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ECOLOGICAL ASPECTS OF INDUSTRIAL COOLING TOWERS EXPLOITATION AND IT's INFLUENCE TO ENVIRONMENT

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Abstract. Authors are analyzing ecological and resource aspects of large-scale chemistry, petrochemistry and power engineering enterprises industrial cooling towers exploitation. Basing on hierarchical approach, the air flow in scales or region, plant and separate shop was examined. Currents of aerial masses at the plant territory are analyzed at presence of one or several sources of harmful gas pressure bumps in atmosphere conditions of interplay of these pressure bumps with steam-air plumes of groups of cooling towers. There are executed the results calculation of bordering zones with increasing of maximum permissible concentrations. The calculations are based on a data of concrete energy object including one or two sources of emission and under condition of one of the sources interaction with a group of cooling towers placed near. There are substantiated the suggestions to organize international ecological monitoring in Baltic region countries.

Keywords: cooling towers, ecology, emissions, ecological control.

1. Introduction

As the atmosphere is a continuum and most movable part of biosphere, affecting on it sets of the dispersed sources of impurity gets global nature. Therefore negative anthropogenous environmental impact now has turned to become a global problem.

In Lithuania the serious attention is paid to research of the aspects of concrete local ecological situations on objects of various plotting scale – from problems of a megacity like Vilnius (Gimbutaitė and Venckus 2008; Baltrėnas and Morkūnienė 2006; Baltrėnas *et al*. 2008) up to an estimation of influencing of works on discharging fertilizers in Klaipeda marine to port to quality of air (Baltrėnas *et al*. 2006), estimation of noise level in Trakai (Butkus *et al.* 2008) and on parking places in Vilnius (Baltrėnas *et al.* 2004). Thus the primary attention recently is given to the problems of rational usage of natural resources and protection of a surrounding atmosphere from impurities industrial enterprises (Zigmontienė and Baltrėnas 2004; Kugelevičius *et al.* 2005).

In the present work from actual ecological aspects of the problems arising at exploitation of cooling towers groups, the large industrial targetsof a chemical, petrochemical and power profile of Baltic countries (Fig. 1). In Lithuania the known enterprises which have been laied out in the cities of Mazeikiai Jonava, Kedainiai, Electrenai and Ignalina are referred to such the objects.

The analysis of summary data on emission of certain pollutants in Baltic countries contains in the report (Pushnov *et al.* 2007) from which one follows that emission of certain pollutants (kgs) counting upon soul of the population of many countries have comparable indexes.

Data on pollutant emission to atmosphere of departing from permanent sources at the cities Kaliningrad and St. Petersburg, are resulted in Table 1. The determined background of harmful emission in aggregate with climatic features of region the determined bases to refer give the country of selected region to the general ecological zone http://www.youtube.com/watch?v=JlK37afEvLc &feature=player_embedded.

Table 1. Emission of pollutants to theatmosphere of the pdeparting from permanent sources at cities of Russian Federation, laid out in Baltic region (Российский ... 2004)

Year	2000	2001	2002	2003
Kaliningrad (thousands of tonnes)	13.5	14.8	12.9	12.8
St. Petersburg (thousands of tonnes)	58.4	57.5	54.2	60.3

2. Ecological target setting

For a group of similar industrial chemical and oil refining objects it is accepted to allocate following problems of engineering ecology:

1. A problem of optimum accommodation of the new industrial enterprise in a territory of theregion.
2. Simulation of constantly operating emission of the existing enterprises of a chemical complex.

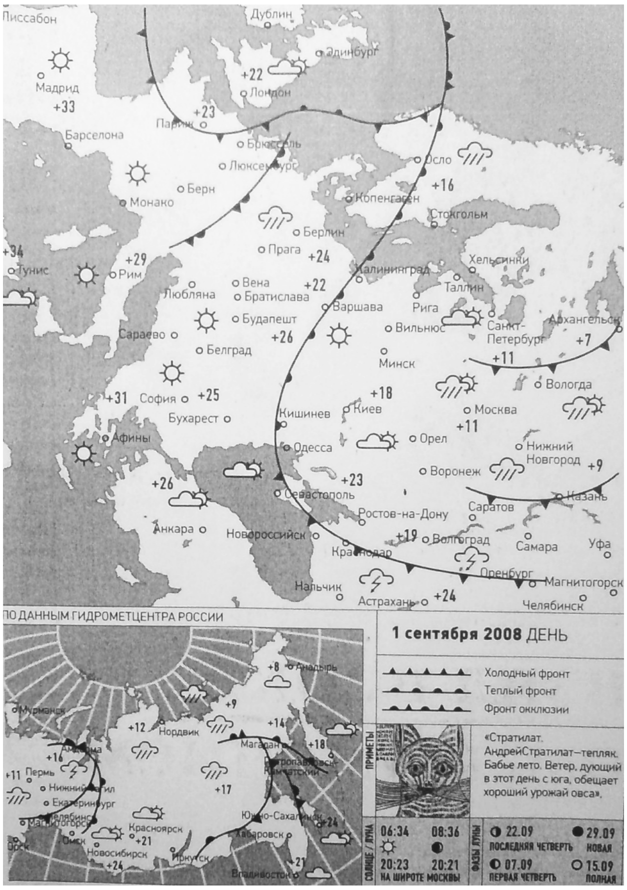


Fig. 1. Promotion of fronts cold, warm and occlusion according to for September, 1st 2008 year

3. Simulation of consequences of technogenic debacles.
4. Simulation of impurity of reservoirs by sinks of industrial enterprises.

