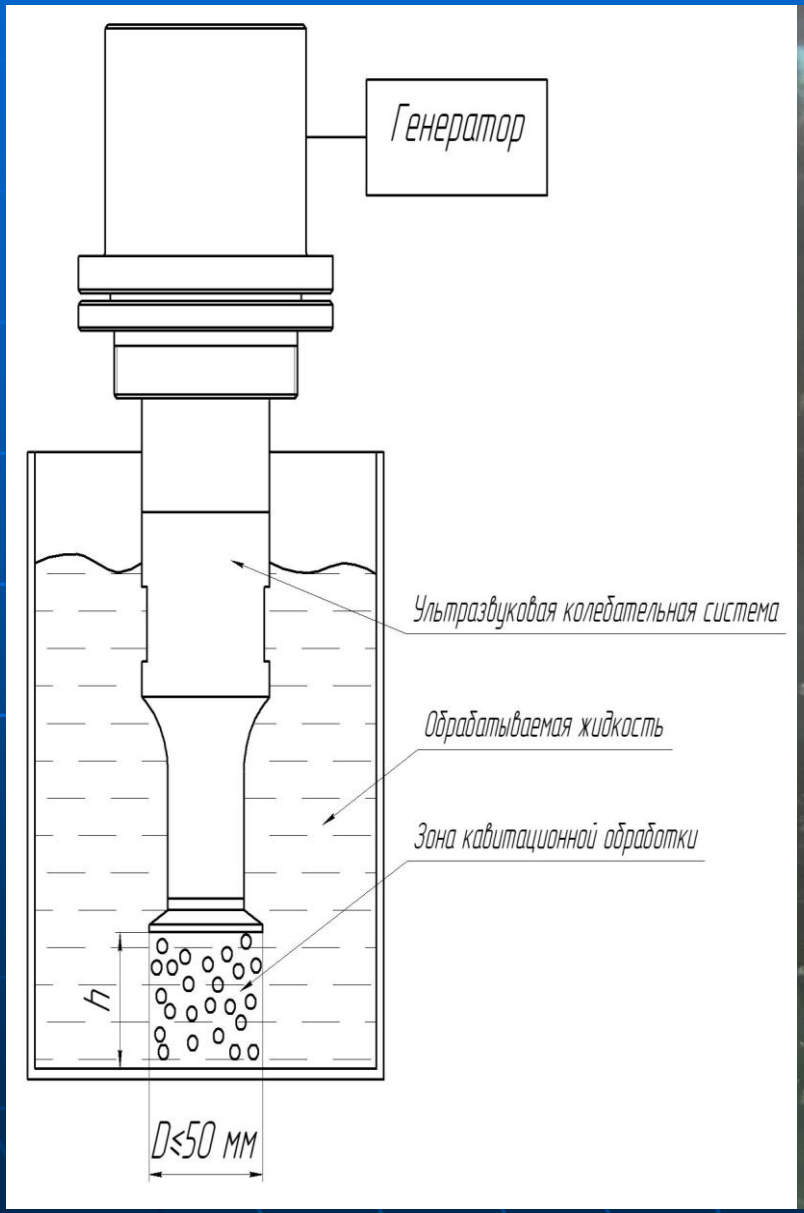
$$R = F(f, A, P_1, P_2, L)$$

Optimization problem

Find functional dependency

R is the vector of optimal criteria, P1 is the vector of properties and characteristics of the active medium, P2 is the vector of properties and characteristics of the passive medium, L is the vector of relative geometric dimensions of the active and passive medium, f is the vibration frequency of the radiator, A is the vibration amplitude of the radiator.

Work of ultrasonic device



When using modern ultrasonic devices, the simultaneous volume of the processed liquid is:

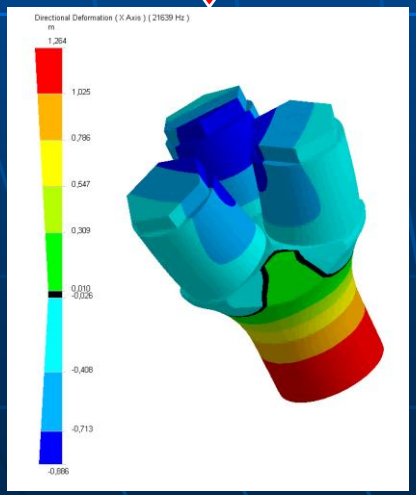
$V_{max} \leq 6\pi \cdot h$ cm³ $= 18{,}8 \cdot h$ cm³

h = 0,1..10 cm depend on liquid viscosity.

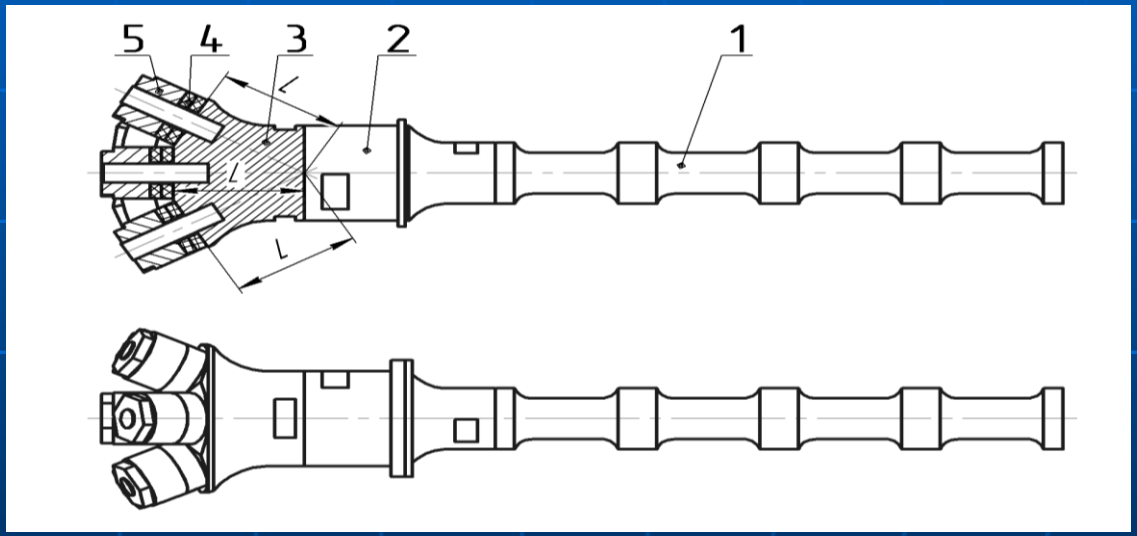
$V_{max} \leq 2...200$ cm³

Industrial devices

Multi-element piezoelectric transducer

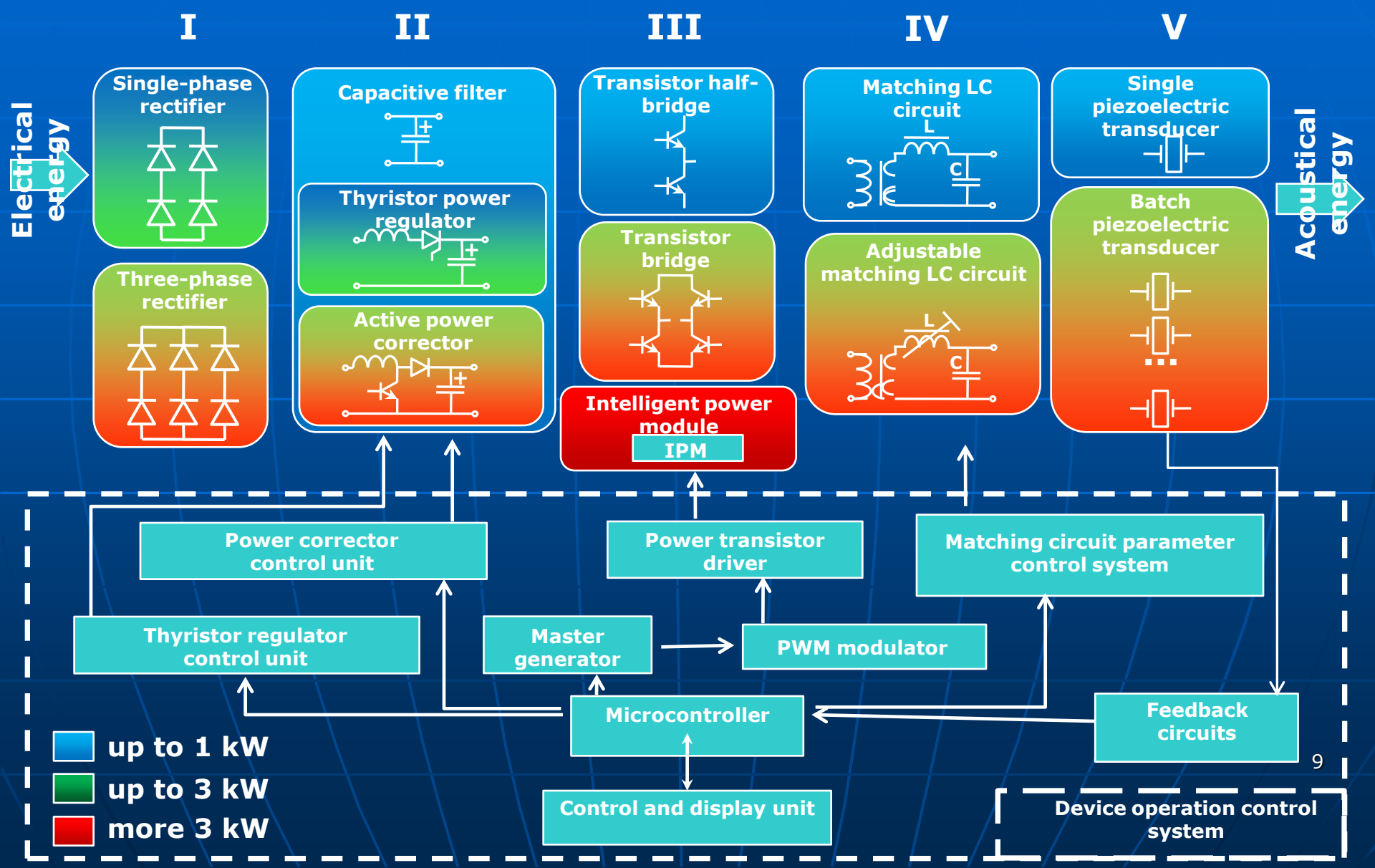


Multi-element piezoelectric transducer with multi-half-waves working tools



1 – active working tool with an increased radiation surface; 2-matching acoustic transformer (concentrator); 3 - frequency-reducing pad; 4-piezoelectric elements; 5-reflective frequency-reducing pads

Block diagram of an electronic generator



Ultrasonic devices with various work frequencies

1. UZTA-0,2/22-OM, 22 kHz

2. UZTA-0,4/22-OM, 30 kHz

3. UZA-0,1/44-O, 44 kHz

4. UZR-0,1/130-OMv, 130 kHz

Ultrasonic devices with various intensity of radiation

1. UZP-0,25/44-O - 5 W/cm^2

2. UZTA-0,4/22-OM - 10 W/cm^2

3. UZTA-0,4/22-OM (variant #3) – 50 W/cm^2

4. UZTA-0,1/28-O (variant #1) – 100 W/cm^2

Ultrasonic devices with various surface of radiation

1. UZTA-0,1/28-O
radiating surface d4,5 mm

2. UZTA-1/22-OM
radiating surface
d40 mm;

3. UZP-1/18-OU
radiating surface 20x250 mm

4. UZTA-10/18-OPg
radiating surface
300 cm^2

Ultrasonic device for exposure of gases

1. UZAGS-0,1/22-O, diameter 105 mm

2. UZAGS-0,3/22-O, diameter 250 mm

3. UZAGS-0,5/22-O, diameter 320 mm

4. UZAGS-0,6/18-O, diameter 418 mm

Ultrasonic devices for abnormal environment (temperature, pressure and chemical aggressiveness)

1. UZTA 1/22-ORv-2

2. UZTA-1/22-OPD

3. UZAP-3/22-OPSt

4. UZTA-1/22-OPg

Ultrasonic devices with various functionality

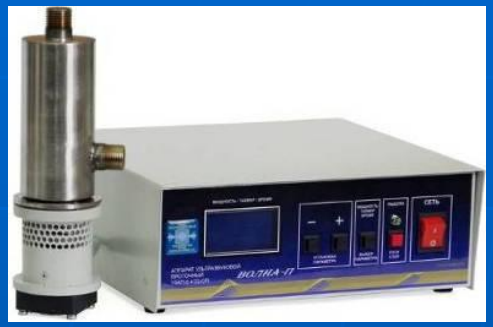
1. for cavitation exposure

2. for exposure at immersion in the volume and through the wall of the test tube

3. for contact transmission of vibrations to a physical object

4. for welding and cutting

Ultrasonic devices for flow-through processing



the flow volume

Volume for mounting multiple vibrating systems

flow volumes with cooling

Ultrasonic devices with multi-half-wave radiators

1. Volna–M
UZTA-1/22-OM

2. Bulava
UZTA-2/18-O

3. Bulava
UZTA-3/18-O

4. Bulava
UZTA-10/18-OPg

Ultrasonic devices for УЗ аппараты для малых производств

Intensity: from 1 to 100 W/cm^2
Frequency: from 20 to 100 kHz

Specialized ultrasonic devices

Processing under high pressure (up to 20 atm.) and high temperature (up to 1000 ºC)

Exposure the phase interface

Industrial ultrasonic devices

Model UZTA-3/22-O

Power consumption, VA	3000
Work frequency, kHz	22
Exposure intensity, W/cm^2	10

Model UZTA-4/22-O

Model UZTA-4/22-OP

Power consumption, VA	4000
Work frequency, kHz	22
Exposure intensity, W/cm^2	10

Model UZTA-8/22-OP

Model UZTA-8/22-O

Power consumption, VA	8000
Work frequency, kHz	22
Exposure intensity, W/cm^2	10

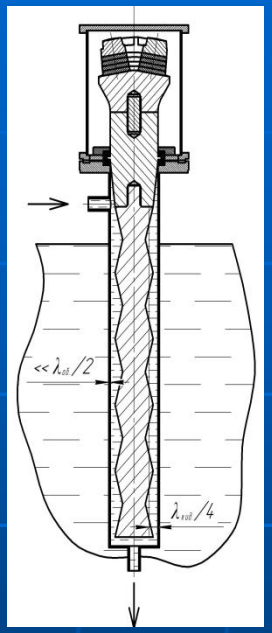
Technical solutions have protected by patents: RU2346206, RU2323788, RU2403085

Ultrasonic devices for coagulation

Ultrasonic laboratory device «Negnost» for processing of liquids (frequency – 44 kHz, intensity up to $4 \cdot 10^4$ W/m^2)

Ultrasonic industrial device “Bulava” for processing of liquids (frequency – 22 kHz, intensity up to $10 \cdot 10^4$ W/m^2)

Ultrasonic vibratory system
Patent **RU2011133748**



Ultrasonic industrial device “Volna-M” for processing of liquids (frequency – 22 kHz, intensity up to $20 \cdot 10^4$ W/m^2)

Upgraded ultrasonic radiator with a sound-conducting volume

Ultrasonic industrial device “Volna” for processing of liquids (frequency – 22 kHz, intensity up to $3.5 \cdot 10^4$ W/m^2)

Technological tank of ultrasonic devices

Technical characteristics:

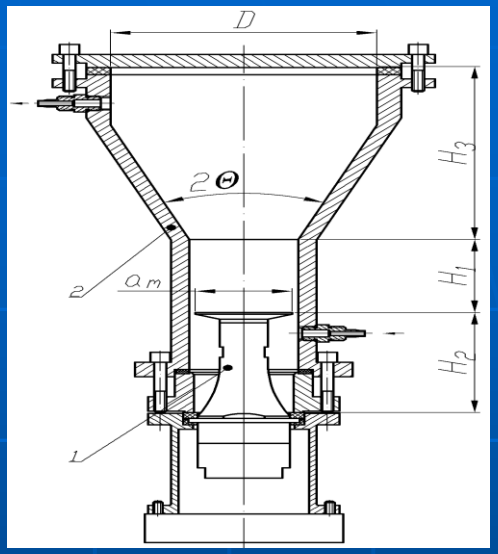
f = 21.6 kHz

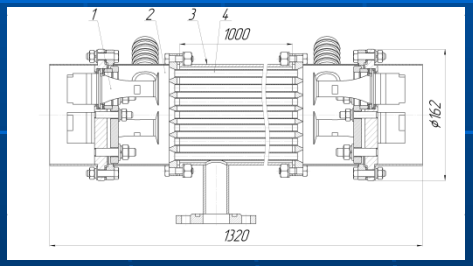
P_{ac} = 315 W

A = 30 um

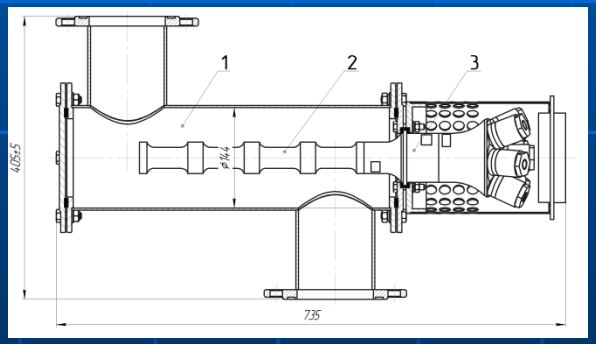
Efficiency = 81%

I = 19,7 W/cm^2

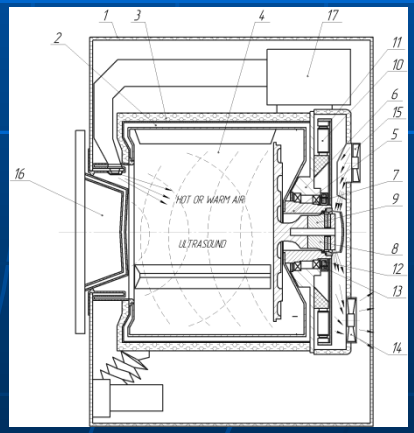




Technological tank for flow processing (filtration) of liquids with combined vibratory systems

