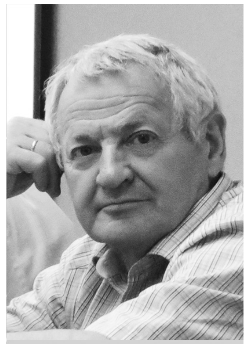

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# Professional Activities in Virtual Learning Environment: Interdisciplinary Training Case Study

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**The technology of professional activities in virtual learning environment has been developed and is being successfully implemented at Gubkin Russian State University of Oil and Gas. The education is provided in the form of trainings for interdisciplinary groups of students, which simulate real world project and production activities. The paper describes one of the training case studies.**

**Key words:** interdisciplinary learning, training, virtual environment for professional activities, professional standards.

In the industry of knowledge, the major sector in national economies. which are the leaders in scientific and technical progress, universities take the role of system-forming institutes. Silicon Valley and its alma mater Stanford University are an example which has already become classical.

A variety of trends in engineering education provided at national high schools are illustrated in the scheme given below (fig. 1).

One of the trends is creation of new training environment, i.e. the virtual environment for modern engineering activities and implementation of interdisciplinary educational technologies. The RF in general, and Gubkin Russian State University, in particular, are pioneers in this sphere.

The corresponding innovative project was launched at the university ten years ago with the support of the Ministry of Education and Science of the Russian Federation, the project team was awarded by the Government of the Russian Federation in the field of education last year for the results obtained.

To better understand this project, it is worth beginning with the fact that ten years ago the Russian Union of Industrialists and Entrepreneurs (RUIE) and the Ministry of Education and Science of the Russian Federation began transition to the new regulatory base in the sphere of qualifications, in particular, professional standards (PS). Intensive implementation of RUIE resulted in the events as follows: in May, 2012 there was the Presidential decree that forced (within two years) development of eight hundred PSs; at the end of the same year, a new article was added to the Labor code of the Russian Federation (195-1), which defined the concept of qualification and status of PS as the main document on requirements to professional qualifications. The competency-based approach failed to be applied to PS requirements; however, necessary professional competencies (such as knowledge, skills) are still implicitly determined. It is essential that these competences are related to specific labor functions and actions. Being the basic document for the Federal State Educational Standards (FSES) and the main education program (MEP) of the higher education, PSs accurately determine efficient professional activity model, which implies high quality of student training.

This activity model is also possible to be implemented in the training environment which was defined as a virtual environment of professional activity (VEPA) [1]. While developing VEPA within the above-mentioned innovative project, Gubkin







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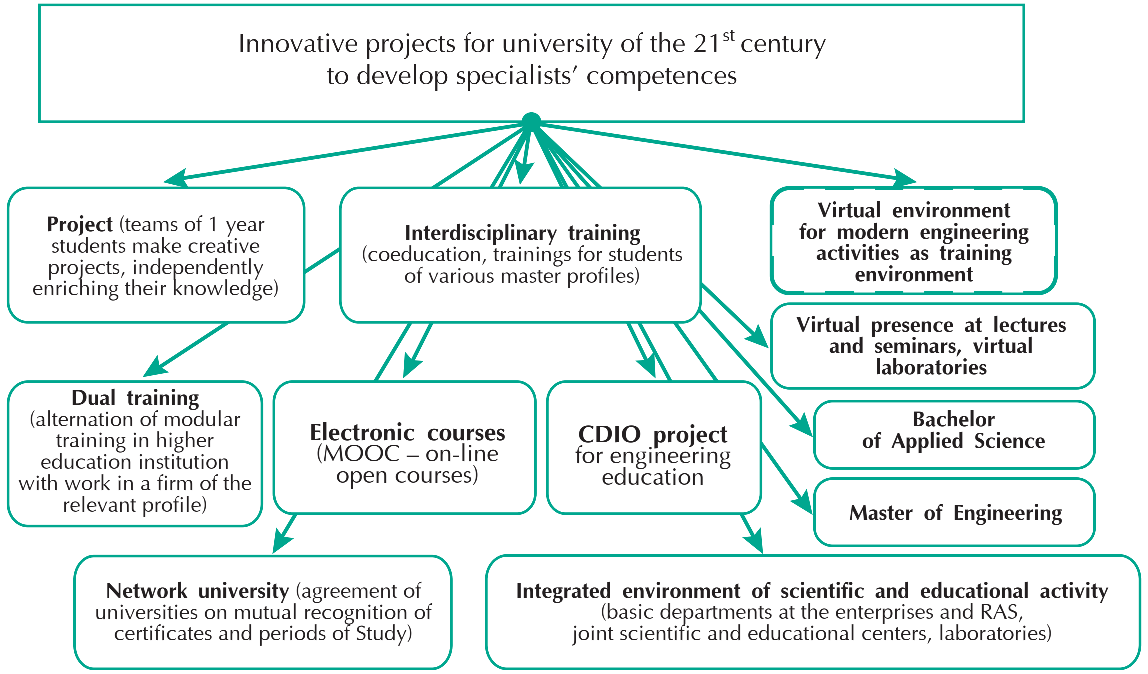
**Fig. 1. A variety of innovative educational projects of the 21st century**




