bakor

BAKOR
RESEARCH AND DEVELOPMENT CENTER

GAS CLEANING EQUIPMENT

EXPERIENCE • INNOVATIONS • RELIABILITY

Bakor Research and Development Center is a national leader in scientific and applied research in special ceramic composites and materials for the most critical parts of thermal plants. We also set the pace in design and manufacture of unique ceramic filters for metallurgy, mining, petrochemical, gas, utilities and other industries.

The Company is focused on treatment of gas, air, aspiration and other discharges of various industrial facilities (metallurgy, power generation, chemical, cement, biochemical, food and other industries) and removal of solids, dust particles and liquid aerosols.

The following priorities are set: development and implementation of non-conventional high temperature dust and soot trapping equipment; cost efficient upgrading of existing low performance dust and soot trapping equipment including turnkey projects.

BAKOR RESEARCH AND DEVELOPMENT CENTER OFFERS SOLUTIONS IN THE FOLLOWING AREAS:

Science and technologies:

- Dust and gas cleaning system inspection
- Characterization of dust laden flows
- Efficiency and power consumption calculations for gas cleaning systems and units
- Engineering solutions for industrial gas cleaning
- Scientific research
- Development and manufacturing of new products for environmental equipment

Manufacturing:

- Centrifugal filters for solids removal from gas and air flows
- Cyclone filters, i.e. high performance dust traps combining benefits of cyclones and bag filters
- Cyclone dust traps upgrading
- Innovative manufacturing of high temperature ceramic gas filters

Bakor Research and Development Center offers innovative in-house products. Our products are protected by national and international patents. We own more than 85 national patents and 2 Eurasian patents and a registered trademark.

The Quality Management System of Bakor Research and Development Center is certified according to GOST R ISO 9001-2008 for engineering, development and manufacturing of ceramic aerators, ceramic filters and crucibles and ceramic refractories.

Certificate of compliance No. СДС.СТ.СМК 3621.04-100106.

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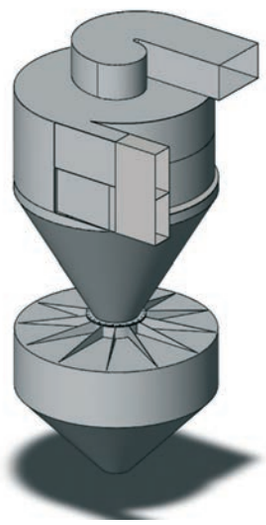
EQUIPMENT

SERVICES

CENTRIFUGAL FILTER

DESIGNED FOR GAS AND AIR FLOWS CLEANING FROM SOOT AND DUST AT UP TO 350°C AND SOLIDS CONCENTRATIONS OF UP TO 1000 g/м^3



Centrifugal filters are used in various industries:

- Aspiration systems for bulk material transfer units
- Gas filtering systems for drying drums, mills, scalping machines, etc.
- Aspiration systems for casting beds, cement grinding mills and clinker chillers
- Soot removal systems for solid fuel boilers

Main benefits of centrifugal filters:

- Capability to meet sanitary requirements for solids discharge into the atmosphere
- Lack of replaceable filtering elements
- User-friendly design and reliable performance

Trapping efficiency vs the number of channels in the centrifugal filter for trapping of dust with particle sizes of over 5 μm may be estimated from the table below:

NUMBER OF CHANNELS IN THE CENTRIFUGAL FILTER, **N**							
1	2	3	4	5	6	7	8
DUST TRAPPING EFFICIENCY, %							
50	67	80	89	94	97	98	99

Reliability of this information has been proven many times by testing of centrifugal filters in various industries.

