References

1. Fedorov B.V., Provodka Wiring wells in difficult conditions: a manual for students. – Almaty: Nauchno-tehnicheskiy izdatelskiy tsentr im. Satpaeva K.I., 2011.-161s.
2. Ginsburg G.D., Solovev V.A. Submarine gas hydrates. VNIIOkeangeologiya.- Sankt-Peterburg, 1994.
3. Installation scheme of stationary methanol bath. Available: http://www.stroi-blok.ru/?p=84 (date of the application: 28.02.2018)
4. Islam MR. A new recovery technique for gas production from Alaskan gas hydrates. J Petrol Sci Eng 1994;11:267–81
5. Installation scheme of stationary methanol bath. Available: http://www.stroi-blok.ru/?p=84 (date of the application: 28.02.2018)
6. Istomin V.A., Iakushev V.S. Gas hydrates in natural conditions.// Spetsializirovannyy zhurnal: Burenie i neft. – 2011.
7. Koulpine L.G., Dubrowski D.A., Obmoroshewa L.B., Tupysev M.K. Gas Hydrate Bearing Capacity of Submarine Cryolitozone: Complication Prognoses in Exploitation of Arctic Off-Shore Fields. 2-nd International Conference on Natural Gas Hydrates, Toulouse (France), 1996. - P. 453-458
8. Moridis GJ, Reagan MT. Strategies for gas production from oceanic class 3 hydrate accumulations. 2007 Offshore technology conference; 2007.
9. Natural features of the development of hydrocarbon deposits in the Barents Sea. Available: http://neftegaz.ru/science/view/1073 (date of the application: 28.02.2018)
10. Shiryaev E. V. Methods of combating hydrate formation and the choice of hydrate formation inhibitor in arranging a gas field «Kamennomysskoe more» // Molodoy uchenyy. — 2015. — №17. — S. 323-326.
11. Sloan, E.D., Koh, C.A. Clathrate Hydrates of Natural Gases 3rd Edn. CRC Press Taylor & Francis Group. 2008.
12. Zheng Rong Chong, She Hern Bryan Yang, Ponnivalavan Babu, Praveen Linga, Xiao-Sen Li. Review of natural gas hydrates as an energy resource: Prospects and challenges. Applied Energy Volume 162, 15 January 2016, S 1633 – 1652.

SEMI-EMPIRICL THEORY OF TURBULENT TRANSPORT IN THE ATMOSPHERE

V.Y. Grishaev
Scientific advisor - assistant professor Vershkova E.M.
National Research Tomsk Polytechnic University, Tomsk, Russia

Since the problem of air pollution appeared in many industrial areas of the countries, many scientists are working on the study of the movement of emissions in the atmosphere. Recently, as the development of technology and technology has become a real large-scale field experiments with registration of the whole complex of parameters, such as: impurity concentration, meteorological parameters these projects can provide more accurate information on the migration of impurities. Into the present time becomes possible the so-called numerical simulation of impurities with the necessary accuracy on computers. The validity of such models is possible by adjusting the parameters during the comparison results of calculation with the final results of the experiments.

Diffusion is one of the most important factors determining the behavior of heavy gas emissions in atmospheres. It was noted that migration processes are mainly turbulent in nature and the coefficients transportations are caused by the turbulent motion of the masses. Here will be described the simplest models of movement impurities in the atmosphere that take into account diffusion, and provides analytical solutions that carry qualitative character [2].

Suppose that the specific content of the impurity – $s(x,y,z,t)$, moving together with the air flow in the atmosphere. We define the solution of the problem with the surface S in the cylindrical region G, which consists of the lower base $\sum_0$ (at z = 0), the lateral surface of the cylinder $\sum$ and the upper base $\sum_0$ (at z = H).

