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**INTRODUCTION**

Electrical Ecology LLC has been manufacturing PlazKat Aero equipment for plasma catalytic air and gas treatment since 2001 on the basis of TC (The Technical Conditions) 3646-004-56321325-2009 Specifications (License agreement No RD0059704 dated 28 January 2010 under patent of Electrical Ecology LLC No 89422).

PlazKat Aero plant is used to clean air of gaseous organic and non-organic contaminants. Cleaning is applicable to the following substances:

- **Organic substances**: alcohols, carboxylic acids, ketones, aldehydes, ethers and esters, aromatic hydrocarbons etc.
- **Non-organic substances**: carbon, nitrogen and sulfur compounds.

Treatment efficiency of the above substances amounts to 85-99% which is supported by measurement reports of independent accredited laboratories.

Equipment operation is based on electrophysical and electrochemical destruction of substances in the plasma catalysis module incorporated into the plant. This module combines plasma chemical and catalytic treatment techniques.

Capacity of PlazKat Aero plants is not limited.
The plants are used in the following industries:
- chemical and petrochemical;
- pharmaceutical;
- production and processing of plastics and polymers;
- paint making;
- printing;
- iron and steel and metal working;
- woodworking;
- food;
- treatment of emissions from motor vehicles and diesel generating sets, and
- smell removal in waste treatment facilities.

**COMPANY PROFILE**

Electrical Ecology LLC has been working on the market of ecological equipment since 2001.

A team of professionals in electrical engineering and engineering ecology used the latest physical and chemical air and gas treatment achievements in their products and designed equipment using unique plasma catalysis technique.

Operating principle of the treatment apparatuses manufactured by the Company is based on cleaning the atmospheric air of harmful and carcinogenic substances via destruction (conversion) thereof down to elementary harmless compounds. The Company provides a full range of services and works including instrument inspection of the facility (source of contamination) to be cleaned, engineering of treatment plants and installations, installation, commissioning, and on-going maintenance.

The Company installed dozens of plants for plasma catalytic air treatment of gaseous contaminants in production facilities in Russia, CIS and European countries. The plants are named PlazKat Aero in compliance with Specifications and Certificates.
DESCRIPTION OF PLASMA CATALYTIC TREATMENT TECHNIQUE

Air is treated in the PlazKat Aero plants via plasma catalytic reactions. The process combines plasma chemical and catalytic effect on gaseous contaminants.

The plasma catalysis considerations are based on the theory that gaseous substances in the gaseous electric discharge zone generated by a strong electric field interact with electro-synthesis products physically and chemically and form final substances of velocities greater than under steady-state and equilibrium conditions. Thus, we may say that plasma generated by electrical discharges acts as a catalyst of oxidation or reduction reactions for both organic and non-organic substances.

Plasma chemical gas treatment technique

Plasma chemical reactors in plants comprise low-temperature weakly ionized plasma (WIP) which may undergo synthesis at low and atmospheric pressure in different ways. To synthesize WIP in the plants a barrier discharge (AC streamer discharge) and glow discharge (which is generated between thin pins and plain at maximum current of 100 μA) are used.

Unique character of WIP generated due to gaseous discharges is dictated by its clear-cut thermodynamic non-equilibrium which occurs once strong electric field in the plasma synthesis zone is created. Great electric field intensity or more precisely reduced value thereof E/N, where E means field intensity and N means density of gas flowing through a discharge, is transformed into kinetic energy of light charged particles, i.e. electrons. It results in that electrons are overheated as compared to ambient gas particles. On average, their energy exceeds gas temperature 100 times and more according to type of discharge. On collision with gas molecules such electrons have insignificant impact on their kinetic energy though efficiently excite and dissociate molecules. It results in generation of a great number of ions, radicals, excited particles, high-energy photons etc. The flow of ionized particles and electrons, generally, supports reactions required in cold gas or on a surface.

Thus, conversion of harmful substances into elementary compounds works in the following way: contaminated air flows through the plasma chemical reactor of the air cleaner where gaseous harmful substances are destroyed due to WIP and other physical and chemical effects.

Catalytic gas treatment technique

Catalytic air treatment technique comprises deep oxidation of conversion products obtained once air has flown through the plasma chemical reactor. This technique uses low-temperature catalyst free of precious metals which due to WIP efficiently works within the temperature range from 20 to 50°C.

Plasma catalytic technique of air cleaning of harmful gaseous substances is unique in that it allows deep treatment of a number of toxic and harmful organic compounds to CO₂ and H₂O just at low temperature.

Plasma catalytic technique solves the air cleaning (gas cleaning) problem with:

- minimum of catalyst (free of precious metals);
- at minimum temperature (from 20°C);
- minimum power requirements.

Basic principles of air cleaning in a plant

Air to be cleaned of harmful gaseous compounds is fed to the PlazKat Aero plant due to depression created by a fan.
The PlazKat Aero plant is composed of modules arranged so that incoming air is uniformly distributed between modules. Each module may treat from 750 to 1,000 m$^3$/h of a contaminated mix.

When with power on there is an electric potential difference between electrodes, due to specific design of modules each module becomes a source of low-temperature weakly ionized plasma.