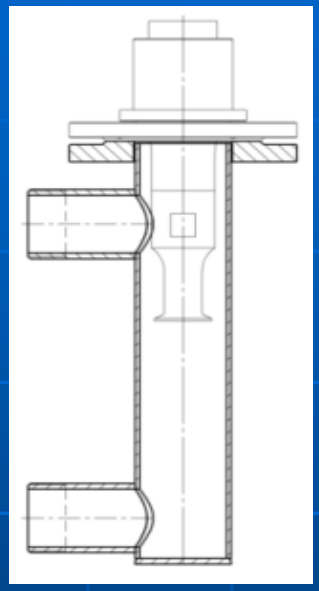


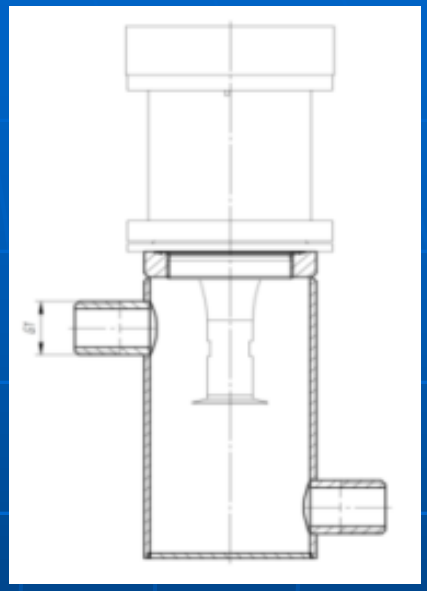
Technological tank for flow processing of liquids based on a vibratory system with an increased radiating surface

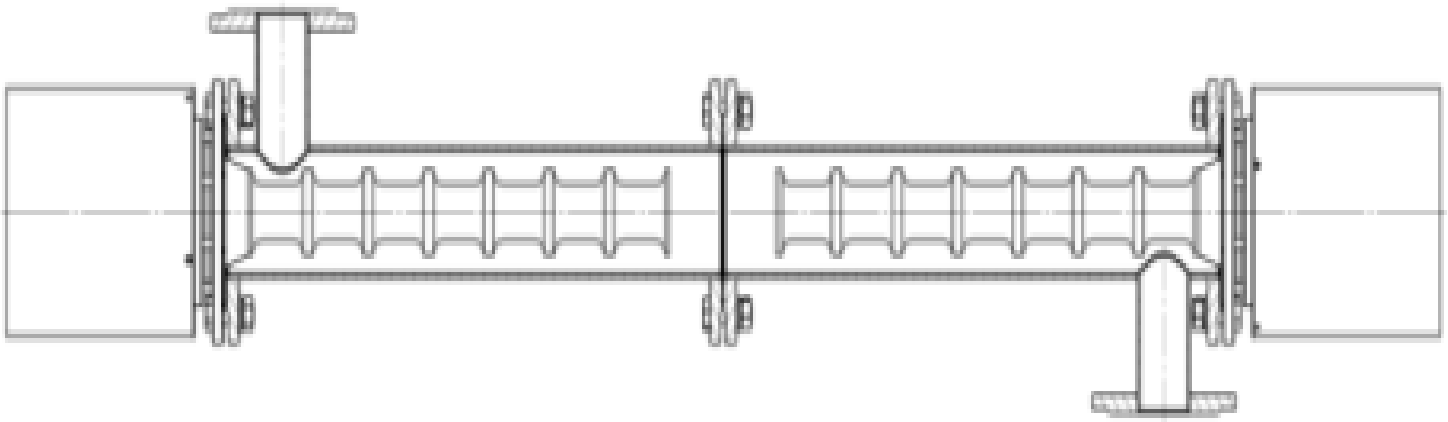


Technological tank for ultrasonic exposure in gases (drying)

Various technological tanks for ultrasonic devices







Processing of liquid-disperse mediums

Intensification of processes and forming of new materials in liquids

Physical and chemical processes

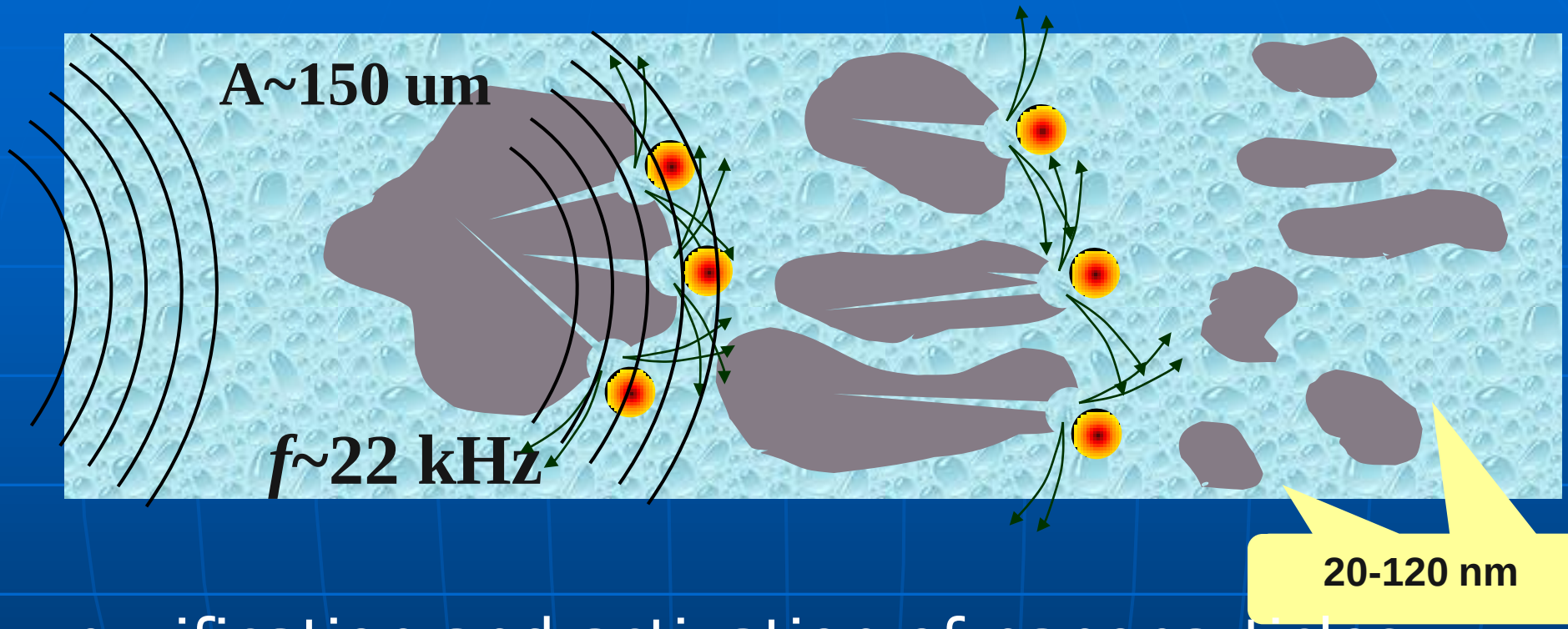
1.Extraction of plant raw materials
- faster in 100...10000 times;
- increasing the output;
- sterilization;

2. Separation of multicomponent systems
3. Demulsification
4. Coagulation of hydrosols
5. Degassing
6. Crystallization
7. Preventing crystallization

Chemical reactions

Breaking of chemical bonds of substances in a cavitation bubble and on its surface
Redox reactions
Depolymerization
Polymerization

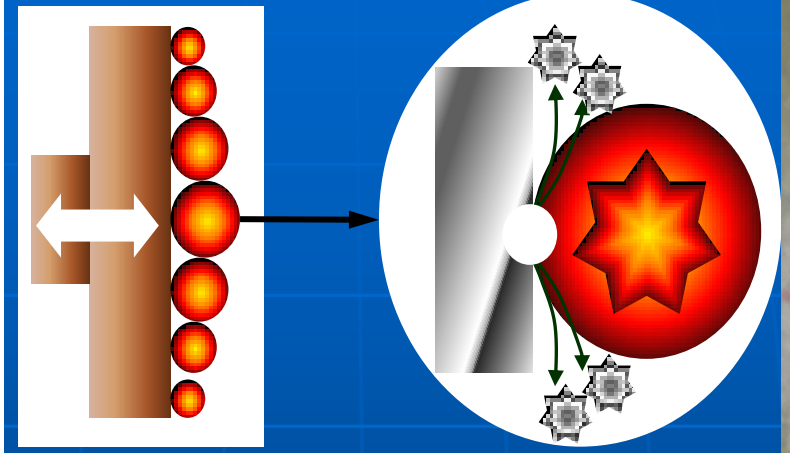
Cavitational dispersing



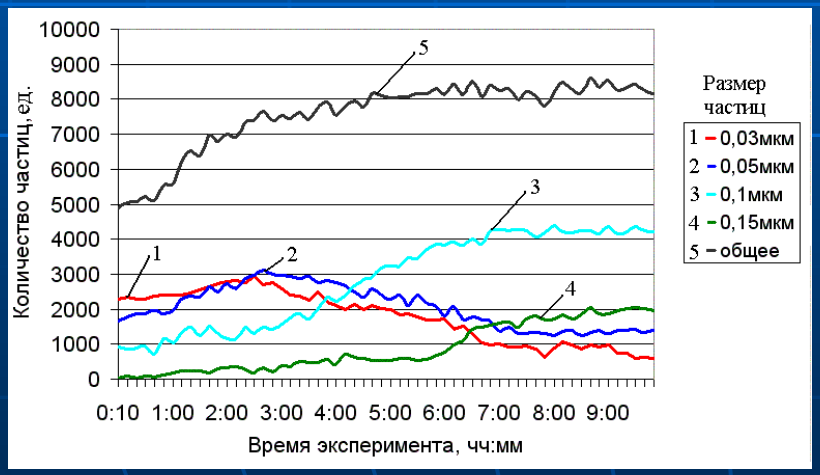
- purification and activation of nanoparticles;
- uniform distribution in viscous media;
- cluster destruction;
- deposition of nanoparticles in a liquid.

Cavitation production of nanoparticles

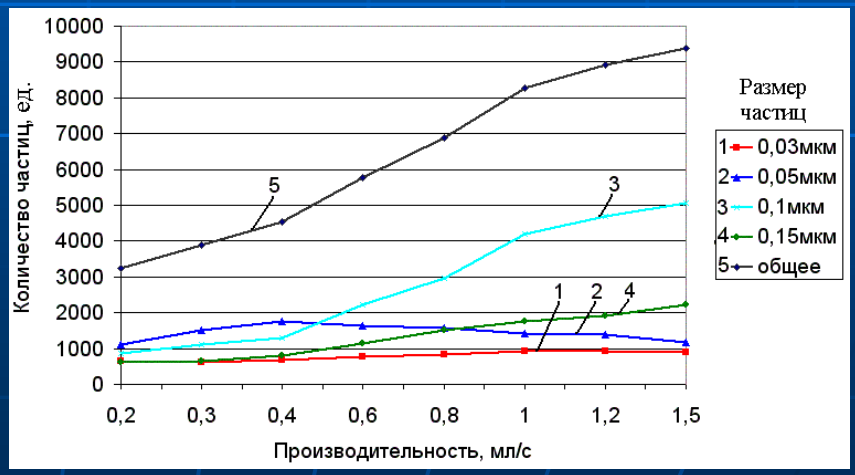
Experimental equipment



Mechanism of cavitation destruction



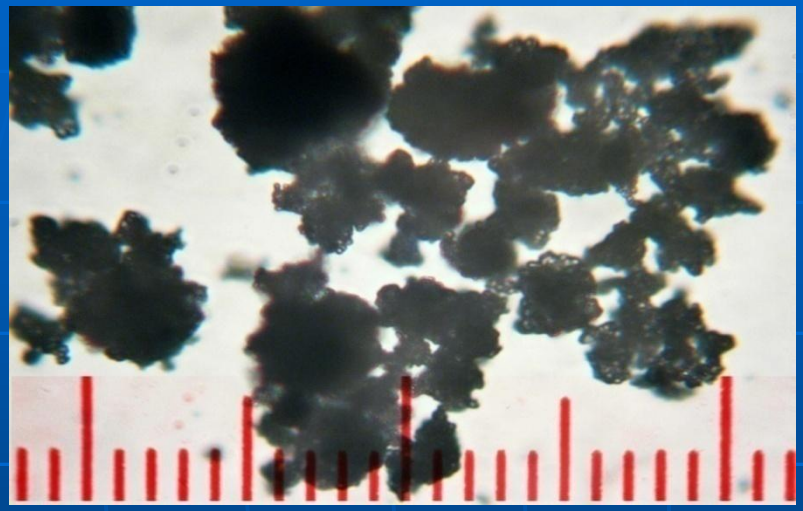
Dependence of the number of generated particles on the time of ultrasonic exposure

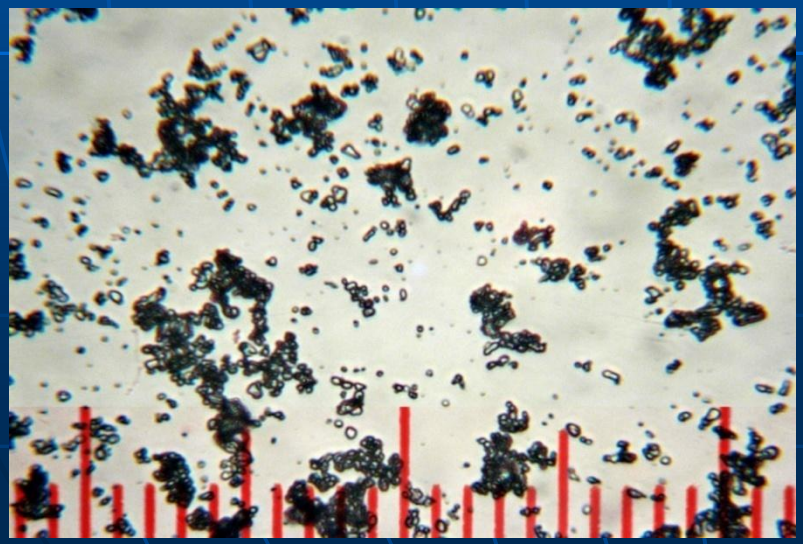


Dependence of the number of generated particles on the exposure intensity

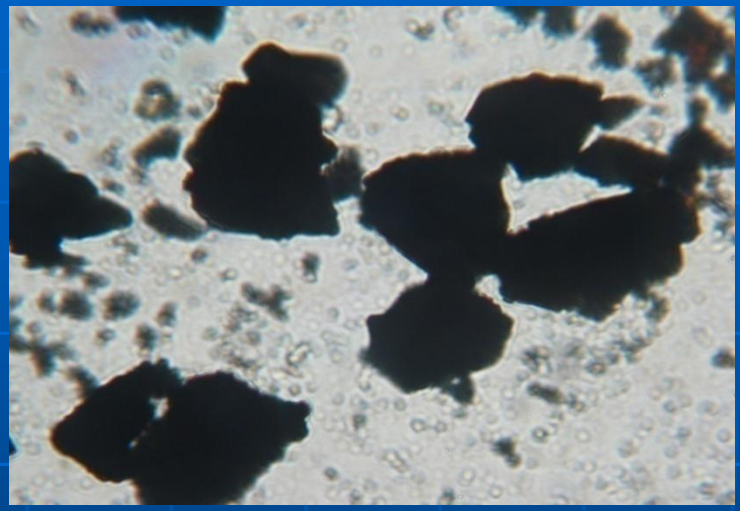
Particles dispergation

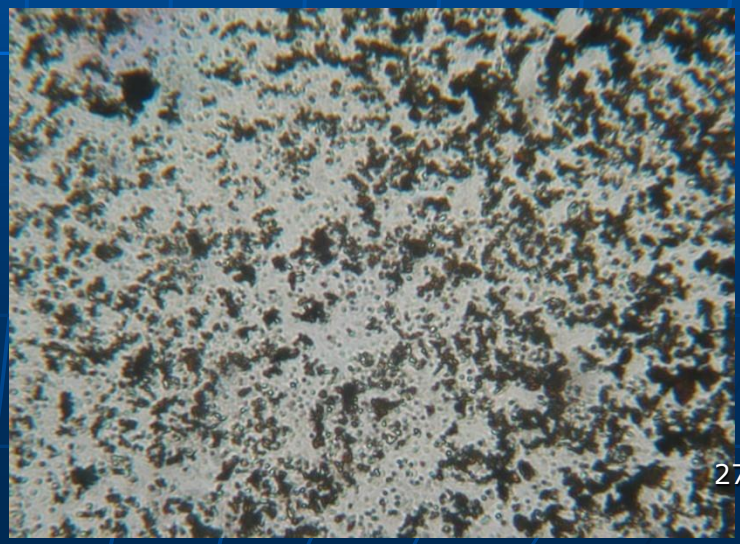
aluminum oxide





water-coal fuel





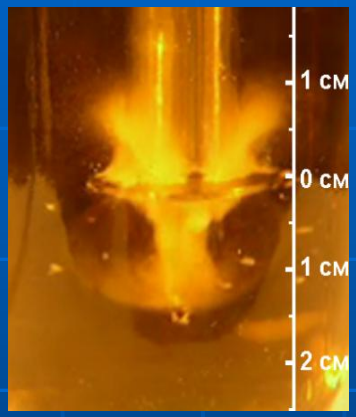
Uniform distribution, homogenization, and destruction of nanoparticle agglomerates in viscous media

