RESEARCH ON ADJUSTING WORKING REGIME FOR MECHANIZED DRILLING BLAST HOLES

GABRIEL PRAPORGESCU[1], SORIN MIHĂILESCU[2]

Abstract: To obtain a high productivity at mechanized drilling of blast holes, it is necessary for pneumatic perforator to work in optimal perforation conditions. In this purpose, there were designed automatic adjustment systems for pneumatic drills that equip the drilling equipment.

Key words: drilling blast holes, working regime, drilling equipment

1. INTRODUCTION

The optimal condition for pneumatic drills that equips the drilling installations leads to maximum drilling speed and high rate productivity.

The drilling speed is influenced by geological and mining factors (compressive strength of the rock, the level of fracturing of the massif, blast hole diameter, etc.) and by the parameters of the drilling conditions given by the drill and by its advance mechanism (frequency and energy of percussions, rotating torque, speed revolution of the drill, advance force).

An often damage is the blocking of the drilling bit in the blast hole. Which could be caused by a number of factors like: uncorrelated of the advance force with the rotating torque, low injection water pressure, low injection water pressure which causes the impossibility of detritus evacuation, the drilling bit penetration in a rock crack from the bottom of the blast hole, deviation of the axis of the drill bit from blast hole axis.

For eliminating this kind of damage, automation of systems for the drilling installations functioning are used.

Automation of systems for the adjusting the drilling regime are dividing in two

[1] *Assoc. Prof. PhD. Eng., University of Petroşani, gpraporgescu@gmail.com*
[2] *Assoc. Prof. PhD. Eng., University of Petroşani, University Street, no. 20, 332006, Phone: +40745947479, mihailescus@gmail.com*

groups:

- systems which operate on the optimal curve of drilling parameters, depending on the characteristics of the rock, on the basis of pre-established curves researches;
- systems that automatically searches for the optimal parameters for a given criterion, called adaptive systems.[1], [2], [7]

In the first case adjusting regime perforation is done by establishing a program of optimal variation curves of parameters of the perforation depending on the characteristics of the rock determined in advance. In this case the most difficult problem is to quickly determine the type of rock. This is accomplished indirectly by measuring the speed of perforation, of the torque of rotation, of the advance force or combinations between these. This system is done with hydraulic or electrohydraulic command elements, but especially with electronic computers. [1], [2], [7]

Adaptive automation systems are mostly used because they require no prior research regime, because the optimum choice is made during the perforation. These systems have the role of compensate for perturbations parameters involved in the process of perforation, to obtain optimum at all times from the point of view of the various performance (production costs, productivity, use of a rational load in terms of forces). Therefore adaptive adjustment system identifies the disruptors process perforation sizes by measuring speed drill, Torque, supply pressure of the rotary engine and corrects advance force as effect and size, or adjust the frequency and the energy of the percussion by the piston stroke mechanism variation.

2. POSSIBILITIES OF ADJUSTING THE WORKING REGIME ANALYSIS

Adjusting the working regime at the mechanized perforation of the blast holes can be done by an automatic system. This system detects, by means of an transducer mounted to the supply circuit of the rotary engine, changes of the speed of the rotation (or the torque) of the drill and sends a command signal to a distribution element which adjusts the supply parameters of the engine for the advance of the drill. As a result it adjusts the value of the advance force. [5]

There have been studied some possibilities for achieving such a system. The initial idea was to “collect” a pneumatic signal from the power supply circuit of the rotating engine of the drill, which must be transmitted to an adjustment element, mounted in the circuit of the advance mechanism of the drill. In this way the adjustment of the advance force is made proportionally to the rotation speed or the torque of the drill.

For this purpose, transducers with diaphragm type elements, ejector, (pressure transducers) or thaler and elastic membrane (i.e. flow transducers) can be used.

In the case of attempts to use a pressure transducer, based on creating a pressure difference that is a pneumatic control signal, the essential problem that arose has been that the pressure difference achieved, has the very low values. This makes the use of common regulating elements (eg. type drawer) to be difficult to implement. For these reasons, the first solution was to use the modular air jet elements which are signal amplifiers, and which may be used as regulating elements.

A first possibility considered is the use a regulator with element type jet turbulence.

In Figure 1 is shown a jet turbulence element whose operating principle is based on the transformation of a laminar flow of the jet in a turbulent flow, [3].

