

Thermodynamic metallization parameters of helium

V.T. Shvets, S.V. Kozytskiy and T.V. Shvets

*Odesa State Academy of Refrigeration, 1/3 Dvorianska Str., 65026
Odesa, Ukraine, E-mail: tarval@breezein.net*

By now helium is still not obtained in a metallic state. Still unknown even values of its thermodynamic parameters at the point of metal-insulator transition. In this paper we determined the density and temperature of helium in that point. We calculated the pressure and electrical resistivity of metallic helium in a wide range of temperatures and densities. For the helium in the metal state used the two-component almost free electrons model. We believed that the system consists of only single ionized helium ions and conduction electrons. Electron-electron interaction was accounted for diffraction model of a metal. To describe electron-ion interaction used the exact electrostatic potential generated helium ions. For the ion subsystem used model of hard spheres. The hard spheres diameter was determined in two ways: from analysis of effective pair interactions between the ions and with help of variational method from the minimum free energy of liquid helium at the given temperature and density. Both methods give similar results. Density of helium at the point of metal-insulator transition was found from the divergence condition in the perturbation series for electrical resistivity of metal helium. It turned out to equal 3.8 g/cm³. Transition temperature determined from the analysis of the depth of potential well for the pair effective ion-ion interaction. She proved equal to 12000–160000 K. The pressure in the vicinity of the phase transition point was obtained with the help of microscopic equation of state in the second order perturbation theory for electron-ion interaction. He was equal 1.6–2.0 Mbar. To find the electrical resistivity was used the perturbation series for electron-ion interaction, because when approaching a phase transition point the role of members of the old order quickly growing. As the density of helium at the point of transition is used its value when the electrical resistivity reached a critical value for metal – 500 $\mu\Omega$ cm