

**PHASE EQUILIBRIA AND THERMODYNAMIC
PROPERTIES OF SOLID AND LIQUID SOLUTIONS
IN THE SYSTEM $(\text{NH}_4)_2\text{SO}_4\text{-K}_2\text{SO}_4\text{-H}_2\text{O}$**

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Potassium and ammonium have close radii, resulting in mutual substitution in their salts [1]. Such solid solutions with sulfate ion contain potassium, sulfur and nitrogen and can be regarded as perspective fertilizer. It is essential to know a phase diagram to obtain a product with a known substitution rate and have a tool to a rapid check of a product quality.

However, phase equilibria with distribution rate between liquid and solid solution were studied only at 298.2 K [1] and are limited only to known liquid solution composition at other temperatures [1]. Thus, the primal goal of the present work was to obtain a phase diagram isothermal cross-section at an elevated temperature (313.2 K) and thermodynamic properties of both types of solutions (for further thermodynamic modeling).

Water activity of non-saturated liquid solutions were obtained at 298.2 K and 313.2 K ($u(T)=0.2$ K, $u(a_w)=0.003$) by a resistive hygrometer Novacina LabMaster-aw neo, expanding temperature and compositional range of results of El Guendouzi et al [2]. Isothermal cross-section at 313.2 K was obtained using isothermal solubility method ($u(T)=0.2$ K). Solid and liquid solution compositions were determined using gravimetric method (total water content in liquid solution, sulfate ion in both types of solutions, $u_r(w)=0.5\%$), flame photometry (potassium content, $u_r(w)=5\%$) and by ion-selective potentiometric method (ammonium content, $u_r(w)=5\%$).

XRD patterns of solid solutions were obtained using TongDa TD-3700, unit cell parameters were refined. For an easier characterization of a solid solution, a dependence of temperature and enthalpy of a low-temperature phase transition of ammonium sulfate solid solution from substitution ratio was studied as well. Temperature and enthalpy of the transition were determined using NETZSCH DSC 204 F1.

1. Dejewski B. The Distribution Coefficient of Isomorphous Admixtures for KCl-KBr-H₂O, K₂SO₄-(NH₄)₂SO₄-H₂O and KNO₃-NH₄NO₃-H₂O Systems at 298 K // Cryst. Res. Technol. 1992. Vol. 27, Nr 3. P. 385-394. <https://doi.org/10.1002/crat.2170270317>

2. El Guendouzi M. et al. Water activities, osmotic and activity coefficients of the system (NH₄)₂SO₄-K₂SO₄-H₂O at the temperature 298.15 K // Calphad. 2003. Vol. 27, Nr 4. P. 409-414. <https://doi.org/10.1016/j.calphad.2004.02.002>

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