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Study Of The Effect Of Hydraulic Systems Operation On The General Performance Of A Hydraulic Excavator

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ABSTRACT

The use of hydraulic excavators in open pits has a high force effect on the teeth of the bucket, reduces the operating cycle compared to mechanical excavators by 15-18%, which in turn increases operational efficiency by 30-35%.

The hydraulic system is the mechanism that performs the excavation period of the hydraulic excavator, the period of bucket rise, the period of torsion of the loaded bucket, the period of loading, the period of torsion of the unloaded bucket, the period of unloading the bucket. Its optimal performance depends on the design of the hydraulic equipment, the technical condition of the hydraulic excavator and the working environment.

KEYWORDS

Hydraulic Excavator, Loading Period, Excavation Period, Pressure Energy, Working Fluid Slip.

INTRODUCTION

The excavation period of a hydraulic excavator, in turn, depends on the theoretical, technical and operational performance of the hydraulic excavator. [3]

Theoretical productivity, m3 / s

$Q_n = 60qn = q\,3600 / T$ (1)

Here;

q-bucket volume, m^3;

n-1- the number of operating cycles per hour;

T- the period of a cycle, sec;

$$T_{tes.kov} = t_q + t_k + t_b^I + t_y + t_b^{II} + t_t$$

$$T_{to\prime g\prime.kov} = t_{zab.kir} + t_{to\prime l} + t_k + t_b^I + t_y + t_b^{II} \quad (2)$$

$t_{zab.kir}$ $+t_{to\prime l}$ = t_q. may also be;

Here;

t_q - excavation period, sec; t_k-bucket rise period, sec; t_b^I-torsion period of loaded bucket, sec; t_t--loading period, sec; t_b^{II}- torsion period of unloaded bucket, sec; t_t- the unloading period of the slaughter, sec. For reverse bucket.

$t_{zab.kir}$ - the period of penetration of the hydraulic cylinder of the handles into slaughter, sec; $t_{to\prime l}$- filling period when turning the bucket at an angle of 45°, sec; t_k-bucket rise period, sec; t_b^I-torsion period of loaded bucket, sec; t_y -loading period, sec; t_b^{II}- torsion period of unloaded bucket, sec. For the right bucket.

Technical productivity, m³/s

$$Q_t^I = 60qnk_t \frac{1}{k_y} k_q \ (3)$$

Here;

k_t - bucket filling coefficient;

k_y- rock softening coefficient;

k_q - the coefficient of rock impact difficulty;

Operational productivity, m³/s

$$Q_e = Q_t^I k_v = 60qnk_t \frac{1}{k_y} k_q k_v \ (4)$$

Here;

k_v -rate of excavator utilization over time.

The effective operation of the hydraulic excavator's working equipment depends on the correct choice of the source unit and the hydraulic drive. [2] (Figure 1)

Table 1. The transition phase of energy in parts and mechanisms

Designation	The name of the energy transition phase
X1	The amount of energy output from a source
X2	Reductor
X3	Output 1
X4	Hydraulic pumps and auxiliary devices
X5	Output 2
X6	Hydraulic Pipes
X7	Output 3
X8	Hydraulic Distributor
X9	Output 4
X10	Hydraulic Cylinders
X11	Energy input to work equipment

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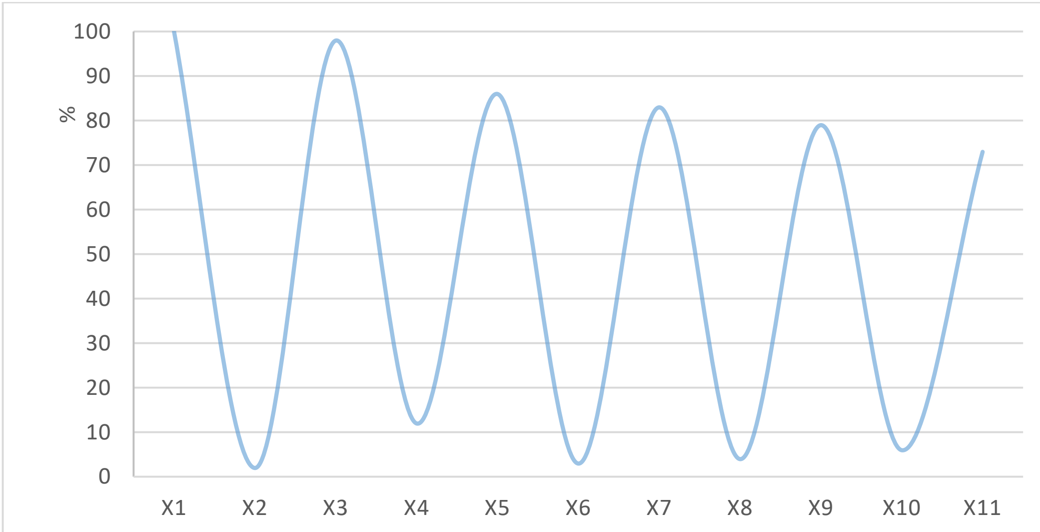


Figure 1. Energy flow diagram through parts and mechanisms.