If $\vec{\upsilon} = \upsilon_x \vec{i} + \upsilon_y \vec{j} + \upsilon_z \vec{k}$ (where *i, j, k* are unit vectors in the direction of *x,y,z* axes, respectively) – vector the velocities of the air particles as a function of *x,y,z,t,* then , hence, the transport of the substance along the particle trajectory air with preservation of its contents will be presented in the form of the following equation

$$\frac{\partial s}{\partial t} + div(\vec{\upsilon} s) = 0, \tag{1}$$

To equation (1) we add the initial data

$$s = s_0 \text{ at } t = 0, \tag{2}$$

And conditions on the boundary S of the region G

$$s = s_s \text{ on s}, \tag{3}$$

where s_0 and s_s are given function.

Equation (1) can be generalized. If, in the process of distribution, the proportion of the substance reacts with the process is interpreted as the absorption of the substance by the external environment or disintegrates. That equation (1) goes to the following:

$$\frac{\partial s}{\partial t} + div(\vec{\upsilon}\, s) + \sigma s = 0, \tag{4}$$

where $\sigma \geq 0$ - is the value inversely proportional to time.

If the sources of the investigated contaminating substance s, are in the area of determination of the solution, described by the function f (x,y,z,t), then equation (4) takes the form

$$\frac{\partial s}{\partial t} + div(\vec{\upsilon}\, s) + \sigma s = f, \tag{5}$$

In this case, in accordance with our models, the unsteady problem of substance transfer will be presented in

$$\frac{\partial s}{\partial t} + \sigma s = f$$

$$s = s_0 \text{ at } t = 0, \tag{6}$$

If *f* does not depend on *t*, the solution of the problem will be

$$s = s_0 e^{-\sigma t} + f(1 - e^{-\sigma t}) / \sigma, \tag{7}$$

and at $t \to \infty$ goes to the solution of the corresponding stationary problem $\sigma s = f$, that is $s = f / \sigma$.

Of course, such a simple model cannot describe the main features of substance transfer from the source. In fact, we know that the impurity in the atmosphere so to speak blurs, creating a complex distribution in the vast vicinity of the release. And this is predictable, because even in weather without wind, the atmosphere is turbulent, where small-scale fluctuations (usually the vortices), dislipidaemia and to create conditions for neoplasms [3].

In order to take into account the effect of turbulence on the transfer of substance in the atmosphere, we use the results semiempirical theory and derive the diffusion approximation of equation (5) distribution of substances in the atmosphere [4]:

$$\frac{\partial s}{\partial t} + div(\vec{\upsilon}\, s) + \sigma s = Ds, \tag{8}$$

where

$$Ds = \left(\frac{\partial}{\partial x}\right) D_x \left(\frac{\partial s}{\partial x}\right) + \left(\frac{\partial}{\partial y}\right) D_y \left(\frac{\partial s}{\partial y}\right) + \left(\frac{\partial}{\partial z}\right) D_z \left(\frac{\partial s}{\partial z}\right) \tag{9}$$

In the equation, the values *v* and *s* are already averaged over time. To equation (8) we need to add the ratio of the continuity [1]

$$div(\vec{\upsilon}) = 0, \tag{10}$$

and initial data

$$s = s_0 \text{ at } t = 0, \tag{11}$$

The process of diffusion and transport of the substance is best considered to begin with on simple one-dimensional task. Therefore, first we consider an exclusively diffusion formulation of this problem

$$\sigma s = D_x \left(\frac{\partial^2 s}{\partial x^2}\right) + Q\delta(x - x_0), \tag{12}$$

in an infinite medium $-\infty < x < \infty$, where Q – the power of the source that emits impurities into the environment.

As boundary conditions in the case it is necessary to use the assumption of the inferiority of decisions about the whole scope. Note that in equation (12) the function f concrete and presented in a form acceptable for the task of this type.