Velocity of air in the module is selected so as to ensure maximum possible breakdown of contaminants due to plasma's "destructive" factors including high temperature, micro discharges (streamers), electron flow, highly concentrated ozone, and hard radiation. Due to their effect organic substances composed of oxygen, hydrogen and carbon atoms are converted into entirely harmless compounds comprising carbon dioxide and water (which is exhibited by insignificant increase in purified air). This may be expressed by the following equation:

$$C_xH_yO_z + h\nu \rightarrow CO_2 + H_2O$$

The substances containing nitrogen, for instance ammonia, under influence of plasma are reduced to free nitrogen N$_2$ nearly in full. The mechanism of the reaction is as follows. Water molecules in release are dissociated down to hydroxyl ions under influence of plasma:

$$H_2O + h\nu \rightarrow OH^- + H^+$$

Influenced by the hydroxyl ions in the plasma field ammonia enters into a reaction as follows:

$$NH_3 + OH^- + h\nu \rightarrow N_2 + H_2O$$

Resultant substances including free nitrogen, carbon dioxide and water are absolutely harmless.

In view of average treatment efficiency of 85-92%, except for the above gases the resultant products shall also include undecomposed molecules of starting substances in amount of 8-15% respectively.

**COMPARISON OF PLASMA CATALYTIC TECHNIQUE WITH OTHER TREATMENT PROCESSES**

<table>
<thead>
<tr>
<th>Treatment technique</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition of clean air</td>
<td>Simple method</td>
<td>Amount of added air is 5-10 times as much which results in consumption for heating of incoming air taken to compensate release</td>
</tr>
<tr>
<td>Adsorption</td>
<td>Simple hardware</td>
<td>Spent sorption material is to be continuously discarded</td>
</tr>
<tr>
<td>Thermal catalysis</td>
<td>High treatment efficiency with small amounts of air to be cleaned and high concentrations of harmful substances (over 3 g/m$^3$)</td>
<td>* High power requirements to pre-heat catalyst * Regeneration of expensive catalyst is needed * Often gas-supply facility is to be provided</td>
</tr>
<tr>
<td>Biological treatment</td>
<td>* High efficiency</td>
<td>* Colonies of microorganisms are killed under temperature below zero</td>
</tr>
<tr>
<td></td>
<td>* No by-products at disposal</td>
<td></td>
</tr>
<tr>
<td><strong>Colonies of microorganisms may be killed by salvo release</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reagent treating method</td>
<td>Process may be automated</td>
<td>Reagent supply facility and appropriate personnel are needed</td>
</tr>
</tbody>
</table>
| Plasma catalytic treatment | * Treatment efficiency over 90-95%*  
* No frequent maintenance is required*  
* Long life of catalyst (over 5-7 years)*  
* No waste disposal is required* | In the event of high concentration of contaminants equipment power requirements may increase |

**PLAZKAT AERO PLANT DESIGN**

Since 2008 Electrical Ecology LLC has been manufacturing and delivering plants of a new type designed on the basis of optimizing the cleaning process and own patent. Today PlazKat Aero plasma catalytic treatment plants consist of the following basic units:

1. Plasma catalysis reactor (hereafter PCR) which comprises a monoblock or a number of monoblocks made in compliance with own know-how and patent of Electrical Ecology LLC No 89422.
2. Power supply unit.
3. Power supply unit control console including short-circuit protection, light indicators, and power voltage frequency converter.
Plasma catalysis reactor

The PCR consists of two sections. The inside of the module, i.e. the gas-discharge module, comprises a structure made of a number of gas-discharge cells manufactured by Electrical Ecology LLC. The cells provide for the plasma chemical treatment step. The external section of the module comprises a cylinder containing catalyst.

The modules use varieties of catalysts and, as a rule, based on aluminum oxides. Catalyst modification is governed by chemistry of air to be cleaned.

Catalysts do not need to be frequently regenerated. Usually, regeneration is undertaken once every 180 days (specified procedure broken down into operations is laid down in the operation manual). During regeneration a catalyst remains in the plant and the process goes at reduced flow rate of clean air in the plant for a period of 12-24 hours. Manufacturer warrants that life span of catalysts amounts to at least 7-10 years.

Exposure of air oxygen molecules to low-temperature plasma results in generation of ozone molecules. Catalysts easily neutralize residual ozone and decompose it into molecular and atomic oxygen. Plant output ozone concentration does not exceed work area TLV of 0.04 mg/m$^3$.

Power supply unit

The plant power supply unit comprises a high-voltage transformer with a control system. The high-voltage transformer is located separately from reactors and the power supply unit control block in special enclosures.

There is a provision made for ВВГ 380V, 50Hz cable entry into the gas cleaning room to feed power to the PlazKat Aero plant PSU. 0.4 kV cable is laid to the control system cabi-
net. The high-voltage cable is laid from the transformer to the plasma chemical reactor in a metal tube and prevents induction in process electronics. The power supply unit is earthed to the grounding bus bar connected to the outside earthing device.

**Control console**

Operation of PlazKat Aero plant is controlled using the console indicator block and from process equipment operator's control boards in the shops which produce audible and visual alarms in case of emergency. Automatic devices of the power supply unit serve to monitor and control parameters of PCR and interlocks in PlazKat Aero plant which ensure safety of the plant operation. They are placed in the power supply unit control cabinet.

The plant's emergency shutdown is undertaken if:

- electric breakdown of the gas-discharge cell occurs;
- fan fails or comes to a standstill;
- power supply unit transformer fails;
- frequency converter in the control console malfunctions, and
- dust filters and catalyst are too contaminated.
PURPOSE OF PLAZKART AERO EQUIPMENT

PlazKat Aero treatment plant for gaseous contaminants is manufactured to order in accordance with TY 3646-004-56321325-2009.

According to the Specifications the plant has the following identification: "PlazKat Aero gas plasma catalytic treatment plant xxxx/yyyy/zzzz". Letters and figures in the marking mean the following: PlazKat Aero stand for plasma catalytic reactor, xxxx stand for capacity of gas (air) treatment in thousands of m$^3$/hour, yyyy stand for electric power consumption by the plant plasma catalytic reactor in kW, and zzzz stand for the number of monoblocks in the plant.