Advantages

- Modification of epoxy resins by organizing nanostructures in the creation of responsible products
- introduction to technical oils of nanodiamonds for the purpose of creating antifriction compositions
- formation of stable emulsion paints, greases
- preparation of highly stable suspensions

Cavitation in epoxy resin

3 s

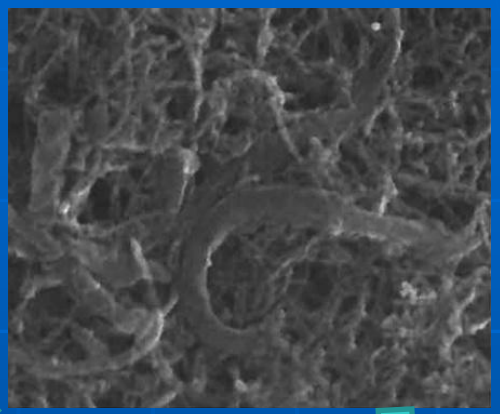


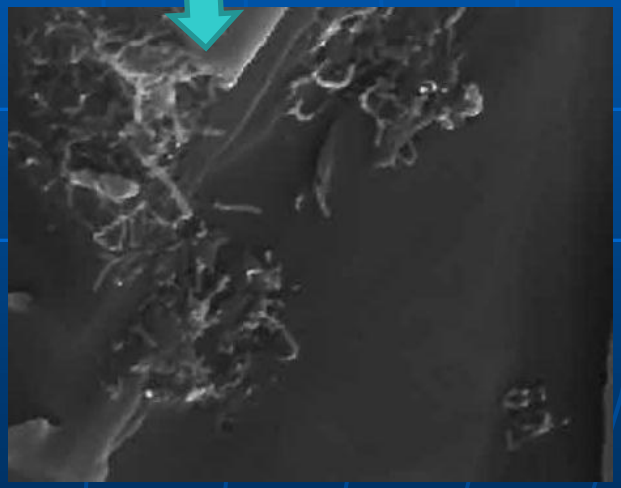
9 s

Cavitation in high-viscosity oil

Ultrasonic exposure at production of composite materials

Dispersion in composite samples

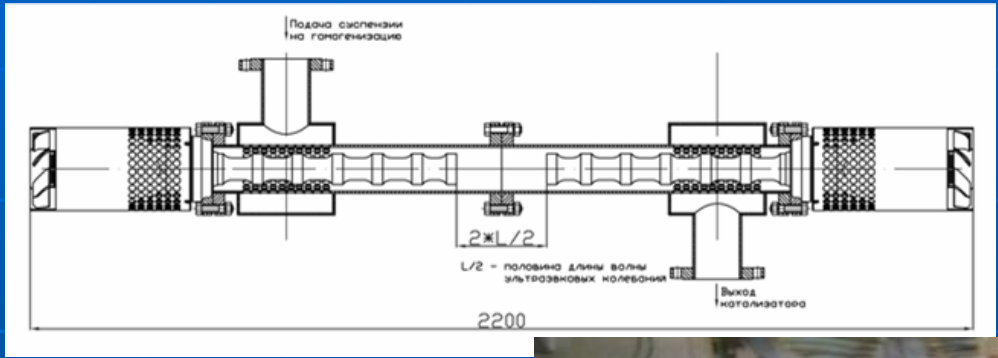




The increase in the tensile strength in samples processed by ultrasound from 65 to 72 % compared to samples in which CNTs were mixed with a mechanically.

Ultrasonic processing at production of gasoline

Sketch of the ultrasonic disperser of the catalyst

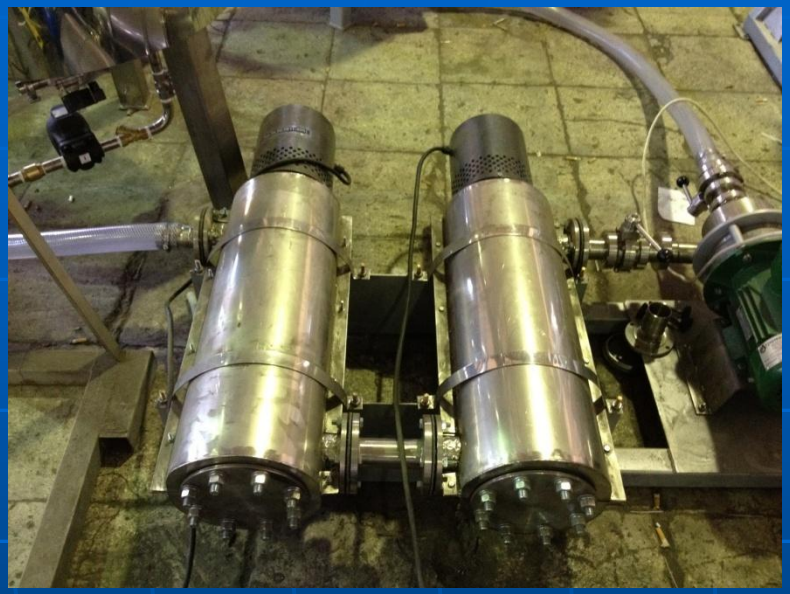


Industrial ultrasonic disperser

The results:

An increase in the yield of light fractions from oil when using a dispersed catalyst by 17% compared to the catalyst obtained by conventional mixing. The achieved capacity is 4.5 thousand tons of catalyst per year.

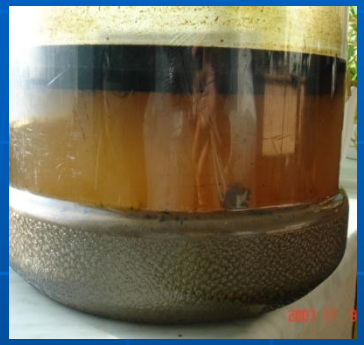
Industrial ultrasonic equipment for the production of nanotubes



Ultrasonic devices for chemical technologies

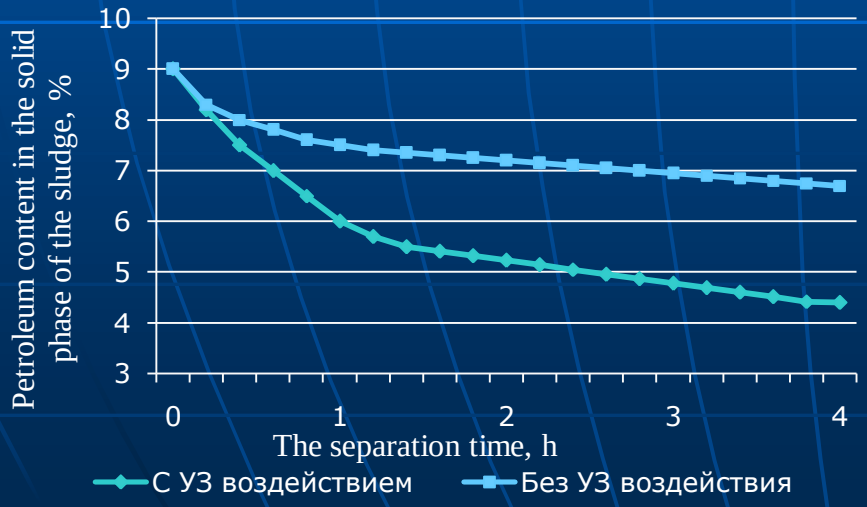
Petroleum sludge before ultrasonic processing

Petroleum sludge after ultrasonic processing



Ultrasonic processor for petroleum

Dependence of the petroleum content in the solid Phase of the sludge on the separation time



The results:

-Increase in the yield of distillates from gas condensate by 17-21%;

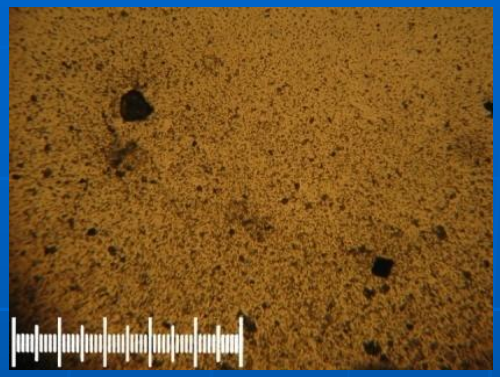
-Increase in the yield of distillates from crude low-viscosity petroleum by 50%;

-Increase in the yield of distillates from high-viscosity fuel oil by 20%.

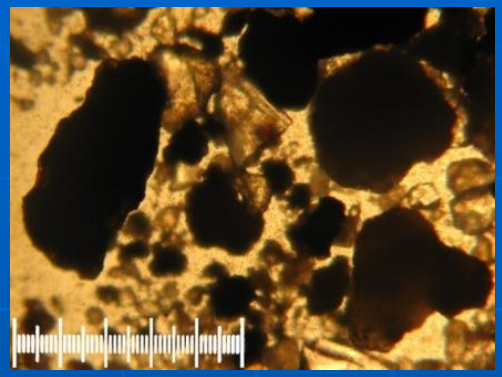
Ultrasonic processing of dispersed systems

Suspension processing (bentonite in water)

Processing of bentonite-water suspension by ultrasonic device "Volna-M“ with sound-conducting tank



Suspension before processing
(particle size less than 5×10-5 m)



Suspension after 5 minutes of ultrasound exposure
(particle size increased to 5×10-4 m)

Separation of emulsions (water and engine oil)

Ultrasonic processing by the device
“Nezhnost "(1-to-1 emulsion)

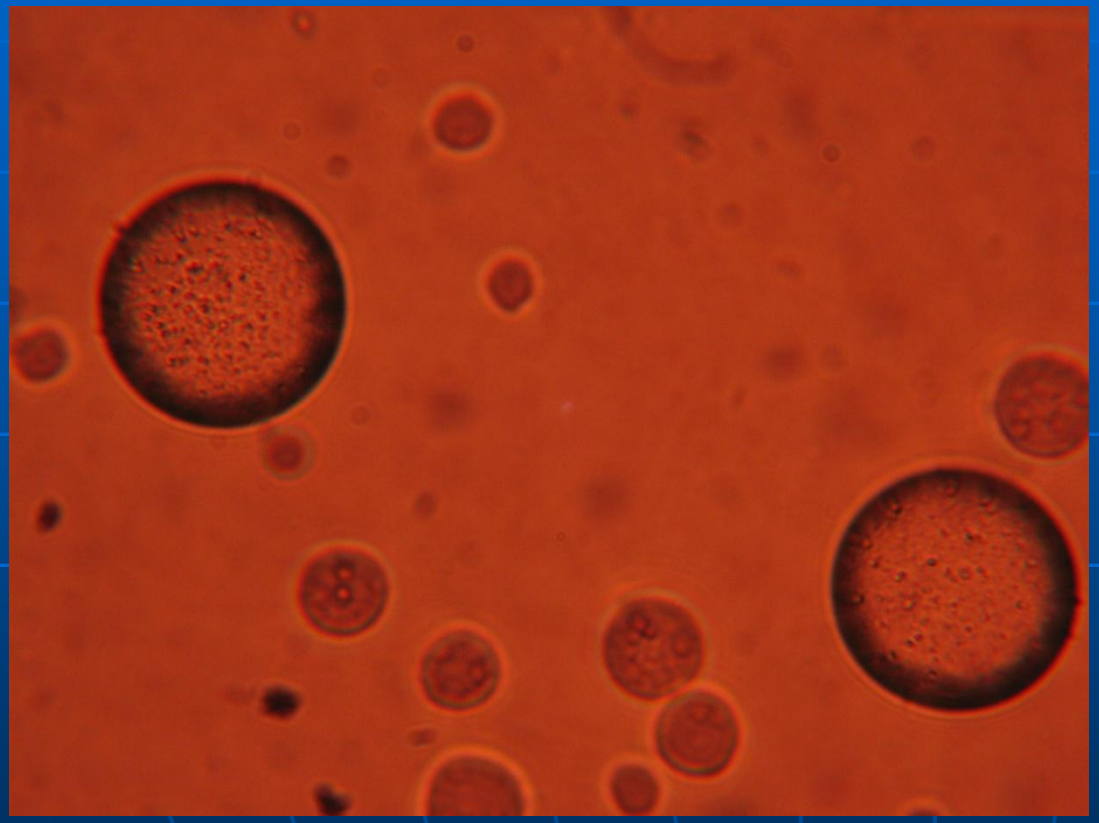
6 12 18 24 30

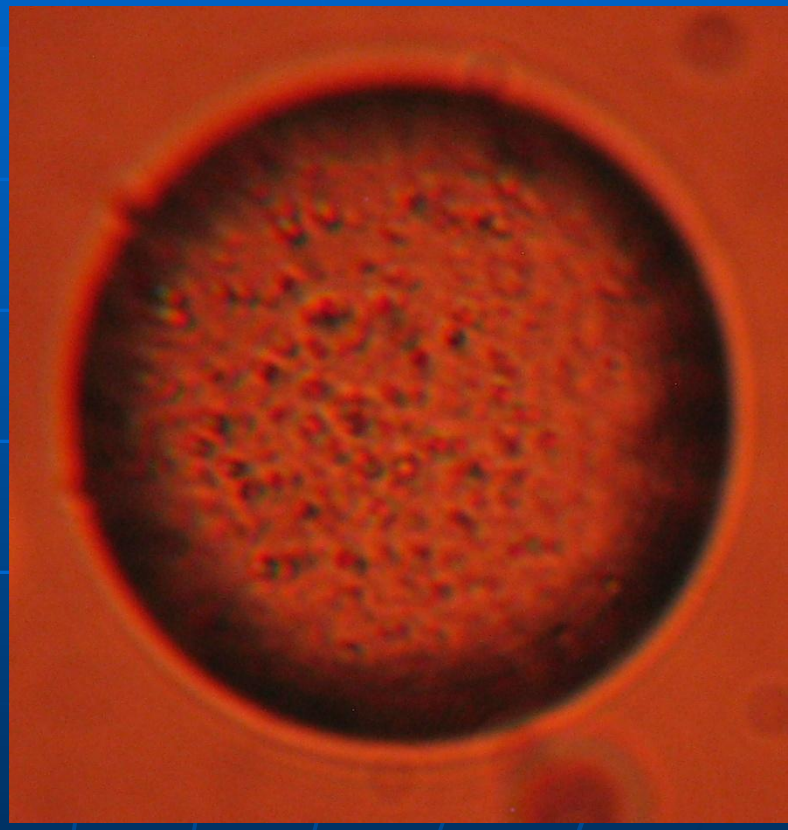
Ultrasonic exposure time (min)

Processing of 1-liter emulsion samples with the "Volna-M" device with a sound-conducting volume

Type of emulsion	Volume of allocated water, %
10 % oil – 90 % water	88,3
20 % oil – 80 % water	75,8
40 % oil – 60 % water	44,3
50 % oil – 50 % water	29,3
60 % oil – 40 % water	24
80 % oil – 20 % water	16,5