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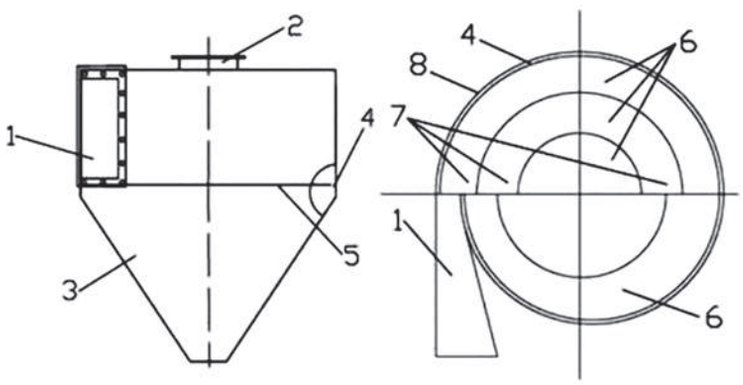
FOUR-CHANNEL CENTRIFUGAL FILTER



1 – Inlet;
2 – Outlet;
3 – Conical hopper;
4 – Annular slot;
5 – Head bottom;
6 – Convoluted channels;
7 – Recirculation slots;
8 – Separation chamber

Photo. Centrifugal filters in the cement grinding mill gas cleaning system No.10 – 3,2*15, Balakleisk Cement Plant

PRINCIPLE OF CENTRIFUGAL FILTER OPERATION:

Dust laden gas flow is fed to tangential inlet 1 and to separation chamber 8. As the flow moves along the curved path, solid particles are collected at the periphery of each channel 6 and discharged via slots 7 to preceding channels. Dust with a part of the gas flow from the first and the second flows of channel 6 is fed to annular slot 4 and to cylinder shaped hopper (dust trap) 3, where most of solid particles are settled and light (small) particles are returned via 7 slot to the active separation (channels) area, where they are re-separated. Internal (circulating) flows in the system of channels create a dynamic gas and dust bed that filters the newly fed gas flow.

CYCLONE FILTER

– High performance dust trap combining benefits of cyclones and bag filters

CYCLONE FILTER PERFORMANCE IS BASED ON THREE-STAGE FILTERING

Stage I

– It is a centrifugal stage in the separation channel, where trapped dust from the separation channel is fed to an individual dust collecting hopper. This pre-filtering stage reduces the initial dust load of the gas flow that is then fed to bag filters. Then the gas flow is fed to the second stage.

Stage II

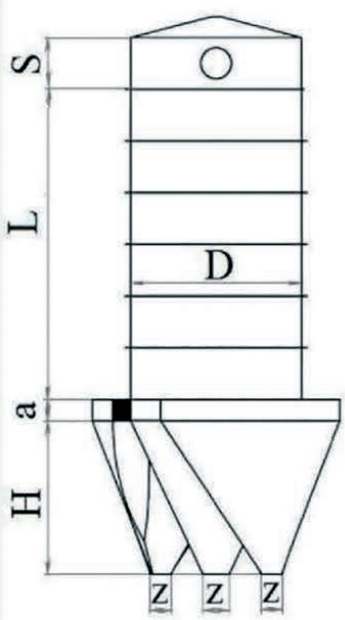
– Centrifugal stage in the cylinder shaped chamber with filter bags. Then the gas flow is fed to the third stage.

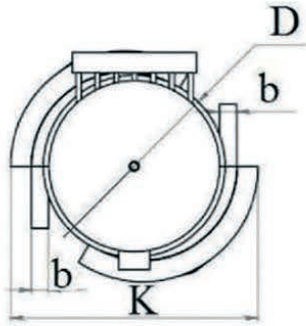
Stage III

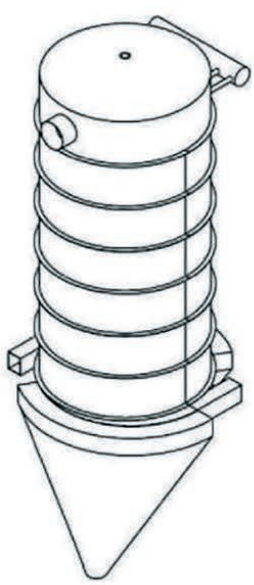
– Gas flow is fed to filter bags, where small dust particles are trapped. Bags are equipped with a pulse recovery system.

To prevent dust explosion during explosive dust filtering, the filter is equipped with a device for blast wave diversion and blast suppression system. The filter is resistant to sharp variations of pressure, and therefore in accordance with a new European standard EN14491 it may be installed in areas with explosive valves.