For instance:
The marking "PlazKat Aero gas plasma catalytic treatment plant 0.5/1.5/1" means that capacity of gas or air treatment for this plant is 0.5 thousand m$^3$/hour, plant electric power requirements reach 1.5 kW, and the number of PCR is 1.

The PlazKat Aero is designed to include plasma catalytic reactor (PCR) in compliance with patent No 89422.

To correctly choose PlazKat Aero modification one needs to complete the questionnaire below and contact the manufacturer or a regional dealer thereof. The electronic questionnaire may be found on the following sites: www.ele-spb.ru or www.plazkat.ru.

To select modifications of equipment and, consequently, technical characteristics thereof, one needs to indicate desired capacity in m$^3$/hour and concentrations of contaminants in mg/m$^3$. If the data is not available, one may identify the industry and process and dimensions of the space where air is to be cleaned.

Air (gas) capacity varies from 100 to 100,000 m$^3$/hour and more. As mentioned above, to be cleaned there may be air containing any organic substances (alcohols, acids, ketones, aldehydes, phenols, ketones etc.) and non-organic substances including carbon, nitrogen and sulfur compounds. The range of concentrations varies from units of mg/m$^3$ to dozens of g/m$^3$. Treatment efficiency is 92-99.5%.
One is to bear in mind that PlazKat plant is used to clean air (gas) of which temperature does not exceed $130^\circ$C, dust content (content of suspended matters) is no more than 5 mg/m$^3$, and air humidity of air is within 95%. If humidity is higher, the plant is to use water-proof materials.

Electrical Ecology Company manufactures plants used to clean industrial emissions into atmosphere and in forced and circulating ventilation.

Plants are installed on agreement with a CUSTOMER.

**KEY TECHNICAL DATA AND DIMENSIONS OF BASE MODIFICATIONS OF PLAZKAT AERO PLANTS**

Below are characteristics of some of base modifications. Electrical Ecology LLC, the equipment manufacturer, reserves the right to unilaterally revise the abovementioned characteristics of the equipment. To receive a commercial proposal as to PlazKat Aero equipment with specified characteristics, it is required to contact the manufacturer's representatives or regional dealers.

*If the desired capacity of the PlazKat Aero gas treatment equipment differs from the figures below, contact manufacturer's representatives to correctly select the equipment.*
Plasma catalytic gas (air) treatment plant
PlazKat Aero 1/3/1 Model
TECHNICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated air capacity</td>
<td>from 700 to 1,000 m$^3$/h</td>
</tr>
<tr>
<td>Waste treatment efficiency</td>
<td>from 85 to 95 %</td>
</tr>
<tr>
<td>Gas temperature at plant input</td>
<td>from 0 to 120°C</td>
</tr>
<tr>
<td>Target air relative humidity</td>
<td>up to 85%</td>
</tr>
<tr>
<td>Maximum plant aerodynamic drag</td>
<td>up to 1,200 Pa</td>
</tr>
<tr>
<td>Plant electric power requirements</td>
<td>1200 VA 380 V, 50 Hz; 3,000 VA 380 V, 150 Hz.</td>
</tr>
<tr>
<td>Catalyst volume</td>
<td>from 70 to 137 l</td>
</tr>
<tr>
<td>Dust concentration at plant input</td>
<td>5 mg/m$^3$ max.</td>
</tr>
<tr>
<td>Concentration of contaminants</td>
<td>up to 3,000 mg/m$^3$</td>
</tr>
<tr>
<td>Plant dimensions</td>
<td></td>
</tr>
<tr>
<td>(w/o power supply unit and control console)</td>
<td></td>
</tr>
<tr>
<td>Length, L, mm</td>
<td>700</td>
</tr>
<tr>
<td>Width, B, mm</td>
<td>665</td>
</tr>
<tr>
<td>Height, H, mm</td>
<td>1,855</td>
</tr>
<tr>
<td>Inlet diameter, mm</td>
<td>160</td>
</tr>
<tr>
<td>Outlet diameter, mm</td>
<td>200</td>
</tr>
<tr>
<td>Plant mass with power supply unit and control console</td>
<td>400 kg</td>
</tr>
</tbody>
</table>