In view of available actual statistical data on cumulative emission of harmful gases on various industrial objects (Gimbutienė and Venckus 2008; Kugelevičius *et al.* 2005; Pushnov *et al.* 2007, 2008; Российский ... 2004; Арефьев и Беззатеева 2007; Пономаренко, Арефьев 1998) territorially united in a zone with dominance of communal features of the climate caused, in turn, by presence of steady marine and atmospheric currents, it is possible to suppose the following scheme of hierarchical levels of ecological systems of the countries of the Baltic basin:

1st level – group of the countries of the Baltic basin;

2nd level – the country that haв positioned ecologically significant objects-enterprises;

3rd level – the enterprise that had marked concrete productions or the power objects having pollutants to atmosphere;

4th level – unique production, workshop;

5th level – group of cooling towers.

Emission to atmosphere which are originating at 1-st level, even being smaller in comparison with magnitudes of marginal concentration (maximum concentration limit), promote creation of the determined background which one, being sheared by primary atmospheric flow, can exist to chemical interaction and accomplish the certain influence to ecological situation to the places distant-positioned from a place of emission.

The local approaches described in the literature to concrete sources of harmful emission, as a rule, are confined to an estimation of daily average allocation of cumulative concentration of pollutant and definition of a zone with excess of maximum concentration limit. In real conditions interaction of local and group sources of pollutants of industrial enterprises with each other and with fields of the raised damp of aerial masses which one is created as a result of exploitation of groups ventilatory cooling towers in this or that region takes place. It is necessary to allow for mutual influencing of many intersected rooms (zones) of ecological affecting (see Fig. 2).

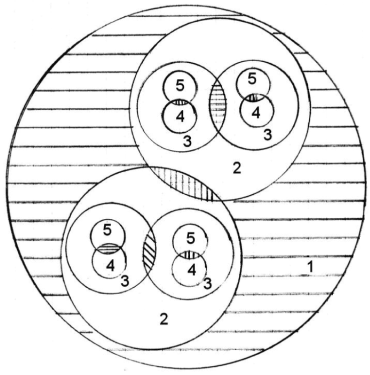


Fig. 2. Intersected rooms mutual ecological Affecting of various environmental-industrial zones: 1 – region – group Baltic basin countries; 2 – territory of a location of ecologically significant object; 3 – the plant; 4 – workshop as source of the basic emission; 5 – group of cooling towers – a source of steam emission

The current condition of emission at the large plant of a modern petrochemical complex is demonstrated on Fig. 3. Pressure emission a steam cloud in cooling towers of various types are illustrated in Fig. 4.

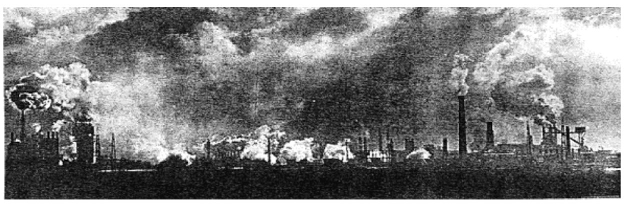
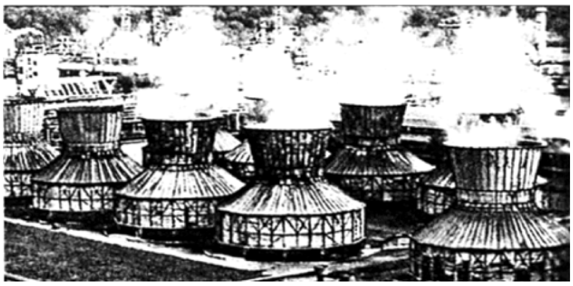
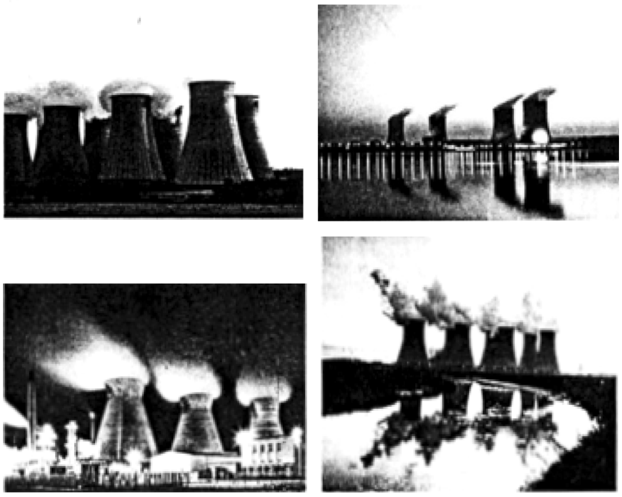