The filter is a simple modular unit comprising interchangeable elements, thus it may be easily rearranged. It is equipped with two inlets for dust laden flow and one outlet for clean flow. Two inlets for dust laden gas flow allow for the implementation of a four position system for gas flow speed control at the first stage of the gas cleaning system (centrifugal section) of the cyclone filter and maintain its high performance in case of dust laden gas flow rate variation. The filter may be used for separation of dry and poorly binding dust particles.







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CYCLONE FILTER BENEFITS

- Capacity 500-80,000 m³/hr;
- Integrated centrifugal pre-filtering;
- Suitable for fine and abrasive dust;
- May be used at high solid concentrations;
- Efficient pulse system for recovery;
- Easy-to-remove frames for easy replacement of filter bags;
- Small dimensions;
- Resistance to sharp pressure surges of up to 2.5 bar;
- Designed for continuous operation;
- Wide choice of filtering materials;
- Optional ex-proof design

FILTER BRAND	VESSEL SIZE D, мм	NUMBER OF BAGS D, мм	GAS INLET SIZE мм	DUST OUTLET d, мм	CONICAL SECTION HEIGHT d, мм	CYLINDER SHAPED SECTION HEIGHT мм	VESSEL WIDTH мм	PURE GAS CHAMBER HEIGHT, мм	BAG LENGTH мм	BAG AREA мм	V PURIFIED GAS FLOW RATE, мм
			axb	Z	H	L	K	S	K	min...max	min...max
ЦКФ-1	600	4	min 30×60 max 70×140	150	15....2D	2000-6000	min 720 max 880	1500	2000-6000	3....11	0,2...1
ЦКФ-2	800	12	min 50×100 max 110×220	150	15....2D	2000-6000	min 1000 max 1240	1500	2000-6000	10....30	0,6...3
ЦКФ-3	1050	21	min 60×120 max 150×300	200	15....2D	3000-6000	min 1290 max 1650	1500	3000-6000	27....54	0,8...5
ЦКФ-4	1250	25	min 90×180 max 160×320	200	15....2D	3000-6000	min 1610 max 1890	2000	3000-6000	32....64	2...6
ЦКФ-5	1450	37	min 110×230 max 200×400	300	15....2D	3000-6000	min 1890 max 2250	2000	3000-6000	48....95	3...9
ЦКФ-6	1650	45	min 120×250 max 220×440	300	15....2D	3000-6000	min 2130 max 2530	2000	3000-6000	58....116	4...10
ЦКФ-7	1850	61	min 140×280 max 250×500	300	15....2D	3000-6000	min 2410 max 2850	3000	3000-6000	79....158	5...14
ЦКФ-8	2050	69	min 150×300 max 270×540	300	15....2D	3000-6000	min 2650 max 3130	3000	3000-6000	89....178	5...16
ЦКФ-9	2250	89	min 170×340 max 310×620	300	15....2D	3000-6000	min 2930 max 3490	3000	3000-6000	115....230	7...21
ЦКФ-10	2450	109	min 200×400 max 340×680	300	15....2D	3000-6000	min 3250 max 3810	3000	3000-6000	141....281	9...25
ЦКФ-11	2650	137	min 220×440 max 380×760	300	15....2D	3000-6000	min 3530 max 4170	3000	3000-6000	177....354	11...31
ЦКФ-12	2850	145	min 220×440 max 390×780	300	15....2D	3000-6000	min 3730 max 4410	3000	3000-6000	187....374	11...34
ЦКФ-13	3050	177	min 250×500 max 440×880	300	15....2D	3000-6000	min 4050 max 4810	3000	3000-6000	228....457	14...41
ЦКФ-14	3250	185	min 260×520 max 480×960	300	15....2D	3000-6000	min 4290 max 5170	3000	3000-7000	239....555	14...50
ЦКФ-15	3450	221	min 280×560 max 520×1040	300	15....2D	3000-6000	min 4570 max 5530	3000	3000-7000	285....663	17...60
ЦКФ-16	3650	249	min 300×600 max 550×1100	300	15....2D	3000-6000	min 4850 max 5850	3000	3000-7000	321....747	19...67
ЦКФ-17	3850	277	min 310×620 max 580×1180	300	15....2D	3000-6000	min 5090 max 6170	3000	3000-7000	357....831	21...75
ЦКФ-18	4050	313	min 330×660 max 620×1240	000	15....2D	3000-6000	min 5370 max 6530	3000	3000-7000	403....939	24...84