Formation and destruction of emulsions

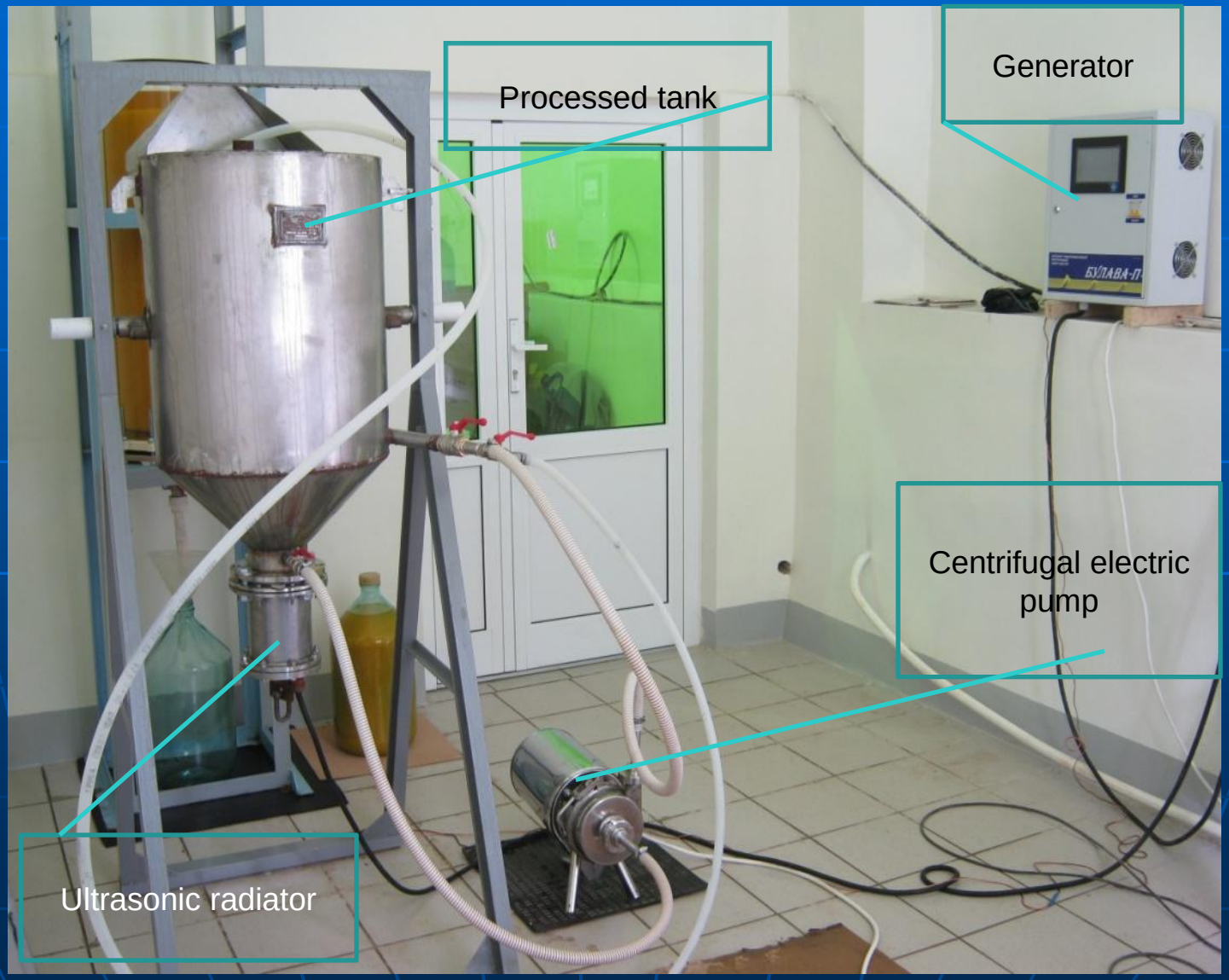




Oil in water
Magnification of 400 times

A drop with a diameter of 5 um

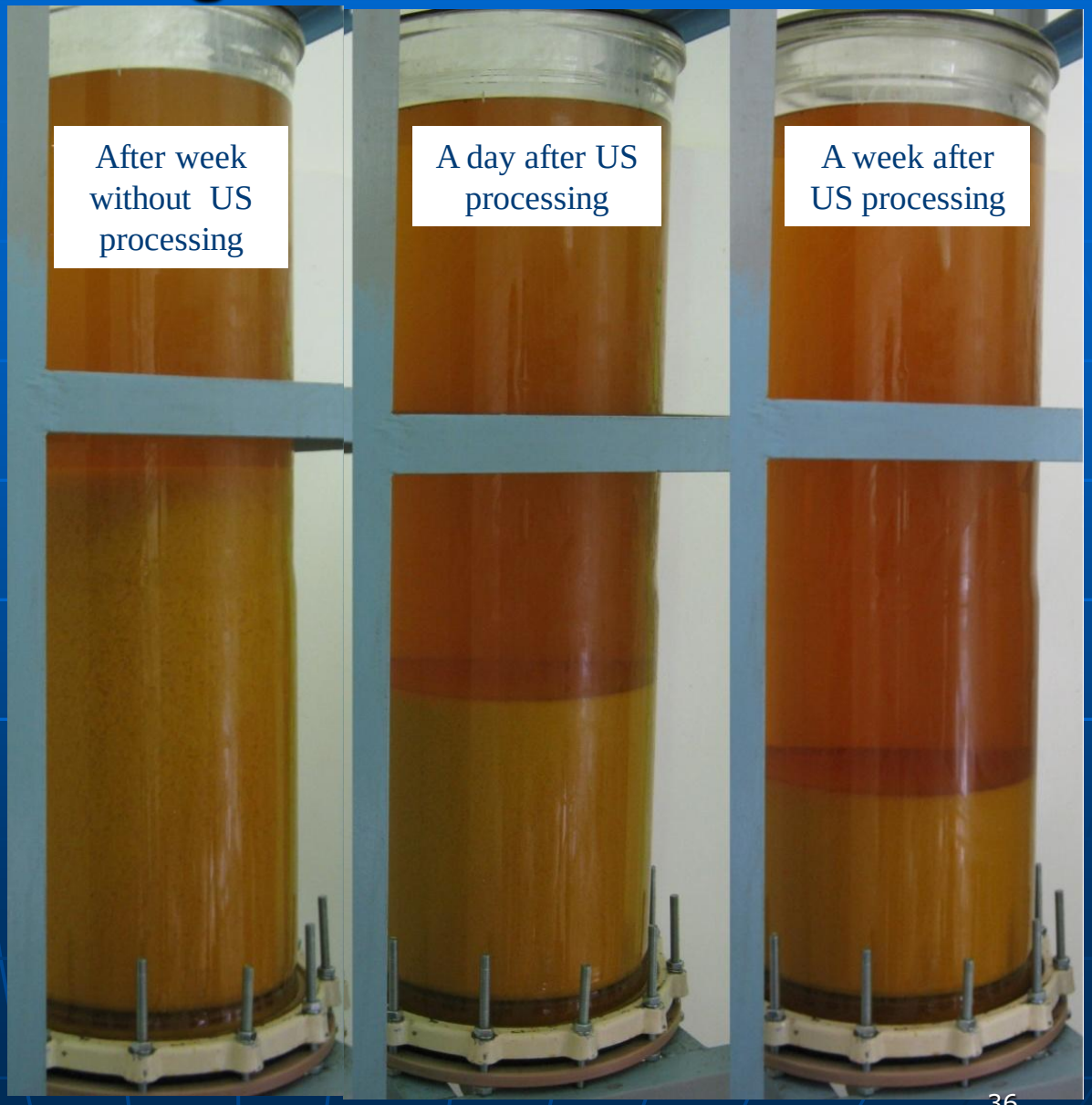
Separation of fine liquid systems



Ultrasonic processing of sea-buckthorn wine

Moving of wine-material at ultrasonic processing

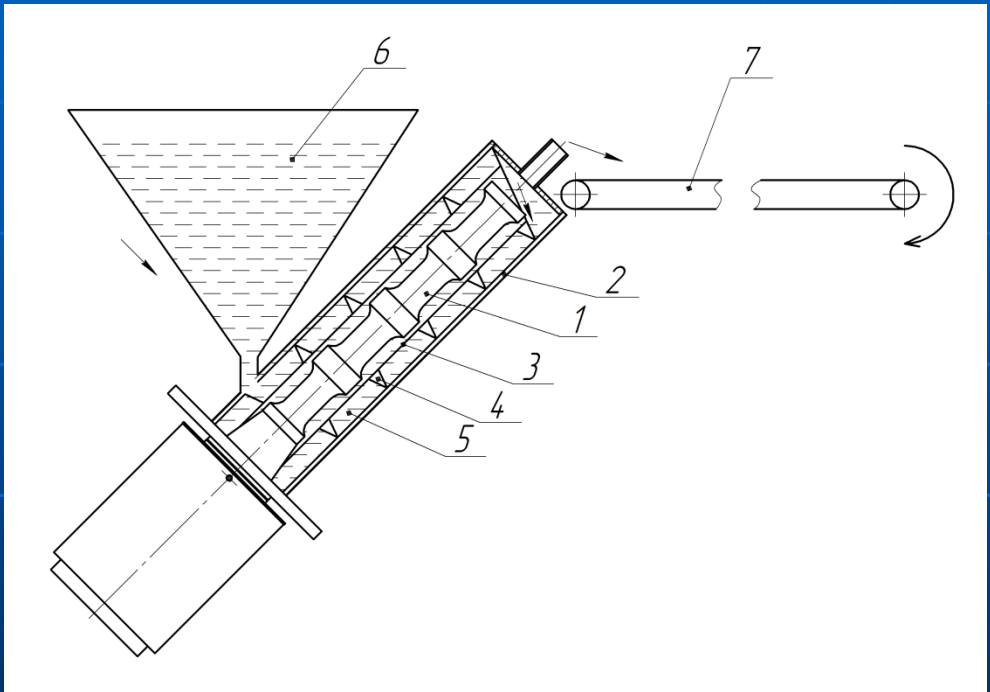
Forming of impurity shards if wine-material at settling after ultrasonic processing



Changing the wine-material at settling

Pre-sowing seed processing

Ultrasonic processing of seeds before planting



US

Can increase the crop productivity by 15-30%

Ultrasonic extraction

Extraction of dry hops

Номер образца	Соот-ноше-ние	Мощность генератора, Вт	Время обработки	Сухой остаток, %	Альфа кислота
Треб. ГФК					2,35–2,5
1	1 : 10	Мацерация	7 суток	1,8121	2,23
2	1: 4	40	30 минут	1,9923	2,29
3	1 : 5	40	30 минут	2,0097	2,31
4	1 : 7	40	30 минут	2,0106	2,33
5	1 : 10	120	30 минут	2,0756	2,38
6	1 : 10	150	30 минут	2,1228	2,44
7	1 : 10	160	30 минут	2,1506	2,47
8	1 : 10	Кипячение	2 часа	1,5163	

Extraction valerian root

Номер образца	Соотно-шение	Спирт, %	Время обработки	Сухой остаток, %	Валериан. кислота
Треб. ГФК				3,0	0,2
1	1 : 10 (без УЗ)	40	7 суток	3,4	0,3
2	1 : 4 (без УЗ)	70	7 суток	7,1	0,4
3	1 : 10 (с УЗ)	40	10 минут	2,9	0,2
4	1 : 10 (с УЗ)	40	20 минут	3,4	0,3
5	1 : 4 (с УЗ)	70	10 минут	6,9	0,4
6	1 : 4 (с УЗ)	70	20 минут	8,2	0,5

Results:

- acceleration of the process by 100...10000 times;

-increase the extraction of useful substances up to 20%;

-sterility of the extract

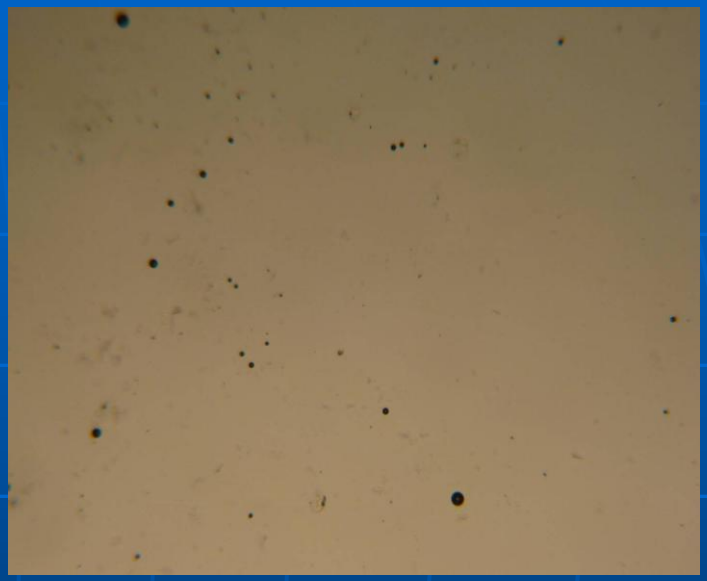
Ultrasonic processing of honey

Ultrasonic processor of honey

Reduction of crystallization centers

before processing

after processing



Honey thinning

Ultrasonic stimulation of root formation

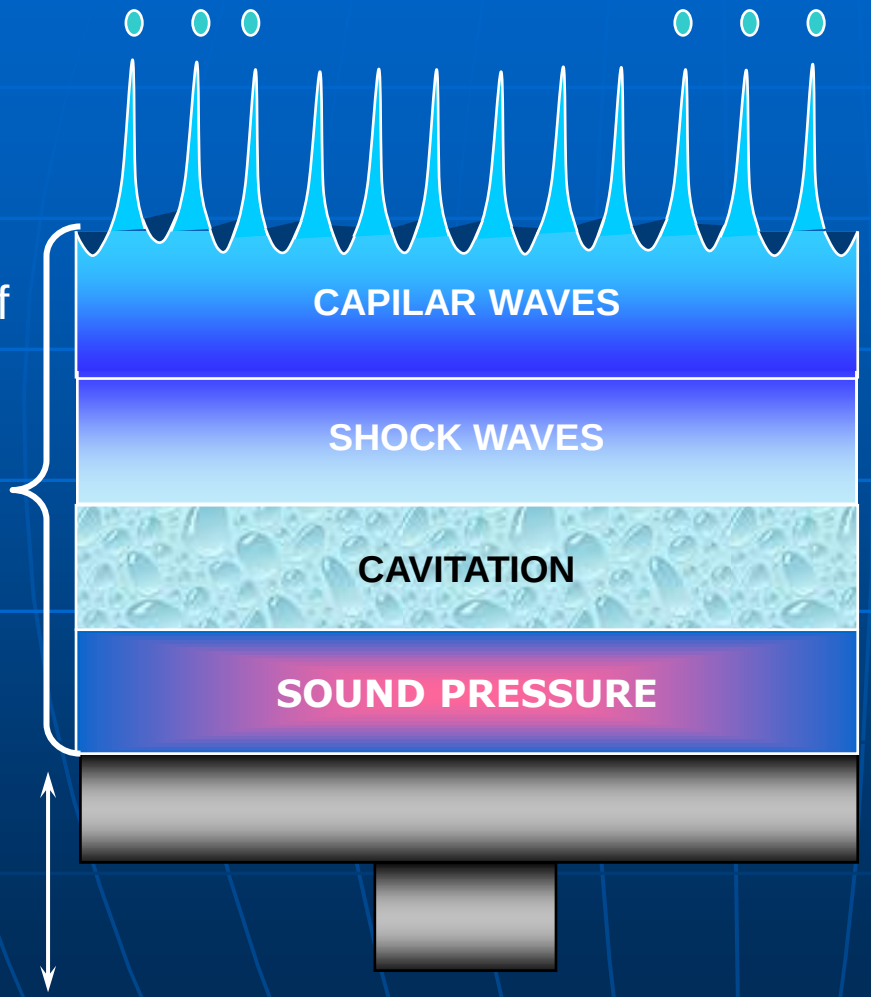
Ultrasonic processor of plant stalks

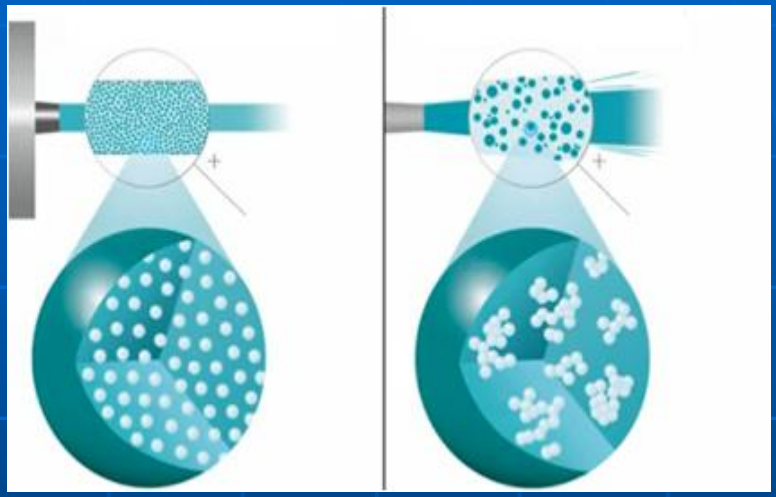
Root weight increased by more than 200 times

without processing

after ultrasonic processing

Devices for fine nebulizing





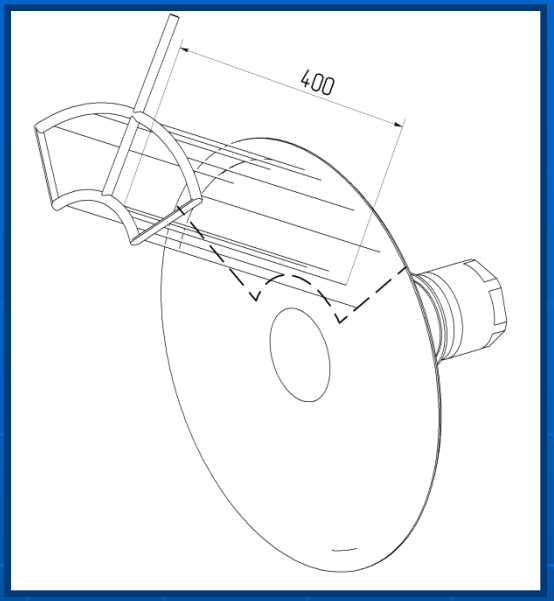
ultrasonic nebulizing

pneumatic nebulizing

Ultrasonic nebulizers

We invented more 50 various ultrasonic nebulizers for electronic, chemical, pharmaceutical industry and medicine

