In a number of cases the gas permeability of a structure affects the processes taking place in industrial furnaces, and often determines the life of the structure itself.

The coefficient of gas permeability is determined with special apparatus on specimens 50 mm high and in diameter.

However, the gas permeability of the structure depends not only on the quality of the brick, but mainly on the joints. Gas permeability of refractory structures is particularly affected by the density of the contact joint between the refractory and the joint mortar.

The permeability of a refractory structure is especially important in connection with the development recently of block and panel construction. Blocks and panels, built up of piece refractories, are made with air-setting mortars in which the bonds are Portland cement and periclase cement and waterglass. The thickness of the joints is as great as 3-3.5 mm, that of the installation joints which connect the various blocks or panels built of piece refractories or heat-resistant concrete being 10-15 mm. The thickness of the joints between the bricks, using clay-grog mortars, is 1-2 mm. It becomes possible that thick joints may be so permeable that they cannot be allowed.

Since 1960, NII Montazhspetsstroi has been studying the gas permeability, not of separate specimens of brick, but of large sections of structures of various types, including panel constructions and sections containing installation joints. The area of the specimens was 1000 x 800 mm, and the thickness 123 (125) or 250 mm. The tests were made at +18 °C and by heating one side of the specimen to 1000°C.

The testing equipment (Fig. 1) consists of a diffuser 1 to which is fitted a ring with the specimen 2. Through the cooler 3 and the gas meters 4 the diffuser is connected by the hose 5 to the low-pressure fan 6 or, leaving out the

Fig. 1. Equipment for measuring the gas permeability of refractory structures.
Fig. 2. Gas permeability of different structures at temperatures from +18 to −20°C (the numbers on the curves indicate the coefficients of gas permeability).

GSh1 — the structure of firebrick class B based on clay-grog mortar, thickness of the structure is 1 brick, and of the joint 1-2 mm; GSh 1/2 — the same, but the thickness of the structure is 1/2 brick; TsSh1 — structure with a thickness of 1 brick using mortars with additions of Portland cement, joint thickness in structure 3-3.5 mm; TsShV1/2 — the same, but with vibration; structure thickness 1/2 brick.

cooler, to the cylinder 7 filled with nitrogen. The combustion chamber 8 with a moving wall 9 is placed in front of the ring with the specimen. A burner 10 is provided with which to heat the specimen. The pressure in the diffuser is controlled by the manometer.

The specimen is stuck tightly to the walls of the ring with mortar. However, it is difficult to completely seal the joint of the ring to the diffuser, and also to stick the specimen to the walls of the ring.

Two tests are made to determine the coefficient of gas permeability of the specimen itself. First, the loss of gas through the joints is determined. A thin steel plate is glued to the side of the specimen facing the combustion chamber, and the gas consumed through the unsealed parts at the joint sites is determined. After this, the plate is removed and the gas permeability of the specimen is measured; the difference between the two readings represents the permeability of the structure.

With a pressure difference between both sides of the specimen of up to 8-10 mm water pressure, loss of gas through the unsealed joints is almost negligible. Only with a big difference in pressure do the unsealed parts affect the readings of the apparatus.

A pressure or vacuum is formed in the diffuser using a fan or cylinder containing gas. The amount of gas or air passing through the specimen in a given time is measured. If, during the passage of nitrogen from the cylinder, the diffuser develops pressure, then the gas consumption is determined by the meters and by the reduction in the amount of gas in the cylinder.

The permeability of each specimen was determined several times: at first at +18°C, then when one side of the specimen was heated to 1000°C. The temperature on the hot side of the specimen was raised at a rate of 100 deg/h. After being tested in the hot state, the specimens were cooled at about 50° an hour and again the gas permeability was measured. This completed the first testing cycle. Two to three cycles were normally carried out.

The amount of gas passing through the specimen was measured in a period of two minutes for each control reading. The maintenance of a steady cycle was checked by readings every minute.

The gas permeability was determined from the difference in pressures in the diffuser and the surroundings; the difference in pressure was 5, 10, 20, 30, 40, and 60 mm water press. Some of the specimens were tested twice — by blowing air from the hot side to the cold and, conversely, by passing nitrogen from the cold side to the hot.