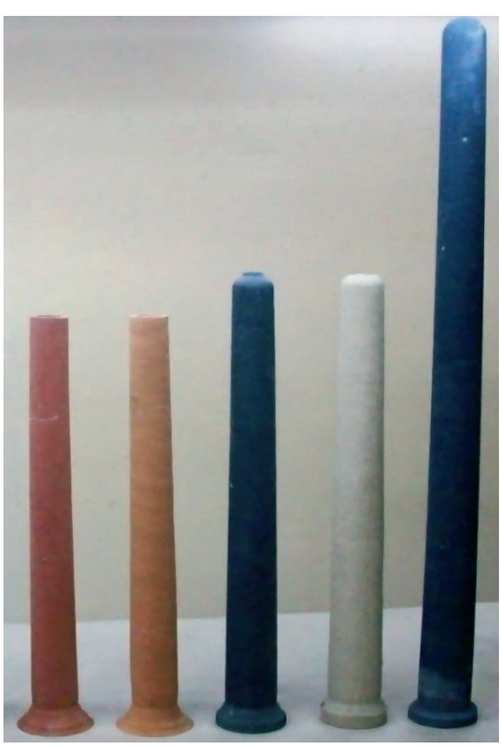
HIGH TEMPERATURE CERAMIC FILTER

As new processes are implemented and the output is increased together with the cost of electric power, new energy saving technologies are developed. They are based on the use of heat and energy of off gases at 250-1000ºC. Heat recovery requires pre-cleaning of off gas from both dust particles and acidic and other poisonous and harmful substances.

HIGH TEMPERATURE GAS FILTERING MAY BE APPLIED IN THE FOLLOWING PROCESSES:

- Steel production: smelting of aluminum, lead, silver and other metals (heat recovery, 540-815°C)
- Cement production: recovery of head from clinker cooling down
- Catalytic cracking of oil products (recycle gas cleaning, gas temperature 600-800°C)
- Gasification of charcoal and peat (trapping of solids, 650-870°C)
- Oil treatment (catalyst trapping, 760°C)
- Silica production (silicon dioxide trapping, 250-400°C)
- Glass production (oxidation furnaces, 540°C)
- and many other processes

POROUS PERMEABLE CERAMIC FILTERING ELEMENTS MANUFACTURED BY BAKOR RESEARCH AND DEVELOPMENT CENTER



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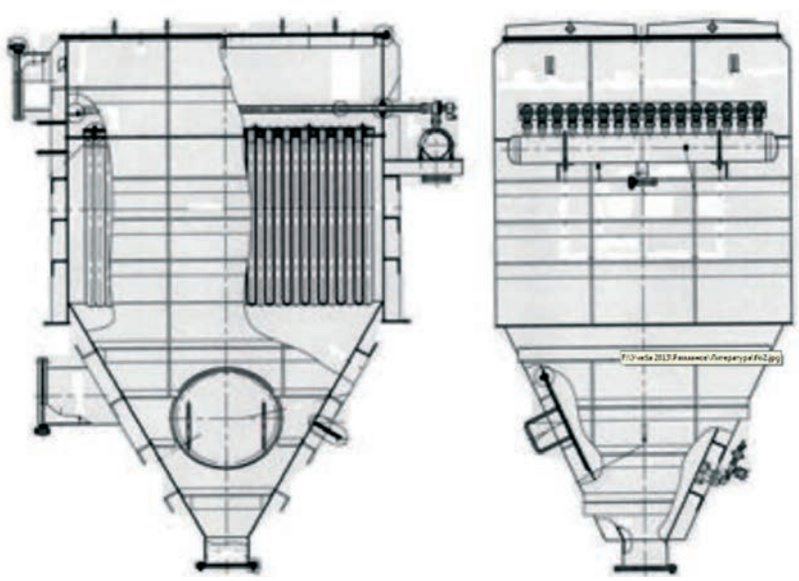
Currently the problem of hot industrial off-gases filtering is solved by the use of filtering elements at up to 300°C. These elements are installed on different types of filtering units in series or in parallel to cyclones, scrubbers, dust-collecting chambers, etc. Efficiency of such systems may reach 70-99%, but the cost of gas cleaning is rather high due to large dimensions of equipment, necessity for gas dilution and cooling down to lower temperatures and large footprint. Moreover, such systems may generally not solve the problem of recovery of harmful gaseous inclusions in off gases, which affects the environment in industrial areas.