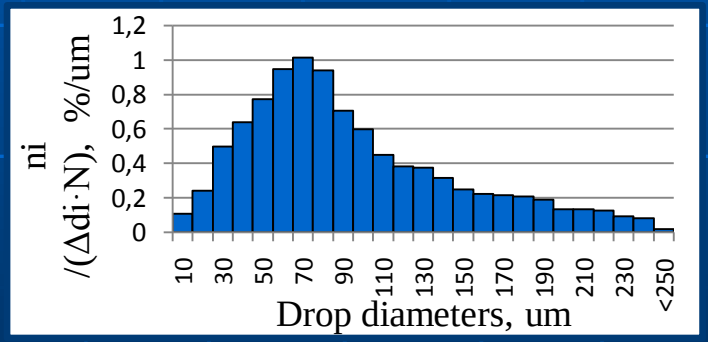
Ultrasonic nebulizing of liquids



Fluid flow diagram

Nebulizing process

Portable version



Distribution histogram of drop diameters

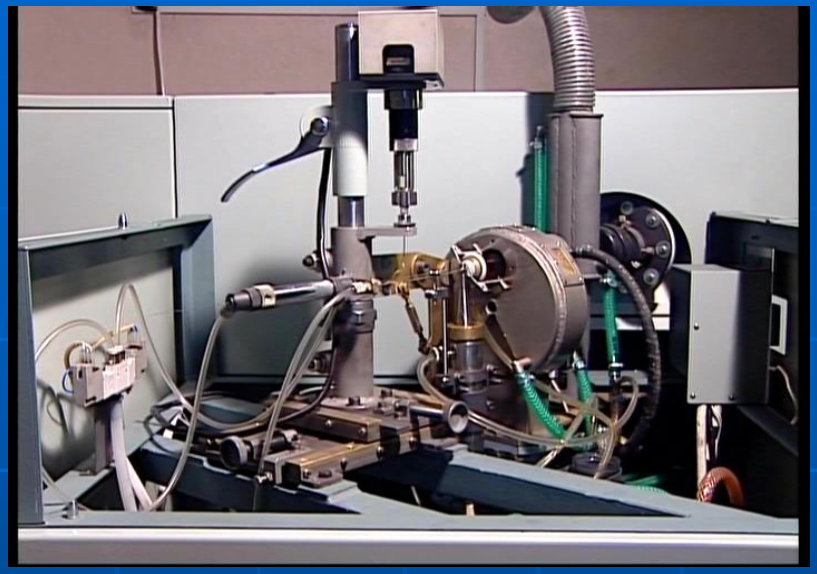
Technical characteristics:

Average diameter of drops (d_{32}), um	100 (197)
Standard deviation, um	68
Performance (disk radiator D=400 мм), l/h	1100
Power consumption, kW/h	0,35

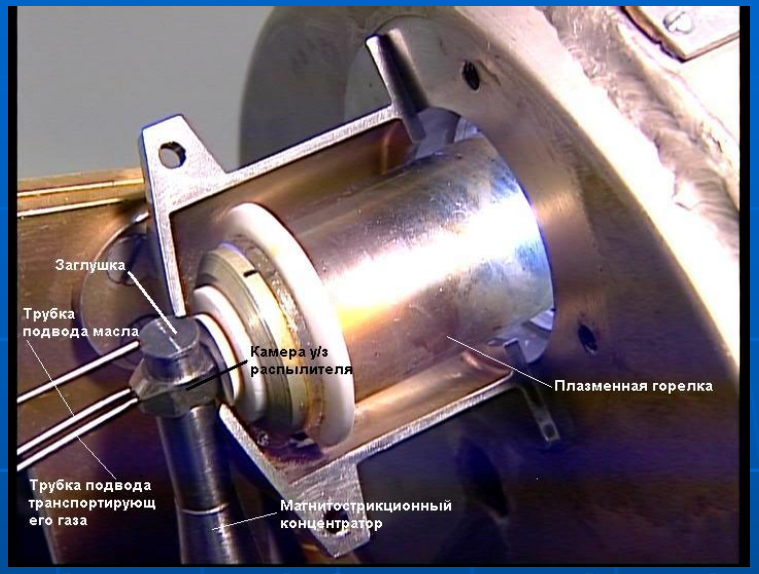
Comparison of the energy efficiency of nebulizing methods

Ultrasonic **from 0,35 kW/t** < Hydraulic 2 – 4 kW/t < Mechanical 15–23 kW/t < Pneumatic 50–60 kW/t

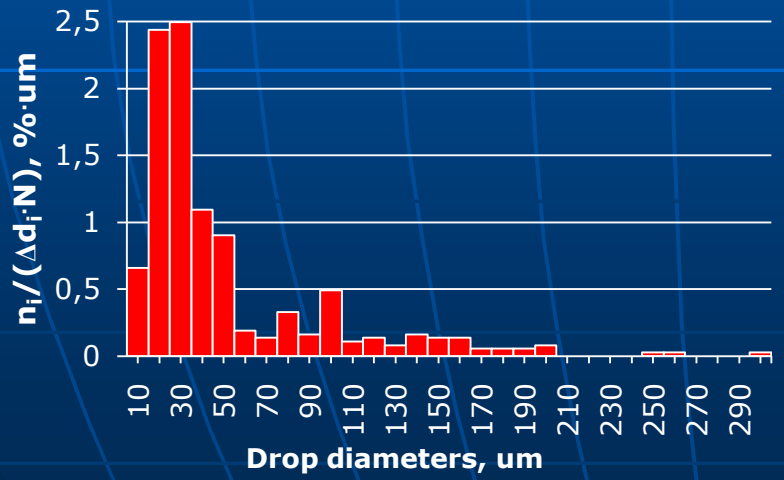
Nebulizing for analysis of aviation oil composition



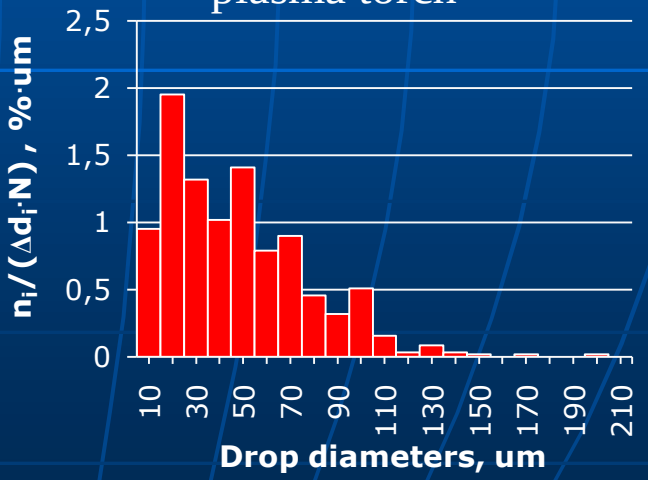
Spectral particle analyzer



Ultrasonic nebulizer mounted into the plasma torch

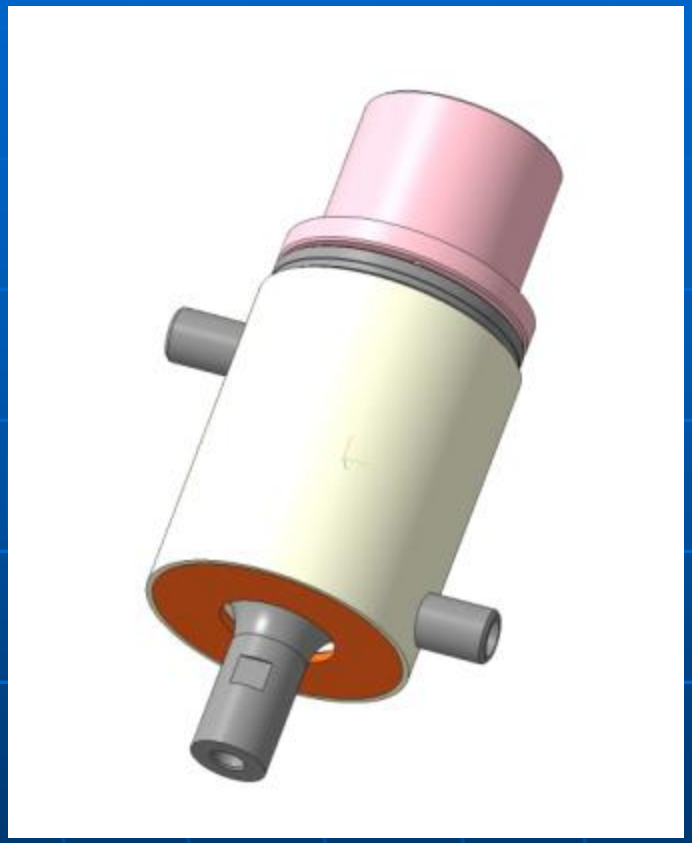


Nebulizer work frequency 60 kHz



Nebulizer work frequency 22 kHz

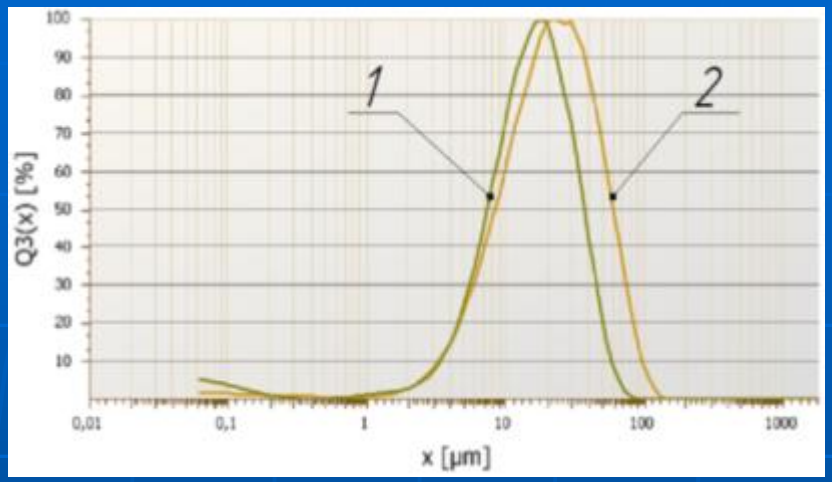
Nebulizing of aluminum



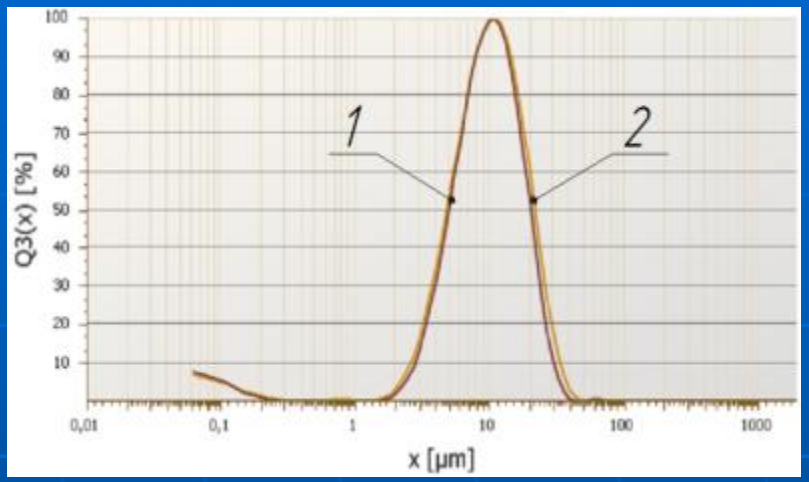
Ultrasonic vibratory system for forming vibration on nebulizing nozzle

Mounted vibratory system

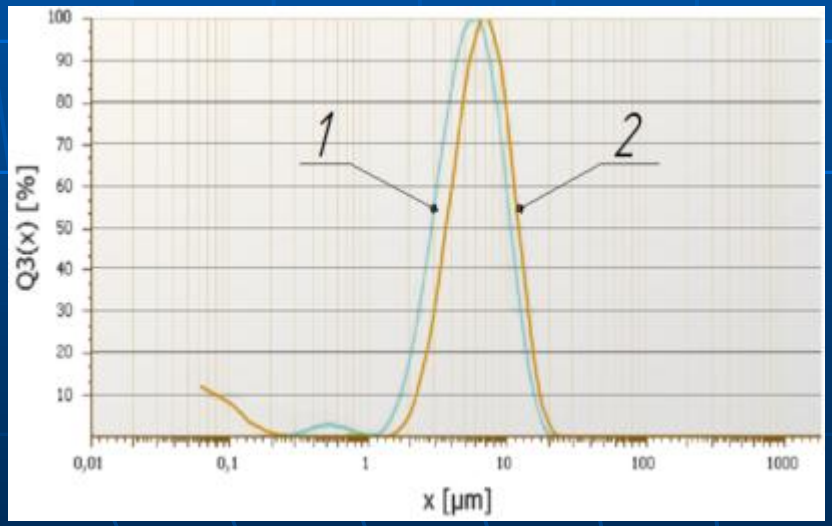
Granulometric characteristics of aluminum



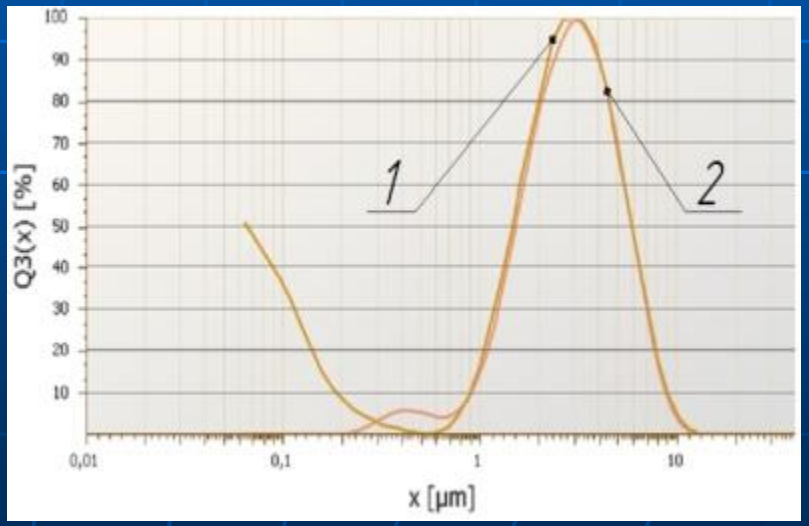
At the outlet on nozzle



From tank of the cyclone #1



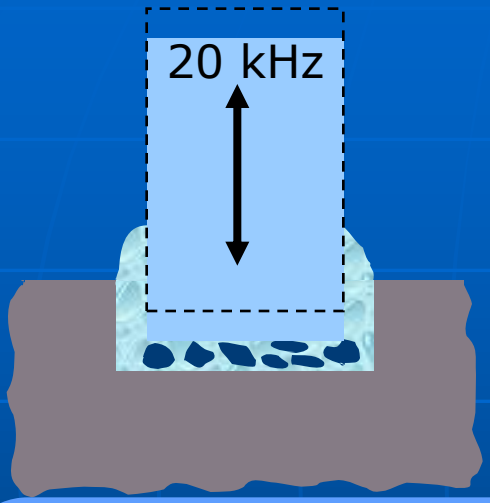
From tank of the cyclone #2



From the bag filter

1 – with ultrasonic vibrations; 2 – without ultrasonic vibrations

Impact on hard materials (sizing of fragile materials)



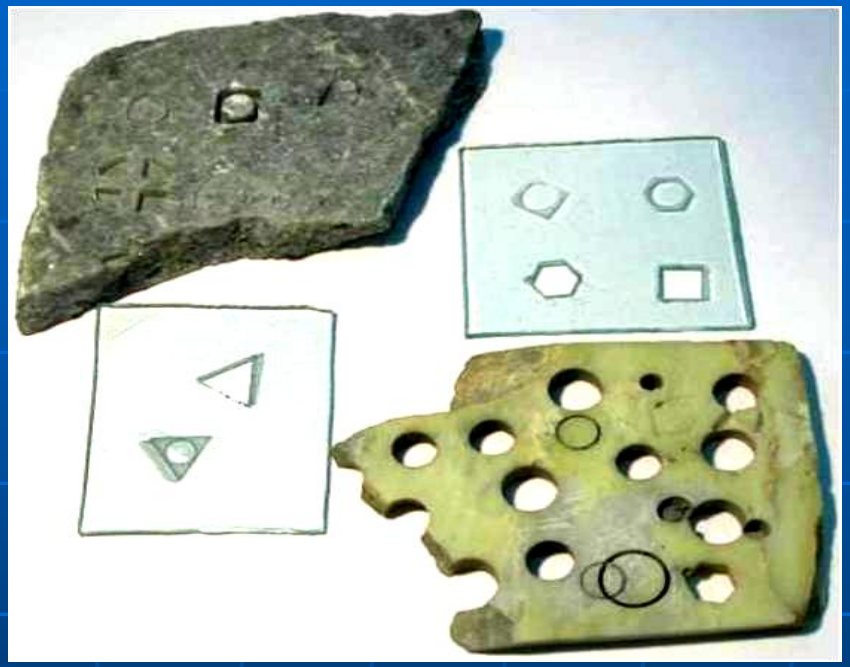
1.Impact of abrasive particles

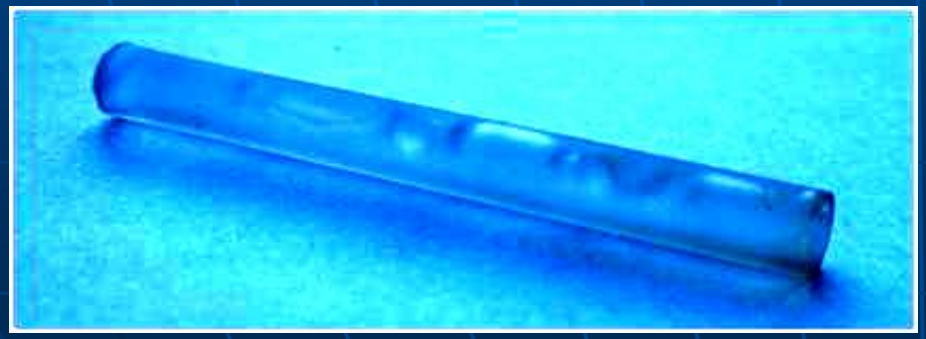
2.Circulation and change of abrasive due to cavitation

