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Optimization of Setting Parameters of a Rotary Drilling Rig Using SIMHYDRAULICS Toolbox

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Abstract

The principal aim of this paper is to apply MATLAB/SIMHYDRAULICS Toolbox to produce a new model of drilling mud circuit in order to provide practical solutions of drilling program problems. We have studied the work of the mud circuit during drilling and we made a model of the process using Matlab/Simulink, then we obtain accurate results for the first time on a similar system. After we have created the numerical model, we run the simulation process to know how much the effectiveness of it in the real time. We used for this purpose the bentonite mud for the choice of fluid. The results proved the effectiveness of the model in order to start using it on the ground.

Keywords: Hydraulic system, Mud circuit, Drilling rig, Matlab/Simhydraulics Toolbox, Valve, Simulation, drilling program

1 Introduction

Human experience today has become available through smart applications, and MATLAB/SIMULINK package is the most famous software at all. Therefore, we have used this program in our studies to design a model of drilling mud cycle then to do the simulation of this model in real time [1].

The simulation of hydraulic systems using Matlab/Simhydraulics is presented in some works, for example: Y. Yang Soon and L. Quang Hoan have developed virtual Excavator using SimMechanics and SimHydraulics toolboxes [2]; L. Hruzik, A. Burecek and M. Vasina have applied SimHydraulics toolbox to study the flow of hydraulic oil in a long hydraulic line [3]; X.F. Xuebao has applied the SimHydraulics Physical Network simulation to an electro-hydraulic servo system which adopted valve-controlled symmetrical cylinder [4]; L. Hruzík, L. Šedenka and R. Sikora have studied simulation of pressure amplitude characteristics of pipe with hydraulic accumulator in Matlab/Simhydraulics [5]; Other scientists have studied drilling operations using other methods and they have provided practical results [6-8], but relying on Matlab/Simulink toolboxes gives better results.

Drilling mud circuit is one of the most important Elements of drilling program with: Tools Program, column Coasts, cementing program, number of phases. The establishment of a mud program is an essential step for a drilling successful drilling. This is indeed to choose the characteristics of the mud. Drilling fluids must have properties such that they facilitate, accelerate the drilling process, then a mud program aims to identify the types of sludge with the qualities and techniques adapted to the requirements of considered drilling.
We rely on our study on the use of MATLAB/SIMHYDRAULICS Toolbox, and we have produced a new model of drilling mud circuit who improves productivity and efficiency compared with practical results.

2 Determination of mud program

The drilling mud must have properties that enable them to optimize the following functions: Cleaning the well, maintaining cuttings in suspension, cooling and lubrication of the tool and the drill string, Prevention of water ingress, gas, or oil, increasing the speed of advancement, maintaining stable walls, decrease the apparent weight of sounding equipment, provision of information on the survey.

Fluids are usually classified according to the continuous phase and the phase which is dispersed therein. There are:

- ✓ Drilling fluid in which the continuous phase is water;
- ✓ Drilling fluid in which the continuous phase is oil.

The mud circuit is illustrated in the following figure:

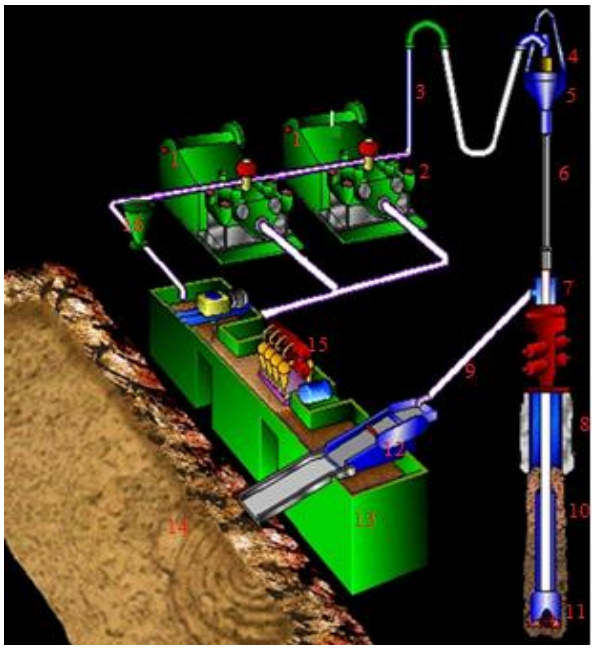

Fig. 1 Drilling mud circuit

With: 1- Mud pumps, 2- Conduct of suppression, 3- Rising column, 4- Injection flexible, 5- Injection head, 6- Kelly stem, 7- Fountain tube, 8- Shutters, 9- Chute pipe, 10- Drill string, 11- Drill bit, 12- Vibrating sieve, 13- Mud tanks, 14- Quagmire (slough), 15- Sand trap, 16- Mixer.