Russian State University was intensively developing PSs for oil and gas complex (OGC). Within the program of national research university development, the PS projects for all technological chains of oil and gas production were developed with participation of the leading OGC employers.

The Interdisciplinary Educational Technologies (IET) in VEPA are implemented in the form of trainings and case-study [2, 3].

A version of the developed IET is given below as an example of virtual oil field.

The basic elements of virtual field are:

- 3D geological and hydrodynamic models of the field;
- digital (computer) models of processes and facilities (well, borehole equipment, gathering equipment and well completion facilities);
- the computerized workstations (WKSs) for the specialists of various profile jointly working in the field, united in a local network system of high performance: geologist, developer, various technologists, driller, mechanic, chemist, ecologist, economist, specialist in industrial safety;
- the situation center of decision making – Control center of field development – CCFD.

Training method of students in the virtual environment of professional activity is simulation of real online productive activity of field specialists – geologists, geophysicists, developers, drillers, mechanics, power engineers, field chemists. Its content includes comprehensive analysis of real production situations (cases), search and decision-making, implementation of decisions, and subsequent monitoring of the situation.

We should emphasize once again: this educational technology is based on the following principles:

- training through activity;
- interdisciplinarity of activity;
- advanced training.

The IET is implemented within the discipline «Field operational management» included in MEP as a practical work of «Methods of engineering activity» for Master students in Petroleum Engineering, Technological Machines and Equipment, Chemical Engineering and Biotechnology, Economy and Management directions.

The method of Case-study involves continuous updating and replenishment of the cases used in training. Experience showed that it is the most complex and expensive work in all the project of the VEPA interdisciplinary training.

The example reviewed in the paper is given to illustrate this fact.

In this context, the case, in other words, information basis of the training scenario, is the production situation on a definite field in the North of Tyumen Oblast, consisting in sharp water production at one of more than 100 production wells. The training should simulate the working meeting for analysis and investigation of the causes for current situation, students of various master profiles play the roles of a field chief engineer, a head of field geological service, a head of the contracting organization, a chief field mechanical engineer.

To train students, they are, first of all, given full field data in advance according to the roles they play. It is the major and most crucial stage in IET implementation.

The paper format does not allow giving full the initial data, as it is mostly presented in the EXCEL tables and copies, etc., therefore, the reduced information is given below.

### General data and geological-physical characteristic of the field

The training field is located in Nadym region of Yamalo-Nenets Autonomous Area of Tyumen Oblast. The area of the field is 322.6 sq.km. The territory of the field is located in the zone of northern taiga; it includes the isolated uplands and separated boggy depressions. The winter is long, frosty and snowy, the summer is short. Steady snow cover is formed approximately to the middle of October and melts to the middle of May. The average annual air temperature is -5.3 $^0$C, the average air temperature of the winter period -29 $^0$C, the average temperature of July +15.5 $^0$C. The frost-free period is less than 90 days a year. The average annual amount of precipitation is 555 mm.

There are zones of deep permafrost occurrence in the site. The cryosolic relief is confined by frost mounds, conical depressions, and thawing fields. The lower frostline can reach 400 m. The hydrographic network of the study area is characterized by high density. There are a lot of lakes, rivers, rivulets and streams.

In the field the oil inflows are produced by reservoir sampling: $Yu_5$, $Yu_4$, $Yu_{2-3}$, $Yu_0$, $Ach_1$ and $Ach_2$ in the exploratory wells, but commercial content is found in the $AC_{10}$ and $AC_9^3$ formations of Cherkashinsky suite deposits of the Lower Cretaceous period.

