On steady solutions to the MHD equations with inhomogeneous impermeability boundary conditions for the magnetic field

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We deal with the system of stationary MHD equations for the unknowns $\mathbf{u}$ (velocity) and $\mathbf{b}$ (magnetic field) in a bounded generally multiply connected smooth domain Ω. We consider the no-slip boundary condition $\mathbf{u} = \mathbf{0}$ on $\partial\Omega$ and we explain what boundary conditions for $\mathbf{b}$ can be considered depending on the electrical properties of the material surrounding Ω. Then we use the inhomogeneous impermeability boundary conditions $\mathbf{b} \cdot \mathbf{n} = \alpha_0$ and $\mathbf{curl}\, \mathbf{b} \cdot \mathbf{n} = \alpha_1$ on $\partial\Omega$, completed by the two conditions $P\mathbf{b} = \mathbf{b}^0$, $P \operatorname{curl} \mathbf{b} = \mathbf{b}^1$, where P is a projection of $\mathbf{L}^{\mathbf{r}}(\Omega)$ onto the finite–dimensional subspace, formed by divergence–free vector functions with zero vorticity and the normal component on the boundary in some sense equal to zero. We discuss the solvability and some other properties of the corresponding boundary–value problem.