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Diffusion and convective instability in multicomponent gas mixtures at different pressures

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Abstract. The instability of mechanical equilibrium in the gas mixtures 0.5538 $H_2 + 0.4462$ N_2 – CH_4 and 0.8846 $H_2 + 0.1154$ CH_4 – He at different pressures is experimentally studied. It is shown, that the convective instability, which significantly intensifies multicomponent mass transfer, occurs as the pressure increase. Within the linear theory of stability, the parameters of the transition from the diffusion mixing to the convective one in a channel of final dimensions are determined. The comparison between the experimental and calculated data shows satisfactory fit between them.

1 Introduction

The study of liquid or gas movements is related to the description of various structural transformations. Almost any condition, as outer conditions change, may have structural transformations [1]. It is obvious that the existence of modes has a threshold nature, and the change of their state is associated with certain values of the dimensionless parameters such as Reynolds, Rayleigh, Mach numbers, etc. The variety of modes of mixing increases significantly in studying the multicomponent systems. The intensity of the heat and mass transfer in them, as a rule, is determined by molecular, convective, and often by the joint action of these regimes [2]. Thus the fact that the process of molecular diffusion may lose stability, followed by the appearance of natural convection [3,4], which significantly intensifies the overall mass transfer, has been practically not taken into account. Moreover, the emergence and development of the concentration gravitational convection is possible not only in the framework of traditional concepts of thermal problems of Rayleigh [1,5,6], but also for the situations when the movements arise in stable stratification of the mixture [7–9]. In multicomponent gas mixtures the instability of mechanical equilibrium, primarily, is due to a difference in the interdiffusion coefficients of the components and the relations between multi-valued partial concentration gradients. As shown by the experiments carried out in [10–12], due to the different mobility of components, stratified on

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