Results

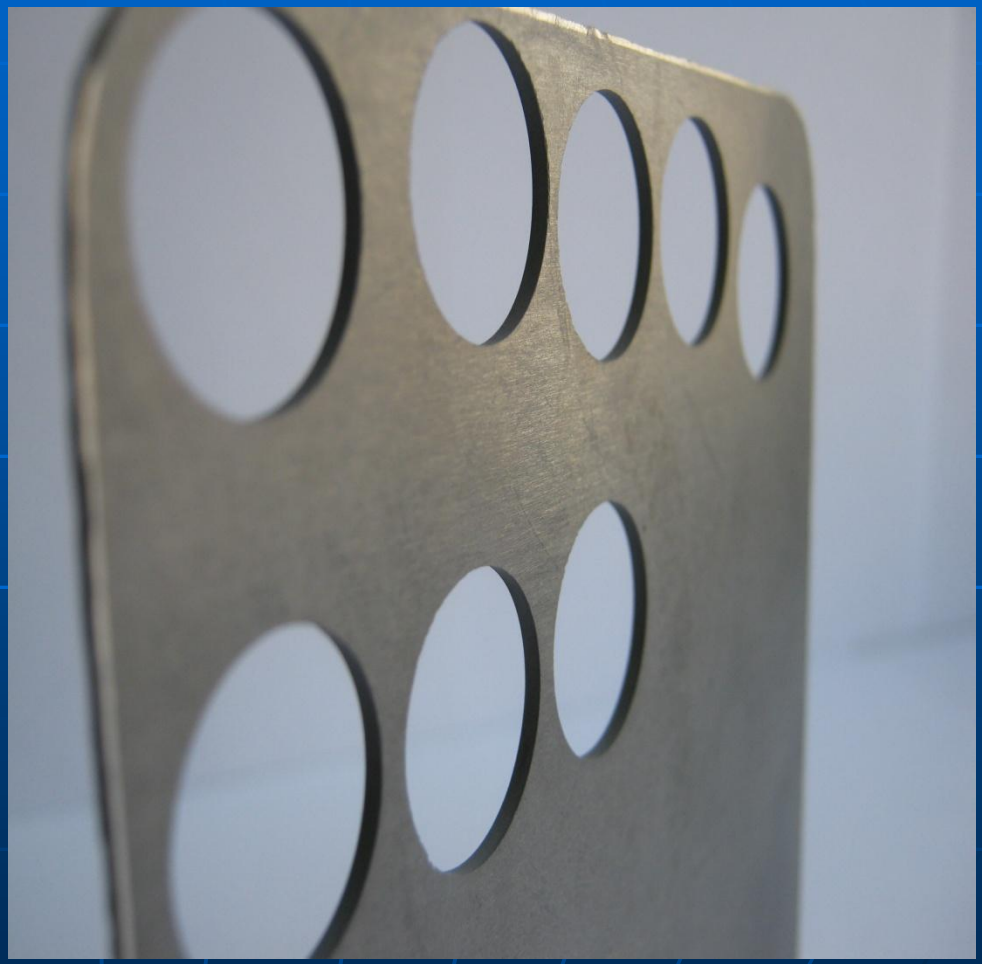
- Energy content < 10J/cm3
- Performance > 10 mm/s
- No cracks
- Diameter from 1 to 120 mm

Ultrasonic sizing of fragile materials





Application at manufacturing of ceramic products



Ultrasonic stand for making channels up to 2 m deep (more than 30 mm in diameter)

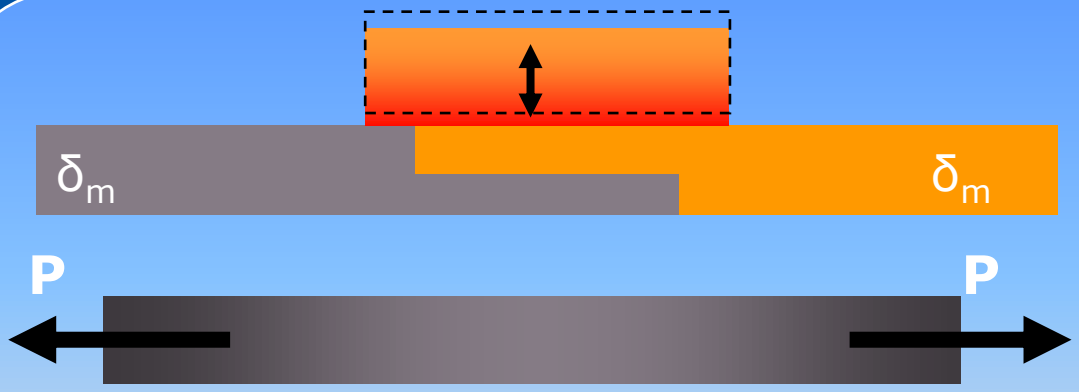
Tool for ultrasonic drilling with soil destruction

Weld of polymer materials

Intensification of processes

at the interface between two media

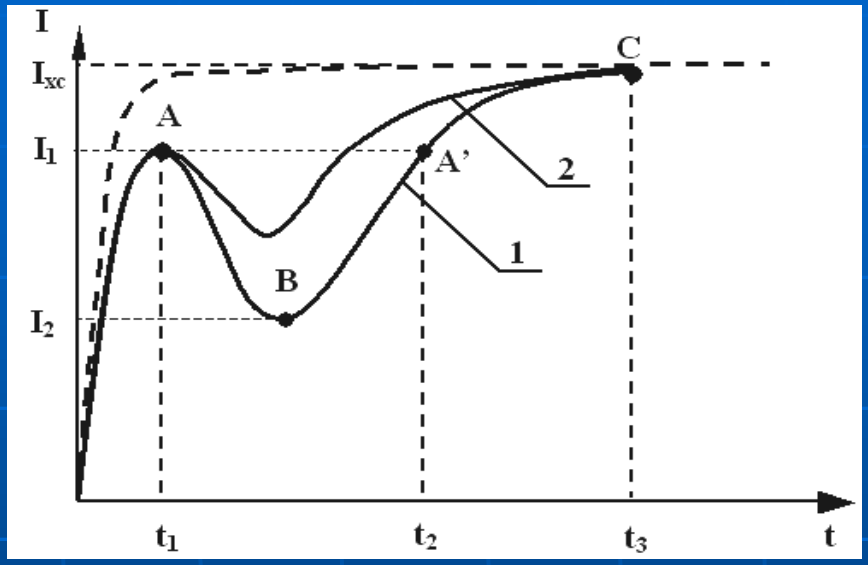
(increasing of temperature)



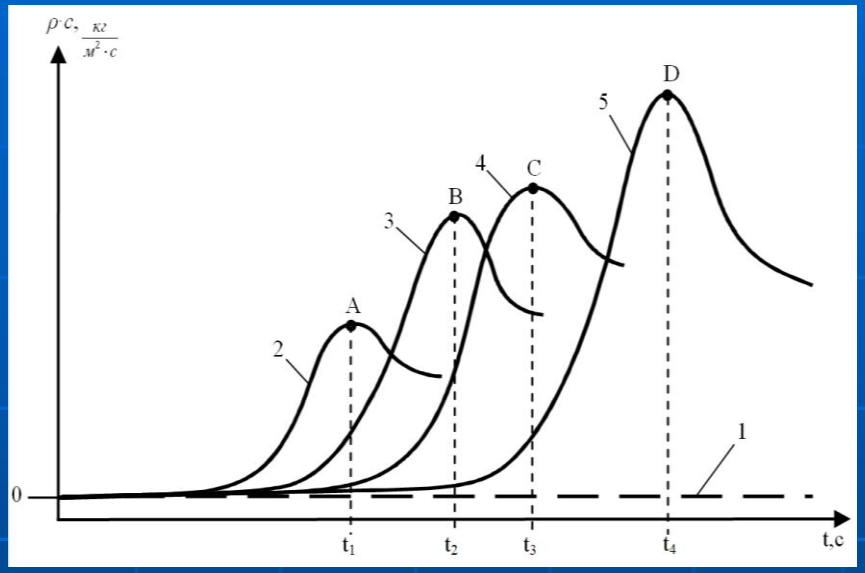
$\delta_{seam} > 70\% \delta_{material}$

Any thermoplastic materials

Optimal modes of ultrasonic exposure



Dependence of the current amplitude through the ultrasonic vibrating system when changing the properties of materials during welding (curves 1 and 2)



Time dependence of the wave resistance of the materials being welded for various materials:
1 – at the absence of materials;
2-5 - for materials of different properties

Optimality criterion: the maximum wave resistance of materials in the welding zone corresponds to the moment of formation of a welded seam with maximum strength

Welding efficiency

PVC samples

a) Old control method

b) new control method

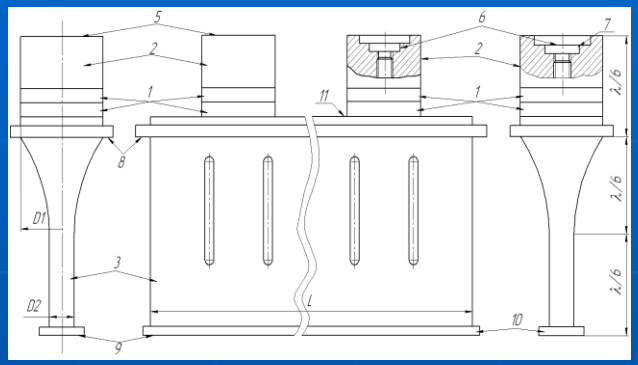
Comparison of the theoretical and experimental welding times

Наименование материала	Время сварки среднее, сек		отклонение, %
	определенное теоретически	определенное экспериментально	
Поливинилхлорид	0,758	0,65	15
Полипропилен	0,698	0,6	14
Полиэтилен	0,212	0,27	22
Полиэтилентерефталат	1,568	1,3	17
Полистирол	0,503	0,6	17

New criterions of optimal welding processes protected by patents RU2192375, RU2269334, RU2247544

Ultrasonic welders for press stepped welding

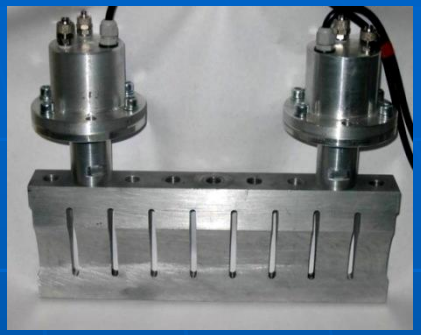
Half-wave and two-half-wave systems for performing extended seams with a length of 150, 220, 360 mm



a) – draft of half-wave vibratory system

b) two-half-wave UVS for seams of 150 mm;

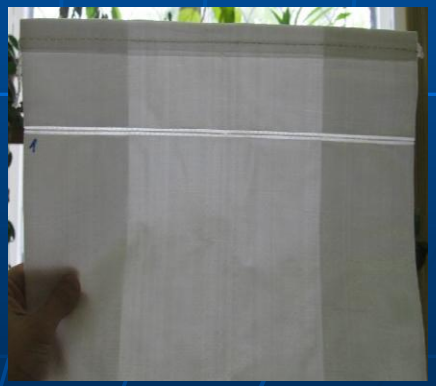
c) two-half-wave UVS for seams of 220 mm;



d) two-half-wave UVS for seams of 360mm;

Ultrasonic welders for extended seams

Products with extended seams of 220 and 360 mm



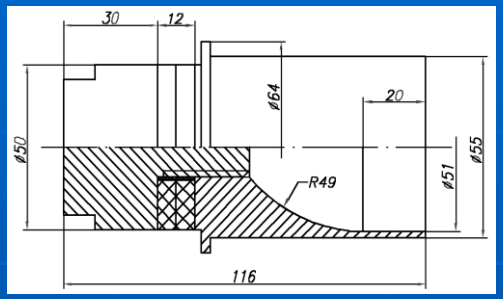
Technical solutions have protected by patents: RU2276014 and RU2322551

Ultrasonic welders of various power

630 W	800 W	1000 W	3000 W
			
Length of surface width			
50-100 mm	100-180 mm	180-220 mm	220-350 mm

Ultrasonic ring welders

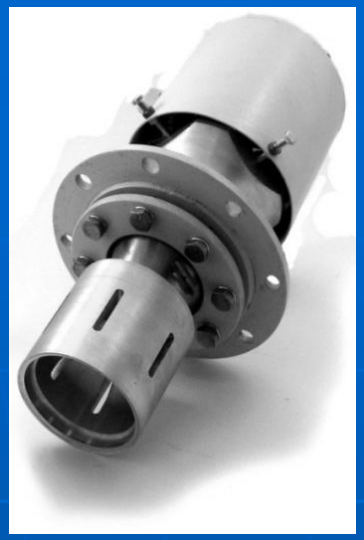
Half-wave, two-half-wave, and three-half-wave vibrating systems for seam with diameter up to 100 mm



a) Draft of half-wave vibratory system

b) half-wave vibratory system for seam with diameter 50 mm

c) two-half-wave vibratory system for seam with diameter 60 mm



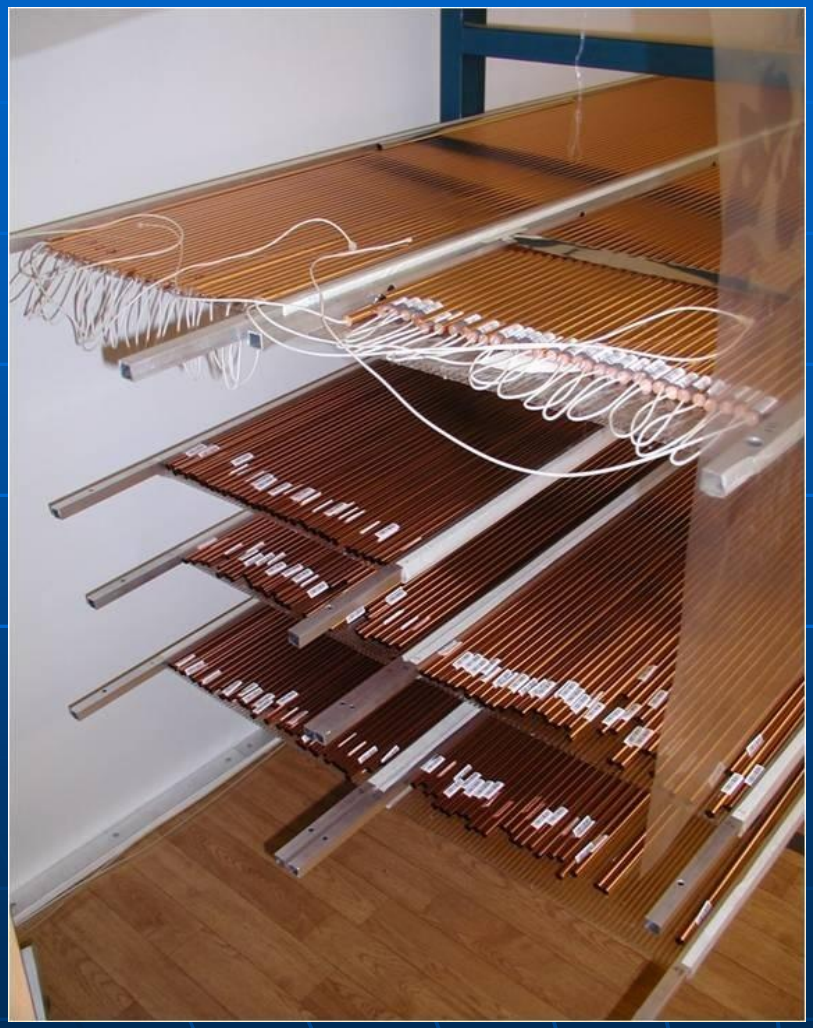
d) three-half-wave vibratory system for seam with diameter 100 mm