In hydraulic systems, hydraulic devices cannot fully deliver pressure energy. The reason is that our working fluid loses part of its energy in accordance with the laws of full hydrodynamic, hydrostatic, thermodynamic pressure energy.

MATERIALS AND METHODS

Under the influence of the nominal pressure of the pump, the hydraulic system of the hydraulic excavator is subjected to a total pressure loss during the delivery of the working fluid through the pipes and hydraulic apparatus.

$$\sum \Delta P_{um} = \sum \Delta P_{ishq} + \sum \Delta P_{ul.q} + \sum \Delta P_{gid.el} \quad (5)$$

Here:

ΣP_{um}= total pressure loss; $\sum \Delta P_{ishq}$= pressure loss along the length of rigid pipes and high-pressure sleeves in the hydraulic system, where the working fluid is pushed, pressure, drainage lines are taken into account. $\sum \Delta P_{ul.q}$= are the connecting parts in the hydraulic system, including nozzle, sudden expansion, sudden shrinkage, plates, fittings, couplings, flanges, etc., On average, the local loss of each part is calculated as 1.5.

$\sum \Delta P_{gid.el}$ = pressure losses of series and parallel connected elements in the system. [4]

As a result, the efficiency will change.

$$\eta_{yu} = 1 - \frac{\Delta Q_0}{Q_0} \quad (6)$$

The leakage of the working fluid from the hydraulics is found as follows. [9]

$$\Delta Q_0 = K * d * 2{,}793 * c \quad (7)$$

Here,

ΔQ_0- Leakage of working fluid from hydraulics l / min;

K-1,6 * 10^{-6} - constant coefficient;

d = particle size; Concentration of c-particles, in liters

The efficiency of the second method of hydraulic drive is as follows.

$$\eta_{yu} = \eta_G * \eta_M * \eta_H$$

Here;

ΔQ_0- hydraulic efficiency; η_M-mechanical efficiency; η_H -volume efficiency hydraulic efficiency.

$$\eta_G = (P - \Sigma\Delta P)/P \quad (9)$$

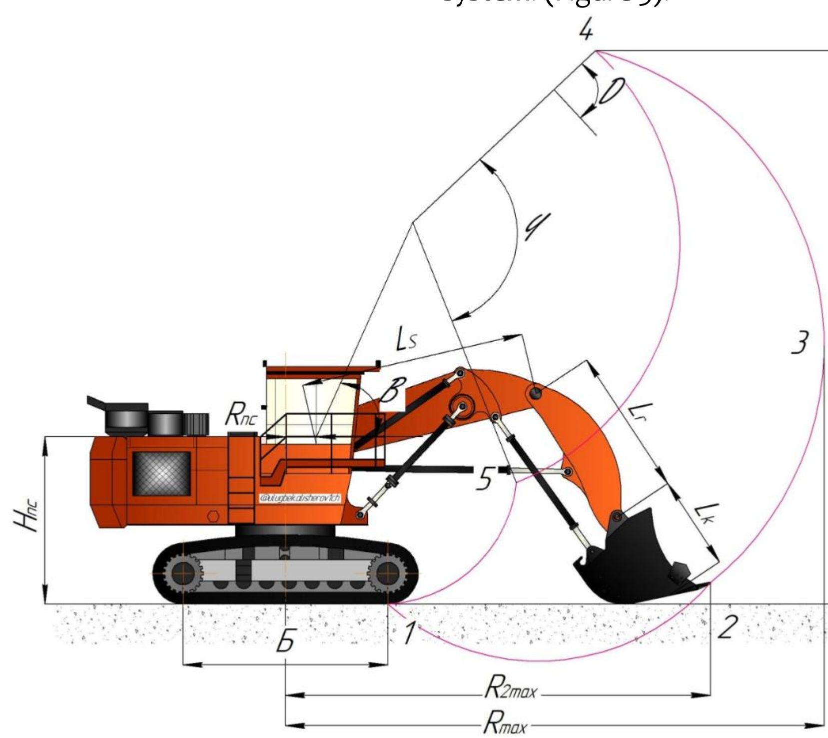
Mechanical efficiency the energy expended on the friction of the hydraulic elements in the series-connected state.

$$\eta_M = \eta_{m.n.} * \eta_{m.r} * \eta_d \ (10)$$

Dimensional efficiency. The volume of hydraulic parts is determined by efficiency found through.

$$\eta_h = \eta_{h.n.} * \eta_{h.r} * \eta_{h.d} \ (11)$$

As an example, based on the parameters of the hydraulic system of the RH-40E hydraulic excavator of the "Arestantau" quarry of the NMMC Mining Administration No. 1 MMP, the excavation diagram of the right-hand hydraulic excavator in Figure 2 is based on the scheme of excavation period 1-4. We can see in the graph of the theoretical calculation of pressure loss in lines and hydraulic devices in a hydraulic system. (Figure 3).



