DYNAMICS OF PARTICLES ACCUMULATION NEAR TOMSKAYA GRES-2 ACCORDING TO SNOW LAYERS' ANALYSES

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Heat- and power-generating facilities are main sources of pollution in cities. Atmospheric emissions consist of dust, gases and vapor, having a negative impact on population's health. Dust and aerosols in combination with other negative factors lead to health hazards.

The aim of research is to evaluate the dynamics of particles' accumulation and their occurance in snow layers near thermal power-plant "Tomskaya GRES-2".

An environmental monitoring system is characterized by a wide usage of natural accumulators of aerosols, including snow cover, which allows estimating not only natural emissions of aerosols but also anthropogenic ones, including industrial and transport emissions [2, 3, 4]. In spring, when snow melts, water causes toxicants to migrate in different form. According to monitoring research, pollutants' concentration in snow is 2-3 times higher than that in air.

As snow cover composition in towns has a lot of contaminants, it is compared with samples from background area.

The sampling was conducted at the end of winter season, 2016/17. The sampling point is located 700 m to north-east from GRES-2. Snow sampling was carried out by using special tool with sampling step 2 centimeters in depth [37]. This way allows us to estimate the dynamics of particles' accumulation in snow layers, define the forming time of layers and find possible sources of solid particles accumulated in snow. The total number of samples was 35.

The next stage was melting of samples with pH and conductivity measurement. pH is used to define probable air pollution, its value for background areas is 5.6. At the same time, values in samples varied between slightly-acidic to slightly-alkaline, that can be connected with ash, solid particles of fuel and metal oxides.

Snow-cover stratigraphy is a result of layer rotation with different structure, physical and mechanical properties of ice-crust or any other borders. Snow structure is characterized by crystal and pores form, size, orientation and relationship between them.

According to Kuzmin P.P [1], snow is classified into three groups (Table 1.).

Table 1

Snow classification by density

Snow type	Density before humidity, kg/m^3
Fresh snow	130-210
Fine and average granular snow	240-320
Recrystallized course granular snow	390-450

Table 2 shows sampling-layers classification of grains, average density, and mass of solid particles deposited in snow, dust load and snow-melting water.

Table 2

Composite snow-samplings

№	Depth, cm,	Grain type	Average density, g/cm^3	mass of solid particles deposited in snow, mg	Dust load (Pn), mg/m^2	Volume of melting water, dm^3
GRES 1-7	0-14	fine	0,15	460	4732,51	1300
GRES 8-11	14-22	fine	0,22	166,1	1708,85	750
GRES 12-15	23-30	fine	0,24	630	6481,48	650
GRES 16-19	32-38	average	0,24	70	720,16	1100
GRES 20-22	38-44	average	0,28	10	102,88	650
GRES 23-25	44-50	average	0,33	130	1337,45	1150
GRES 26-28	50-58	average	0,32	40	411,52	800
GRES 29-32	58-66	course	0,28	160	1646,09	1060
GRES 33-35	66-72	course	0,30	90	925,93	1060

Snow cover compaction is a very fast process explaining the difference between the layer of fresh snow and the same layer after a few hours.

The higher the air temperature, the faster the snow density increases. The temperature 0…-2 ^{o} C causes the maximum density to amount for 1-1.5 hours. The low temperature delays density increasing, especially temperature lower -10 ^{o} C [2]

Each snow characteristic depends on its density, but this value is very variable: from 10 to 700 kg/m^3. Snow density is a common subject of numerous research works.

Crystals are decomposed into the separate particles. It causes steam condensation on the grains, which size is bigger and their form becomes circle.

Collection and analysis of weather data are based on information from the RP5 website. It is necessary to take temperature, wind vectors, precipitations and altitude of snow cover into consideration. According to this information, snow accumulation process started on 21 October, 2016. Water equivalent calculation is necessary to explain the forming time for each snow layer (Fig.1).

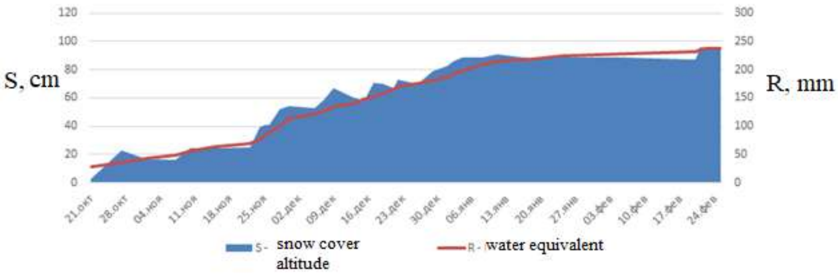

Fig. 1 Graph of changing snow cover density and water equivalent

Then the analysis of wind conditions was performed to predict probable sources of dust-aerosols in snow layers. Wind condition analyses allow estimating dust-aerosols accumulation by snow cover and have an effect on quantity and quality characteristics of snow pollution. According to wind roses analysis, winter period is characterized by predominance of Southern winds.

New-fallen snow becomes stiffer because of its weight and this process takes place down the gradient layers. Furthermore, snow grains change their structure because of crystal thermodynamic instability and mass-transport. These processes are known as metamorphism due to snowflakes form and changes in size.

Crystals are decomposed into separate particles. It causes steam condensation on the grains, which size is bigger than others and their form becomes circle. These particles form new layers and sugar snow.

Besides, melting and steaming are caused by liquid precipitation and others meteorological factors.

Due to snow cover forming, ice-layer, packed snow, sugar snow and different structured layers can also originate. For a long time, when snow cover is on surface, each layers' characteristic can change. It depends on thermodynamic conditions.

As a result, snow cover is a very active system, as its characteristics - density, structure, physical and mechanical properties undergo permanent changes before the snow-melting process starts [2].

To analyze the mineral composition of snow, solid particles of snow layers were sampled near thermal power plant GRES-2. The samples of solid particle were analyzed by scan electron microscopy. Layer composition was different. Research allows for classification of common particles found in all layers, as specified particles were indicated only in one layer. The first type consists of aluminosilicate microspheres, intermetallic compounds with Ti and Fe and iron oxides. Fine-grained layer is characterized by the following particles: barium sulfide, lead particle with chrome and iron, and zirconium particle. Probably, these particles were accumulated in snow cover within the period from January to February. This period is characterized by the lower temperature and the fact that the power plant had to involve additional boilers, the operation of which can increase emission rate. In middle-grain layer the following specified particles were found: wolframite nanoparticle, which can be an indicator of not only coal combustion at power plant, but also transport emissions. In this layer the other particles were found: zirconium, phosphate of rare elements, and thorium. This type of particles is an indicator of coal combustion, our opinion is based on the other investigations. The least quantity particles were found in course-grained layer, which was formed the first. Specified particles of this layer include iron, lead, copper, and chrome compounds. The next step was comparison of these samples with snow sample from the background station (observatory "Fonovaya").

According to our results, particles' distribution in snow layers is of irregular character. Their chemical composition is different. Technogenic particles consist of groups of aluminosilicates, intermetallic compounds of heavy metals and rare-elements particles. The largest quantity of particles was found in fine-grained snow layer. It can be caused by the operation of power plant or other sources, furthermore, geochemical processes in snow cover also can result in particles' distribution.

Having compared the results with the background samples, we can see stark differences between them. It can be caused by hard technogenic load in Tomsk.

References

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