Bakor Research and Development Center manufactures ceramic cartridges for gas filtering, which use filter elements made of corundum and silicone carbide with OD 60 mm and up to 1,000 mm long. The filtering area of a single filter element is 0.17m^2.

FCI-45 filtering unit, capacity – 4,800 μm^3/hr.
Filtering units are arranged in modules.

Filter operating conditions:

- Inlet gas temperature - up to 600°C;
- Residual gas pressure inside the filter casing - up to 5,000Pa;
- Maximum gas load on the filter area - up to 1.8 m^3/m^2 min;
- Mass concentration of trappable particles in gas flow:
  at filter inlet - up to 1.5 g/m^3;
  at filter outlet (assumed) - up to 0.001g/m^3.

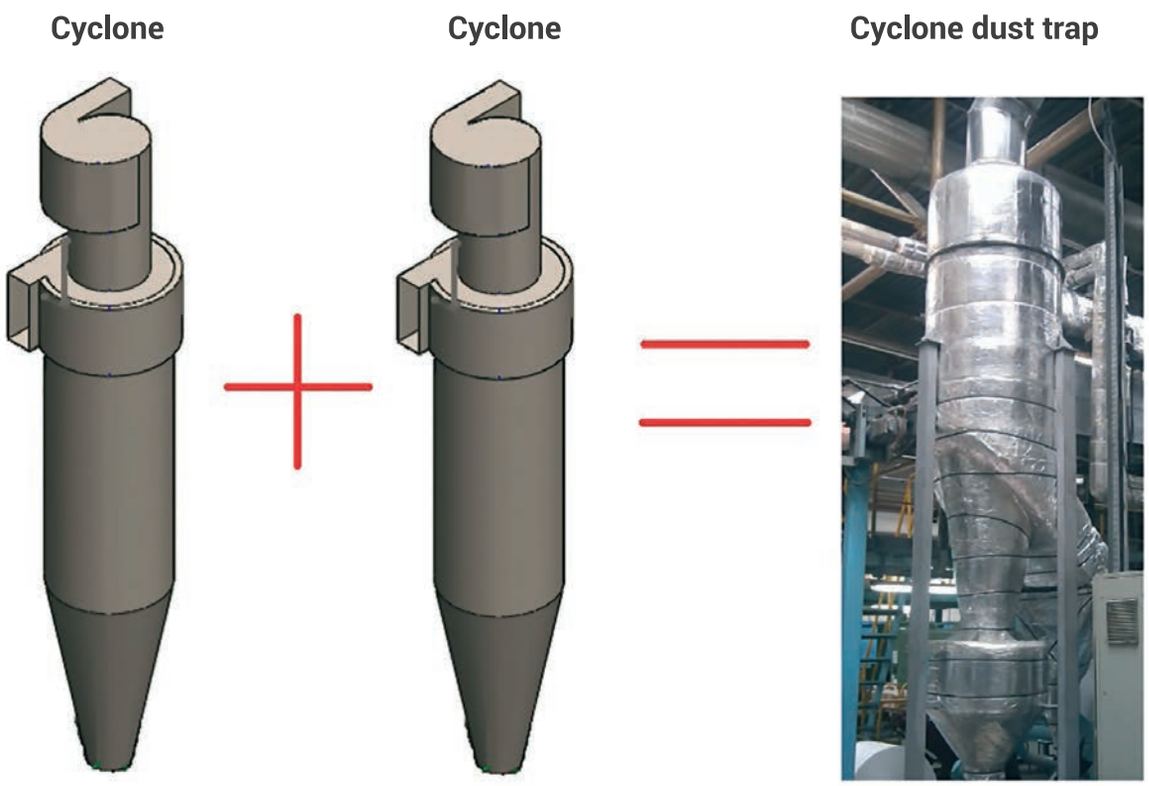


FCI-45 high temperature filter

CYCLONE DUST TRAP

This newly developed method for upgrading of conventional cyclones (is based on the design philosophy of a cyclone dust trap (new design). It allows for upgrading of a conventional cyclone at the minimum capital cost and results in reduction of solid dust particles discharge from the filter by 2 - 4 times without any additional energy demand for gas cleaning.

TWO CYCLONES IN A SINGLE CASING = CYCLONE DUST TRAP



CYCLONE DUST TRAP PERFORMANCE IS BASED ON TWO-STAGE FILTERING

Stage I

– Centrifugal cleaning of a highly concentrated flow in the wall-adjacent area of the vessel with solids discharge to a separate dust collecting tank.

Stage II