Plasma catalytic gas (air) treatment plant  
PlazKat Aero 5/15/6 Model
## TECHNICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated air capacity</td>
<td>from 5,000 to 6,000 m$^3$/h</td>
</tr>
<tr>
<td>Waste treatment efficiency</td>
<td>from 85 to 95 %</td>
</tr>
<tr>
<td>Gas temperature at plant input</td>
<td>from 0 to 120°C</td>
</tr>
<tr>
<td>Target air relative humidity</td>
<td>up to 85%</td>
</tr>
<tr>
<td>Maximum plant aerodynamic drag</td>
<td>up to 1,200 Pa</td>
</tr>
<tr>
<td>Electric power consumption by the plant plasma catalytic reactor</td>
<td>7.5 kVA 380 V, 50 Hz; 15 kVA 380 V, 150 Hz.</td>
</tr>
<tr>
<td>Catalyst volume</td>
<td>from 600 to 850 l</td>
</tr>
<tr>
<td>Dust concentration at plant input</td>
<td>5 mg/m$^3$ max.</td>
</tr>
<tr>
<td>Concentration of contaminants</td>
<td>up to 3,000 mg/m$^3$</td>
</tr>
<tr>
<td>Plant dimensions (w/o power supply unit and control console)</td>
<td></td>
</tr>
<tr>
<td>Length, L, mm</td>
<td>4,264</td>
</tr>
<tr>
<td>Width, B, mm</td>
<td>720</td>
</tr>
<tr>
<td>Height, H, mm</td>
<td>1,765</td>
</tr>
<tr>
<td>Inlet diameter, mm</td>
<td>200*620</td>
</tr>
<tr>
<td>Outlet diameter, mm</td>
<td>400</td>
</tr>
<tr>
<td>Plant mass with power supply unit and control console</td>
<td>up to 800 kg</td>
</tr>
</tbody>
</table>
Plasma catalytic gas (air) treatment plant
PlazKat Aero 10/30/12 Model
### TECHNICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated air capacity</td>
<td>from 10,000 to 12,000 m$^3$/hour</td>
</tr>
<tr>
<td>Waste treatment efficiency</td>
<td>at least 85-95%</td>
</tr>
<tr>
<td>Gas temperature at plant input</td>
<td>from 0 to 120°C</td>
</tr>
<tr>
<td>Target air relative humidity</td>
<td>up to 85%</td>
</tr>
<tr>
<td>Maximum plant aerodynamic drag</td>
<td>up to 1,200 Pa</td>
</tr>
<tr>
<td>Electric power consumption by the plant plasma catalytic reactor</td>
<td>15 kVA 380 V, 50 Hz</td>
</tr>
<tr>
<td></td>
<td>30 kVA 380 V, 150 Hz</td>
</tr>
<tr>
<td>Catalyst volume</td>
<td>from 0.54 to 1.14 m$^3$</td>
</tr>
<tr>
<td>Dust concentration at plant input</td>
<td>5 mg/m$^3$ max.</td>
</tr>
<tr>
<td>Concentration of contaminants</td>
<td>up to 3,000 mg/m$^3$</td>
</tr>
<tr>
<td>Plant dimensions</td>
<td></td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>(w/o power supply unit and control console)</td>
<td></td>
</tr>
<tr>
<td>Length, $L$, mm</td>
<td>4,264</td>
</tr>
<tr>
<td>Width, $B$, mm</td>
<td>1,420</td>
</tr>
<tr>
<td>Height, $H$, mm</td>
<td>1,765</td>
</tr>
<tr>
<td>Inlet diameter, mm</td>
<td>600</td>
</tr>
<tr>
<td>Outlet diameter, mm</td>
<td>600</td>
</tr>
<tr>
<td>Plant mass including power supply unit and control console</td>
<td>up to 1,200 kg</td>
</tr>
</tbody>
</table>

Plasma catalytic gas (air) treatment plant  
PlazKat Aero 30/60/33 Model
## TECHNICAL DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated air capacity</td>
<td>from 30,000 to 35,000 m³/hour</td>
</tr>
<tr>
<td>Waste treatment efficiency</td>
<td>at least 85-95%</td>
</tr>
<tr>
<td>Gas temperature at plant input</td>
<td>from 0 to 120°C</td>
</tr>
<tr>
<td>Target air relative humidity</td>
<td>up to 85%</td>
</tr>
<tr>
<td>Maximum plant aerodynamic drag</td>
<td>up to 1,200 Pa</td>
</tr>
</tbody>
</table>
| Electric power consumption by the plant plasma catalytic reactor | 30 kVA 380 V, 50 Hz  
                                             | 60 kVA 380 V, 150 Hz            |
| Catalyst volume                               | from 1.5 to 5 m³                |
| Dust concentration at plant input             | 5 mg/m³ max                     |
| Concentration of contaminants                 | up to 3,000 mg/m³               |
| Plant dimensions (w/o power supply unit and control console) |  |
| Length, L, mm                                 | 7,234                           |
| Width, B, mm                                  | 2,100                           |
| Height, H, mm                                 | 1,875                           |
| Inlet diameter, mm                            | 400*2,000                       |
| Outlet diameter, mm                           | 1,000                           |
| Plant mass with power supply unit and control console | up to 6,500 kg                  |
PLAZKAT AERO PLANT SERVICE AREA

To assemble, undertake individual and integrated equipment tests and maintenance a provision is made for the service area 1,500 mm wide in front of the face of the PlazKat Aero plants. Below is the layout diagram which shows the service area in front of PlazKat Aero plant of 15,000 m³/hour capacity.

1 – plasma catalytic reactor;
2 – dust filter;
3 – contaminated air;
4 – clean air to fan;
5 – working area;
6 – Dimensions (L x W x H):
   Power supply unit: 1,100 x 1,100 x 1,400
   Control console: 600 x 300 x 1,200
   Both are to be located next to equipment
   Working area: 1.5 m
VERSIONS OF EQUIPMENT LAYOUT

A. INSTALLATION IN A STANDARD CONTAINER OR IN A DEDICATED GAS CLEANING ROOM

1. Automatic control console
2. Mixing chamber
3. Dust filter
4. Transformer
5. Inlet airlock
6. Plasma catalytic reactor
7. Outlet airlock
8. Automatically-operated locks
9. Standard container
10. Bypass gas flue
11. Inlet pipe
12. Outlet pipe

The plant is placed in a standard metal container or room. The container (room) walls have entries for inlet (12) and outlet (13) gas flues. The container (room) encloses pre-filter (3), plasma catalytic reactor (6,7), power supply unit (4), and automatic control console (1).

Usually, 20- and 40-feet containers are used. Containers are furnished with lighting, heating and ventilation system which allows maintenance to be performed at any time of the year. Containerization of the gas treatment plant ensures good noise insulation, electrical, explosion and fire safety and protects gas cleaning equipment from precipitation and low temperature. Air capacity of containerized gas cleaning systems varies from 3,000 to 40,000 m³/hour.