We chose the bentonite mud for the choice of fluid, whose is a drilling fluid used to start drilling the surface fields, generally is poorly consolidated, the choice of starting fluid depends on the nature of the fields, bentonite mud is a water-based mud with high gel. This choice has a lot of purposes like: High filtrate for cake formation consolidating training and clogging the sand, high viscosity for good hole cleaning, simple and low-cost manufacturing, Rheology easily adjustable.

Bentonite	75 – 105 kg / m^3
Caustic Soda	1.3 kg / m^3
Soda Ash	$\pm$0.8 kg / m^3
PolySal	6 Kg / m^3

Table 1 Formulation of the drilling fluid

Mud Weight	<1.28 SG
Funnel Viscosity	70 - 85 sec./qt
YP	45 - 65 lbs/100 ft^2
Gels	25 / 50 lbs/100 ft^2
API Fluid Loss	+ 40 cc's
PH	10.5-12
MBT	90 - 120 kg/m^3

Table 2 Properties of the drilling fluid

3 Modeling and simulation of drilling mud circuit

Mathematical and computer models, and better knowledge of the drilled substrates used to better predict the behavior of sludge when the pressure and temperature increase or decrease. This makes it less difficult to plan the injection of mud and the introduction of certain additives. The modeling is also used to better control the drilling and completion of wells. Using Matlab/SimHydraulics we performed a numerical model of mud circuit, this model and his simulation results are presented above (The mass in this model is a symbol for drilling rig):

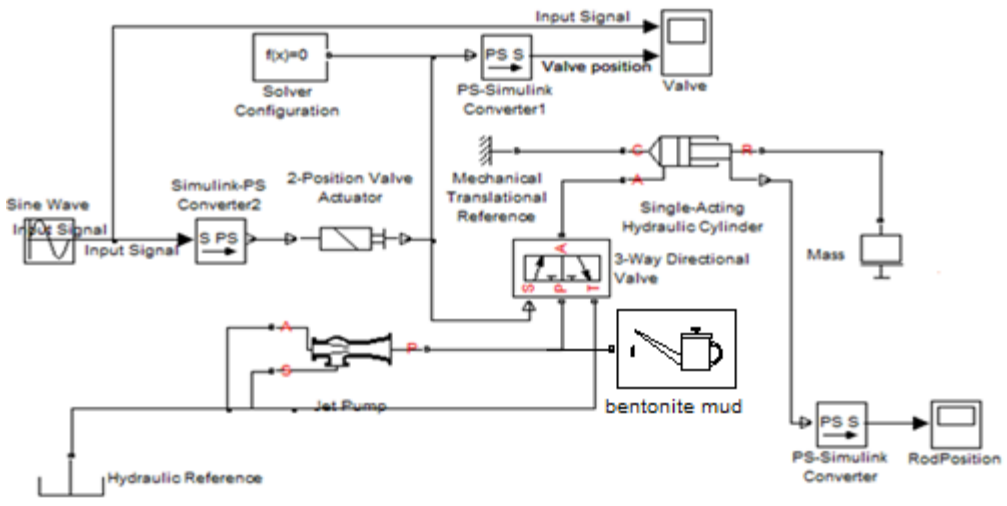

Fig. 2 Numerical model of mud circuit ((SIMHYDRAULICS)

4 Conclusion

The importance owned by drilling mud circuit for drilling systems made us support this area by using Simhydraulics Toolbox to increase characteristics accuracy. By applying the control of mud circuit, speed and accuracy were been increased. The simulation operation is an interactive process and this means that it is possible to make adjustments to the variables and see the results immediately.
The use of MATLAB/SIMHYDRAULICS Toolbox in drilling process is still limited so we seek to expand his use: First, by application to drilling mud circuit; Second, by application to the other elements of drilling program.
We have compare simulation results of this study with experimental results and we found convergence between them, so the model we created has proved its effectiveness; therefore, it is useful to reduce the production costs and accessing to great results, more accurate and less expensive.

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