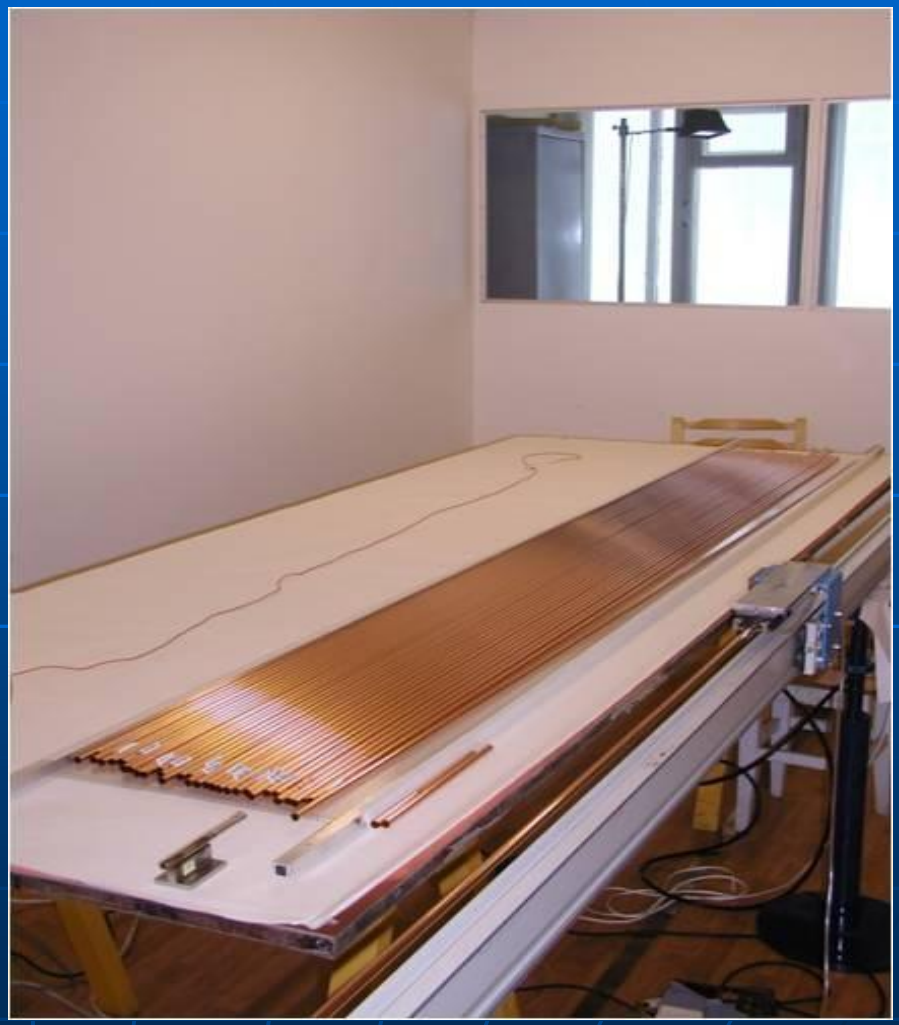
Ultrasonic girth welders

Products with ring seams

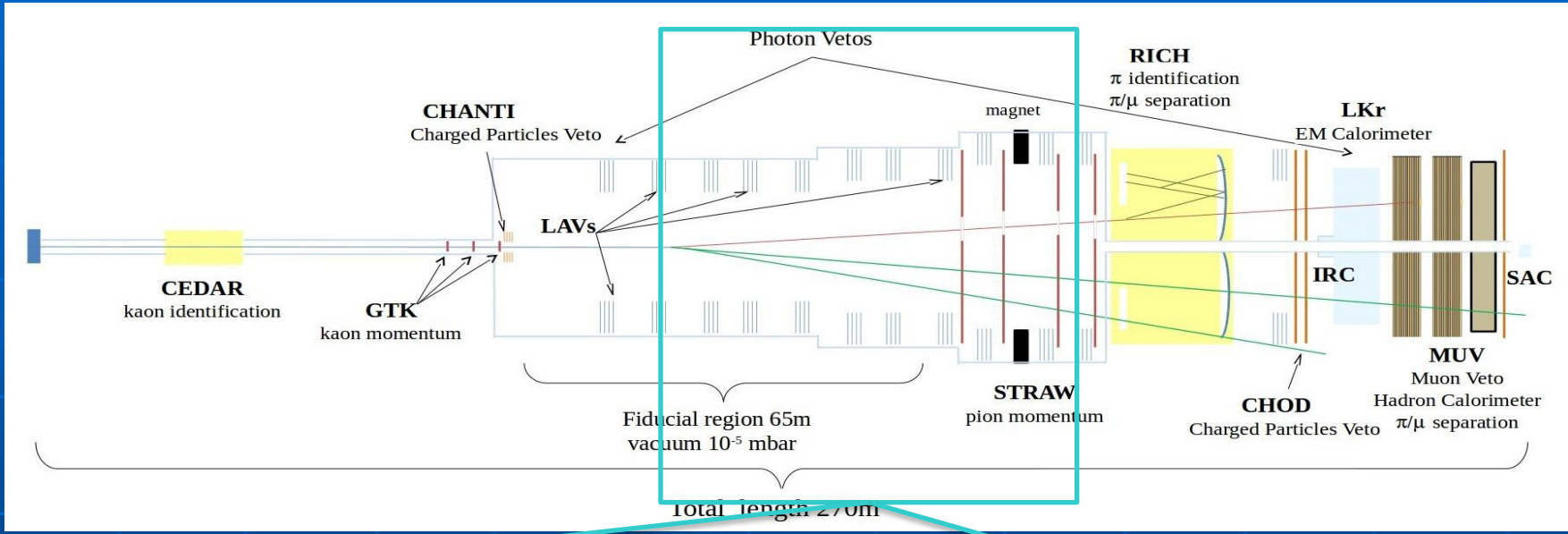
Technical solutions have protected by patents: RU2241599

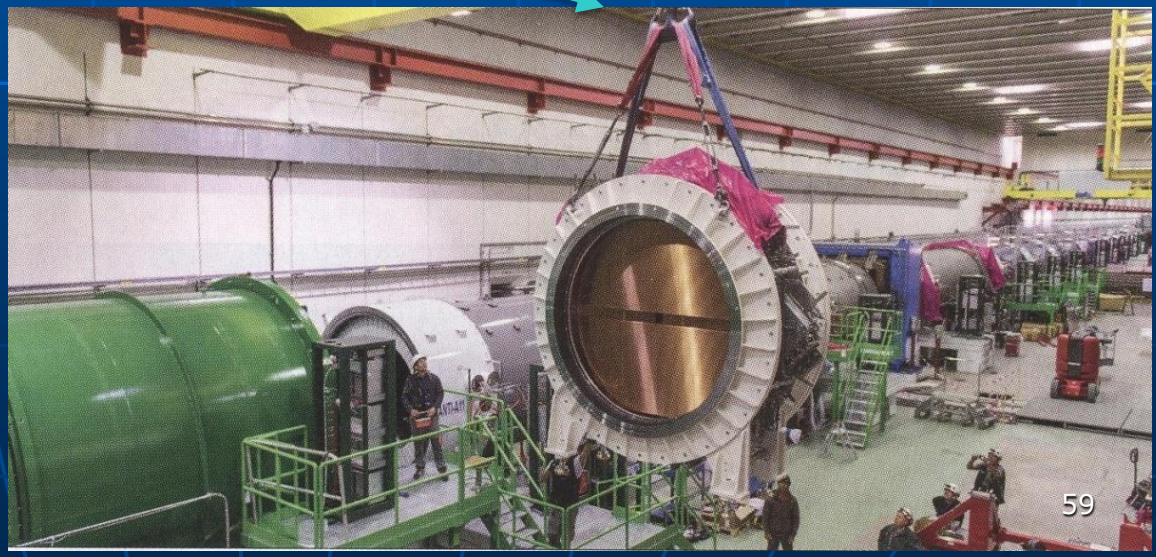
Application of ultrasonic welders for tube-detectors (straw-detectors)





Application of ultrasonic welders (Large Hadron Collider)





Ultrasonic welders in automated lines

Conveyor type

Carousel-type

Complex contour welder

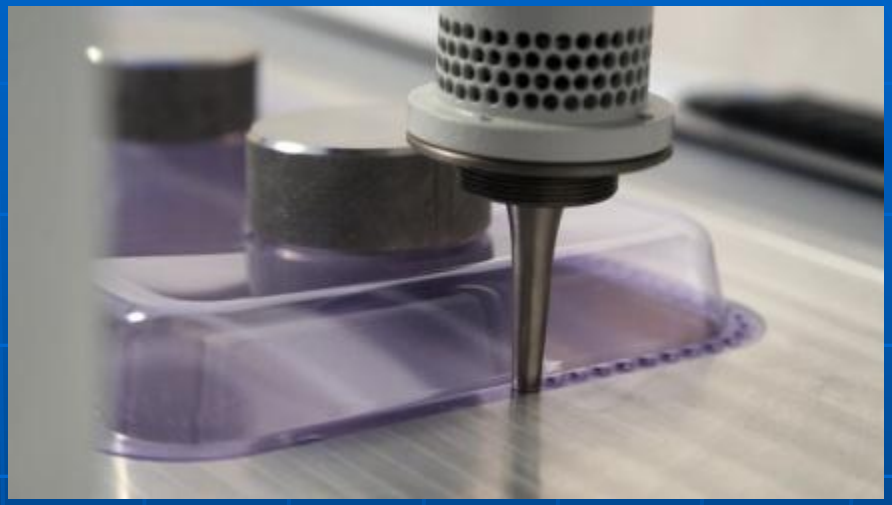
The combination of selected and invented moving and welding devices allows you to cover a wide range of products made of thermoplastic materials. A high degree of automation and easy reconfiguration of equipment can improve the quality of the final product and reduce production costs.

Ultrasonic welder for spherical products

Product gripping system

Place of product supply

Automated welder on a complex contour



Ultrasound devices for medicine

Preparation of medicinal aerosols

liposuction

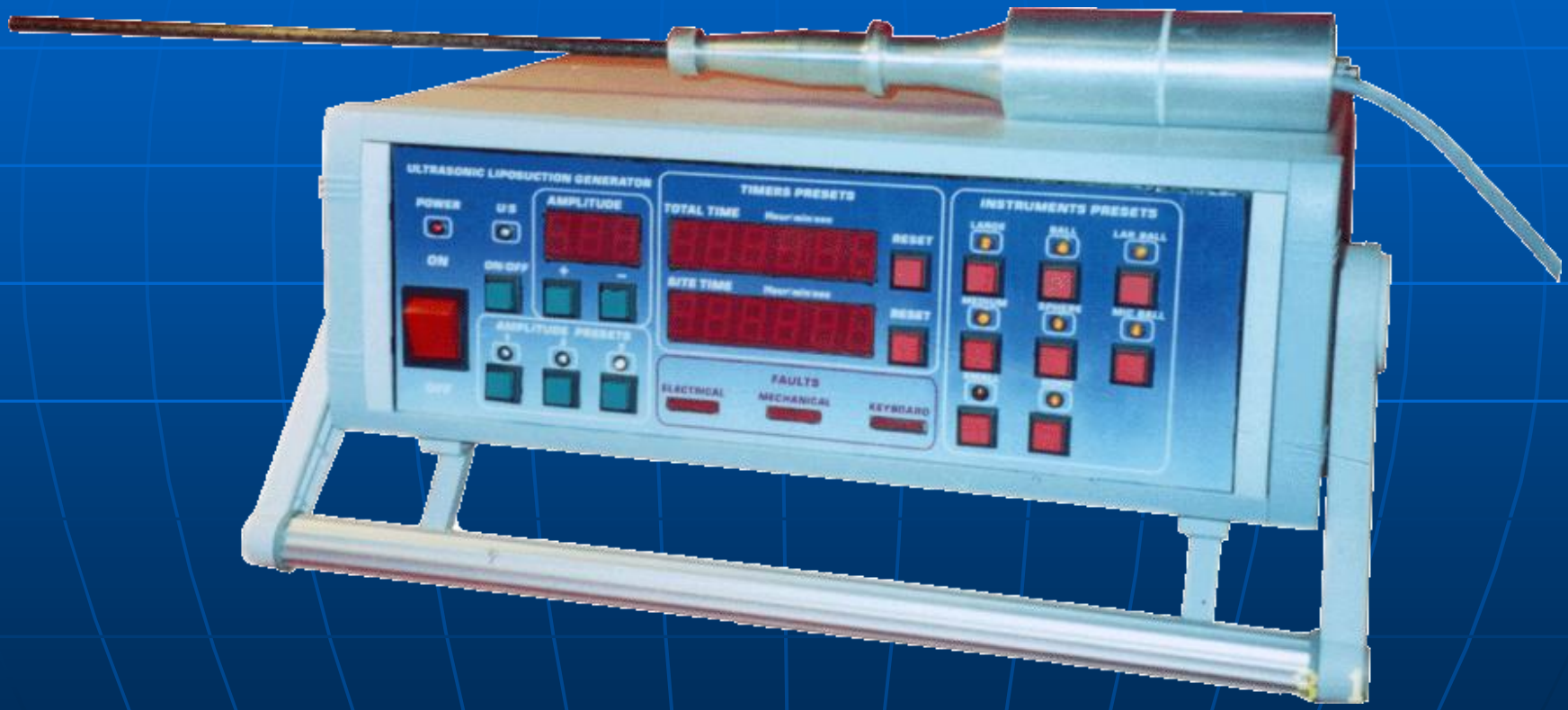
Sealing containers with blood products

Aerosols, particle size ~50 microns at an ultrasonic frequency of 20 kHz

T<Tflowings
No gases
Contamination welding

•Speed
•Quality
•Safety

Ultrasonic device for liposuction



Invented and patented surgical working tools

13 working tools

Patents
RU2141386, RU223938
3.

Exposure efficiency increased by
10 times

Ultrasonic massager

The device allows you:

1. External liposuction procedure.
2. A delicate therapeutic and cosmetic effect on any skin type.
3. Increase the effect of creams and ointments due to deep penetration.
4. Local heating of the massage area.
5. Normalization of metabolic processes in the epithelial cells.

Ultrasonic sealer

Full sealing cycle, seconds, no more	5
Weight of the manual welding unit, without wire, grams	300
Weight of the device, kg, no more	8
Power consumption, W, less	130
Diameter of sealed tubes, mm	4-8

Technical solutions have protected by patents: RU2141386, RU2171669, RU2192375, RU2269334.

Ultrasonic exposure in gases

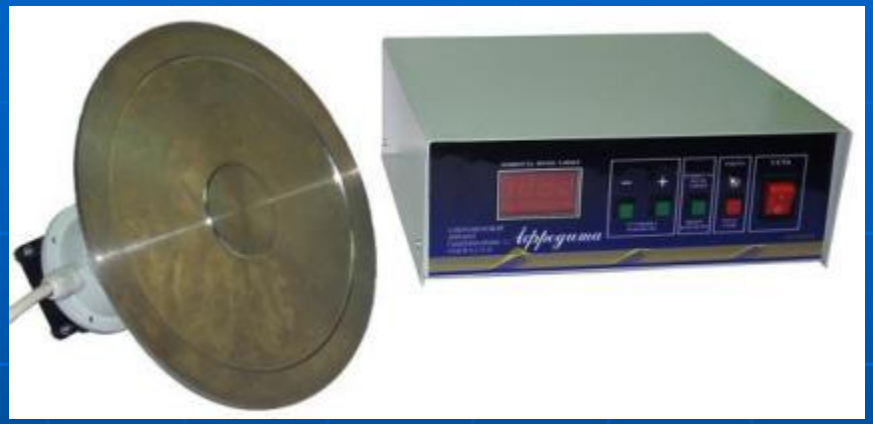
Intensification of processes in gases

- Acoustic coagulation
- Absorption
- Burning

Ultrasonic drying

- Drying without heating the material
- Lower limit of drying acceleration 135-140dB
- There is no significant dependence on the frequency
- Drying of thin layers of material (2-3 cm)

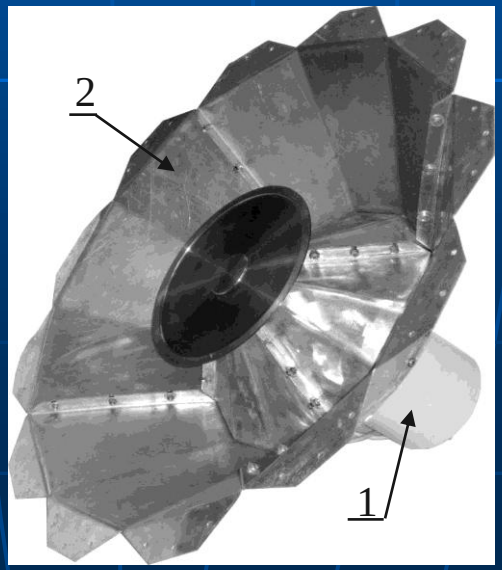
Ultrasonic processors for gases



Radiator with generator

Radiator with phase-leveling elements

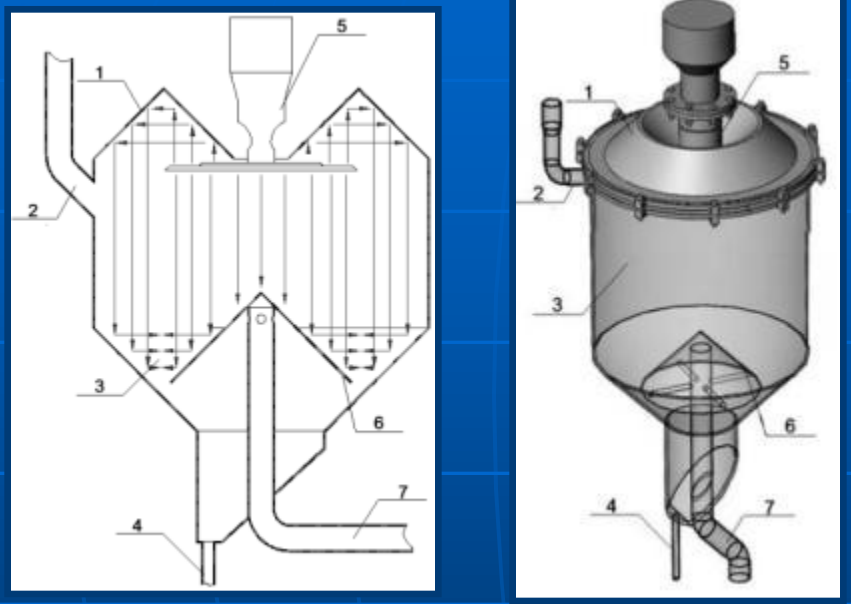
Multi-element UVS with a focusing radiator



Ultrasonic device with reflector
1-ultrasonic vibration system;
2-reflector

Ultrasonic gas cleaning

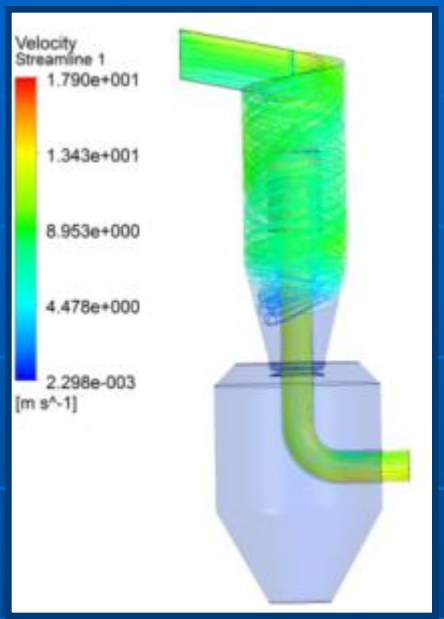
Sketch of the coagulation chamber



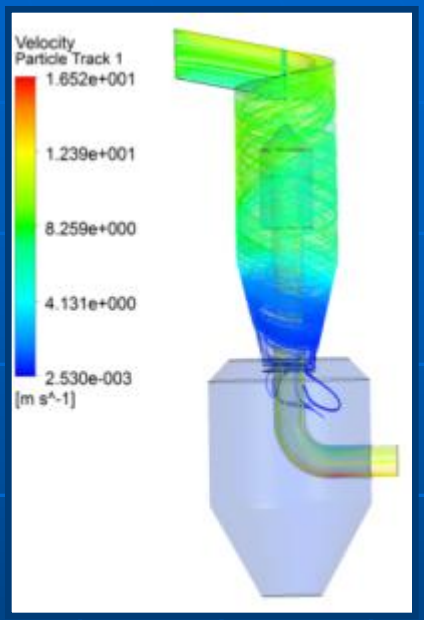
1 – upper reflector; 2-inlet pipe; 3 – cyclone body; 4-outlet to the hopper; 5-electroacoustic transducer; 6-lowerreflector; 7-outlet pipe.

