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THEORITICAL ANALYSIS OF THE CAUSES OF HYDRAULIC SYSTEMS FAILURES

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Annotation: *The article reveals that during the manufacture, assembly and use of a column, the inevitable eccentricity of the load occurs and axial directed work of the rod and cylinder occurs. Under these conditions of maximum compressive stress in the middle span, the column is equal to the sum of the axial components and the bending component. Theoretical analysis has shown that due to wear of elastic seals, frequent failures of hydraulic cylinders occur.*

Key words: *hydraulics, stress, cylinder, eccentricity, critical load, mechanical system, working fluid, rod.*

Introduction. Hydraulic cylinders are the most common actuators in hydraulic systems. When operating as hydraulic components, they often must function as structural elements and therefore must be designed to meet specific structural requirements. It is known that the critical load is minimal as the distance of the cylinders increases.

Cylinder failure may occur due to excessive axial stress; excessive tension on the hoop; axial conditions; bending stresses leading to excessive lateral deflections. Axial stresses act parallel to the cylinder axis when the cylinders are axial loaded. Due to the presence of a sliding joint in the innermost tube (or rod). There are methods for calculating stresses in any configuration of a telescopic cylinder tube.
Bending stresses, like axial stresses, both act in the axial direction and can be additive or subtractive. The maximum bending stress in a given section will occur at extreme fibers and in the interval with a constant cross-section and is determined from the moment equations.

The voltage in the cylinder tube fluctuates from a maximum on the outer surface. The hoop stress acts perpendicular to the axial and bending directions (axial plus bending stress and hoop direction) of the cylinder.

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Road construction, municipal and other machines operate in difficult operating conditions. However, most failures occur due to malfunction of hydraulic system components.

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If a malfunction has led to the loss of machine functions, and/or has a negative impact on the safety of its operation, or harms the environment (for example, a break in a high-pressure hose), then the machine should be stopped immediately.

The main factor contributing to the occurrence of stress at any point in the cylinder is axial load. In the rod it produces direct axial stresses of the hoop. The axial load also interacts with the shutdown to initiate bending forces in both the rod and cylinder sections.

Research methods and methodology. Modern equipment and machinery based on hydraulic drives require constant attention and qualified diagnostics. Of decisive importance in servicing hydraulic systems is equipping the company with diagnostic equipment, which expands the capabilities of the diagnostician and allows one to make the correct conclusion about the condition of a particular element and elements for monitoring the operation of the hydraulic system of the system as a whole. A key role in system maintenance is played by organizations that repair hydraulic elements and equipment. They must be equipped with high-precision measuring instruments (bore gauges, micrometers, etc.), since the dimensions that need to be measured are accurate to hundredths or even thousandths of a millimeter, depending on the unit. The availability of repair documentation, special devices, high-quality tools, and an assortment of various adhesives and sealants, among other things, allows for high-quality repairs.

The locations of the cylinder support and the type of support, fixation or fastening, determine the effective length of the structural member. As the cylinder support is moved toward the end of the rod, the spacing of the pins increases its load-bearing capacity. On the other hand, in the case of an inclined or horizontal cylinder with an intermediate cylinder support, the hanging part behind the cylinder support will produce a constant moment on the cylinder pin, which will cause moments and stresses in the system.

You can calculate the load at which the cylinder is tightened. This load represents the smallest axial force that will cause a straight column to collapse after slight deflection. This critical load is a function of the material stiffness E and the column size. This critical load is expressed by Euler's equation

$$Rcr = \frac{\pi^2 E\, I}{L^2} \qquad (1)$$

where: *R*cr–Eulerian critical load;

E - elasticity model;

I – moment of the region;

L – rod length.

To account for different end conditions, Euler's formula can be written as follows:

$$Rcr = \frac{C\pi^2 E\, I}{L^2}$$

where coefficient C is a constant state. In practice, it is convenient to express it:

$$\frac{Rcr}{A} = \frac{\pi^2 E}{(L_{eff}/\kappa)^2} \qquad (3)$$

where A is the cross-sectional area of the rod;

*L*eff - effective length of the rod;

k is the radius of rotation.

The effective length depends on the distance between the point of application of the load and the point of resistance of the cylinder. The tensile potential of different final configurations depends on the following factors:

1. The shorter the effective length, the greater the load before buckling;
2. Fixed ends give the highest buckle load for the cylinder;
3. Rotary and directional ends are located next to the fixed ends for recoil loads;
4. Free end buckle configuration;
5. The worst end conditions are the loose and swivel end configurations.

Most designers prefer to describe the geometry of a column by the parameter *L*eff*I*k, a term called elongation factor.

When the device accepts critical loads, given by equation (2) is built on the elongation coefficient, the Euler curve is obtained, as shown by the solid load curve at which buckling occurs, occurring as seen by Euler. According to the loss of stability, it is proportional to the elongation coefficient squared. However, for short, thick columns, there comes a point where the stress reaches an exit point in front of the column buckles, hence we have maximum failure, not buckle failure. The transition from one type of failure to another is not as abrupt as it seems.

Based on the test results, it was found that a good approximation for the transition from the transition from constant yield to the Euler critical load curve is a parabola.

