

NON-ISOTHERMAL DESORPTION OF THIN LAYERS OF AQUEOUS SALT SOLUTIONS

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Abstract. Nonisothermal desorption of the aqueous salt solutions layers on the horizontal heating surface was experimentally investigated. Water solutions of NaCl, CaCl₂, LiBr, LiCl were used. Surface temperature was $T_w=80$ °C. After warming, the desorption rate for salt solutions continuously decreases with increasing time. Evaporation rate of distillate is constant for a long time period. There is a significant growth of the rate at the end of the evaporation, when the film thickness becomes substantially less than 1 mm. Desorber of absorption heat pump can operate without failure when there is a small local (partial) crystallization.

1 Introduction

The efficiency of absorption thermotransformers is determined by the processes of absorption and desorption. The theory of nonisothermal absorption is presented in monograph [1]. The processes of layers nonstationary desorption of aqueous salt solutions can be hardly described by the available theory of nonisothermal sorption, and they need experimental investigation in a wide range of operation parameters. To date, sorption kinetics in the vicinity of the melting point and kinetics at the start of crystallization is poorly studied. Evaporation of liquids was studied in [2-4] and desorption of solutions was considered in [5-7]. The crisis phenomena of liquids at high heating are considered in [8, 9]. Combustion of fuel in a gas-droplet mixture is considered in [10]. Measuring method for non-isothermal flows with thermal imager was presented in [11].

2 Experimental data

To register the current parameters of nonisothermal desorption of the aqueous salt solutions layers on the horizontal heating surface (see fig. 1), we used the experimental method for direct measurements of the weight of the layer. The working section was mounted on a laboratory balance. The values of mass solution concentrations C_0 were determined by the standard densimeters. The thermal field of layer surface (T_s) was measured by the thermal imager. The surface temperature of the heated wall was determined by thermocouples located near the wall with a relative error within 1%. The external pressure was 1 bar. Ambient temperature was 22 °C. Heat transfer law was $T_w=const$. We use titanium as the

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working material allowed experiments with corrosive water solutions of NaCl, CaCl₂, LiBr, LiCl at heating surface temperatures $T_w=80$ °C. In the process of desorption the layer thickness varied from 3 mm to 0.2 mm.

Experimental data on the desorption rate of layers for distillate and aqueous salt solutions are presented in fig. 1.

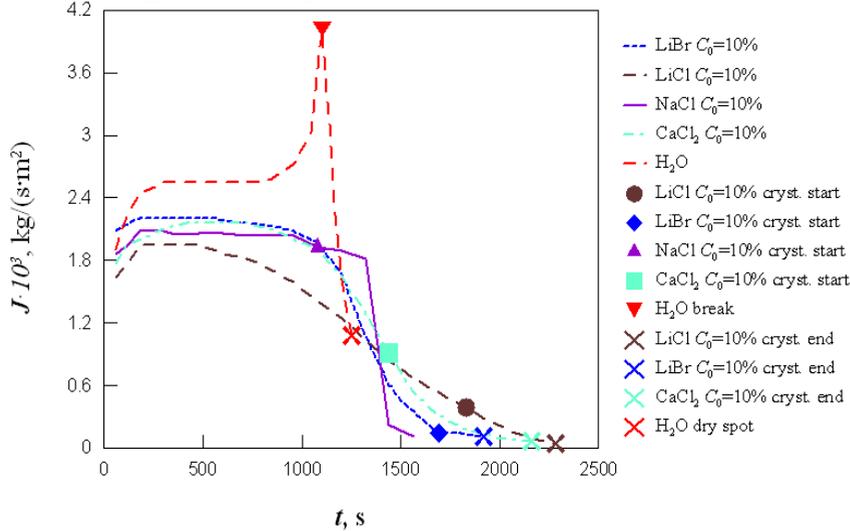


Fig. 1. The evaporation rate for distillate and the desorption rate for solutions ($T_w=80$ °C, the initial salt concentration is 10 %, the initial thickness of the liquid layer is 3.1 mm).

The bold dots (cryst. stat) indicate the beginning of the crystallization of solutions and the beginning of film disruption for distillate. The dots in the form of a cross indicate the end of the crystallization (crys. end). The temperature of heated wall (T_w) was 80 °C. At the initial moment the liquid is heated from the wall and the desorption rate increases. After this warming, the desorption rate for salt solutions continuously decreases with increasing time. Evaporation rate of distillate is constant for a long time period. There is a significant growth of the rate at the end of the evaporation, when the film thickness becomes substantially less than 1 mm.

3 Conclusion

Previously it was believed that in the vicinity of the crystallization the desorption rate is close to zero. However, because of low rate of crystallization front, the desorption rate remains essential for a long time after the onset of crystallization. In this regard, the desorber can operate without failure when there is a small local (partial) crystallization.

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References

1. V.E. Nakoryakov, N.I. Grigorieva, *Nonisothermal absorption in thermotransformers* (Nauka, Novosibirsk 2010)
2. M.V. Bartashevich, O.A. Kabov, V.V. Kuznetsov, *Fluid Dyn.* **45**, 924 (2010)

3. D.V. Feoktistov, I.A. Afanasyev, E.G. Orlova, EPJ Web Conf. **82**, 01054 (2015)
4. S.Y. Misyura, Exp. Thermal Fluid Sci. **70**, 389 (2016)
5. E.G. Orlova, G. V. Kuznetsov, D. V. Feoktistov, EPJ Web Conf. **82**, 01053 (2015)
6. S.Ya. Misyura, Int. J. Therm. Sci. **92**, 34 (2015)
7. S.Y. Misyura, Exp. Thermal Fluid Sci. **75**, 43 (2016)
8. A.N.Pavlenko, A.A. Tairov, V.E. Zhukov, A.A. Levin, A.N. Tsoi, J. Eng. Thermophys. **20** (2011)
9. A.N. Pavlenko, E.A. Tairov, V.E. Zhukov, A.A. Levin, M.I. Moiseev, J. Engineering Thermophys. **23**, 173 (2014)
10. S.Y. Misyura, Energy **103**, 430 (2016)
11. S.L. Elistratov, E.Yu. Slesareva, V.V. Ovchinnikov, J. Engineering Thermophys. **24**, 346 (2015)