Solutions of problems (fig. 1) in the right and part of the axis coordinates are

$$s(x) = \begin{cases} \exp\left\{-\sqrt{\sigma / D_x}\,(x - x_0)\right\} \\ \exp\left\{-\sqrt{\sigma / D_x}\,(x_0 - x)\right\} \end{cases} \tag{13}$$

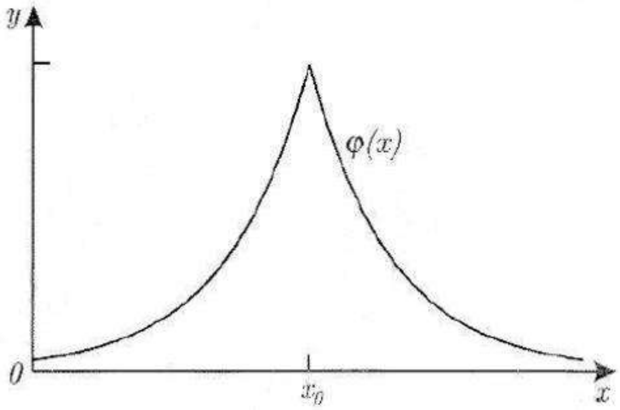

Fig. Graph of analytical solution of (13) diffusion equation [1]

References

1. Khrgian A.K. Physics of atmosphere. T.2. – L. Hydrometeorology, 1978. 319 c
2. Marchuk G.I. Mathematical modeling in the problem of environment. – M., Science, - 2001. – 320 c.
3. Matveev L. T. Rate of the General meteorology. Atmospheric physics. – L. Hydrometeorology, - 2009, - 639c.
4. Piskunov V.N., Aloyan A.E., Modeling of regional dynamics of gas impurities and aerosols. Atmospheric and ocean physics. 2011. T.41, N3. – C. 328 – 340.

FORMATION CLASSIFICATION BASED ON THE WELL LOGS DATA WITH THE USE OF MACHINE LEARNING

I.S. Kanaev
Scientific advisor - associate professor O.S. Chernova
National Research Tomsk Polytechnic University, Tomsk, Russia

In today's world the machine learning methods are used in different life spheres. With the increased amount of information, a single person becomes unable to process and analyze the entire array of data. However, ignoring some parts of data or simply not noticing signs may leads to wrong conclusions. That is why researchers and specialists need to use methods of data analysis such as machine learning.

From finding other planets and stars to customer`s food behavior determination, in all of these theme machine learning is used to.

Petroleum industry does not fall behind. There are a lot of scientific researches that are used machine learning and especially neural networks as a part of it. There are many aspects where artificial neural networks (ANNs) are used, so formation classification problem is one of them.

Czech specialists: Malvic, T., Velic, J., Horvath, J., and Cvetkovic, M. analyzed the data from three fields located on the territory of the Czech Republic [1]. One of the tasks in that work is the prediction of sand-marl facies by the data of Okoli field. For this purpose, researchers use a backpropagation ANNs.

The work of Y.Zee Ma is interesting in case of classification process and methods, which were used in the research project [2]. For the lithofacies clustering author used artificial neural networks and principal component analysis (PCA) as data preprocessing method. Y.Zee Ma used such well log data as: GR, self-potential log (SP), density log and acoustic log for clustering process. One of the most interesting aspects is the use of cascades of ANNs. The author mentions that cascaded ANNs shows the better result than a single benchmark ANN. This statement is quite interesting and is analyzed for the purpose of current publication.

The analyzed data set contain well log data from three fields: B, C and D, which are located in Tomsk region (the Russian Federation) (Fig.1). All of the fields are structurally situated in Nurolskaya megadepression.

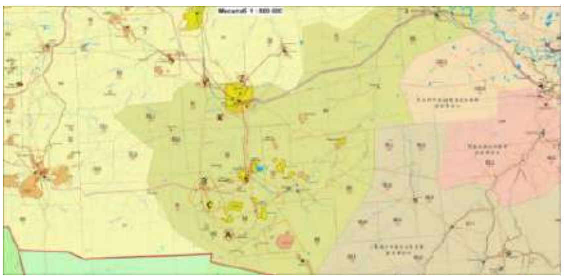

Fig. 1 Relative location of investigated fields