Fig. 3. A panorama of the representative industrial enterprise

Now in Institute of aqueous and environmental problems (Siberian Department of Russian Academy of Sciences) there are elaborating a three-dimensional mathematical model of forecasting of variation of a microclimate and propagation of a fog near to objects of intensive vaporization. It is marked, that by means of such model regime performances of field of propagation of plumes of cooling towers will be received. However, the account in an aerologic oilpainting of harmful pressure bumps of the chemical enterprises in this work is not planned, as it will demand the big massive of the complementary information.



a) Groups single ventilatory cooling towers СК-400



b) Groups of tower cooling towers

Fig. 4. Groups single (a) and tower cooling towers (b) on chemical and power objects

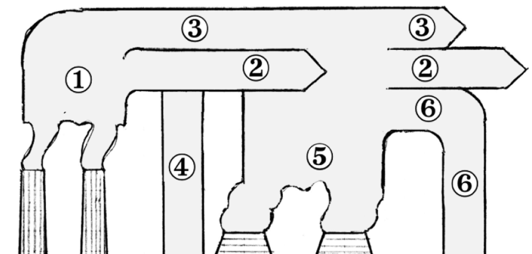


Fig. 5. The scheme of atmospheric circulation of matters in area of the plant: 1 – anthropogenous emission from workshops of the plant; 2 – propagation; 3 – propagation + transformation; 4 – dry sedimentation; 5 – a steam plume of group of cooling towers; 6 – damp sedimentation

It is well visible, as smokes of product gas at power objects. The plants merge with emission of steam plumes from cooling towers (On a photo (Fig. 4) is presented a central part of a Fig. 5).

3. Cooling towers in systems of turnaround water

Ventilator and tower cooling towers now are widely using for chilling reused water circulation at the large industrial enterprises of chemical, oil refining and energy power profile. Classification of cooling towers is introduced on Fig. 6. The representative scheme of turnaround water facilities including some section ventilatory for cooling towers is more often using for chilling compressor machinery (see Fig. 7). At chemical, power and oil refining plants the systems of turnaround water facilities are widely applied as cooling systems for basic process equipment. Cooling of reused water in cooling towers is carried out by atmospheric air during evaporative cooling. Due to collection of physical process of vaporization and ablation of drop moisture an air flow cumulative losses of recirculated water in such systems according to (Пономаренко, Арефьев 1998) compounds 4% of a cooling tower. Thus, The losses of water only owing to drop ablation of a moisture, for example, in tower cooling towers without special ventilator devices, are valued by magnitudes of the order 0.5÷1% (Пономаренко, Арефьев 1998; Рябушенко 2004).

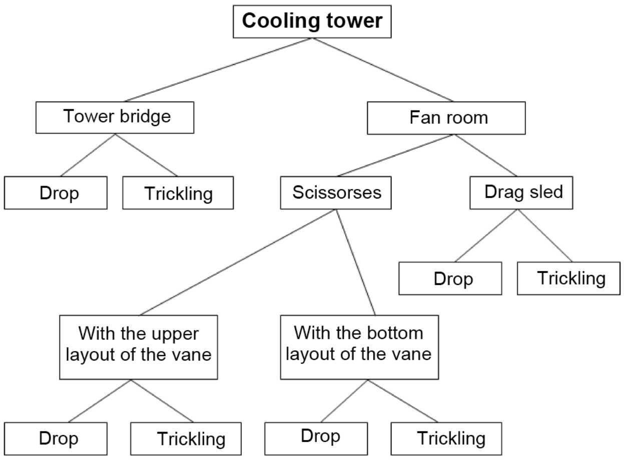


Fig. 6. Classification of cooling towers of evaporative chilling of recirculated water of industrial targets of a petrochemical and power profile

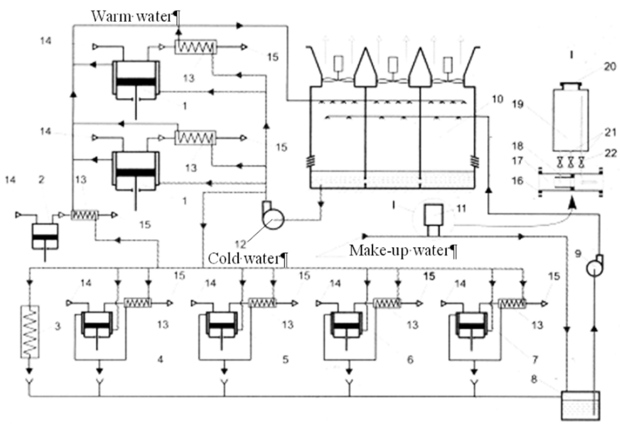


Fig. 7. The principal schema of water-turnaround system of an oxygen factory: 1 – compressors aerial; 2 – cooler; 3 – heat exchange the machinery using recirculated water; 4, 5 – nitrogen compressors; 6, 7 – oxygen compressors; 8 – the reservoir of warm water; 9 – the pump of hot water; 10 – section ventilatory a cooling tower; 11 – system of cooking and dosing of a solution complexation in running water; 12 – the pump of cold water; 13 – interstep and trailer refrigerators of compressors; 14, 15 – lines of suction and injection of compressors