Experimentally it has been found that a laminar jet which coming out of a nozzle maintains its laminar character up to a distance equal to, a hundred times the diameter of the nozzle. If in the front of the jet supply which exiting the nozzle 1 (fig. 1a) is placed a receiver nozzle 2, then to the output it, a static pressure is achieve, because the jet is laminar. If the receiver nozzle 2 (Fig. 1b) moves away from a sufficient distance from the supply nozzle 1, the laminar jet becomes turbulent, forming a cone of scattering 4, which make the static pressure to decrease, at the exit the receiver nozzle 2. Output pressure increases with increasing speed laminar of the jet until it the jet becomes turbulent and output pressure decreases sharply. After complete turbulent regime passing, increasing supply pressure leads to increased output pressure.

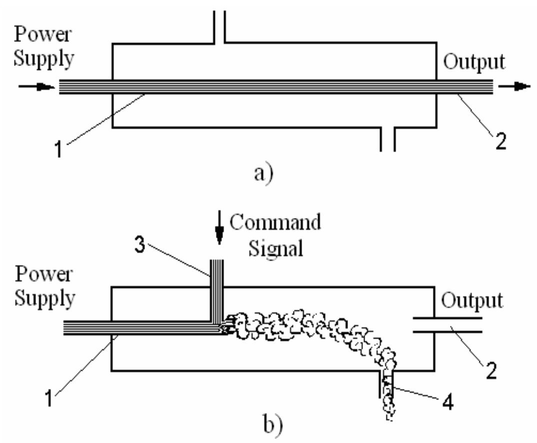

Fig. 1. Regulator with element type jet turbulence

The passing the main laminar jet in a turbulent condition with a low power of the laminar jet 3 can be achieved, which is acting transversely, named command jet. With the increase of the distance between the receiving nozzle 2 and the supply nozzle 1, becomes the more sensitive the amplifier, but increase the influence of the perturbations on the main jet.

An adjustment of the advance force can be achieved by inserting an element with jet of turbulence on the power supply circuit of the drill advance. This is possible by adjusting the pressure in the power supply circuit of the motor, by means of the turbulence element using a command pressure of low value, coming from a pressure transducer which is mounted on the power supply circuit of the rotation mechanism of the drill.

Another analyzed possibility is the use of an amplifier jet with a vortical effect. It may also operate together with the pressure transducer mounted on the power supply circuit of the rotary engine of the drill.

The vortical amplifier consists in a cylinder 1, with a supply channel located in the radial direction, a command channel 2 in a tangential direction and an exit orifice 3

(Figure 2), [3].

The cross sectional area of the supply channel 1 is greater than that of the exit orifice 3. In the absence of the command jet with the pressure, p_c, the supply jet encounters a low resistance in the cylinder, so that the output pressure, p_e, is approximately equal to the supply pressure, p_a.

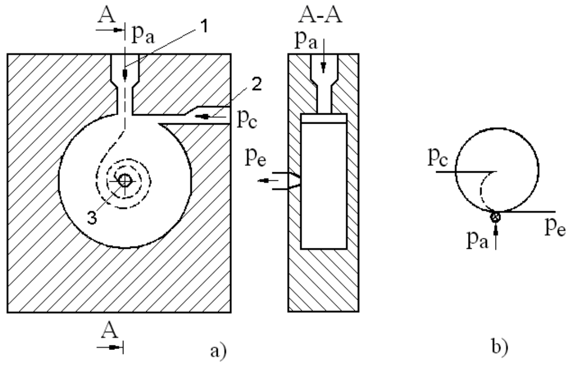

Fig. 2. Adjustment element with amplifier with vortical effect jet

When applying a reduced pressure command jet, p_c, the main jet will move on a spiral trajectory, due to the emergence of a vortex and the pressure difference increases for a certain flow, due to the angular acceleration of the fluid.

It can achieve a linear variation of the pressure difference depending on the size of command jet, through a corresponding designing. A more powerful vortex can produce a very large pressure gradient and hence the output pressure will be void.

By using an amplifier with vortical effect, inserted on the supply circuit of the advance mechanism engine, can be achieved adjusting the working regime of the mechanized drilling of the blast holes. This adjustment is possible by sending a pneumatic command signal coming from the pressure transducer mounted on the power supply circuit of the rotation engine of the drill, towards the amplifier with vortical effect.

The usage of the modular jet elements (the element with turbulence jet and the amplifier with vortical effect) as adjusting elements, faces some difficulties, because they are sensitive to noise fluctuations, and variations in flow and pressure (which are quite common in the compressed air supply networks). The shielding against the external sound oscillations of these elements is difficult because even they generate sound oscillations.

However, for this reasons there was studied the usage of flow transducers working together with drawer type adjustment elements. These studies are set out below.

