HERMETIC SEALING OF DISMOUNTABLE AND NONDISMOUNTABLE CONNECTIONS IS ONE OF THE MAIN STRUCTURAL REQUIREMENTS FOR FURNACES WITH PROTECTIVE ATMOSPHERES.

THE GREATEST NecessITY FOR HERMETIC SEALING OF GAS-FILLED FURNACES EXISTS IN THE CASE OF ATMOSPHERES WITH HIGH CONCENTRATIONS OF EXPLOSIVE AND TOXIC GASES.

THE GREATEST DIFFICULTY OCCURS IN SEALING DISMOUNTABLE CONNECTIONS, AND thus the number of such connections should be kept to the minimum.

However, dismountable connections cannot be eliminated altogether, and therefore the safe operation of such furnaces is of particular importance.

All the dismountable connections in gas nitriding furnaces and also in pipelines carrying ammonia are flanged, cornerplate, packing gland connections or covers. Reliable seals in flanged and cornerplate connections can be achieved by careful assembly and the use of chemically stable gasket materials with good sealing properties such as fibrous asbestos-rubber, paronite, etc. In connections subjected to heating the gasket material should be asbestos cord impregnated with graphite.

Flanged connections of large size (for example, the flanges of the cover and the muffle of muffle furnaces) which are subject to heating during use must be annealed before machining in order to avoid breaking the seal of the joint during operation as the result of warping induced by relief of internal stresses.

The design and dimensions of the flanges must prevent a large temperature drop along the radius of the flange. In a number of cases compensators are needed to avoid breaking the flange and the seal. The material most often used as a seal between the muffle and the cover is water-cooled rubber or asbestos cord impregnated with graphite.

A packing gland (Fig. 1) is used mainly to provide a hermetically sealed inlet into the working chamber for heating elements, thermocouple jackets, shafts for fans, etc. The packing material in these joints is usually asbestos cord impregnated with graphite.

To provide sufficient pressure on the packing material and also electrical insulation of the heating elements the packing material is encased in strong ceramic sleeves. It is best to use cordierite for these instead of the widely used fireclay, porcelain, and asbestos cement. The maximum dimensions of the packing gland S and h (see Fig. 1) should be S = 2\sqrt{d} - 2.5\sqrt{d}; h = 7-8\text{S}. The angle \(\alpha\) is equal to 45-60°. Tests have shown that seals with smaller dimensions of S and h are not tight enough.

When the fan is located under the furnace the seal around the shaft is made so that the shaft passes through a chamber filled with oil. In this case the seal on the shaft serves only to prevent leakage of the oil.

However, the closing device presents the greatest difficulty in design and operation. The closing devices for heat treatment furnaces are filled with oil, water, sand, marshallite, and chromium ore.

In nitriding furnaces the closing device is filled with chromium ore with a density of 3.74 g/cm³. The composition of the chromium ore is 20–35% Cr₂O₃, 5–10% SiO₂, 10–20% Fe₂O₃, 10–18% Al₂O₃, 10–18% MgO.

Fig. 1. Packing gland.
Fig. 2. Diagram of closing device.

The disadvantage of closing devices filled with loose materials (including chromium ore) is the substantial leakage of gas caused by its filtering through the filler material during operation of the furnace as well as the high resistance of the material during coupling of the two halves.

There are various data in the literature on the escape of gas through the closing device. For the dome of a gas-filled electric furnace it is usually considered that 1.4 Nm$^3$/h of gas escapes per linear meter of sand seal [1]. According to [1], a deep and well-tamped seal through which 0.65 Nm$^3$/h of gas escapes per linear meter of the seal provides sufficient protection of the parts in the furnace.

For large electric furnaces with a muffle of 10 m$^3$ the gas loss per linear meter of seal was found to be 1.1 Nm$^3$/h [2]. An empirical formula was found in [2] for calculating the gas loss through a sand seal:

$$Q = 0.14 \Pi p^{0.42}$$

where $Q$ is the gas loss, Nm$^3$/h; $\Pi$ is the perimeter of the seal; $p$ is the pressure from the muffle.

At the pressures normally found in large nitriding furnaces (15-25 mm water column) the gas loss determined by this formula amounts to 0.5-0.6 Nm$^3$/h per linear meter of seal, which is close to the actual value. Large nitriding furnaces with a seal perimeter of 10 m lose more than 5 m$^3$/h of ammonia to the atmosphere of the shop, which is impermissible. During the operation of muffle-free electric shaft furnaces with double seals (the width of each groove is 100 mm, the depth 90 mm, the average diameter 3.5 m), with careful tamping of chromium ore in the outer seal, the gas loss was reduced to 0.4-0.45 Nm$^3$/h per linear meter. However, with such gas losses the working conditions in the shop remained unpleasant, not only near the furnace but throughout the shop.

To reduce the gas leak the perimeter was lined with asbestos and then smeared with water glass. This substantially reduced the gas leak and returned working conditions to normal. However, this procedure is very time-consuming and cannot be recommended for wide use.

For electric shaft furnaces it is expedient to use double closing devices, since it is possible to improve the seal and reduce the depth of the filler and the force necessary to cut into it. However, double closing devices do not prevent the ammonia from passing through the filler from the furnace into the shop or the reverse filtering of air from the shop into the chamber of the furnace when the gas pressure in the furnace drops. This may result from stopping the flow of ammonia or rapid cooling of the furnace, and causes oxidation of the parts or even explosion of the furnace. An increase of the gas pressure in order to maintain a low degree of dissociation of ammonia leads to still greater escape of ammonia into the shop.

Aside from this, double closing devices have substantial shortcomings. During coupling of the two halves of the seal the air pressure increases due to the compression occurring when the rim bites into the filler material.

If the two halves are coupled fairly rapidly the seal is broken and filler material is forced out of the inner or outer channel in one or several places.

The seal can be achieved by using the device shown Fig. 2.