Table 2. The charge of recirculated water at the large plants of Russia according to work

Industry	The charge of recirculated water at the large plants, thousand. m^3/hour	Losses of recirculated water, thousand.m^3/hour	
		Communal	Including the ablation of a drop moisture
Oil refining	100	4.0	2.0
Chemical and petroche-mical	100	4.0	2.0
Ferrous metallurgy	300	12.0	6.0

Table 3 represents the data on objects of turnaround and reused water facilities on Kaliningrad and Leningrad regions of Russia are.

Submission about charges of recirculated water on the largest refineries the chemical and petrochemical enterprises of Russia is given with Table 3.

Table 3. Bulk of turnaround and consistently used water on the fields of the Russian Federation which have been laid out in the Baltic region

Year	2000	2001	2002	2003
Kaliningrad field, one million cubic meters	128	155	171	174
Leningrad region, including St.-Petersburg, one million cubic meters	1706	1775	1957	2011

Now only thermal power stations (TPS) in Russia (there is in exploitation of 365 cooling towers by a total area of an irrigation of 650 thousand m^2, individual output from 2000 till 36 000 m^3/hour and the general output 4 million 500 thousand m^3/hour) (Калатузов 2008). Thus, the general output of TPS cooling towers annually will compound 39 billion 312 million m^3/year. According to estimations of Kalatuzov (Калатузов 2008), the loss of recirculated water only as a result of drop ablation in cooling towers of TPS will be 1.02% according to the analysis represented in work (Пономаренко, Арефьев 1998).

Representative structure of recirculated water we shall esteem on an example of a water handling of ammoniac production of joint-stock company "ACHEMA". On this production fluvial water the river Neris is used. The peer structure of recirculated water in shop and fluvial water is resulted in Table 4. Average discharge of recirculated water on the pointed production (according to data of 1978) is to be compounded with 18 800 m^3/hour. The structure of water of a turnaround cycle also is known.

4. Regional ecological and raw aspects of a problem

First of all, here it is necessary to point a problem of deficiency of sweet water which one step-by-step becomes strategic raw.

On an output of warm damp air the steam-air plume containing fine drips of recirculated water there is a cooling tower. The size of the pointed drips, for example, in tower cooling towers compounds 100÷500 mkm in quantity 0.5÷1.0 g/m^3 air. Depending on the location of cooling towers, their type and power, a lay of land and meteorological conditions pressure bumps of drop moisture in the form of an aerosol from a cooling tower can render the determined negative environmental impact.

Major factors of harmful affecting of cooling towers to near environment:

- Variation of chemical composition of soil due to its humidifying;
- Overwetting soils;
- Humidifying air, condensation of moisture on a metallical surface of machinery;
- Icing of soil during the autumn – winter period;
- Harmful affecting on vegetation;
- Influence to sanitary and hygienic conditions at presence of an aerosol in drips of toxic matters.

Recirculated water cooled by cooling towers, as a rule, goes on inhibitor constant treating with a view of strife with corrosion attack of pipe lines and machineries. In some cases in systems of turnaround water facilities industrial sewage are used also. Concentration, for example, in atmospheric air can reach chromate-ions 0.003–0.005 g/m^3. Besides as modern systems of turnaround water facilities usually work at values of coefficients evaporation more 4÷6, the drop moisture contains in plumes of cooling towers, accordingly, in 4÷6 the concentrated salts not settling out any more in a sediment.

The drop moisture, carry away air from cooling towers, contains mineral, organic and chemical admixtures of recirculated water. And, the structure of impurities of this drop moisture usually corresponds to the type of production, and also reactants used there for stabilization treating recirculated water (see above Table 4).