Advantages of such arrangement are as follows:

1. Smaller area occupied by the plant.
2. Smaller scope and shorter time of construction and installation work.
3. Electrical and fire safety issues are addressed.
4. Equipment tightness and, consequently, low noise level.
5. Long service life of cleaning equipment, high level of automation and stable air cleaning process.
B. ARRANGEMENT IN A PRODUCTION SHOP

The plant is placed in a dedicated area for ventilation, air-conditioning and cleaning equipment such as ventilation chambers and process floors.

This arrangement does not require additional heating of the plant location. Equipment is installed next to exhaust ventilators. A provision is to be made for the equipment service area and a bypass (bypass gas flue) required for equipment scheduled maintenance.

C. INSTALLATION ON BUILDING ROOF

If there is no space in exhaust ventilation chambers in production shops, equipment may be immediately installed on roof of building. In this case equipment is to be preferably installed in a shelter made of light structures. Inlet and outlet gas flues are wrapped in insulant.

The equipment control console may be backed up inside the shop to make plant control easy.
**COMPLETE SET OF PLAZKAT AERO EQUIPMENT**

The standard complete set of PlazKat Aero plant equipment includes:

1. Plasma catalytic reactor.
2. Catalyst.
3. Plant power supply unit.
4. Plant control console.

Optionally, the delivery set may include the following items (at the discretion of a CUSTOMER).

1. Inlet and outlet gas flues.
2. Bypass (bypass gas flue).
3. Lock-up valves.
4. Inlet power supply cables.
5. Medium pressure exhaust fan.

**IMPORTANT:** On commissioning equipment a medium-pressure exhaust fan is to be used which creates depression of at least 1,500 Pa at plant's rated air capacity. If this requirement is not met, the manufacturer does not make a warranty in regard to equipment serviceability and reserves the right to terminate such warranty.

**PRICING**

Price of equipment is set by our specialists after review of the completed questionnaire. In a first approximation, price of equipment is directly proportional to amount of contaminants (g/s).

**Lease of gas treatment plants and air cleaners**

For the first time our company offers on the market the ecological engineering equipment of own make for leasing. Today industry people understand that production of industrial equipment and consumer goods implies enforcement of environmental and sanitary regulations. Often, it involves use of ecological engineering equipment for various purposes. In particular, it includes gas treatment plants and air cleaners manufactured by our Company. It is clear that our plants differ in price dictated by a number of factors which are easily found on our official site. Prices may vary within wide ranges. Production facilities that need ecological engineering machinery sometimes may not afford expensive cleaning equipment. The only satisfactory solution to both parties lies in leasing.

General terms and conditions of a lease agreement on cleaning equipment are as follows:

The price of an item of equipment is known at the moment the agreement is signed and remains unchanged for the whole term of the agreement. The term of an agreement varies from 1 to 3 years and sometimes may reach 5 years. Lessee's own funds must account for 30%. Lease rate (appreciation of an item under lease) is 10% and more. Equipment shall be purchaser's property as soon as the price of cleaning equipment is paid in full. Collaterals that may provide for guarantees in a contract include an item under lease, lessee's mortgaged property, financial surety, bills of exchange, and bank guarantees.
### PLAZKAT AERO PLANT MAINTENANCE

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Operations</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once every two weeks</td>
<td>Visual inspection of plant's modules, power supply unit, connections and attachment, and attachment of the device to structural frames.</td>
<td>Control is exercised by operational service of a production facility.</td>
</tr>
<tr>
<td>Once a month</td>
<td>Visual inspection of earthing devices for safety, operation of the power supply unit, dust filters and plants aerodynamic drag.</td>
<td>Control is exercised by operational service of a production facility.</td>
</tr>
<tr>
<td>Bi-annually</td>
<td>Inspection of catalyst, plasma modules, and power supply unit.</td>
<td>Control is exercised by a manufacturer.</td>
</tr>
<tr>
<td>Annually</td>
<td>Check of earthing devices for resistance. Check working characteristics of the device.</td>
<td>Control is exercised by a manufacturer.</td>
</tr>
</tbody>
</table>

**Warranty in regard to PLAZKAT AERO plants is made for a period of 12 months after plant's commissioning.** We suggest to customers that a maintenance contract be concluded for the warranty and post-warranty period to include the following operations:

1. Visual inspection of the plant.
2. Inspection of power and high-voltage cables, grounding, and transformer.
3. Test of switches, indicator lights and plant's protection.
4. Inspection of gas-discharge modules:
   4.1. for workability;
   4.2. dust;
   4.3. growth of decomposition products on contaminants;
   4.4. resistance measured by a megohm meter;
   4.5. working current in phases, and
   4.6. condition of insulators;
5. Check of catalyst for:
   5.1. dust;
   5.2. growth of resins and decomposition products;
   5.3. moisture on surface, and
   5.4. loss.

6. Plant functional tests:
   6.1. measurements of aerodynamic drag, and
   6.2. determination of gas treatment efficiency.

The average price of a maintenance contract varies from 100 to 250 thousand rubles per year according to sophistication of equipment purchased.

PLAZKAT AERO PLANT APPLICATIONS

The plants are widely used in the following industries (major):

1. Chemical
   Plasma catalytic treatment is rather desirable in the following processes of chemical industry: basic organic synthesis, production of artificial fibers and manufacture of mineral fertilizers.
   This technique is believed to be promising since it allows practically complete breakdown of organic contaminants in air released into atmosphere. Plasma catalytic air cleaners efficiently destroy harmful impurities with unpleasant smell including amines, sulfides, mercaptans, unsaturated hydrocarbons etc.
   Usually, industrial ventilation systems do not contain special-purpose equipment for chemical and bactericidal indoor air treatment, and conventional increase of ventilation system capacity may not efficiently reduce concentration of contaminants in shop working areas. Plasma catalytic treatment systems built into existing ventilation and local mobile air cleaners on work sites make it possible to solve this problem.