Technical solutions have protected by patents: RU2421566, RU2432235, utility model patent: RU102197, RU131307, RU132000 certificate for a computer program RU2010617783.

Air flow trajectories



Trajectories of motion of dispersed particles

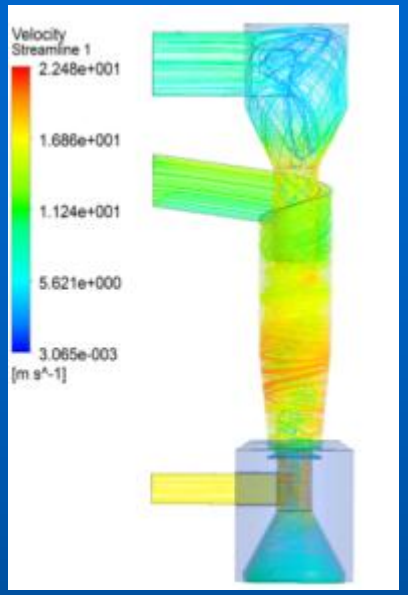


The diameter of the dispersed particles is 1 um

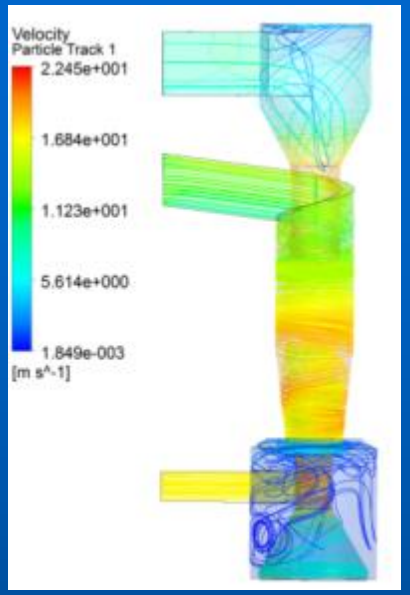
The invented the equipment allows due to the ultrasonic exposure to ensure the degree of capture of particles with the size of from 1 to 5 um - 95% ... 99%.

Micron and submicron particle catchers

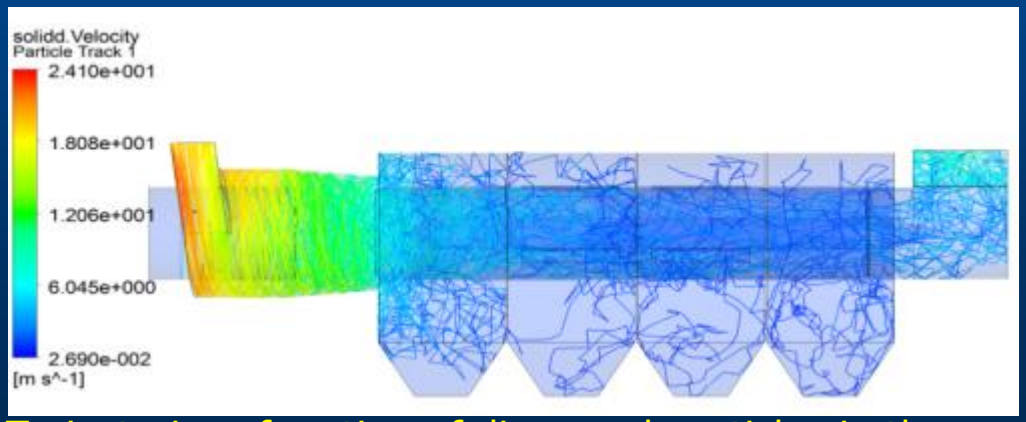
Model of the coagulator



Air flow trajectories in the coagulation chamber



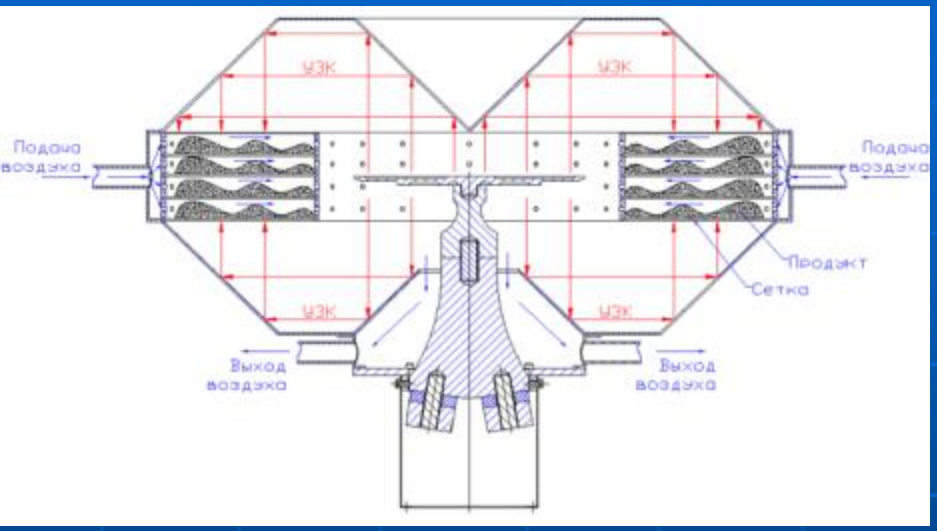
Trajectories of dispersed particles in the coagulation chamber

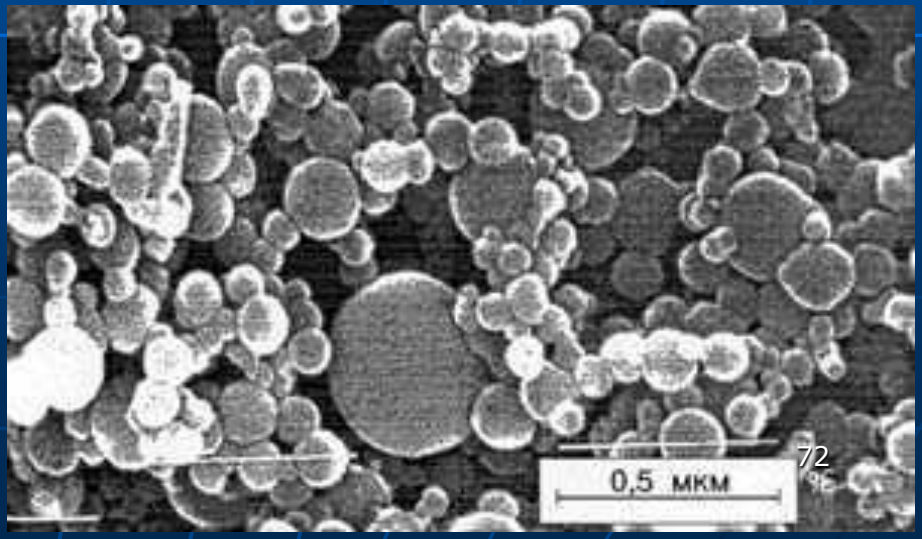


Trajectories of motion of dispersed particles in the preliminary agglomerator

The invented design of the equipment for the capture of submicron particles due to ultrasonic exposure provides the degree of capture of particles with a size of 0.2 to 1 um – 90%...98%.

Ultrasonic driers

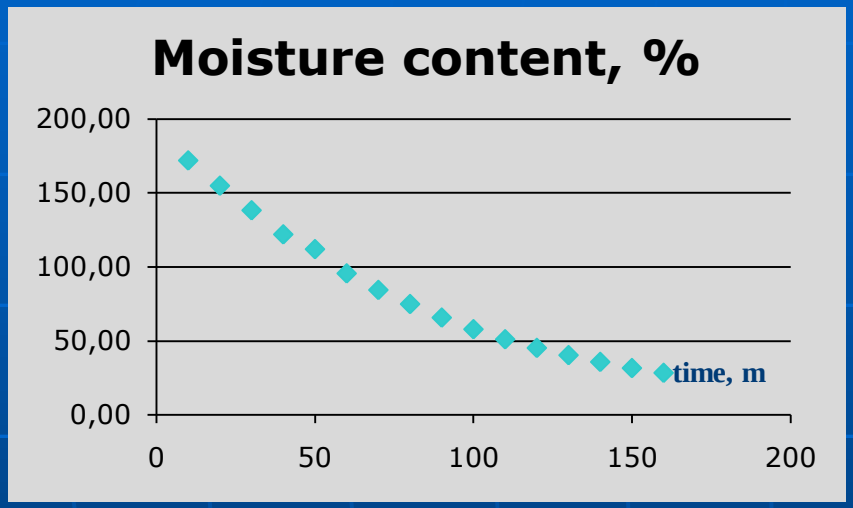




Ultrasonic drying

A large number of experiments were carried out that showed the high efficiency of ultrasonic drying of plant raw materials

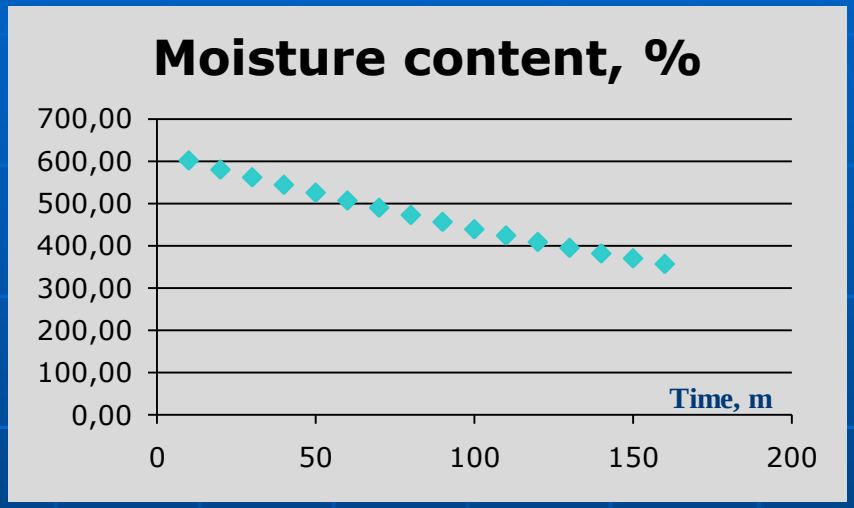
Drying gelatin



Before

After

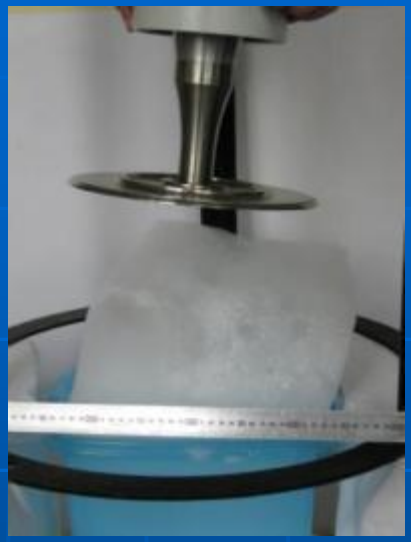
Drying carrots

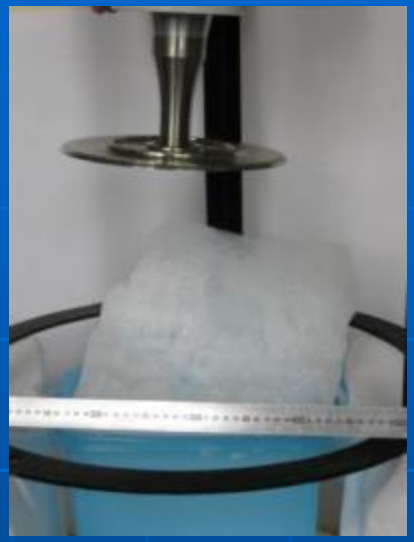


Before

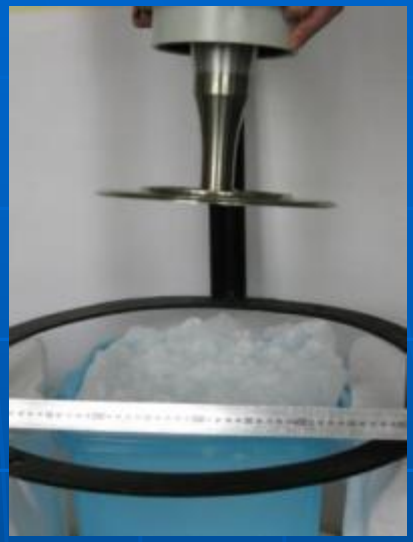
After

Ultrasonic devices for foam destruction

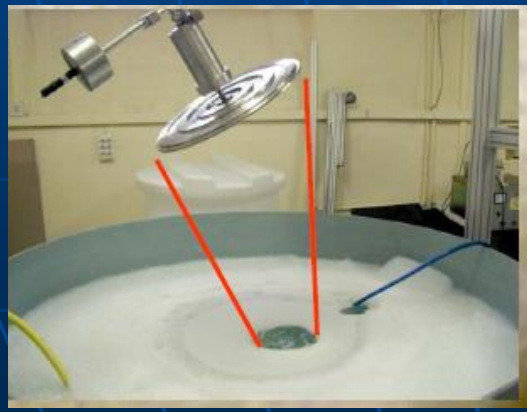

1 s

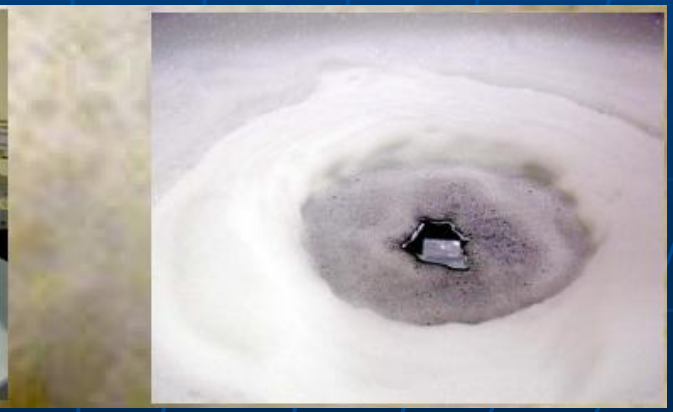

10 s


40 s


60 s

The experiment was carried out at the following parameters of the disk emitter: the sound pressure level-140 dB; the frequency of the generated sound vibrations-20.5 kHz, the ultrasonic exposure time - 60 seconds.





Ultrasonic devices for home

Extraction and mixing	Cutting	Processing of milk	Cooking
•Increase in the extraction rate by 100-10000 times. •Production of resistant emulsions of the "Water-oil" type. •Increase the rate of dissolution by hundreds of times.	Getting the minimum portions of food products (dough, cheeses, muffins, sausages) without the formation of waste (crumbs).	•Milk sterilization. •Reduction of contamination •Increasing the nutritional value of milk. •Reducing the size of fat balls.	1.Getting, ketchup, sauces, chocolate. 2.Meat processing 3.Processing of yeast. 4.Salting, smoking.