Asian Journal of Information Technology 6 (4): 520-523, 2007

Optimal Experimental Parametrage of Rotary Drilling

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Abstract: The realization of holes in open mine exploitation can be carried out in three different ways: Percussive drilling (out/bottom of the hole), Rotary drilling (with tri-cone) and rotary Drilling (cutting). According to the method employed, the mechanism of rock destruction differs. The principle remains the transmission of energy coming from a drilling jumbo to a tool intended to destroy rocks. In practice, it is very difficult to regulate the push being given the means available. Generally the only indication is given by a pressure gauge installed on the feeding circuit, that makes its value very delicate to optimize. The main object of this research is to put in obviousness experiments and by validation on site, the evaluation of the optimal parameters for a rotary drilling machine.

Key words: Drilling, optimization, select, methodology

INTRODUCTION

Drilling constitutes one of the phases or progress and the innovations were most significant during this decade (Cumingham, 1988). The improvements obtained relate for a significant share on the performances of the materials, but also to qualities of the formation carried out (establishment and recording of the parameters) (Zaburunov, 1990).

Each career has its own specificities related as well on the characters of materials to be destroyed, the geological context and the environmental conditions as production targets. In addition, the efforts made by the manufacturers, from material as well as the improvements made to the working conditions of the drilling machines also go in the direction of the best deal with drilling. The optimization of the drilling parameters is thus the goal to reach.

The mode of drilling machine operation must take into account all the parameters Fig. 1(Borquez, 1981):

- Rock properties
- Type of the tool
- Characteristics of the machine according to the model

Variable parameters are:
Pressure of air which affects the whole of the other parameters and minimal push with applied to the edge which is proportional to:

- Speed of the piston
- Number of blows
- Piston mass

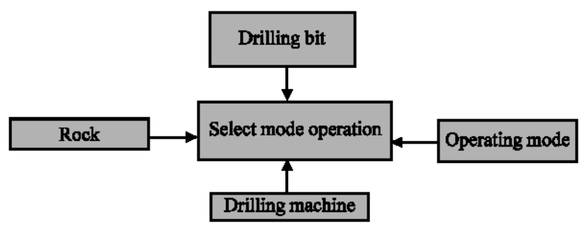

Fig. 1: Selection mode operation

MATERIALS AND METHODS

These parameters are recorded by sensors fixed on the puncher (stand) experimental Fig. 2. The Analysis of the results makes it possible to evaluate the reactions of the puncher consequently to characterize material (Hadjadj, 1989, 2001; Hadjadj and Singh, 1989; Khochmane and Hadjadj, 2006) we vary the variables:

- Push on the tool
- Pressure of the flushing fluid.

The knowledge of the complementary parameters such: the torque, the energy of a blow the frequency of struck, allow by their combinations to know the optimal push to destroy rocks, therefore the rate of advance can be known.

Calibration: The experiment is carried out for two cases (punching moving and with the stop) with weight variation Fig. 3.

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Fig. 2: Experimental stand

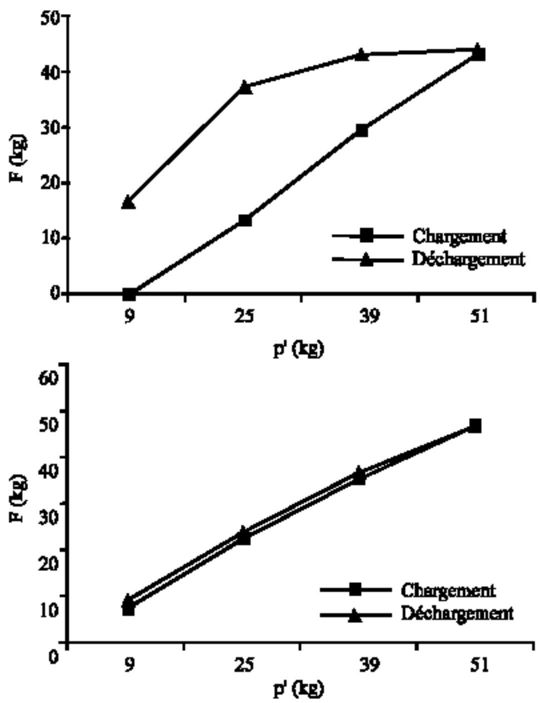


Fig. 3: Calibration forces

Speed calibration: The experiment consists in fixing displacement H of the needle which corresponds to the advance distance S. The factor of displacement is given by Scoble *et al.* (1989), Peck and Pollitt (1990):

$$\mu_s = \frac{S}{H}$$

S, mm	80	60	29	8
H, mm	62	48	22	6
μ_s	1,29	1,25	1,31	1,33

Pression Calibration: The experiment consists of filling the compressed air receiver and to record the displacement height to each increase.

p, bar	1	2	3	4	5
H, mm	6.5	12.5	18.5	24.5	36
μ_p	0.15	0.16	0.162	0.164	0.166

$\Rightarrow \mu_p \approx 0.163$

Compressor flow determination and the pressure losses.