2. Oil and gas
   To reduce atmospheric emissions by gas processing and gas transport industries is an acute problem of today. Most widely used technique of tail gas treatment comprises complete burning though this method does not provide adequate treatment efficiency.
   Gas compression stations that maintain pressure in gas lines use a part of natural gas as a heat transfer agent. Stations located along gas lines pose risk to environment and health of people, since gas turbine discharge nitrogen and carbon oxides and formaldehyde of which emissions are regulated.
   To solve the problem of emissions only by burning in turbines is not possible because it may result in growth of CO and hydrocarbon emissions. To reduce emissions it is advisable to use plasma catalytic treatment of tail gases.
   Air treatment problem is acute for facilities which use great amounts of oil refinery products.

3. Pharmaceutical
   Requirements for clean ambient air in areas for production of drugs and medical equipment reflect a great variety of products. Products have various shapes and size, operations are different and time of stay in production area varies. For this reason standards that set out requirements for air purity in production areas tend to omit details. However, unlike other industries, here restrictions on biological air contamination are more stringent.
Use of plasma catalytic air treatment apparatuses in pharmaceuticals is particularly desirable since the technique allows treatment for biological contaminants in addition to harmful impurities.

Independent test have shown high-level decontamination of air treated in a plasma catalytic air cleaner. Therefore, the apparatuses may be rather useful in pharmaceutical processes which require air disinfection. What is most important is that plasma catalytic treatment apparatuses may be efficiently used in the processes where finishing sterilization is not allowed, and extraordinary safety precautions are to be taken to avoid product contamination with viable microorganisms.

Efficiency of plasma catalytic apparatuses in air treatment for biological contaminants is governed by ozone effect. Ozone kills microorganisms and destroys their protein structure. Air is treated with ozone in the plasma chemical reactor of air cleaners. Excessive ozone is completely neutralized in the second stage of the apparatus and is prevented from mixing with ambient air in rooms.

4. Production and processing of plastics and polymers

In production of polymers ambient air in the working area is contaminated with a lot of pollutants (contaminants) which comprise organic substances of various origins (carboxylic acids, ketones, hydrocarbons C_1-C_{10} and other).

Production of items from thermoplastics including polyethylene, polystyrene, and polypropylene is associated with atmospheric emissions of contaminants such as styrene, acetic acid, carbon oxide.

Production of thermosetting plastics where starting materials comprise phenolic plastics is associated with release of phenol. Sources of air contamination include heater and molding machines.

In production and laser cutting of plastics ambient air is contaminated with methylmethacrylate, vinyl chloride etc.

The mentioned substances contained in the working area ambient air produce harmful effect at least on personnel. In addition, release of organic substances into atmospheric air is regarded as environmental pollution and penalized in compliance with current regulations.

Use of plasma catalytic plants in the industry is economically justifiable since consumed resources include electric power only, and no need for changeable elements and catalyst regeneration.

5. Paint making

It is known that 100% of solvents contained in paints are released into atmospheric air when paint is, first, applied and then dried. In addition, when paint coating is applied in a paint spray booth about 30% of sprayed paint is released into ambient air.

Paint spray booths, usually, are equipped with hydro filters which, however, fail to catch solvent vapors. Content of solvents in circulating water rapidly reaches saturation and they may not be absorbed any more. Where once-through water supply system is used, solvents are released into atmosphere via sewerage.

Harmful substances (xylene, benzene, acetone and other solvents) evolved in paint spray booths and drying ovens mix with ambient air in working sites and released into atmosphere via general exhaust ventilation. Use of gas treatment plants to prevent harmful emissions is evident.

6. Printing industry

In production of printed matters ambient air in the working area catches a lot of pollutants (contaminants) which comprise solvents of various origins (alcohols, ketones, aromatic hydrocarbons and other).
The mentioned substances contained in the working area ambient air produce harmful effect at least on personnel. In addition, release of organic substances into atmospheric air is regarded as environmental pollution and penalized in compliance with current regulations.

PlazKat Aero plant ensures removal of solvents from emissions from the following printing equipment:
1. Flexographic presses.
2. Solvent printers.
3. Laminators and other printing equipment.

7. Iron and steel and metal working
Metal casting and heat treatment processes are associated with harmful emissions into atmosphere which include such substances as carbon oxide, nitrogen oxides, oil vapors and sulfur dioxide. Investment casting yields significant concentrations of saturated hydrocarbons (paraffin), acetone and isopropanol vapors. In precision casting contaminants evolve on curing of mix that contains phenol-formaldehyde resins including phenol, formaldehyde, and methanol. On treating items, solvent ingredients are released into ambient air. Sources of significant amounts of air contaminants comprise steel tempering sites.

Arc welding with stick electrodes is associated with evolvement of fluorides, nitrogen dioxide, and carbon oxide.

PlazKat Aero plants allow neutralization of the above substances.

8. Woodworking
Significant air pollution occurs during wood milling and production of such popular materials as plywood, wood-chip and wood-fiber materials, and paper. In terms of air and water pollution almost all wood impregnation and heat treatment operations are harmful, for instance, sleeper impregnation and production of thermowood.

Air treatment systems are indispensable for gluers, veneer impregnation chambers, hot presses, dryers, sites for natural resin processing other equipment of which operation yields harmful substances of concentrations that exceed MAC, in particular, phenol, formaldehyde, ammonia, turpentine, and alcohols.