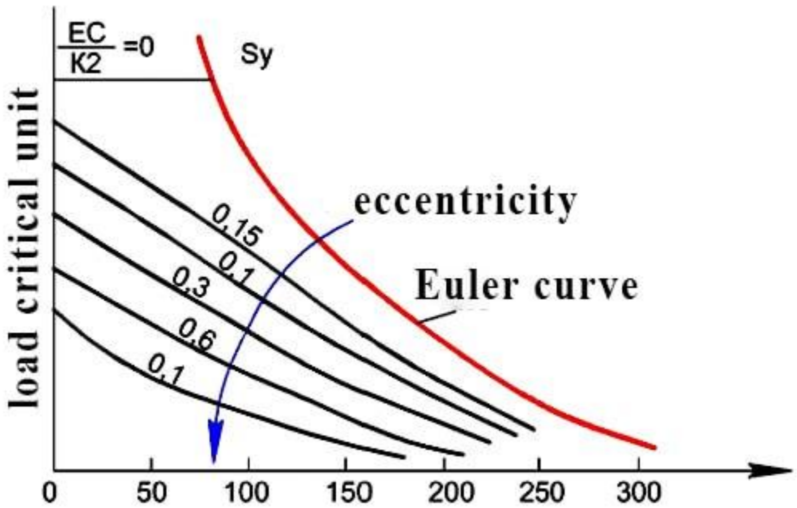

Fig.1. Euler curve and experimental parabolic curve.

In practice, during the manufacture, assembly and use of a column, eccentricity of the load is inevitable, and axial directed work of the rod and cylinder occurs. Under these conditions of maximum compressive stress in the middle span, the column is equal to the sum of the axial components and the bending component.

Mathematically, when the magnitude of the eccentricity can be determined or estimated, the force in the column can be determined using the relationship between the critical load and as described by the formula and graphically shown in Figure 3.

$$\frac{\mathrm{Rcr}}{\mathrm{A}} = \frac{S_y}{1+\frac{EC}{k^2}\sec(\frac{L_{\mathrm{eff}}}{2\kappa}\sqrt{\frac{\mathrm{P_{cr}}}{\mathrm{AE}}}} \quad (4)$$

where: sy is the yield strength;

E - load eccentricity;

C is the distance from the neutral axis of bending to the outer fibers of the rod, quantitatively called eccentricity.

As can be seen, the stability curves of the cylinders further deviate from the Euler curve with increasing eccentricity coefficient, namely with increasing angle of curvature. In other words, the structure tends to be unstable for a large mechanical system.

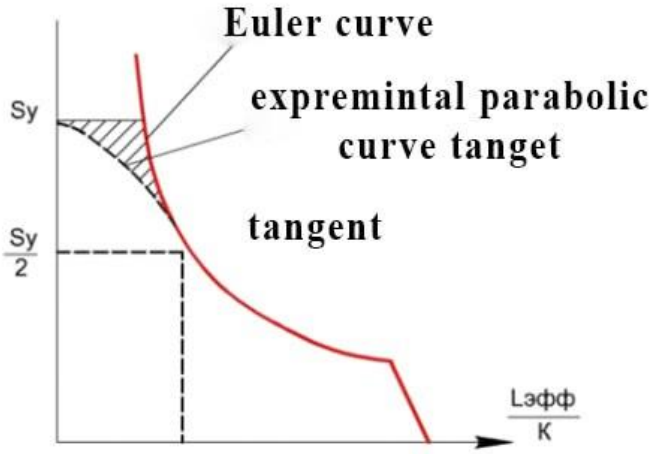

Fig. 2. The influence of eccentricity on the critical load of the cylinder.

Results. The angle of curvature of the cylinder at the sliding connection as shown in Fig. 2 leads to angular deviation and, as a consequence, to an increase in the bending moment in the cylinder and their frequent failure.

Theoretical analysis to assess the mechanical strength of hydraulic cylinders showed that due to wear of elastic seals, frequent failure of hydraulic cylinders occurs. Each case of hydraulic system failure is unique and requires its own approach. However, the information provided will allow you to solve a problem that suddenly arises right on the spot.

The above analytical dependencies can be used to calculate hydraulic systems used in fish farming.

References:

1. Khamidov A.A., Isanov R.Sh., Ruzmatov M.I. Swirling flow of aerated mixture in a cylindrical pipe. // Sat. scientific articles. International scientific and practical conference "Current problems of ensuring the integration of science, education and production." -Tashkent. 2008, pp. 283-286.
2. Khamidov A.A., Khudoykulov G.I. Theory of jets of multiphase viscous liquids. - Tashkent, “Fan”, 2003, 146 p.
3. Gupta A., Lilly D., Saired N. Swirling flows - M., Mir, 1987, 588 p.
4. Rakhmatullin H.A. – Fundamentals of gas dynamics of interpenetrating
5. Ahrendt, W. R. and C. J. Savant. Servomechanism Practice. New York, NY: McGraw-Hill Book Co., 1960.
6. Isaev A.P. Sergeev B.I. Didur V.A. Hydraulics and hydromechanization of agricultural processes - M: “Agropromizdat” 1990
7. Bashta T.M. and others. Hydraulics. Hydraulic machines and hydraulic drive - M: Mechanical Engineering. 1982

8. Collacott, R.A. Mechanical Fault Diagnostic and Countermeasure Monitoring. London: Chapman and Hall 1977
9. Fitch, E.C. 'Hydraulic System Assessment Procedures.' Basic Fluid Power Research Journal, Stillwater, OK: Fluid Power Research Center, Oklahoma State University, 1987.
10. Eun, P. S., Kh, M. G., & Xasanova, G. (2023). The Role and Classification of Parenthesis in Literature. American Journal of Language, Literacy and Learning in STEM Education (2993-2769), 1(10), 324-328.
11. Fluid Power Communication Standards. Milwaukee, Wisconsin: National Fluid Power Association, Inc., 1977
12. Stuntz, R.M., G.E. Maroney, et al. "Hydraulic Component Modeling Manual." Basic Fluid Power Research Journal, Stillwater, OK: Fluid Power Research Center, Oklahoma State University, 1968.