

## ENERGY SAVING

## 7.3. New sealing and fire-proof materials for power enterprises

## 7.3.5. Hermetic sealing of rods and spindles of accessories

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For providing the hermetic sealing of gland with keeping the elastic properties of seal made of TEG6 it is necessary to use the material with strictly certain density and to carry out the tightening of gland with the determined effort depending on the working pressure of medium. The dependence of recommended material density on the working pressure is presented in fig.7.18.

As the operating experience and test results showed, a number of sealing rings installed in gland chamber must be chosen in correspondence with recommendations, presented in fig. 7.19. It is not acceptable to install in gland chamber the superfluous rings made of thermo-expanded graphite, because it is impossible to compress the increased amount of rings with applying the rated force of tightening. Not quite pressed lower rings of sealing material could result in the penetration of the working medium in the space between rings that promotes the thermo-premature failure of seal. Besides, there is the attenuation of gland tightening effort that can result in occurrence of leakage and even promotes the gland splitting out. A raise of the tightening effort above the rated level with more rings results in increase in the density of upper rings and reduction of their sealing properties, it makes necessary to apply the more effort for the rod movement, and can result in occurrence of pressure that may break the pins or draw bolts. Therefore, if the gland chamber has the large depth, it is necessary to make the distance ring (see Figs. 7.16, 7.17), which will allow to pack the gland made of material "Graphlex" in correspondence with recommendations

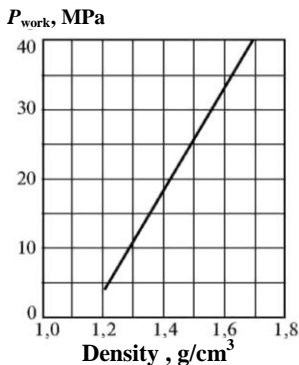


Fig. 7.18. Working pressure versus the changing density of the sealing material "Graphlex" pointed out in figs. 7.18, 7.19.

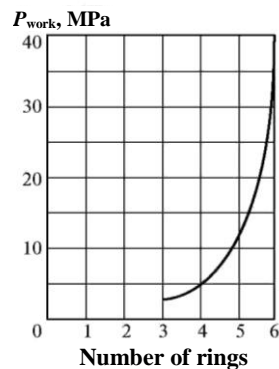


Fig. 7.19. Working pressure versus the changing number of rings

The results of investigations showed that for securing the necessary standards of gland tightening, the following number of rings should be installed, depending on parameters of the working medium:

- at  $p_{work} > 13$  MPa — 6;
- at  $p_{work} > 6.5$  MPa — 5;
- at  $p_{work} < 6.3$  MPa — 4.

For providing the more uniform distribution of lateral pressure coefficient along the height of gland chamber, it is necessary to have the ring in the zone of plastic deformation with applying the effort that is equal to the compression one. Therefore, the density of rings, installed in the gland chamber, should be chosen depending on working pressure in accordance with the curve of plastic deformation. The optimal density of sealing rings made of TEG for the accessories, op-

erating under the mentioned pressure, should correspond to the following range:

- $P_N < 6.3$  MPa,  $P = 1.1...1.3$  g/cm<sup>3</sup> (without initial prepressing);
- $P_N < 6.3$  MPa,  $P = 1.3...1.4$  g/cm<sup>3</sup> (preliminary prepressed rings);
- $10$  MPa  $< P_N < 30$  MPa,  $P = 1.4...1.6$  g/cm<sup>3</sup> (preliminary prepressed rings).

The last rings in a set of seals serve for preventing the extrusion of sealing material in the clearances between rod and bottom box, as well as between gland chamber wall and bottom box. They are manufactured either from TEG with the increased density ( $P = 1.8...1.9$  g/cm<sup>3</sup>), or the strengthening of last rings by reinforced elements made of metal or metal yarn. The examples of completing the rod seal for high-pressure accessories are presented in fig. 7.16 and 7.17.

The reliability of hermetic gland joint is substantially determined by the accuracy of fulfillment of operation on the gland tightening. As the testing results showed, in the process of gland tightening during "dry" friction, when the working medium supply is absent, the friction ratio is, as a rule, in 2...4 times higher than for operating gland with working medium supply. As a result, the lower sealing elements seem to be compressed with insufficient strength in initial gland compression. The benchmark test and experimental operation showed that the considerable reduction of compression effort occurs with the fulfillment of the first steps of rod after the initial tightening of gland. But the change of effort is gradually decreased with each following rod stroke. For the complete sets, consisting of 6 rings, compressed in one mode, after fulfillment of 10 strokes of rod, the attenuation of axial strength occurs by 20...40% depending on complete set type and applied effort. The stabilization appears after fulfillment of 5...10 strokes by rod, and there is no further attenuation of axial effort of tightening. It is connected with the fact that with the reciprocating motion of rod there is a violation of frictional connection, appearing at the surfaces of packing contact with the elements of gland joint. In the process of destruction of frictional connections the available voids are filled by material of packing, which is in the state of stress. As a result, the stress in packing is decreased; the friction force is also decreased as well as the axial and side forces that can result in the depressurization of gland.

Thus, for securing the hermetic joint, it is necessary to execute 5...10 steps of rod no-load, without supply of working medium, after which the attenuation of tightening effort will take place, and then to make the additional tightening up to the initial specified effort. Otherwise, it is possible to have in the process of operation the attenuation of axial effort of tightening below the working pressure that could result in the gland steaming and the knockout of gland. The more optimal tightening of gland is the initial tightening with a half of effort and the fulfillment of some rod steps and then with the specified fulfillment of 5...10 steps of rod. After it the additional tightening of gland is carried out to the specified level.

Unfortunately, the operating personnel often doesn't not follow the instruction relating to the rules of gland installation, and as a result the failures occur.