PlazKat Aero plants allow neutralization of the above substances to elementary compounds.

9. Food
PlazKat Aero plants may be installed in large-scale food production facilities, including:
– confectionary;
– production of chewing gum and candies;
– bakery, and
– coffee roasting shops.

In the aforementioned operations main pollutants comprise products of raw material heat treatment, in particular, carboxylic acids (acetic and formic), aldehydes (formaldehyde), and ketones (acetone).

10. Motor vehicles and diesel generating sets
PlazKat Aero plants are used to treat emissions from motor and railroad vehicle.
It has been found that exhaust gases from internal combustion engines contain over 250 ingredients. Major components include carbon oxides, nitrogen oxides, and hydrocarbons.

Plant applications:
1. Parking lots (underground, inground).
2. Road tunnels.
3. Garages in motor vehicle fleets (bus fleets, truck fleets)
11. Smell removal (neutralization) in waste treatment facilities

PlazKat Aero plants are used to neutralize smells in waste treatment facilities caused by sulfur and nitrogen compounds including hydrogen sulfide, mercaptans and ammonia. Urban waste treatment facilities, local treatment systems in production facilities and pump stations in wastewater canalizing systems are characterized by strong smell of sulfuric and nitric compounds.

Our equipment is used for treatment of the aforementioned compounds. High treatment efficiency makes it possible to reduce strength of unpleasant smells 10-25 times. Use of these plants allows strong smell issue to be addressed in the whole facility. For the purpose of reducing capital costs for treatment plants they may be installed next to the source of release and predilution with air may be omitted.

Substances to be neutralized are as follows: hydrogen sulfide, methylmercaptan, ethylmercaptan, dimethyl sulfide, dimethyl disulfide, and ammonia.

Plant applications:

1. Treatment of exhaust ventilation in rooms of sewerage pump stations.
2. Treatment of ventilation on sludge drying beds.
4. Treatment of ventilation emissions in wastewater manifolds.
5. Treatment in open settling pits.

EMISSION TREATMENT EFFICIENCY USING PLAZKAT AERO PLANTS

Really, there are a few major techniques to acquire information about efficiency of gas treatment equipment:

1. Reports on treatment of emissions in similar operations drawn up in independent certified laboratories which show treatment efficiency regarding to each substance in emissions. The report may be found on the Company's official site at www.ele-spb.ru.

Below is a summary table which tabulates pollutants, major industries and treatment efficiency.

<table>
<thead>
<tr>
<th>harmful substance</th>
<th>Concentration suppression efficiency, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paint making and printing</td>
</tr>
<tr>
<td>Nitrogen oxides</td>
<td>85-92</td>
</tr>
</tbody>
</table>
Acetone  
Acetaldehyde  
benzene  

<table>
<thead>
<tr>
<th></th>
<th>92-95</th>
<th>96-99.9</th>
<th>93-96</th>
<th>83-90</th>
<th>80-85</th>
<th>93-96</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzpyrene</td>
<td>92-95</td>
<td>95-98</td>
<td>94-97</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Butanol</td>
<td></td>
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<td></td>
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<tr>
<td>Hexane</td>
<td>93-95</td>
<td>95-98.4</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Dimethylsulfide</td>
<td>92-95</td>
<td></td>
<td>87-91</td>
<td></td>
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<tr>
<td>Xylene</td>
<td></td>
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<td></td>
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<tr>
<td>Carboxylic acids</td>
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<td>Methane</td>
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<td></td>
<td>93-95</td>
</tr>
<tr>
<td>Mercaptans</td>
<td>90-92</td>
<td>83-92</td>
<td>80-82</td>
<td>93-97</td>
<td>92-95</td>
<td>92-97</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
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<tr>
<td>Sulfur dioxide</td>
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<td>Solvent</td>
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<td>Toluene</td>
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<td>Hydrocarbons</td>
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<tr>
<td>carbon oxide</td>
<td>85-92</td>
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<tr>
<td>Phenol</td>
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<td>93-98</td>
<td>87-91</td>
<td>93-98</td>
<td>87-91</td>
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<tr>
<td>Formaldehyde</td>
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<tr>
<td>Ethanol</td>
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</tbody>
</table>

2. At CUSTOMER’S option pilot testing may be undertaken immediately at the CUSTOMER’S production facility.

Advantages of pilot testing:

- CUSTOMER’S technicians acquaint themselves with operational features of gas treatment equipment and may receive on-site engineering advice;
- Treatment of emissions from a specified source is undertaken at the CUSTOMER’S production facility;
- There is an opportunity to conduct testing under various working conditions of the source of emissions (for instance, under full load on basic process equipment which results in greater content of harmful pollutants in emissions etc.)

Equipment for pilot testing

Equipment includes: plasma catalytic reactor, flow booster (exhaust fan), and power supply unit (transformer).

The pilot air treatment plant is connected to the pollution source. This plant is capable of treating about 850 m$^3$ of contaminated gas and air mix per hour. Air flow passes through the plasma catalytic reactor where it is exposed to various physical and chemical factors including low-temperature gas-discharge plasma, chemically active radicals, local thermal shock within the streamer zone, ultraviolet radiation etc. A short period of time ($10^{-5}$ s) is required for formation of breakdown products of excited and ionized substances which contact with the catalyst or chemical absorbent in the reactor where they are completely decomposed down to elementary non-toxic compounds or contact with surface of the chemical absorbent, and a deep oxidation (reduction) reaction occurs. Active atomic oxygen and hydroxyl ions generated due to electric discharge react with pollutants which facilitates their rapid decomposition.