β - is the angle of rise of the arrow, γ - is the angle of rotation of the arrow, θ - is the angle of rotation of the bucket, L_s is the height of the arrow, B- is the base of the hydraulic excavator, R_{max} - is the maximum digging radius, R_{2max} - is the maximum radius of the bottom of the step, H_{max} is maximum excavation height, Z_0 - distance from the axis of rotation of the hydraulic excavator to the axis of the arrowhead, $H_{пс}$ is the height of the arrowhead.

Figure 2. Excavation diagram of a straight bucket hydraulic excavator.

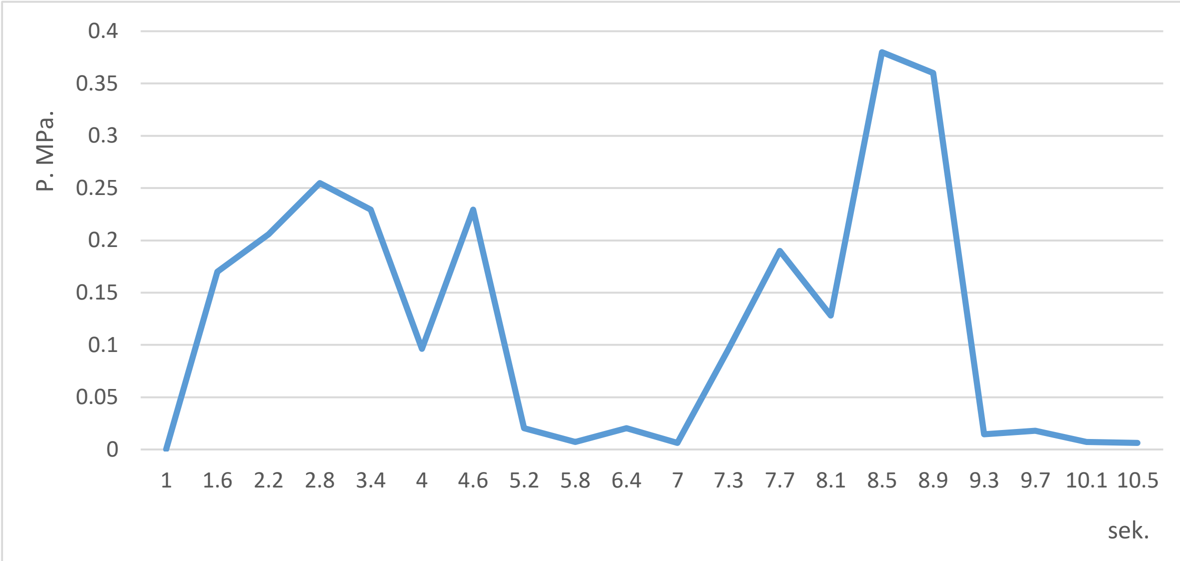


Figure 3. The pressure loss graph from point 1 to point 4 is the period of operation of the bow and arrow together.

Hence, the results of our analysis show that the overall performance of a hydraulic excavator depends on the efficient and reliable operation of the hydraulic system, which confirms the loss of hydraulic efficiency in the working study of the hydraulic system [4]. Our research shows that the hydraulics of the RH 40E hydraulic excavator are 74-80% hydraulic efficiency in parts. As a result, hydraulic excavator hydraulic system failures will have a higher impact on the above performance and will also affect the overall performance of the hydraulic excavator.

The main reasons for this pumping are the purity state and viscosity of the working fluid carrying the pressure energy. As an example, the excavation cycle in Figure 1 shows the hydraulic efficiency. During 77% operation, a decrease in the index due to internal and external slippage due to the formation of dust particles in the system in the hydraulic apparatus and the erosion of parts leads to a prolongation of the excavation cycle.

The origin of the faults in the line parts of the hydraulic system of the hydraulic excavator is determined by the hydraulic efficiency. An increase in unscheduled maintenance and repairs, and even some failures, can lead to accidents and complete shutdown of the hydraulic excavator. The problem is that problems can be grouped into faults, which can be broken down into groups for repair and maintenance. To the first group: high-pressure sleeves, pipes, fittings, filters, valves, chokes, tanks. To the second group: hydro cylinder. To the third group: hydraulic distributors, hydraulic pumps, compactors, hydromators. [8,10]

Faults in the first group led to the emergency shutdown of the hydraulic excavator due to the rupture of the high-pressure handle and pipe, the separation of the working fluid at high pressure as a result of the breakage of the high-pressure handle from the connecting part of the fitting. Such failures are often caused by hitting the pipe joints, cutting the outer surfaces of high-pressure handles, friction, corrosion of the fitting, overpressure, failure to tighten the fitting to the required level, and the average working fluid of the hydraulic excavator pressure reaches 3 l/sec in high pressure lines. This not only stops the hydraulic excavator, but also affects the environment. The loss of volume and properties of the sealants as a result of exposure to ambient temperature and dust, as well as the heating of the working fluid, leads to the displacement of the working fluid. Maintenance costs increase by 25-30% for the case of contamination of the working fluid with a purity class of 15-16 (CIS countries). [9,11,12]

CONCLUSION

Therefore, it is important to maintain a positive working condition of the hydraulic system during operation, and the development and research of scientists around the world who have studied these solutions is important the need to be analyzed can guarantee optimal solutions.

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