– Centrifugal cleaning in the cylinder shaped and conical sections of a cyclone dust trap.

Cyclone dust traps are used by many industrial facilities, but for some reasons they do not meet modern requirements for the quality of solids removal from gas flows.

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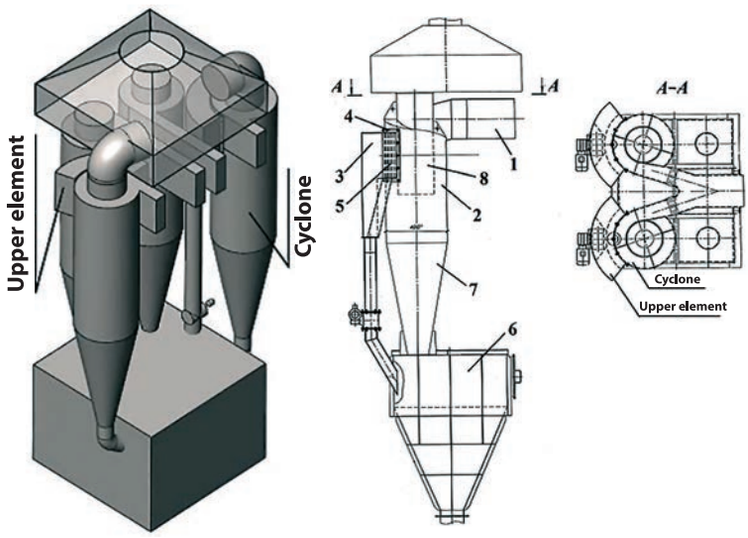
EXAMPLE OF COST- EFFICIENT CYCLONE UPGRADING



UPGRADED CYCLONE PRINCIPLE OF OPERATION:

Dust laden gas flow enters inlet 1 and then it is fed to the vessel. Solid particles are pressed to the wall of cyclone casing 2 by centrifugal force. After reaching the wall of the cyclone casing, particles are discharged via upper element 3 that is connected to the cyclone casing by flanged connection 4 and provided with louvers 5. Gravity forces solids from the upper element to settle in hopper 6. Thus initial concentration of solids in the gas flow is reduced. Partly separated gas flow continues its movement to conical section of the cyclone 7, where gas flow is separated from solid particles. Trapped particles are settled in hopper 6. Then, clean gas flow is discharged to the atmosphere via outlet 8.

EFFECT OF CONVENTIONAL CYCLONES UPGRADING

- discharge of solid dust particles from the cyclone is reduced by 2 – 4 times without any additional energy for cleaning
- cyclone service life is extended by 1.2 – 1.4 times
- low CAPEX for upgrading of existing cyclones
- easy access to individual elements of the cyclone for maintenance
- minimum footprint

