Modern high-temperature technology requires the use of heaters made from silicon carbide in air, oxygen, nitrogen, carbon dioxide, and other atmospheres [1]. The behavior of heaters in oxidizing atmospheres has been studied in most detail [2-4]. It was found that in heaters made from silicon carbide, the SiC oxidizes to SiO$_2$ and CO$_2$; oxygen is the best oxidant.

There are statements that nitrogen scarcely affects these heaters [4]. Other authors state that during the operation of heaters in nitrogen, SiO is evolved [5]. The correct operation of heaters requires a knowledge of their behavior in different atmospheres. Therefore they were tested in vacuum, nitrogen, argon, oxygen, air, and carbon dioxide.

We tested coarse-grained heaters made from SiC with front contacts and fine-grained elements with thick contacts. Tests were done in a single-rod tube furnace placed in a sealed chamber (Fig. 1). The walls and the cover of the chamber were cooled with water. Tests were done at 1600°C on the surface of the heaters with a periodic cycle; after heating of the rods for 1.5 h in the stated atmosphere to the necessary temperature, it was maintained for 10 h, after which the heater was turned off. The next day testing was continued with the same sequence. The optical pyrometer inserted through the examination window in the wall of the furnace was used to determine the temperature; simultaneously the voltages and currents were measured as they passed through the heater, and the resistance calculated together with the specific current and watt load at different times.

The heaters were tested, as a rule, until complete destruction; after testing they were subjected to chemical, spectral, and x-ray analyses and microscopic investigation; their basic properties were also determined.

During testing, the vacuum was maintained at a level of $10^{-2}$ mm Hg (about $133 \cdot 10^{-2}$ N/m$^2$). With the attainment of a temperature of up to 1500-1600°C, the vacuum first fell and then rose to the previous level and before failure of the heater the vacuum again sharply and rapidly diminished.

Apertures in the examination tube through which the temperatures were measured were gradually reduced in diameter, and at the end of the service of the heater were completely filled with a substance. Chemical analysis of this substance showed that it consists mainly of SiO in admixture with Si, SiO$_2$, and SiC.

During the tests in oxygen, carbon dioxide, and air, the surface of the heater developed a film of silica, normally white and semitransparent. During the testing of coarse-grained heaters we noted the evolution of a white smoke which was deposited on the internal surface of the chamber.

The heaters were tested in nitrogen.
During the tests we noted the evolution of smoke settling on the walls of the chamber in the furnace, and also in the examination hole. The walls of the chamber in the apertures of the examination pipes were covered with a white, very light, wool-like mass with a fibrous structure. Chemical, microscopic, and x-ray analyses showed that the material consists of a mixture of $\alpha$-$\text{Si}_3\text{N}_4$ and SiC with small amounts of Si and SiO$_2$ (Fig. 2).

The tests on the heaters were carried out with argon in which there was about 0.005% oxygen. Separation of the smoke from the furnace during testing, this time in argon, was not noted. However, after testing, the walls of the chambers were seen to have deposits of a light-brown amorphous substance. Chemical analysis showed that the deposit consists of silica, silicon, and about 36% silicon monoxide. Analysis of the gas after testing of the heater in nitrogen and argon showed the presence of about 3% oxygen in them, which apparently evolves with the dissociation of the oxides of iron from the ceramic parts of the furnace.

The electric resistance of the heaters during service increases all the time; only with the fine-grained heaters in vacuum and nitrogen, and in coarse-grained heaters in nitrogen, air, and oxygen, before distillation, did we observe a certain lowering in the resistance, sometimes quite sharply (Figs. 3 and 4).