Computer modeling using multimedia technologies to calculate the main indicators of the oil and gas field development process.

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Annotation

Oil and gas well drilling involves the use of a variety of equipment, such as drill bit, travel block, winch, sand pipe, motors, fuel and water tanks, swivel sleeve, drill hose, rotary table, pipe walkways, guide pipe, chisel, drilling column, mud storage tank, circulating mud pump and more. The process of drilling oil and gas wells has already been studied quite well. Much more interesting is that with the same drilling rig it is possible to carry out seismic surveys based on acoustic waves. The acoustic waves generated by drilling equipment propagate deep into the earth and are reflected back to the surface by various rock layers. Waves will propagate at different speeds depending on the density or variety of rock layers they pass through. Reflected waves are recorded by audio-sensitive vibration-detecting devices (microphones). On the surface of the earth, reflected waves are perceived by seismometers, and on the water - by hydrophones. Thus, seismologists can interpret signal distortions associated with hydrocarbon traps. The following article is devoted to investigating computer modeling using multimedia technologies to calculate the main indicators of the oil and gas field development process.

Key words: computer modeling, drilling, dynamics, storage tank, pipeline, fuel, turbine, 3D representation.

Modeling in the oil and gas industry

Typical calculations used to improve the performance of oil and gas equipment:

Well drilling - static and dynamic strength analysis, computational fluid dynamics (CFD), thermodynamic calculation;

Hydropower Devices – strength and CFD calculation;

Pumps - strength calculation, CFD, thermal calculation;

Pipeline systems and fittings - strength calculation and hydrodynamics;

Storage tanks (fuel tank, oil tank, high pressure tanks) - determination of pressure in the structure, analysis of fluid circulation;

Oil platform - static and dynamic strength analysis.

Consider the practical application of modeling tools on real examples:

Study of the impact of waves on an oil platform The process of drilling oil and gas wells has already been studied quite well. Much more interesting is that with the same drilling rig it is possible to carry out seismic surveys based on acoustic waves. The acoustic waves generated by drilling equipment propagate deep into the earth and are reflected back to the surface by various rock layers. Waves will propagate at different speeds depending on the density or variety of rock layers they pass through. Reflected waves are recorded by audio-sensitive vibration-detecting devices (microphones). On the surface of the earth, reflected waves are perceived by seismometers, and on the water - by hydrophones. Thus, seismologists can interpret signal distortions associated with hydrocarbon traps.

An interesting example of modeling in the field of mining and conservation of mine workings, wells and other underground structures is the thermomechanical calculation of a high pressure reservoir. Such tanks are usually used to store liquid or gas under high pressure. In this case, a copper tank is considered. Inside it has a steel coating and contains hot water at a temperature of 290 C, which is further cooled by cold water at a temperature of 25 C.

To solve this problem, a non-stationary thermal calculation was carried out in order to have an idea of how the temperature changes over time. In this model, the following materials are used: for the tank - copper, for the internal coating - steel. Temperature-dependent properties of materials were used in the calculation.

The tank has two pipes: the upper one serves to supply cold water, the lower one to drain hot water. Between the pipes and the vessel, the presence of valves is taken into account. The simulation results show the change in temperature, heat flow and stress in the pipes and tank for 35 minutes.

Vibration of fluid in the fuel tank while driving

Also an important task in the field of fuel storage is the simulation of fluid oscillations in a moving fuel tank. The movement of the fuel tank was set using the Rigid Body Dynamics tool. The geometry is a 113-liter cylindrical tank. The internal calculated volume was divided into finite elements using the Meshing tool, the number of elements is ~ 0.5 million.

In this example, the liquid is assigned the properties of water, the second phase is air. The simulation was carried out on eight computer cores, the calculation time was about 11 hours. Calculation of the dynamics, strength and durability of the gear section of the turbo drill.

Another example of the use of numerical simulation tools in the oil and gas industry is the calculation of a drilling device containing several long sections. To study the response of complex mechanical systems during operation or as a result of external forces, it is convenient to use simulation in a dynamic formulation. But the complexity of this method lies in the fact that it requires large time and computational resources. Therefore, it is convenient to model the kinematics of bodies in the formulation of the dynamics of absolutely rigid bodies. To take into account the influence of the stress-strain state on the characteristic of the transient process, the system must have absolutely rigid bodies that are deformable. This method is called Component mode synthesis (the method of superposition of natural vibrations of individual parts of the system).

Taking into account the natural frequencies of the deformable parts, which perceive the main load from torsion, makes it possible to determine the dynamic response of the system to the sudden braking of the drill by the bit.

The model takes into account the rigidity of the axial support and radial bearings, as well as the radial clearance of the bearings. The torque on the drive shaft is set in such a way that the torque specified in the passport is provided on the output shaft.

Modeling the flow of flushing fluid in the flow part of a turbodrill

The purpose of this work is to create a computational model that allows you to explore the operation of a turbodrill in various modes. Simulation in the study was carried out in two modes - nominal and mode with a stopped shaft - for subsequent comparison of the calculated values of the turbine torque and pressure drop in the turbine section of the turbo drill with the corresponding experimental data.

The main tasks to be solved in the study:

simulation of the plant operation in two modes;

identifying ways to reduce the resource intensity of the task and improve the accuracy of calculations;

verification of numerical calculations.

Geological modeling is a way of representing how porosity, permeability and saturation of formation fluids are distributed within a field. The model must also necessarily reflect such key parameters as heterogeneity in the distribution of these properties and in the structure of the reservoir, the interconnection of permeable bodies with each other and the presence of barriers and screens that affect the movement of fluids. The main goal of the geological model of the field is to provide a basis for further modeling of the movement of fluids in this field. The main problem is the uncertainty in building a geological model. It remains at all stages of field exploration. Direct information about the structure and properties of the reservoir can only be obtained by studying well data (first of all, by examining the core), which cover an insignificantly small part of the deposit. Accordingly, the idea of the rest of the deposit can be built only on the basis of assumptions about the environment of sedimentation based on the results of sedimentological analysis, study of outcrops - analogues, as well as a set of indirect data obtained through remote sensing methods (seismic attributes , interpretation of well test results, etc.) , which often give very limited and ambiguous results. Geostatistics deals with the study and solution of this problem. Geostatistics Geostatistics provides a toolkit for generating a range of realistic 3D representations of the distribution of reservoir heterogeneities; The method used in geostatistical modeling depends on the type of variable being modeled, the depositional environment, and the scale of the model: geostatistics allows a series of equiprobable realizations to be generated, each corresponding to the input data and statistical parameters used to build the model: the divergence between equiprobable realizations serves as a measure of the uncertainty running after accounting and model of all available data and statistical parameters . This discrepancy makes it possible to quantify the ambiguity of the resulting model: geostatistics considers deterministic information as a source of data that is used in implementations. Geostatistics generates a set of equiprobable representations of that part of the reservoir that is not characterized by deterministic data; geostatistics links the various disciplines together. it provides the ability to integrate various types of data into a single construct of 3x dimensional representations of the distribution of reservoir heterogeneities: Geostatistics. . . geostatistics provides the tools to create a range of realistic 3D representations of reservoir distribution and heterogeneities; the method used in geostatistical modeling depends on the type of variable being modeled, the depositional environment, and the scale of the model; geostatistics allows you to create a series of equiprobability.

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