In the study area there are numerous deposits with productive AC, $AC_9^3$ and $AC_9^1$ formations. General thickness of the complex from the suite section changes from 87 to 137 m, an increase in thickness is observed westward.

As a part of productive strata the most reliable local benchmark is the clay strata dividing $AC_9^3$ and $AC_{10}$ formations. Its thickness increases from 10 to 18 m westward.

AC10 formation lies in the range of 2727.2 – 2788.2 m and is confined by a thick stratum of alterating sand-stones, aleurolites, limestones and clays. The general well thickness changes from 29.8 m (well 357) to 52.8 m (well 712). The average net thickness of the formation is 10.5 m, the average oil-saturation is 7.1 m.

The permeable differences in the formation section are everywhere. The thickness of reservoir layer changes from 0.2 m to 6.4 m, the quantity is 2-26, and only in several wells the reservoir is confined by two interlayers.

According to the results of GIS data interpretation and well sampling, the water oil contact in the deposit is accepted at the absolute mark-2651 m and confirmed by data of well operation.

Based on the developed geological model the area of oil zone is 24 % of all field area, water and oil zone is 76 %. The effective oil saturation of the wells in the oil zone changes from 2.2 m to 15.6 m, in water oil – from 2.6 m to 31.8 m.

The oil deposit of AC10 formation has the sizes of 23.9 x 2.3-7.0 km., the height of 15.1-33.2 m. The deposit type is bedded, arch-like.

According to the hydrodynamic researches of 27 $AC_{10}$ formation wells the permeability changes from 0.9 to 180.0x10$^{-3}$ mkm$^2$. The average value is 53.6x10$^{-3}$ mkm$^2$.

According to 300 laboratory core saturation determination of connate water was 31.3 % in average with the change interval of separate samples from 2.1 to 81.5 %.

According to GIS, porosity was defined 580 times in the intervals of oil and water-saturated strata; the average value is 18 % with the change interval of separate interlayers – 15-21 %.

The average initial oil saturation of 99 wells was defined 580 times; it was 56 %, separate interlayers changed from 44 to 69 %. Distribution of oil saturation in three-dimensional geological model is shown in Fig. 2. The geological and physical parameters of the field are given in Tab. 1.

### History and current development

B In December, 2007 the exploratory well No. 57 was put into operation. In 2008 the rotation and turbine drilling methods were used for field development.

The MS-GAU (MSGSh) and SVSh (SV) cone cutter bits were used as rock cutting tools. The clay drilling mud with a density of 1.16-1.18 g/cm3 was used for the well. The completion drilling was performed with the drilling fluid of the following parameters: relative weight – 1.06-1.17 g/cm$^2$, fluid loss – 5-6 cm$^3$/30 min. Such a fluid allows preventing well-drilling accidents, but leads to high reservoir productive zone contamination while drilling. The well mouth was equipped with the casing heads of OKK2-35 168x245x324 type and AFK-2-65x35 christmas tree. The geological section of $AC_{10}$ consists of terrigenous rock inclined to caving formation.