3. AUTOMATIC REGULATOR WITH DRAWER WORK SCHEDULE ADJUSTMENT

This automatic regulator is designed to adjusting the work schedule on mechanized drilling of mine holes with drilling installations equipped with pneumatic drillers and engines for operating the advance mechanisms of the drillers.

Figure 3 presents a constructive solution for the drawer automatic regulator for drilling schedule adjustment.

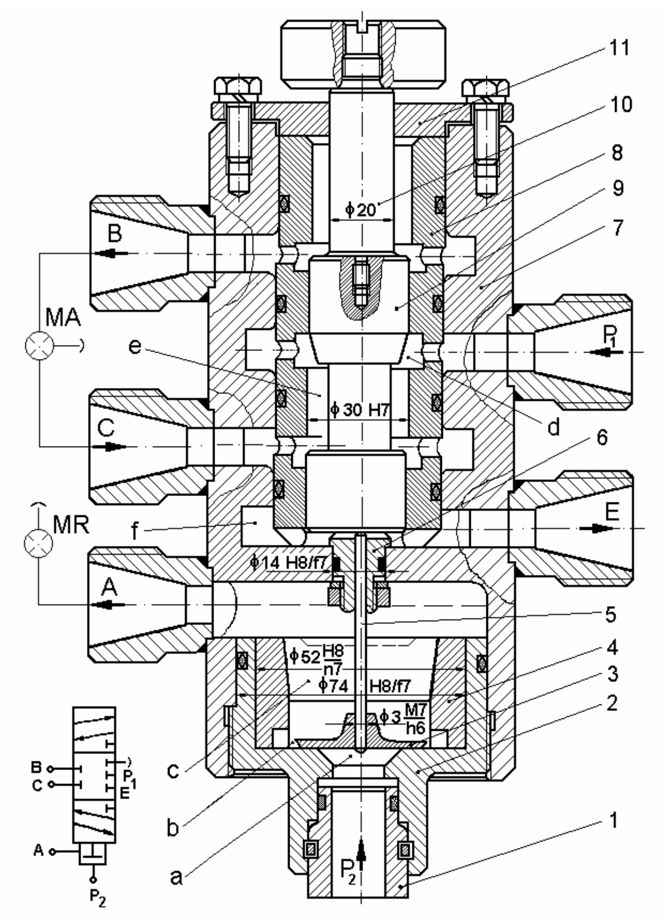

Fig. 3. Automatic regulator with drawer.

The designed regulator is composed mainly of a flow transducer and a drawer regulation element. From the construction point of view, the regulator is composed of a body 7 equipped with connection nipples, where the flow transducer and the regulation element are installed. The flow transducer is composed of the screw cover 2 having a nut for fast conjunction, the input nipple 1, the tray 3, installed on the rod 5, which glides in the guidance nut 6 and the nut 4 which forms in fact, together with the tray 3, the flow transducer. The regulation element installed also on the body 7 is made of the bronze nut 8, the regulation drawer 9, the connection rod 10 between the drawer 9 and the counterweight 12, and the closing cover 11 installed using four screws. The nut 8 is sealed from the body 7, where it is installed using some rubber rings. Also the screw cover 2 is sealed from the cover 7 using a rubber ring.

The vertical displacement of the tray 3 is done during the compressed air supply of the driller rotating engine on the path P_2-A, and through the tray 5 acts on the drawer 9 of the regulation element (distributor with three work positions) and opens the path P_1-A for supply the advancing mechanism engine. The adjustment of the drawer 9 for an opening leading to the optimum operation of the driller, respectively to a maximum rotation moment and speed of the driller, is done by screwing and unscrewing the cover 2.

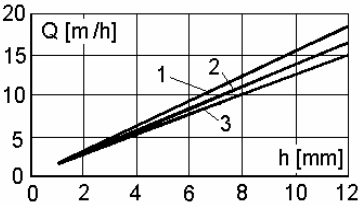

Fig. 4. Flow curves depending on the regulator drawer course.

Figure 4 presents the flow curves depending on the opening course of the regulation element drawer, in case of pressure difference (p_1 - p_2) of 0,01 MPa. The lines from figure 4 represent: 1 - debit curve for input pressure p_1 = 0,4 MPa; 2 - debit curve for p_1 = 0,5 MPa; 3 - debit curve for p_1 = 0,6 MPa. The movement speed of the driller given by the advance mechanism (MA) varies proportional with the flow variation passing through the regulating distributor. [6]

In case the pressure difference (p_1 - p_2) on the path P_2-A increases, the regulator distributor drawer moves upwards until reaching the maximum course (up to cover 11). This situation occurs on driller idle work.

