J. Sharikadze

I. Javakhishvili Tbilisi State University
Tbilisi, Georgia

EQUATIONS OF DYNAMIC, TEMPERATURE AND MAGNETIC BOUNDARY LAYERS AND THEIR INTEGRATION

Space in which usually happens the action of magnetic field on the motion of conducting fluid for the large meaning of Reynolds magnetic number is called magnetic boundary layer.

We have two kinds of magnetic boundary layer. Vector tensity of magnetic field in the first kind of magnetic boundary layer is in the plane of vector velocity. And the angle between the magnetic field and the velocity is small. Magnetic field in the second kind of magnetic boundary layer is normal for the both components of vector velocity.

We can write equations of dynamic, temperature and magnetic boundary layers for the both cases:

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}=\frac{\partial u_\infty}{\partial t}+u_\infty\frac{\partial u_\infty}{\partial x}+\nu\frac{\partial^2 u}{\partial y^2}+\frac{\alpha}{\rho\mu_0}\Big(B_x\frac{\partial B_x}{\partial x}+B_y\frac{\partial B_x}{\partial y}\Big),$$

$$\rho c_\tau\Big(\frac{\partial T}{\partial t}+u\frac{\partial T}{\partial x}+v\frac{\partial T}{\partial y}\Big)=\lambda\frac{\partial^2 T}{\partial y^2}+\eta\Big(\frac{\partial u}{\partial y}\Big)^2+\frac{1}{\sigma\mu_0^2}\Big(\frac{\partial B_x}{\partial y}\Big)^2,$$

$$\frac{\partial B_x}{\partial t}+u\frac{\partial B_x}{\partial x}+v\frac{\partial B_x}{\partial y}=\alpha\Big(B_x\frac{\partial u}{\partial x}+B_y\frac{\partial u}{\partial y}\Big)+\nu_m\frac{\partial^2 B_x}{\partial y^2},$$

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}=0,\quad \alpha\Big(\frac{\partial B_x}{\partial x}+\frac{\partial B_y}{\partial y}\Big)=0,$$

and conditions:

$$u=v=0,\quad T=T_w(x,t),\quad B_x=B_w(x,t),\quad y=0,$$

$$u=u_\infty(x,t),\quad T=T_\infty=\text{const},\quad B_x=B_y=0,\quad y\to\infty,$$

$$u=v=T=B_x=B_y=0,\quad t=0;\quad B_w(x,0)=u_\infty(x,0)=T_w(x,0)=0.$$

In the case, where $\alpha=1$, we have the equations of the first kind of magnetic boundary layer, and in the case, where $\alpha=0$ and $B_x=B_z$, we have the equations of the second kind of magnetic boundary layer.

There are two methods of solving a system of equations in the report. They are based on the asymptotical approximation of boundary layer and on the method of finiteness thickness of boundary layer.

In the first case the solution of the systems reduce to the solution of an integro-differential equation, in which the method of successive approximations is used. In the second case method of successive approximations helps us to determine thickness of boundary layer: δ_u, δ_T, δ_B. For them we may write the system of partial equations of the first order.

All physical properties of boundary layer are found.