Table 4. Mean annual structure of water river Neris and recirculated water in shop of ammoniac production of joint-stock company "ACHEMA"

Parameter	River Neris	Turnaround cycle of shop
Alcalinity, mg.ekv./*l*	2.99	3.4
pH	7.34	7.7
Oxidability, mg/*l*	27.8	26.3
Transmittance, mm vote.st.	27.2	
Contents, mg/*l*:		
the dry rest (after evaporator)	218.6	291
suspended matters	–	12
chlorides	8.27	9.2
sulphates	15.44	12.2
nitrates	0.03	3.2
nitrites	0.0083	1.4
ammonia	0.44	0.55
copper	0.01	trails
silicates	–	9

Full scale study of propagation of damp warm air from cooling towers in surrounding room has been lead in work (Пономаренко, Арефьев 1998). The group surveyed section ventilatory cooling towers м2 has been laid out by the floor space of section 192 in 4 of some on 6 sectioning in each number. Temperature of atmospheric air measured on dry and damp thermometers in area of a layout of the pointed cooling towers. The metered temperatures were compared to audit gaugings outside of a zone of a layout of group of surveyed cooling towers. Expertises (Пономаренко, Арефьев 1998) had demonstrated, that as a result of pressure bump of warm damp air in area of cooling towers and the determined removal from them the special microclimate alee is created. At speed of a wind 4.5÷6.0 m/s the zone of the raised temperatures and damp can be diffused to spacing interval of 100 m and more (Пономаренко, Арефьев 1998).

The problem consists that near to a zone of a layout of group of cooling towers at a territory jfchemical (or oil refining) enterprises there are the potential sources of pressure bump in an atmosphere of those or diverse harmful matters, some of which are introduced in Table 5. From ecological stands to esteem the collection of harmful pressure bumps of the chemical enterprises and steam pressure bumps of damp air of group of cooling towers working in the same place follows. Thus it is necessary to mean, that, for example, molecules of dioxide of sulfur (stay time in an atmosphere about 2 day) at speed of a wind of the order of 10 m/s (at altitude of 1 km above a surface of the Earth) on the average can be displaced on spacing interval of the order of 2000 km.

Table 5. Emission of pollutants from the enterprises of oil-and-gas industry are growing according to (Воробьев 2005)

The naming of matter	The chemical formula	Maximum concentration limit, mg/m^3	
		Settlements	
		Is max single	Daily average
Methane	CH_4	50	–
Ethane	C_2H_6	100	–
Prosir	C_3H_8	70	–
Butane	C_4H_{10}	200	–
Pentane	C_5H_{12}	100	25
Hexane	C_6H_{14}	60	–
Gas condensate	C_5	5	–
Gasoline (in recalculation on carbon)	–	5	1.5
Hydrogen sulphide	–	0.008	–
Hydrogen sulphide in a mixture with hydrocarbons	$C_1 - C_5$	–	–
Sulphurous anhydride	SO_2	0.5	0.05
Soot		0.15	0.05
Carbon bisulphide	C S2	0.03	0.05
Magnesias of nitrogen	N Ox	0.085	–
Benzapiren	C20 H12	–	1
Diethyl amine	–	0.05	0.05
Ozone	O3	0.16	0.03
Phenol	C6 H5 OH	0.01	0.03

Propagation of pollutants to a horizontal direction on greater spacing intervals originates as a result of advection in a direction of speed of a wind. The spacing interval which one there can go on a molecule of pollutant, except for speed of a wind, depends on stay time of matter in an atmosphere. So, molecules of dioxide of sulfur (stay time about 2 days) at speed of a wind of the order of 10 m/s (at altitude of 1 km above a surface of the Earth) on the average can be displaced on spacing interval of the order of 2000 km. For dioxide of nitrogen this time is more because of greater stay time.

Precipitation of the matter from atmosphere can originate two paths: in the form of outwashing by atmospheric precipitation (damp sedimentation) and in the form of dry sedimentation – immediate precipitation of fragments of matter above ground. At damp sedimentation of pollutant can serve condensation as the centers of formation of drips of clouds. Members of a cloud occlude aerosol fragments and molecules of gases and by gravity settle out from altitude of several hundreds or thousand meters to the Earth, occluding new molecules of gases and catching aerosol fragments. Thus, on literary to data, fragments in diameter less than 1 micron are to a lesser degree subject to outwashing by atmospheric precipitation, than larger fragments.

Dry precipitation originates in two ways. The matters which are being a gaseous state are plated out as a result of eddy diffusion which one driving force is decreased by concentration of matters in a vertical direction because of fast occluding by a spreading surface. The firm and liquid fragments having the sizes on some orders greater, than molecules of gases, are plated out both due to eddy diffusion, and under operating of forces of gravitation. Speed of gravitational sedimentation it is forward it is proportional to mass of a fragment. At the sizes of fragments less than 0.01 microns the dodge of sedimentation is mainly instituted by eddy diffusion. Gravitational sedimentation starts to play an essential role at diameter of fragments more than 10 microns. At the sizes of fragments from 0.01 up to 10 microns, characteristic aerosols for the majority, stay time of fragments of an aerosol in an atmosphere is rather great. Such fragments can be transferred on greater spacing intervals from a place of formation. So, for example, aerosol fragments of a solution of sulfuric acid (about 0.1 microns) have greater stay time and are transferred by the size in an atmosphere on much greater spacing intervals, than molecules of dioxide of sulfur.