The downwards movement of the distribution and regulation drawer 9, which, for a 9 mm distance, causes the strangulation of the advance engine supply path, takes place as the pressure difference decreases due to the increase of the resistance moment of the driller rotation engine (MR), therefore, the pressing force of the driller on the rock decreases.

If the resistance moment to the driller does not decrease, so the resistance couple of the rotation engine of the driller (MR) does not decrease, the drawer 9 moves further downwards, which causes the interruption of the compressed air supply of the advance engine (MA), therefore its stopping while the pressing force of the driller on the rock decreases to zero.

If the drawer 9 moves further downwards to the inferior limit position (rest) the advance engine supply is done on the path P_1-C, which leads to reversing its supply direction and influences the driller withdrawal from the mine hole.

If the driller withdrawal causes its release, the resistance moment of the driller rotation engine (MR) decreases. This causes the increase of pressure drop at flow transducer level (the pressure difference on both sides of the tray 3 increases) and leads to the elevation of the drawer 9 to the superior position, using the tray 5.

The supply of the driller advance engine (MA) on the path P_1-B is done this way and leads to its front movement and to a new drill.

Figure 5 presents the supply and command diagram of a drilling installation provided with automatic regulator with drawer for the drilling schedule. [4]

The supply is done from the compressed air socket, where the compressed air enters the steam trap 1, is air filtered and reaches the air lubricator 2, the pneumatic distributors 3 and 4 (the distributor 3 operates the driller percussion and rotation supply while the distributor 4 operates the driller advance engine supply). If the distributors 3 and 4 are in neutral position, the compressed air pressure is also restrained.

The distributors 3 and 4 are switched to position "b" and "a" during the mine hole drilling process, so the drilling rotation, percussion and advance are supplied. The supply circuit of the driller rotation switches to the path P_2-A, of the scheduled regulation distributor 10, which leads to its switching to the position "a". In this position, the advance engine 6 is supplied by the inverting distributor 5, for the front movement of the driller and to increase the pressing force of the driller on the rock.

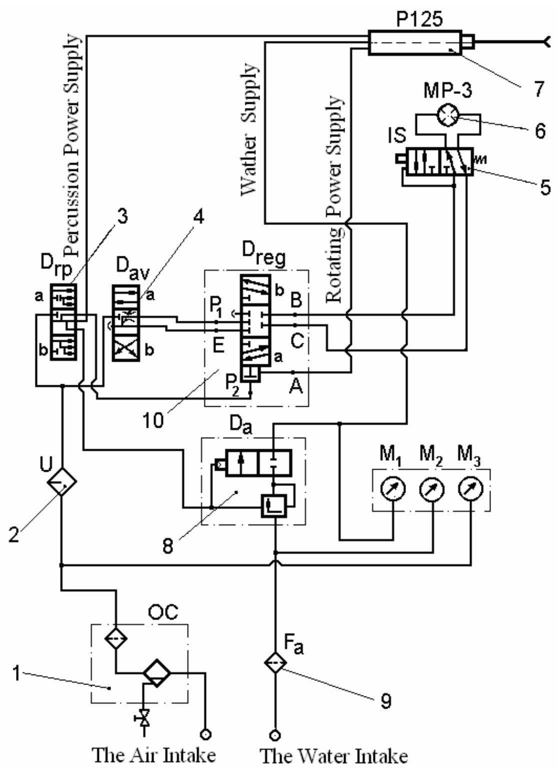

Fig. 5. The supply and command diagram of a drilling installation provided with automatic regulator with drawer.

If the driller resistance moment increases and appears a blocking trend during the mine hole drilling process the flow transducer on the path P_2-A will acknowledge this and will try to switch the distributor 10 on the position "b".

This will gradually decrease to cancellation the supply flow of the advance engine 6, leading to the gradual decrease of the pressure force of the driller on the rock, down to its cancellation. As the pressure force decreases, the driller is released and its rotation couple increases. This driller couple increase is noticed by the flow transducer.

4. CONCLUSIONS

The work schedule regulation for mine hole mechanized drilling leads to achieving maximum drilling speed and high productivity.

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The research lead to conceiving an automatic work schedule regulation system for mechanized drilling of mine holes, system which uses a flow transducer with tray and a regulation element with drawer. This regulator prevents the driller blocking in the work front, accomplishing an automatic and continuous regulation of the pressing force of the driller on the mine hole base, depending on its rotation couple. There were determined the flow curves of the automatic regulator with drawer depending on the opening course of the drawer for multiple values of the input pressure (0,4; 0,5 şi 0,6 MPa). Using the automatic regulation systems for scheduled drillers leads to the productivity increase of the driller with 20…40 % and to the drill heads consumption reduction of 30…50 %.

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