**Fig. 2. Oil Saturation Distribution of $AC_{10}$ formation of the Training field**

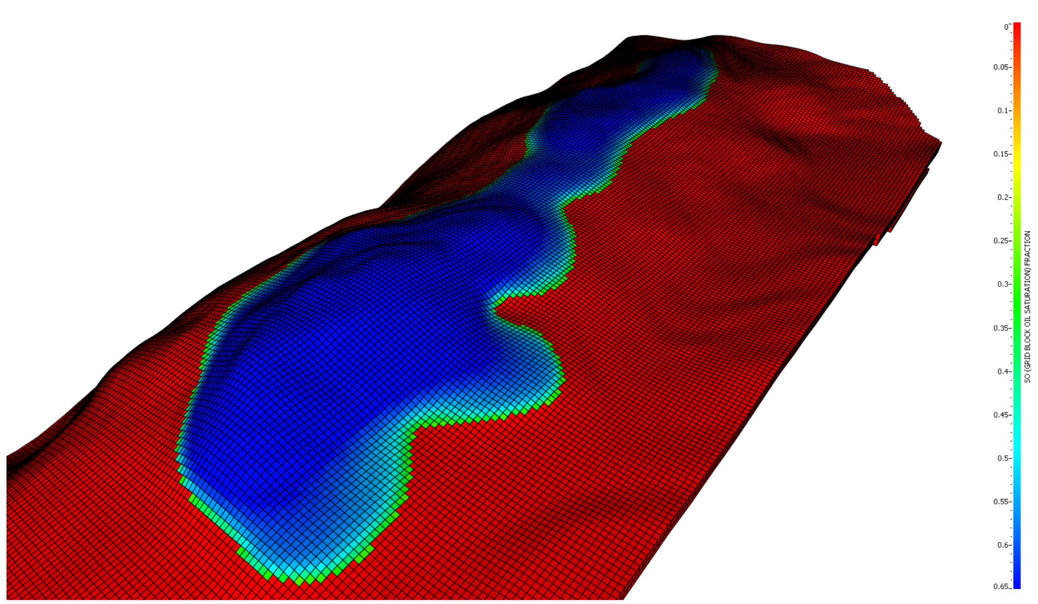


**Table 1. Geological and physical characteristic of the field**

| Parameters | $AC_{10}$ |
|---|---|
| Average stratum depth, m | 2727-2788 |
| Deposit type | bedded, arch-like |
| Reservoir type | porous |
| Average general thickness, m | 40,9 |
| Average oil saturation, m | 7,1 |
| Average oil saturation, fr.unit | 0,56 |
| Porosity, fr.unit | 0,18 |
| Permeability according to the core sampling, mkm$^2$*10$^{-3}$ | 89 |
| Net/gross ratio, fr.unit | 0,25 |
| Number of permeable intervals | 9 |
| Initial formation temperature, $^0$C | 85,9 |
| Oil viscosity in the formation, mPa*s | 0,49 |
| Oil density in the formation, t/m$^3$ | 0,729 |
| Oil density on the surface, t/m$^3$ | 0,815 |
| Absolute OWC mark, m | 2651 |
| Formation volume factor | 1,218 |
| Initial formation pressure, MPa | 26,2 |
| Bubble-point pressure, MPa | 11,1 |
| Gas-oil ratio, m$^3$/t | 93,9 |
| Water viscosity in the formation, mPa*s | 0,42 |

There are no AHRP intervals in the section. The well equipment 57 of production string includes stage cementing collar. MSC is at the depth of 1540 m down (Fig. 3).

According to the existing project document $AC_{10}$ formation is an independent unit to be developed. The project provided its development by watering, wells placement in terms of the nine-point scheme with a well grid density of 32 hectares/well. Selective watering is implemented in reality.

By the meeting day 114 wells including 100 production, 5 injection, 9 water-supply ones have been drilled up.

The most part of production wells was transferred to artificial lift (about 92 %). 6 wells of the field were developed by free-flow production method.

Wells placement on the net oil map and the target site near the well 57 are given in Fig. 4.