Propagation of fragments to an atmosphere and allocation of atmospheric fallouts to an earth surface as a result of sedimentation depend on altitude on which one fragments have been pushed original up. This altitude institutes speed of horizontal movement of these fragments with aerial masses.

The altitude ventilatory cooling towers compounds from 10 up to 41 m. Altitude of tower cooling towers compounds from 34 m up to 120 m (Пономаренко, Арефьев 1998). Thus the vanes of section and single cooling towers throw out air upwards with a speed of 6–10 m/s (Пономаренко, Арефьев 1998). Vertical direction of a current of damp air after escaping diffusers of section cooling towers is kept on a lease in altitude 10÷12 m.

Fig. 8. A panorama modern TPS

Altitude of chimneys on TPS in the various countries according to (Коротаева 2004) depending on power from 80 m up to 320 m it is necessary to note, that the altitude of chimneys and cooling towers in some cases can be commensurable. It is well visible from a photo on Fig. 8.

5. Interaction of harmful pressure bumps with steam-air plumes from cooling towers. Simulation impurity of the aerial environment

Sources of harmful pressure bumps at the enterprises of an oil-and-gas complex usually are torches and chimneys. Leakages and pressure bumps are possible owing to small overpressure, and also because of leakinesses heat-transport machineries.

It is necessary to note, that at the enterprises usually near to cooling towers chimneys are laid out. Thus in case of laying a spray of an admixture on a plume of a cooling tower allocation of concentration of an admixture can be inflected; in particular, its ground concentration will be augmented. As gradients of temperature in a zone of a plume of a cooling tower on an absolute value essentially exceed usual atmospheric gradients it can result in to peephole variation of stratification of a boundary layer of an atmosphere and, hence, and to variation of intensity of turbulence. Results of the calculations executed in VNIIG by it B. E. Vedeneyev (Левитин 1977) had demonstrated, in particular, that calorific pressure bump of cooling towers at small speeds of a wind can render essential influencing on intensity of eddy diffusion that causes appreciable magnification of ground concentration of an admixture.

Groups ventilatory section and single, and also tower cooling towers in aggregate with chimneys and other sources of harmful pressure bumps, being concentrated in the bounded territory of an industrial platform of the enterprise it is possible in plotting scale of a surrounding atmosphere, to esteem as peephole point sources. At calculation of initial rise and pressure bumps, an event due to initial vertical speed of gases and raised in comparison with air in temperature of a steam-air plume (the temperature 35–40^{o}) according to A. A. Fedoseev known model (Федосеев 2006) is offered to allow for a layout of a source of pressure bumps concerning a boundary layer of an atmosphere, a resizing of a boundary layer, allocation of speed of a wind on altitude with variation of a class of stability of an atmosphere and unevenness of a spreading surface. The relevant condition thus is the invariance of meteorological arguments.

The affected area of cooling towers on an environment essentially depends on an operating mode, number and their layout on a platform, type of a cooling tower and type of equipment used there entrainment separator devices, temperatures and damp, a wind rose, an extent of turbulence of atmospheric air.

The altitude of a steam-air plume for tower cooling towers output on cooled water from 2000 m^3/hour and above can reach 300 m and more. For section and single ventilatory cooling towers altitude of a plume is a little below.

As a result of interplay of a steam-air plume with pressure bumps of harmful matters of the chemical productions which have been laid out in a zone of propagation of a plume, namely in radius of 2–10 km, under the determined meteorological conditions there is an odds of fallout on soil of the pointed harmful matters.

In Table 5 the structure of pressure bumps of pollutants on the oil-and-gas enterprises of Russia is resulted.

According to (Техника... 2005) it is is most active under harmful pressure bumps drips in a size 1000÷3000 mkm contact. As in a steam-air plume of a tower cooling tower the size of drips as it was already marked, above, compounds 100÷500 mkm, and speed of air flow W ≈ of 1.0 m/s, it is possible to expect, that in this case interplay with chemical agents will originate was less active, than in a plume ventilatory cooling towers where the size of drips is more, and speed of an air flow is commensurable with magnitude W ≈ 2.0 m/s.

However from cooling towers on soil of surrounding territory ecological influencing of cooling towers is not confined to affecting of drop moisture. At a layout of group of cooling towers within the limits of radius R = 10 km from other sources of harmful pressure bumps chemical or a refinery in an atmosphere as it will be demonstrated below, it is necessary to allow for complex interplay of the pointed chemical gas pressure bumps with field of the raised damp of atmospheric air in the pointed zone.

The results of experimental researches published in work (Воробьев 2005), allowing to conclude, that at pressure bumps from high sources the maximum concentration of impurity is observed at travelling speeds of a wind 3…6 m/s depending on speed of an output of an air-gas mixture from a mouth of a source.