Pilot testing is conducted by competent mechanical engineers who optimize characteristics of the pilot air treatment apparatus due to regulation of the following parameters:
Specific energy value per unit of gas treated.
Type of catalyst.
Gas flow rate in reactors of the air cleaner.
Time of catalyst saturation with products of decomposition.

Basic steps of pilot testing

a. Preliminary step

- origination of measurement charts in compliance with gas treatment plant test schedule;
- selection of chemical analysis procedure;

b. Installation and commissioning

- installation of the air treatment plant in the place of testing;
- installation of instruments to monitor parameters of the plant and gas-and-air mix;
- air treatment plant performance trial and setting parameters required;

c. Test procedure

- air treatment plant start-up for continuous operation at preset flow rate of gas-and-air mix;
- metering at the plant input and output of volumetric flow rate, velocity, gas temperature, and total aerodynamic drag of reactors;
- once aerodynamic parameters have been set, gas-and-air mix is fed to the plant reaction zone and gas is sampled at air cleaner input and output to determine gas treatment efficiency;
- characteristics of the air cleaner are optimized, and
- the results are recorded in tables and metering tables are attached.

d. Report origination

Results of the pilot air treatment plant tests are put down in two documents:

1. Report on pilot air cleaner tests.
2. Statement of the joint commission which shows the following:
   - air cleaner efficiency in gaseous substance suppression;
   - air cleaner use restrictions, and
   - recommendations for use of the PlazKat Aero industrial air treatment plant.

3. At CUSTOMER’S option the laboratory of our Company may conduct bench tests.

Advantages of bench tests:

- There is an opportunity to determine treatment efficiency with specific and rare substances (for instance, aromatizing agents), and
- Tests are possible when CUSTOMER’S facility is designed rather than erected. At this step model emission chemistry may be prepared on the basis of process description and treatment efficiency data obtained may be used as the basis for design of facility treatment systems.

*We have PlazKat Aero pilot plasma catalytic treatment plant of about 850±50 m³/h capacity.*
**Bench test flowchart**

As is known, emission chemistry in production facilities is multi-component and the substances belong to different classes. Our process engineers on the basis of the data provided by a CUSTOMER may create a model multi-component emission chemistry which is as close to the real chemistry as possible.

Possible model chemistry:
- alcohols (methanol, ethanol);
- ketones and aldehydes (acetone, formaldehyde);
- aromatic hydrocarbons (xylene, phenol, toluene);
- carboxylic acids (acetic acid, formic acid);
- non-organic substances (ammonia), and
- specific complex mixtures in the CUSTOMER'S facility (for instance, liquid for sleeper impregnation, aromatizing agents);

Concentration of substances in the model chemistry for single-step treatment varies from 10 to 2,000 mg/m$^3$.

In bench tests a number of samples of model emission chemistry are taken prior to and after treatment in the pilot plant to be analyzed in an independent certified laboratory. In this case the reports indicate emission treatment efficiency.

1 – plasma catalytic reactor; 2 – fan; 3 – catalyst zone; 4 – gas-discharge cell; 5 – flow rate and temperature metering; 6 – metering point; 7 – mixing zone; 8 – metering point; 9 – clean air; 10 – flow rate and temperature metering; 11 – mixing chamber
OUR CLIENTS
# APPLICATION FOR GAS TREATMENT

**QUESTIONNAIRE**

**Date of filing:** ___.___.20___

**Customer:** ______________________________________________
**Country, city:** ______________________________
**Contact:** ______________________________________________
**Title:** ________________________________________________________________________
**Tel.:** ___________________________________; **Fax:** ___________________________________; **E-mail:** ________________________________________________________________

<table>
<thead>
<tr>
<th>Production facility</th>
<th>Equipment vendors (B and K)</th>
<th>Private individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
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</table>

<table>
<thead>
<tr>
<th>Design organization</th>
<th>Investment company</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

**How you acquired information about company and equipment:**

- ☐ Internet
- ☐ Reference books
- ☐ Mailing
- ☐ Other (describe)_____________________________________

1. **general data on source of emissions:**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Process</th>
<th>Purpose of treatment</th>
</tr>
</thead>
</table>

2. **Characteristics of source of emissions:**

<table>
<thead>
<tr>
<th>Flow rate of tail gases, m³/h</th>
<th>Temperature of tail gases, °C</th>
<th>Moisture content in tail gases, %</th>
<th>Dust content in tail gases, mg/m³</th>
<th>Required treatment efficiency, %, at least</th>
<th>Pressure (+) or depression (-) at gas cleaner inlet, Pa</th>
<th>Description of harmful substances: chemistry, concentration, MAC, mg/m³:</th>
</tr>
</thead>
</table>

**Hoe air (gas) was treated before (flowchart, equipment, treatment efficiency):**

<table>
<thead>
<tr>
<th>Plant’s required operating conditions (shift, hours)</th>
<th>Ambien air temperature in gas treatment area, °C</th>
<th>Restrictions on electric power requirements</th>
<th>☐ Yes ☐ No</th>
<th>Rules and regulations to be observed</th>
<th>☐ Yes ☐ No</th>
<th>Required deadline of gas treatment equipment delivery</th>
</tr>
</thead>
</table>

**Engineering with approval ☐ or delivery only ☐**

**Note or additional information**

3. **Characteristics of the plant to be used:**

- ☐ Local with closed air circulation
- ☐ Cleaning of forced ventilation
- ☐ Treatment of industrial emissions

You are requested to fill in the questionnaire as complete as possible. This shall allow our employees to reply to your request soonest.