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# The asymptotic expansions of the solution for boundary value problem to a convective diffusion equation with chemical reaction near a drop.

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*Abstract:* The work deals with a boundary value problem for a quasilinear partial elliptical equation. The equation describes a stationary process of convective diffusion near a drop and takes into account the value of a chemical reaction for large Peclet numbers (Pe) and for large constant of chemical reaction. For the problem considered, an asymptotic expansions of solutions on the small parameter ( $\varepsilon = 1/\sqrt{Pe}$ ) is obtained near a drop. Previously, the case of a first-order bulk chemical reaction (linear problem) was investigated. In bisingular problems, the method of matching asymptotic expansions becomes effective. Several boundary and inner layers naturally arise in the vicinity of the drop. In this case, between neighboring areas, it is required to set the conditions of matching. In the boundary and inner layers, the leading terms of the asymptotics of the solutions of the problem are obtained.

Keywords: asymptotic expansions, convective diffusion, matching method, Peclet number.

## Introduction

The boundary value problem is considered

$$\Delta U = Pe(\overline{V}, \nabla) \cdot U + k_v F(U), \tag{1}$$

$$U = 1 \text{ at } r = 1;\ U \to 0 \text{ when } r \to \infty, \tag{2}$$

where

$$\bar{V} = (V_r, V_\theta, 0), V_r = \frac{1}{r^2 sin\theta}\frac{\partial\psi}{\partial\theta}, V_\theta = -\frac{1}{r sin\theta}\frac{\partial\psi}{\partial r}, \tag{3}$$

$$\psi(r,\theta) = (r-1)\left(2r - \frac{\lambda}{\lambda+1}\left(1+\frac{1}{r}\right)\right) sin^2\theta/4, \tag{4}$$

is the stream function, $r$ and $\theta$ are spherical coordinates, $\Delta$ is the Laplace operator, Pe is the Peclet number, and $k_v$ is parameter depending on the chemical reaction rate. The angle $\theta$ is measured relative to the free-stream direction.

It is assummed that F(C) is continuous and

$$F: R^1 \to R^1,\ F(0) = 0,\ 0 < F'(U), \tag{5}$$

$$F(u) = u + F_2 u^2 + F_3 u^3 + \cdots + F_k u^k + O(u^{k+1}) \tag{6}$$

Problems analogous to (1), (2) and a broader class of problems, were considered in [1]. In the absence of chemical reaction (i.e., with $k_v = 0$), problem (1), (2) was analyzed in [1-3] by the method of matched asymptotic expansions [4].

In this paper, we construct asymptotic expansion of solutions for the problem (1) - (2) in the boundary layer near the drop.

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