According to full scale studies GGO it A. I. Voejkova (Russia) to the most dangerous conditions of air pollution for high sources is referred:

1. The raised inverse, which one bottom boundary is above a source of the pressure bumps, augmenting the max ground concentration on 50…100%.
2. Slick the stratum which has been laied out below a source of pressure bumps when at a level of pressure bumps travelling speed of a wind in 1.5…2.0 times exceed magnitude of speed of pressure bump.

According to calculations at presence slick a stratum diffused from a surface of the ground up to altitude of 30 m, the max concentration of an admixture from a source in altitude 100…150 m are augmented approximately by 70% in comparison with concentration at absence of a calm.

In GGO it A. I. Voejkova had been investigated laws of atmospheric diffusion at various weather situations for "dangerous" conditions of weather when greater concentration of an admixture in a ground stratum of air can be observed. These studies have demonstrated, in particular, that harmful operating of smoke and gas admixtures at fogs are detected more sharply, than in other weather conditions (Воробьев 2005).

Significant influencing on a level of ground concentration of harmful admixtures besides a state of an atmosphere also renders a lay of land, especially in anomalistic conditions at calm at low and light-duty sources of pressure bumps.

At propagation of an admixture from a point source the plume is reamed owing to turbulent pulsations depending on altitude of a layout of a source and intensity of turbulence of a taking down current. Such oilpainting of propagation is characteristic for altitude gas-escape channel tubes at which one the plume has calorific and drop energy.

Major factor at simulation of process is the dominating direction of a wind in an annual cycle of repeatability. In a real atmosphere nature of variation of coefficients of eddy diffusion and speed of a wind is rather pile.

On Fig. 9 there are shown results of simulation of impurity of the aerial environment executed by us depending on quantity and nature of sources of harmful pressure bumps are introduced. Influencing of work of cooling towers on forming of boundary of front of pressure bumps of harmful matters we shall esteem on an example of work of a power complex. As baseline source data on a source of smoke pressure bumps the published experimental data on pressure bumps $SO_2 + NO_2$ on Moldavian hydroelectric power stations (state district power station) (Воробьев 2005) have been accepted. Extent and the floor space of a zone of impurity from a single source, accordingly, on this object compounded 45 km and 6350 km^2. Altitude of a tube – 180 m.

Esteemed propagation of a plume from a single source of pressure bumps (Fig. 9a), two next sources of pressure bumps (Fig. 9b), and also influencing of a source пáровых pressure bumps on a single source of chemical pressure bumps (Fig. 9c).

From the data resulted on Fig. 9 it is visible, that the account of influencing of steam plumes of group of cooling towers can essentially augment the floor space and extent of boundary of zones of cumulative concentration of harmful pressure bumps. In the same place for comparison results of calculation for group (two sources) harmful pressure bumps are resulted.

The problem was solved us in flat system of coordinates: X:У.

As the worker the simplified model of propagation of an admixture due to carrying and diffusions was accepted. The applicable equation for one mixture looks like:

$$\frac{\partial \varphi}{\partial t}+\frac{\partial u\varphi}{\partial x}+\frac{\partial v\varphi}{\partial y}+\sigma\varphi=\frac{\partial}{\partial x}\cdot\mu\cdot\frac{\partial \varphi}{\partial x}+\frac{\partial}{\partial y}\cdot\mu\cdot\frac{\partial \varphi}{\partial y}+\sum_i f_i. \quad (1)$$

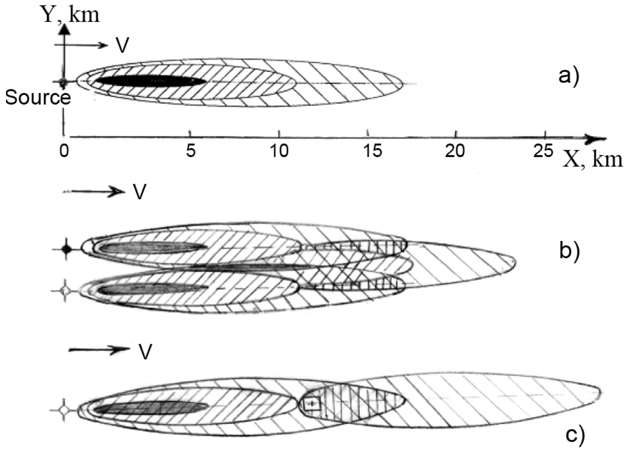


Fig. 9. Simulation of zones of max cumulative concentration $SO_2 + NO_2$ a state district power station in flat system of coordinates: X:У: a – a single source of pressure bumps; b – a panel source of pressure bumps; c – a source of chemical and steam pressure bumps

Identifications: – A source of chemical pressure bumps; – Group of cooling towers; V – a vector of speed of an air flow

Concentration: – 1.0 MCL; – 1.5 MCL; – 1.0÷1.5 MCL; – 2.0 MCL

Source study the member f_i was instituted by the equation:

$$f_i(\bar{r})=Q_i\cdot\delta\cdot\left(\bar{r}-\overline{r_{oi}}\right), \quad (2)$$

where: Q_i – intensity of pressure bump of i-th source.