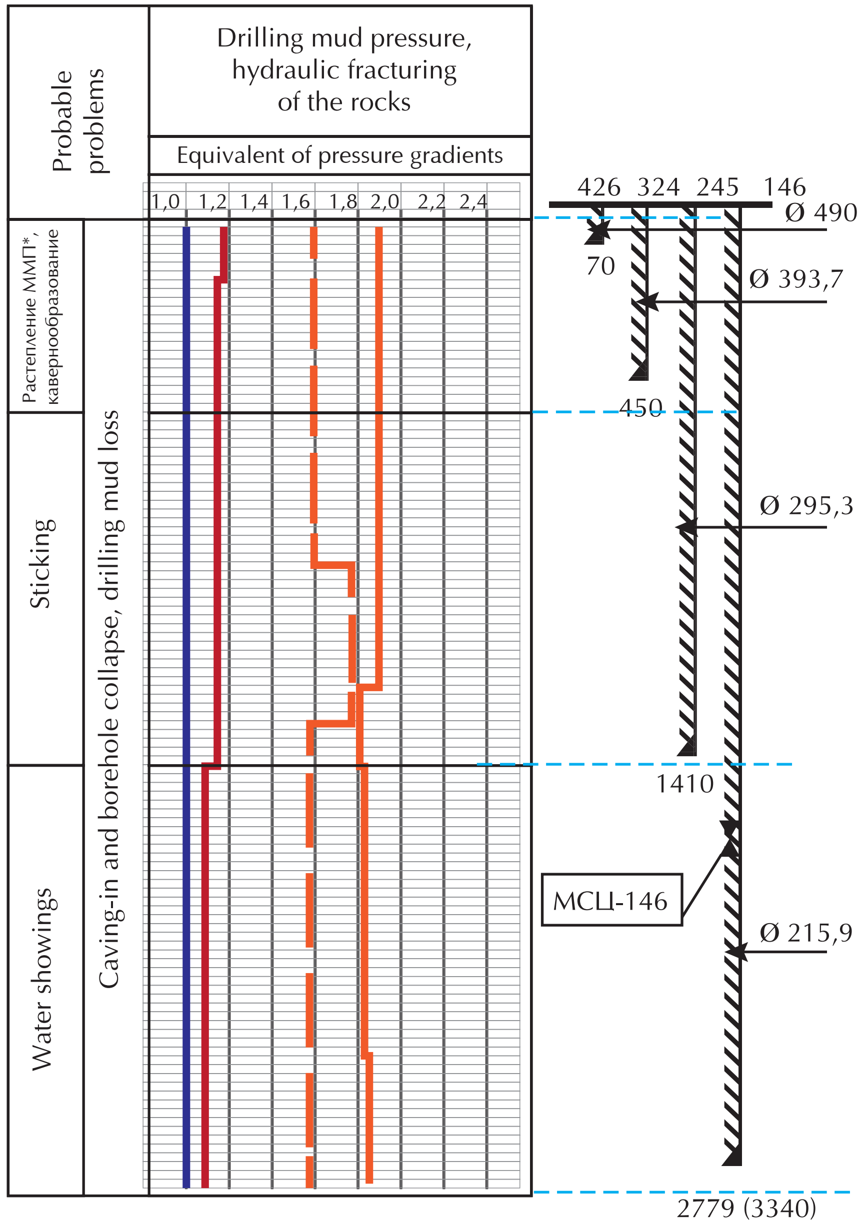
The average formation values of the well 57 and surrounding wells according to the results of well geophysical survey interpretation are given in Tab. 2.

The results of geophysical survey interpretation of all wells, laboratory core sampling, and data processing, for example, geological profiles (Fig. 5) are





**Fig. 3. Well 57 scheme**




* ММП – многолетнемерзлые породы

also presented as the initial data in electronic form.

An intensive water breakthrough occurred in well 57 in August, 2009. According to the monthly production reports (MPR), water production increased from 30 % up to 90 % (Fig. 6).

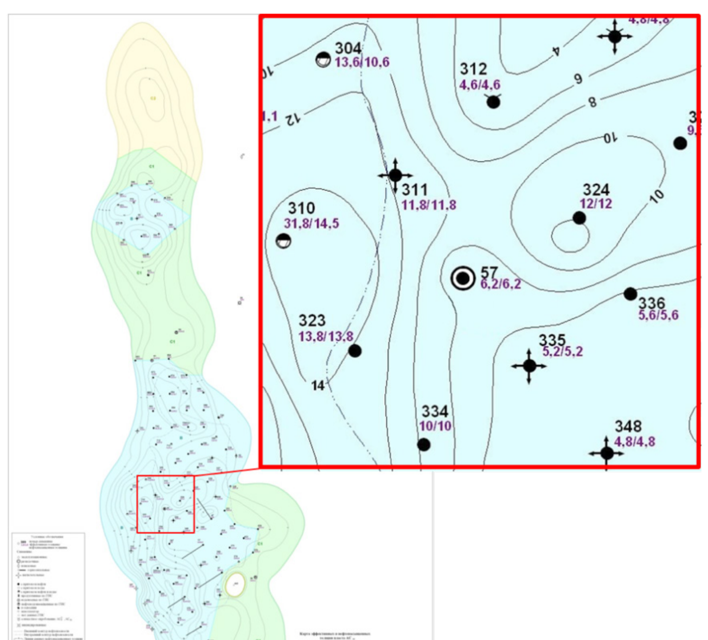
Besides, in accordance with the electronic MPR, artificial lift methods were introduced in August.

