Aerogel as a non-ideal gas of impurities in superfluid ^{3}He

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The standard theory of superconducting alloys disregards possible correlations between impurities. Such idealization is not sufficient when impurities form a random network, like aerogel in superfluid ^{3}He. That creates discrepancies in the observed properties of this physical object with predictions of the standard theory. As a step to a better approximation we consider a situation when correlations are weak and can be treated as a perturbation. It is possible if correlation radius R meets the condition $R^2 \ll \xi_0 l$, where ξ_0 is the coherence length of the superfluid and l is a mean free path. In a principal order on the ratio $R^2/(\xi_0 l)$ only binary correlations are important. Effect of correlations is significant, when $R > \xi_0$. Corrections to the suppression of the T_c and to the temperature dependence of the square of the order parameter Δ^2 within the Ginzburg and Landau region caused by the correlations are expressed in terms of the structure factor of aerogel. In comparison with the non-correlated impurities T_c for ^{3}He increases and temperature dependence of Δ^2 on T_c-T significantly deviates from linear. Reasonable agreement with experimental data for ^{3}He is obtained for a realistic value of the correlation radius R. The obtained results can be of importance for impure superconductors with a short coherence length ξ_0 as well.