MAINTENANCE, REVAMPING AND UPGRADING

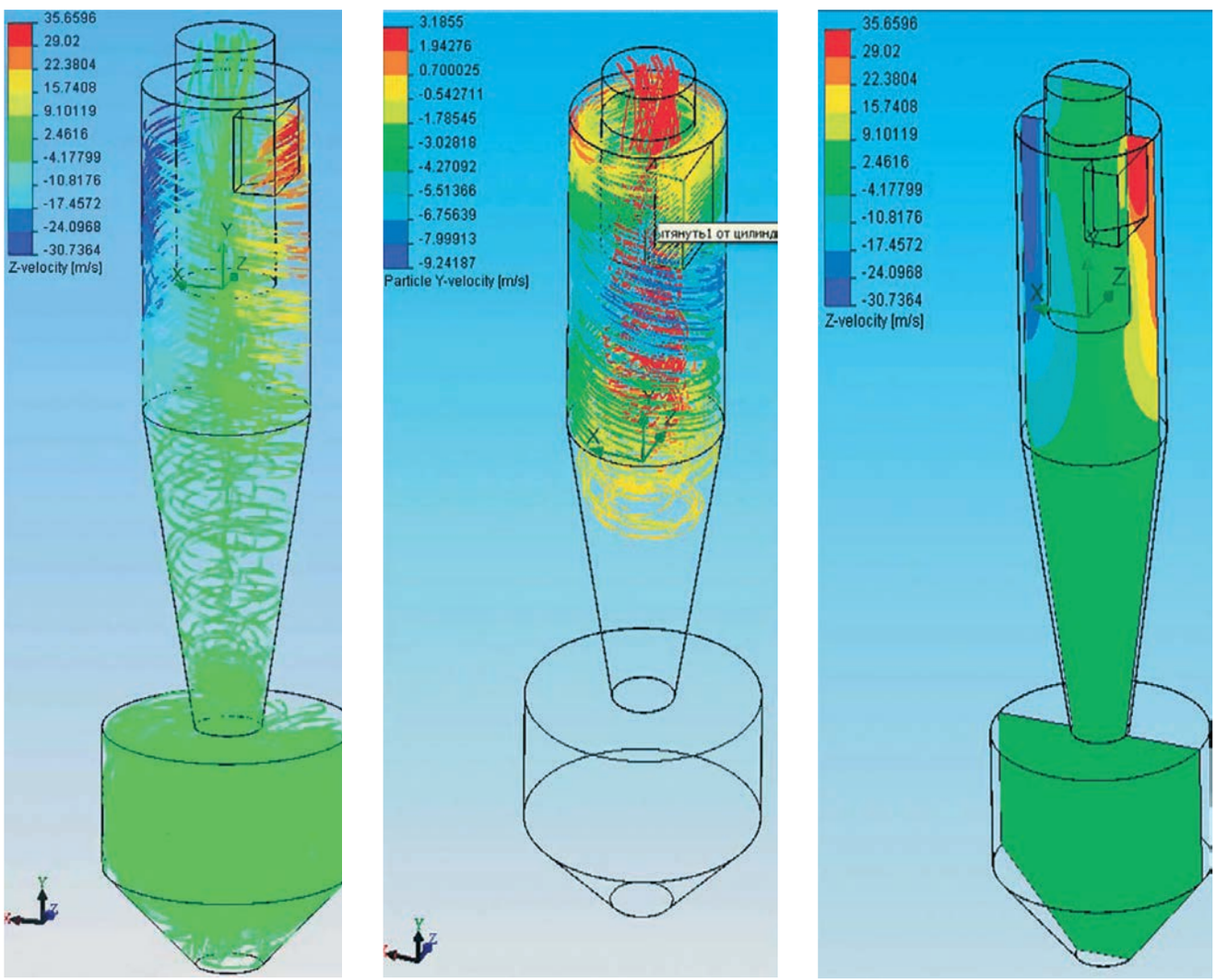
- Concept solution development for aspiration systems for various processes
- Cost efficient upgrading of existing dust trapping equipment (cyclones, dust-collecting chambers, scrubbers, etc.) for improved dust trapping efficiency

Upgraded ЦН-15 cyclone
for the dry coke quenching plant

Upgraded gas filtering scrubber
for the coke furnace battery

EFFICIENCY AND POWER CONSUMPTION ESTIMATIONS FOR GAS CLEANING SYSTEMS AND UNITS

Efficiency and power consumption estimations for a non-conventional dust collecting system is performed by computed simulation followed by results verification at lab and semi-industrial test benches. Simulation results allow for significant reduction of the cost of experimental analysis and provide high accuracy of the estimation of the total and fraction-by fraction cleaning capacity of dust trapping equipment at the engineering stage.