To determine filtration velocity and direction, as well as hydrodynamic pattern in injection and production zones, log-inject-log techniques were applied in the

Table 2. The average parameters of the well 57 and neighboring wells formation

| Well № | Formation | Formation interval, m | | $H_{eff}$, m | $H_{eff.i}$, m | Kp, fr.unit | Kпр, $10^{-3}$ mkm² | Kн, fr.unit |
|---|---|---|---|---|---|---|---|---|
| | | Top | Bottom | | | | | |
| 57 | $AC_{10}$ | 2727.2 | 2767.1 | 6.2 | 6.2 | 0.175 | 11.7 | 0.664 |
| 304 | $AC_{10}$ | 2985.2 | 3027.3 | 13.6 | 10.6 | 0.197 | 54.30 | 0.597 |
| 311 | $AC_{10}$ | 2809.6 | 2852.4 | 12.8 | 11.8 | 0.187 | 30.00 | 0.555 |
| 322 | $AC_{10}$ | 3037.7 | 3080.5 | 15.0 | 7.6 | 0.194 | 55.78 | 0.530 |
| 323 | $AC_{10}$ | 2787.5 | 2826.3 | 13.8 | 13.8 | 0.186 | 30.12 | 0.600 |
| 234 | $AC_{10}$ | 2879.7 | 2928.6 | 18.4 | 12.0 | 0.177 | 20.10 | 0.566 |
| 325 | $AC_{10}$ | 2884.6 | 2933.8 | 15.4 | 9.6 | 0.173 | 13.36 | 0.525 |
| 335 | $AC_{10}$ | 2807.0 | 2843.8 | 5.2 | 5.2 | 0.170 | 12.25 | 0.585 |

Fig. 4. Wells placement on net oil map




study area within wells No. No. 311, 368, 381, 55R and 335 one year prior to the meeting. The obtained results revealed that the most intensive connectivity is between injection well No. 311 and production wells No. No. 57, 312, 303, 304, 310, 324.

## Case study procedure

With the data given above, the participants should be ready to discuss and resolve the issues according to the following agenda:





