IVAN VE60 0495

HIGH-PRESSURE HYDRAULIC COMPRESSORS WORKING WITH OIL AND WATER

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Translated from Pribory i Tekhnika Éksperimenta, No. 1, January-February, 1960, pp. 126-128

Original article submitted October 15, 1958

A hydraulic compressor is described whose special features consists in the possibility of working with a separate supply of the liquid to be compressed and the lubricant, and its high output. The experience of the compressor operation with water at a pressure of 5000 atm and an output of 120 liters/hr and on a mixture of kerosene and oil at a pressure of 8000 atm and an output of 60 liters/hr is described. The relations of the required power to the pumping pressure and output are given.

The compressor consists of an electric motor with a multi-V shaped belt drive for the crankgear mechanism, a cylinder, and several auxiliary units: a receiver for the compressed fluid, cylinders for supplying the liquid to the inlet pipe, a pointer pressure gauge, and various fittings mounted on a solid frame.

Figure 1 represents the cross section of the compressor cylinder. The compressor is intended for compressing liquids in large volumes up to a pressure of $(8\text{-}10) \cdot 10^3$ atm and is a periodically operating machine; its working cycle is completed over one revolution of the crankshaft. This cycle is completed in the following manner. The working liquid is fed from the cylinder under a pressure of 25-30 atm along connecting pipe 9 to the annular cavity between the cylinder 8 and collar 7. Next the liquid penetrates along three holds in the body of the collar to the annular space between rod 10 and the inner surface of the collar. When the piston travels downwards the liquid enters the piston channel 6 along the side holes of the rod and, lifting the inlet valve 13, fills the compression chamber. As soon as the rod passes its bottom dead center the compression stroke begins. At the instant that the pressure in the compression chamber exceeds that on the other side of valve 12, the valve opens and the compressed liquid is ejected into the space beyond the valve.

To avoid deformations of the compression chamber, an automatic support is used. Cone 3, which holds all the components (of the compression chamber), is placed into cone-shaped support 5. For a close contact between the cone and the support these two details are carefully ground-in. As the pressure rises, obturator 11 tends to come out of cone 3, whereas support 5, held by flange 1 and bolts 2, tends to come over the cone still further and to compress it still harder. Since the pressure on the obturator in the space beyond the valve is variable, the compression of the cone by the support is also variable. Thus, the greater the pressure in the compression chamber, the greater becomes the compression of the cone by the support. The packing of the moving piston is achieved by a considerable hydraulic resistance to the liquid flowing in the gaps between the components moving relatively to each other. The packing device used in the compressor was previously described [1, 2].

In a hydraulic compressor [3], contrary to a gas one, the compression temperature is low owing to the relatively small compression of liquids. The present authors, however, have observed heating of the liquid when it was passing through a throttle from the compression equipment into the atmosphere. The throttle ejection is carried out through the annular slit of the shut-off needle valve. In passing rapidly through the slit between the needle and its seating, the liquid heats up considerably and heats all the components around it. Throttle ejection

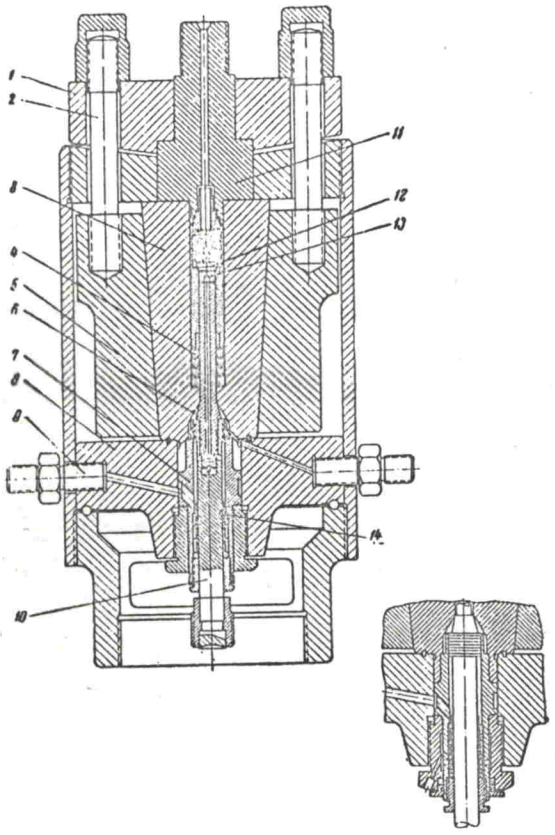


Fig. 1. Cross section of the compressor cylinder.