Computer simulation of dust trapping equipment performance

DUST AND GAS CLEANING SYSTEM INSPECTION

State-of-the-art aerodynamic equipment made by TESTO and conventional equipment for the estimation of dust load of the flow (dust collecting tube with internal and external filtration, Migunov aspirator, etc.) are used for test measurement of dust laden gas flow properties.

DUST PARTICLE SIZE DISTRIBUTION IS MEASURED WITH A 11-STAGE NIIOGAZ MODEL 8 IMPACTOR, THAT ENABLES DUST LADEN GAS SAMPLING IN A GAS PIPE

NIIOGAZ impactor, model 8

NIIOGAZ impactor is included into the RTM regulation approved by the Department of gas cleaning of the USSR Ministry of Chemical Machinery: Industrial dust. Procedures for physical and chemical properties analysis of industrial dust in lab conditions. RTM 26-14-10-77. Impactors are designed for Stokes diameter determination for gas suspended particles from 1 to 40μm and for indication of mass fraction of particles outside this range. Dust particle size distribution analysis with impactor gain in weight of dust on substrate is used for calculation of relative ratios of particles settled on various tool stages. Larger particles are determined by sieve.

OTHER PILOT TESTS ARE AVAILABLE AT THE REQUEST OF THE CUSTOMER

Portable pilot dust cleaning unit with a capacity of 200 m^3/hr.

REFERENCES

№			
1	ASPIRATION	cement mill No. 8, 9,10. Dust trapping efficiency 92..94%. - four ЦФ2-6-22.5 centrifugal filters are installed; - two ЦФ2-2-45Г centrifugal filters are installed; - two ЦФ1-6-8 centrifugal filters are installed; - one ЦФ2-2-16Г centrifugal filter is installed; - ФРИР bag filter upgrading.	Eurocement (Ukraine, Balakleya)
2		cement mills. Dust trapping efficiency 92...94% (Q=20,000 m^3/hr)-6-20 - four ЦФ2 centrifugal filters are installed;	Eurocement (Ukraine, Kramatorsk)
3		hammer mill (upstream of ФРКН-60 bag filter) Trapping efficiency 95% (Q=6,000 m^3/hr) - ЦФ1-4-6 centrifugal filter is installed	JSC Moldova Steel Works (Moldova, Rybnitsa)
4		end product bin of the coal-bearing powders area (upstream of ФРКН-30 bag filter) Trapping efficiency 95% (Q=2,500 m^3/hr) - ЦФ1-4-5 centrifugal filter is installed	JSC Moldova Steel Works (Moldova, Rybnitsa)
5		wallpaper printing lines: three ЦКФ-4 cyclone filters are installed	Moldavskie Oboi JSC (Ukraine, Kryukovka)
6	GAS FILTERING	drum dryer of the coal-bearing powders area (upstream of FRKN-90 filter) Trapping efficiency 97% (Q=10,000 m^3/hr) - ЦФ1-4-10 centrifugal filter is installed	JSC Moldova Steel Works (Moldova, Rybnitsa)
7		molten steel degassing systems Trapping efficiency 95% (Q=10,000 μm^3/hr). ЦФ1-4-10 centrifugal filter is installed	JSC Moldova Steel Works (Moldova, Rybnitsa)
8		Drum dryer for coke Trapping efficiency 97% - ЦФ2-6-10 centrifugal filter is installed	Zaporozhye Titanium and Magnesium Combine (Ukraine, Zaporozhye)
9		4MW solid fuel boiler with fluidized bed - two ЦФ2-2-15.5 centrifugal filters are installed	Belarus, Minsk
10		ДКВР-10/13 solid fuel boiler off gas cleaning from sulfur dioxide and soot - two ЦФ1-6-8 centrifugal filters are installed; - one ЦФ2-2-16Г centrifugal filter is installed;	Butovskaya mine Makeevugol State Company (Ukraine, Makeevka)

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