Fig. 5. Geological cross-sections through wells 304-311-57-335-348

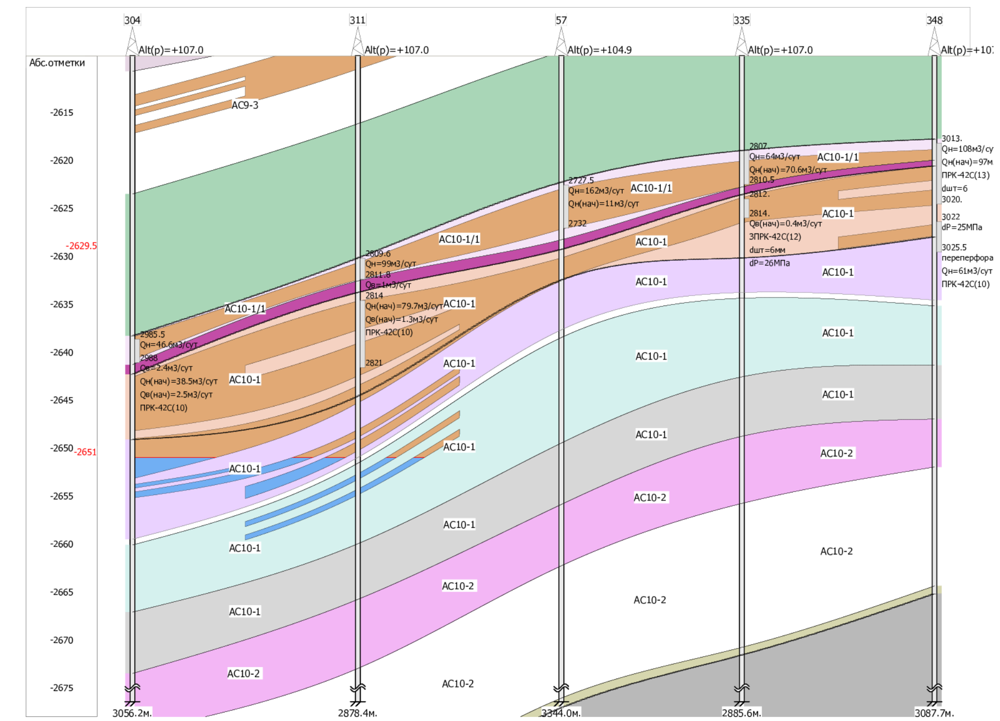



Fig. 6. Oil/water ratio and dynamics of coning in well № 57

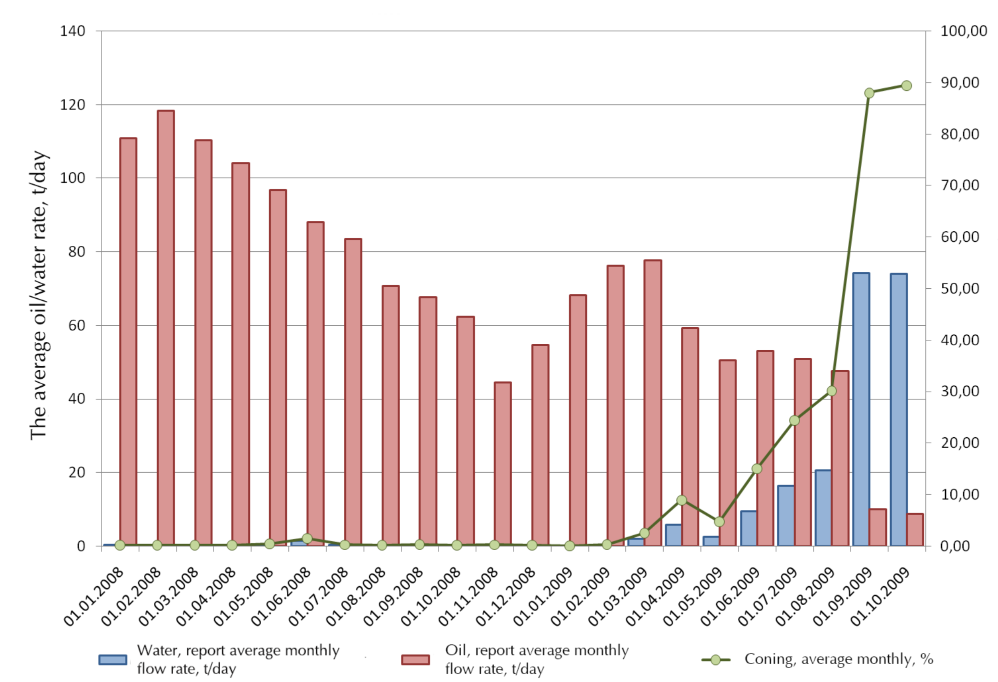


**Table 3. Case study procedure**

| № | Tasks | Duration |
|---|---|---|
| 1 | Rationale for the possible causes for the well 57 watering | 30 min. |
| 2 | Development of the reasonable research program for the watering cause determination | 30 min. |
| 3 | Search for possible methods to increase the efficiency of the well operation | 20 min. |
| 4 | Preparation of the presentation | it is carried out simultaneously with the tasks 1-3 |
| 5 | Presentation of the results to the chiefs of the departments | 15 min. for each of five departments (teams) |
| 6 | Team discussion and making the final decision including the research program and possible actions | 25 min. |

1. Reasons for intensive water breakthrough in well 57.

2. If required, additional investigation techniques to clarify the cause of water breakthrough

3. Methods to improve production efficiency.

In order to do a comprehensive analysis of the case, students are divided into five groups that correspond to five different departments of the enterprise. The work is carried out in CCFD where students can meet, discuss the progress of the project, make carefully weighed decisions in the time allotted (4 academic hours).

To resolve the tasks and be ready to participate in the meeting held to exchange views among the departments of "oil producing enterprise", the teams are made on the basis of the professional principle, i.e. each team is made up of students pursuing degree in one and the same field. For example, Field Development Department may consist of the undergraduates studying the programs 131000.05 "Modeling of oil field development» and 131000.06 "Management of oil field development" within 131000 "Oil and Gas Engineering"; Drilling Department may consist of the undergraduates studying the programs 131000.01 "Oil and gas well completion", 131000.02 "Construction of oil and gas wells in difficult mining and geological conditions" and 131000.03 "Off-shore drilling" within 131000 "Oil and Gas Engineering", etc.

A team leader, i.e. "head of the department" is selected by team members; one of his/her basic tasks is to allocate the roles to team members depending on the objective.

Case study procedure is given in tab. 3.

The training consists of a wide range of the issues related to geology and oil field development, drilling and operation of wells, water control technologies, etc. It leads to non-standard process of the training – the teachers of the departments of oil and gas well drilling, geographic information systems and development and operation of oil fields are simultaneously involved in the training. One of the teachers (the moderator) plays a role of chief geologist, the others answer the arising questions and actually supervise the work of the relevant departments.

The importance of the team discussion stage should also be noted. At this stage the «mistakes» are corrected with the assistance of all teachers; the decisions which cannot be realized for any reasons are rejected, and the final decision is accepted.



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