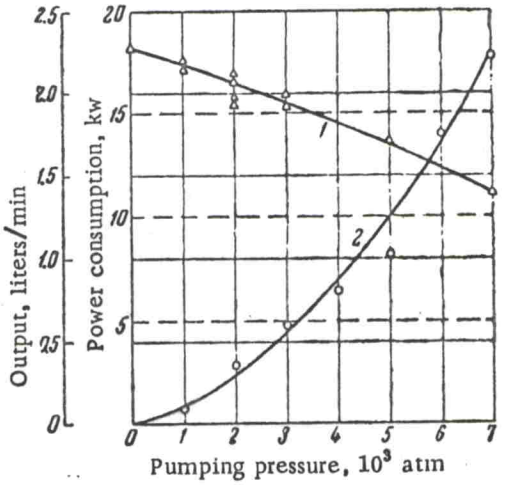


Fig. 2. Relation of the compressor output and the power consumed to the pumping pressure.

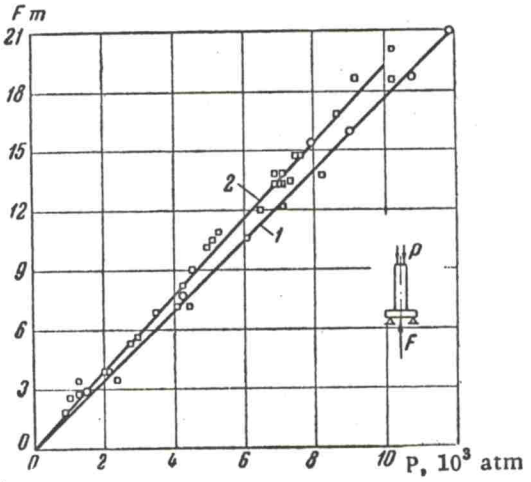


Fig. 3. Losses in piston friction against packing.

at pressures of (7-8) · 10^3 atm into the surrounding atmosphere leads to a temperature rise of the liquid up to 180-200°C. Moreover, after 10-15 min of this operation the surface of the stopper needle becomes noticeably worn.

The special feature of the compressor model working with water is its piston and rod lubrication. It consists in the lubrication of piston 6 and the packing steel rings 4 through the connecting pipe and the holes shown in Fig. 1. The right-hand drawing of Fig. 1 shows the way the bottom packing rings 14 and rod 10 are lubricated. The hypoiodous lubrication is supplied under pressure of 25-30 atm.

Curve 1 in Fig. 2 shows the relation between compressor output and the pumping pressure with a constant suction pressure. It will be seen that with a rising pumping pressure the output falls considerably. A detailed analysis of the causes of this phenomenon shows that the main reason for the loss of output is the so-called "sticking" of the pressure valve, i.e., a delay in its closing which allows some of the liquid to flow back into the cylinder at the beginning of the suction stroke. It will be seen from Fig. 3 that for 7000 atm the losses amount to 60% of the initial and calculated output. The power consumption of the motor is shown in curve 2 of Fig. 2.

Curve 2 in Fig. 3 shows the characteristic of the total force applied to the piston base (rod), which consists of the hydrostatic pressure and the friction forces of the piston and rod against all their packing (piston pressure is plotted along the X axis). Curve 1 represents only the hydrostatic pressure on the piston. From the comparison of these two curves it will be seen that all the friction losses amount to 6.7% of the total force.

Above compressor is very convenient for compression of liquids in large volumes. Its dimensions (including the frame and the motor) are: 1.5 m in length, 0.8 m wide and 1.5 m high including the pressure gauge. It can

be used in running-liquid installations or equipments with large losses for maintaining constant pressure and it can also be used for operation with water.

LITERATURE CITED

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