It was supposed, that the source is laid out in neighborhood of a dot $\bar{r}_{oi}=r\cdot\left(x_{oi},y_{oi}\right)$.

Initial conditions: $\varphi=\varphi_0$ at t = 0,

here: t – time of observation.

Boundary conditions for the equation (2) look like:

$$\frac{\partial^2\varphi}{\partial z^2}=0.$$

On boundaries of field

After integrating on time of observation of everyone of j – that reductants of impurity we receive allocation of cumulative concentration on all field of the decision:

$$\overline{\varphi_j}(x,y)=\sum_{i=1}^{N}\frac{1}{\tau\cdot H}\cdot\int_0^{\tau}\int_0^{H}\varphi_j(x,y,z,t)\,d\varphi_j, \quad (3)$$

here: N – number of the enterprises (shops) with sources of pressure bumps; i – number of the enterprise (object); j – an esteemed reductant; τ – time of the decision; H – altitude of field of the decision.

6. Conclusions

In connection with forecast severe variation of a climatic situation in the world and in the countries of the European community there is obvious qualitatively a new approach to the organization of ecological monitoring at an international level.

Stated above demonstrates an especial urgency of a problem of scale regional ecological monitoring in the countries of the Baltic basin. For the decision of these volumetric information ecological – meteorological KIP problems actually creation the international system of the operative monitoring according basic aerodynamic arguments, such as: speed and a direction of a wind, temperature, damp and stress, by adding data about presence and concentration in an atmosphere of harmful matters. As a basis thus national meteorological stations after them equipping and can serve retrofit. In this connection there can be beneficial sensory systems designed in Slovakia (Čimo and Šiška 2006). The published data on a pathway of distant carryings reverse aerial masses in territory of the Europe (Šaulienė and Veriankaitė 2006) confirm a opportunity and expediency of constructing of international system of operative ecological monitoring.

It is clear, that for the decision of the pointed problem gathering and statistical treating of significant bulk of the ecology-meteorological information for a long time in all territory of region is required. In our opinion, the organization and the general monitoring of a discussed problem is expedient for carrying out forces Vilnius Gediminas Technical University (VGTU) Department of Environmental Protection which one have wide experience of implementation of large international projects. Probably also involvement in project Moscow State University of Environmental Engineering (MSUEE), UNESCO Chair in Environmentally Clean Engineering, and St. Petersburg State University of Technology and Design, Department of Engineering Chemistry and Industrial Ecology.

7. Deductions

1. The detailed analysis of ecological and resource aspects of a problem of drop of losses of recirculated water is lead at exploitation of cooling towers. Major factors of ecological affecting of a steam-air plume of cooling towers are demonstrated.

2. On concrete examples of calculation it is demonstrated, that simultaneous affecting of collection of several sources of impurity and steam-air plumes of groups of cooling towers in conditions of the large industrial enterprise essentially influences quality of atmospheric air – degrades a communal ecological situation.

3. It is offered for detailed learning and forecasting of an ecological situation in region to organize its constant monitoring.

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AKTUALŪS AUŠINIMO BOKŠTŲ EKSPLOATAVIMO ASPEKTAI IR EKOLOGIJA

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Santrauka

Analizuojami ekologiniai bei išteklių panaudojimo aspektai eksploatuojant aušinimo bokštus chemijos, naftos ir energijos pramonės srityse. Oro masių, išmetamų iš šių bokštų, srauto judėjimas nagrinėjamas regioniniu, gamyklos teritorijos bei pavienių cechų mastu. Gamyklos teritorijoje įvertinamas oro masių srovių srautas bei jų sąveika, kai iš skirtingų aušinimo bokštų išmetami vienas ar keli kenksmingų išmetamųjų dujų ir garų srautai. Pateikiamos apskaičiuotos teritorijų, kuriose sklinda oro teršalai, ribos, kai viršijamos ribinės teršalų išmetimo koncentracijos. Siūloma organizuoti tarptautinę oro teršalų stebėseną Baltijos regiono šalyse.

Reikšminiai žodžiai: aušinimo bokštai, ekologija, išmetimai, ekologinė kontrolė.

АКТУАЛЬНЫЕ АСПЕКТЫ ЭКСПЛУАТАЦИИ ГРАДИРЕН И ЭКОЛОГИЧЕСКИЕ ПРОБЛЕМЫ

А. Пушнов, М. Беренгартен

Резюме

Проанализированы экологический и ресурсный аспекты эксплуатации группы промышленных градирен на больших химических предприятиях нефтехимического и энергетического профиля. Оценены особенности потока воздушных масс при присутствии одного или нескольких источников вредных выбросов и паро-воздушного потока группы градирен. Приведены предложения по организации международного экологического контроля на территории Прибалтийских стран.

Ключевые слова: градирни, экология, загрязнение окружающей среды, экологический контроль.

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