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Features of Multicomponent Mass Transfer in Gas Mixtures Containing Hydrocarbon Components

The features characterizing the transition from a diffusion process to the concentration gravitational convection in multicomponent gas mixtures containing hydrocarbon components are analyzed. It is demonstrated that this transition is possible due to the difference in interdiffusion coefficients of components, initial concentration of components, and the pressure of the experiment. A mathematical model for describing the transition from the diffusion process to the concentration gravitational convection in multicomponent gas mixtures is considered. The key feature indicating the transfer from the diffusion regime to the convective one is the curvature of an isoline of the heavy component of the gas mixture.

Keywords: Concentration gravitational convection, Diffusion, Hydrocarbon components, Multicomponent gas mixtures

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1 Introduction

A wide variety of blending modes in multicomponent gas mixtures is determined by the mutual influence of the molecular and convective components of the partial transfer of components [1]. In this case, the fact that molecular diffusion can lead to instability of the mechanical equilibrium of the mixture with the subsequent occurrence of natural convection, which noticeably intensifies the total mass transfer, is practically not taken into account [2]. Moreover, the emergence and development of concentration convection in this case occurs not only within the framework of traditional concepts of Rayleigh's heat tasks [3] for liquid and gaseous mixtures [4, 5], but also in situations where motions occur during stable stratification in an isothermal mixture [6].

In experiments on the study of mixing in multicomponent systems at different pressures and compositions [6], and diffusion of a mixture of solution vapors into an inert gas [2, 7], convective flows were observed leading to a synergistic effect associated with a significant increase in the rate of mixing of the system components. At the same time [6], the predominant transfer of the component with the highest molecular weight was noted, which is not typical for diffusion. Therefore, the solution of issues related to the determination of the mechanism of change of the regimes "diffusion – convection" in multicomponent gas mixtures and the parameters determining the occurrence of the convective mode are important for fundamental and applied problems of convective mass transfer.

Experimental results on the study of diffusion and convective mixing in some ternary gas mixtures containing hydrocarbon components at different pressures are presented. A computational model for the study of isothermal transfer in a ternary mixture by means of 2D modeling in a vertical channel of finite size is proposed. The results of numerical research are compared with experimental data.

2 Experimental

The change of the kinetic regimes "diffusion – concentration convection" was investigated on the example of the following gas mixtures: CH_4 (1) + Ar (2) – N_2 (3); CH_4 (1) + R12 (2) – n-C_4H_{10} (3), 0.5143 He (1) + 0.4857 Ar (2) – 0.5148 CH_4 (3) + 0.4852 Ar (2) at various pressures. The numbers in brackets after the chemical element determine their numbering. The initial composition of the studied systems was chosen so that the

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