THEORY AND TECHNOLOGY OF SINTERING PROCESS
AND THERMAL AND CHEMICOTHERMAL TREATMENT

THE EFFECT OF HEAT TREATMENT ON THE PROPERTIES
OF POROUS STAINLESS STEEL

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No information is available in the literature on the heat treatment of porous stainless steels. Experiments have shown that porous parts sintered from reduced stainless steel powders* have low corrosion resistance, and rust in water. This is due to the nonhomogeneity of the starting powders, which was noted in [1].

In addition, in the technology which is at present being introduced into industry, stainless steel parts are allowed to cool down after sintering, together with a massive muffle, for 4-6 h or more, which may also adversely affect their corrosion resistance. For this reason, it was considered necessary to discover how accelerated cooling after sintering and other forms of heat treatment influence the corrosion and strength properties of such parts.

This investigation acquires particular significance in connection with the current organization of industrial manufacture of filters from reduced stainless steel powders.

OBJECT OF INVESTIGATION AND PROCEDURE

The investigation was carried out on sintered specimens from Kh17N2 (17% Cr, 2% Ni), Kh30 (30% Cr), 0Kh18N9 (0.08% max. C, 18% Cr, 9% Ni) and Kh23N18 (23% Cr, 18% Ni) steels, with porosities of 15, 25, 35, and 45%. The effect of porosity fluctuations on properties was eliminated by plotting curves of the properties versus porosity. All specimens were sintered in a hydrogen atmosphere at 1473K for 2 h and were slowly cooled with the muffle for 4 h, after which they were heat treated.

The term "normalizing" in this study means that the specimens were cooled from a high temperature to room temperature in 5-10 min, while water quenching was performed in a hermetically sealed holder. After heat treatment, measurements were made of the shear strength of the specimens; the scatter of the results did not exceed 5 MN/m².

Corrosion resistance tests were performed by pickling in a 20% HNO₃ + 1% NaF solution, using the procedure described in [2]. This is a method for the rapid testing of cast stainless steels for intercrystalline corrosion. In the case of sintered steel, corrosion (at points of contact) will be more prominent that intercrystalline (intraparticle) corrosion. Corrosion resistance was evaluated from the increase of electrical resistivity after pickling.

The method of electrical resistivity measurement for assessing the corrosion resistance of porous stainless steels was first successfully used in [6]. The corrosion resistance of porous materials can be quite accurately evaluated from changes in their electrical resistivity. The corrosion of a porous material (e. g., in a liquid corrosive medium) proceeds at the maximum rate at points of contact, i. e., zones of maximum defectiveness. For this reason, the resistance and service life of a porous material in a corrosive medium is determined by the rate of attack on the contact cross section; when the contact area decreases below a critical value, the porous material may fail under load.

Thus, bearing in mind that the resistance of a porous material in a corrosive medium is governed chiefly by the corrosion resistance of its interparticle contact zones and determining the corrosion resistance of a porous material as the rate of decrease of its contact cross section area, one can obtain quantitative information on the change in the corrosion resistance of the material from the change in its electrical resistivity after pickling. It must be remembered that an increase of electrical resistivity directly reflects a decrease of the interparticle contact area.

*Reduced stainless steel powders were produced at the Novotul'skii Factory according to a process developed at the Central Scientific Research Institute of Ferrous Metallurgy.
In order to determine the effect of heat treatment on the structure of stainless steels, the latter were subjected to magnetometric phase analysis with a Steinberg magnetometer*. The properties of specimens (strength and corrosion resistance) after heat treatment were compared with those of specimens cooled with the muffle after sintering.

**DISCUSSION OF RESULTS**

Figure 1 shows the effect of porosity and heat treatment on the shear strength of steel Kh17N2. All types of accelerated cooling after sintering increase the strength compared with cooling with the muffle after sintering. Normalizing from 1473°K gives a higher strength than does water quenching from 1303°K. This is due to the greater solubility of carbides at 1473°K, which leads to fuller alloying of the solid solution, consequently, to increased strength [3, 4].

Quenching from 1303°K gives a higher strength than does normalizing from 1573°K. The reason for this is that, during heating to 1573°K, the amount of austenite in steel Kh17N2 (in accordance with the diagram) sharply decreases, while the amount of ferrite increases, as a result of which the amount of martensite secured after cooling is significant, and the strength decreases [3, 4]. This is confirmed by results of the magnetometric study, which demonstrated that, compared with slow cooling from 1473°K, the amount of the ferromagnetic phase in steel Kh17N2 after normalizing from 1573°K increases by 15%.

*The magnetic analysis results are of a comparative character; quantitative data could not be obtained because of the lack of completely ferromagnetic reference standards alloyed to an extent similar to that of the ferritic phase of stainless steels.