The flow can be determined by:

$$Q_d = \frac{60V}{t_1}$$

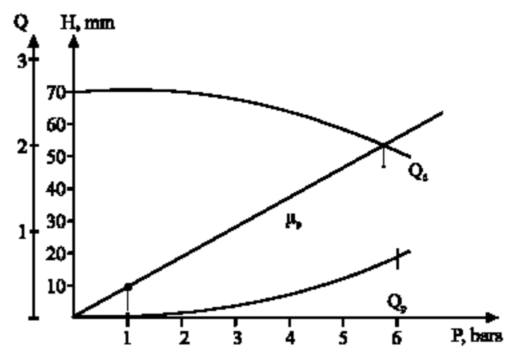
V : Volume of the tank

t_1 : Increase in the pressure time

by analogy, the losses are determined as follow:

$$Q_p = \frac{60V}{t_2}$$

t_2- pressure decrease time



S, mm	80	60	29	8
H, mm	62	48	22	6
$\mu_s = \frac{S}{H}$	1,29	1,25	1,31	1,33

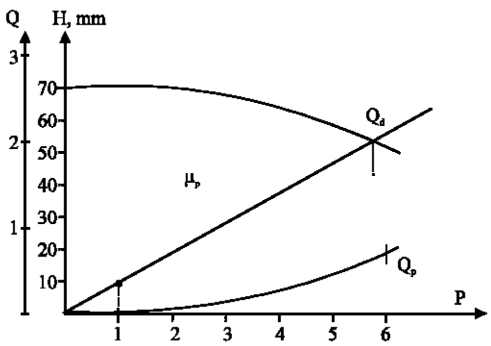
$\approx 1.29\ \mu_s$

The experiment consists to fill the compressed air receiver and to record the height of displacement.

p, bar	1	2	3	4	5
H, mm	6.5	12.5	18.5	24.5	36
μ_p	0.15	0.16	0.162	0.164	0.166

$\mu_p \approx 0.163$ bars mm^{-1}

$$Q_d = \frac{60V}{t_1}$$



RESULTS AND DISCUSSION

The variation of thrust, while fixing the pressure variation, every 5 sec, enabled us using the recording to obtain the parameters Xp and Xs with Xpi-height of displacement. Indication of the pressure during time corresponding Xsi-height of displacement

$$\bar{P} = \mu_p \frac{X_{pi} + X_{p(i+1)}}{2}$$

$$V_f = \mu_s \frac{60}{t_{i+1} - t_i}(X_{s(i+1)} - X_{si})$$

$$Q_d = 1.6 \cdot \frac{60}{t_{i+1} - t_i}(P_i - P_{i+1}) - Q_p$$

The treatment method used is the regression analysis. By supposing that the relation between Vf and the pressure for various thrusts is represented by a straight line whose equation is:

$$Vf = B + FP$$

Where B and F are the unknown factors which must be determined by the experiment's results. Using the method of least squares for which the sum of square of the residues is minimal, these parameters are given according to expressions:

$$P = \mu_p \frac{X_{pi} + X_{si}}{2}$$

$$V_f = \mu_s \frac{6(X_{si+1} - X_{si})}{5}$$

$$Q = 1.6 \cdot \frac{60(P_1 - P_2)}{t}$$

$$f = \frac{N\sum P_i V_{fi} - \sum P_i \cdot \sum V_f}{N\sum P_i^2 - (\sum P_i)^2}$$

$$b = \frac{\sum P_i^2 \cdot \sum V_{fi} - \sum P_i \cdot \sum P_i V_f}{N\sum P_i^2 - (\sum P_i)^2}$$

N-Nb experiment observations Pi, Vfi pressure and progress drilling for the ieme experiment.

The treatment of the results enabled us to lead to the following equations.

For $F_1 = 39$ kgf $V_f = -0.294 + 0.0904\,P$
$F_1 = 51$ kgf $V_f = -0.404 + 0.124\,P$
$F_1 = 65.5$ kgf $V_f = -0.644 + 0.187\,P$

CONCLUSION

We note that the increase in the pressure allows the increase the progress drilling. To highlight this improvement, let us use the relations speed by varying each pressure time:

F	39	51	65.5
$V_{m/mm}$	0.09	0.124	0.187

The dependence between the three parameters in question, which makes us say that effectiveness of a drilling machine use, i.e., a significant output (V) can be assured only by regular increase, the pressure and the thrust load.

F \ P	4	4.5	5	5.5
39	0.068	0.112	0.156	0.192
51	0.092	0.155	0.216	0.266
65.5	0.104	0.196	0.296	0.355

As the relation between speed and the thrust load presents a parabolic form:

VF = has + bF + +CF_2 the parameters will be:

P_b	$F_{kg/f}$	$V_{F\,m/fmm}$
4	67.62	0.105
4.5	108	0.248

This confirms the dependence between the different parameters, such as the drilling rate for various pressures and Energy (E).

P	4	4.5	5	5.5
E	6.15	7.5	9	10.5

The increase in the thrust load automatically does not allow the increase drilling progress, but there is a critical force for each pressure considered. This phenomenon is explained by the fact that the transmissions of a piston blow for the destruction of the rock, but creates a larger torque.

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