International Workshop on Flow Control by Tailored Magnetic Fields
Collaborate Research Center SFB 609, Dresden, April 1-2, 2004

MAGNETOHYDRODYNAMIC DRAG REDUCTION AND EFFICIENCY

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Two cases are considered in order to study possible drag reductions due to the action of electromagnetic forces.

1. A direct numerical simulation of a turbulent channel flow is performed. The unsteady Navier-Stokes equations and Poisson electric potential equation are solved at a Reynolds number $Re_l = 3000$ and 6000, based on the laminar centreline velocity V_o and channel half-width d. The τ-collocation spectral method developed by J. Kim. $et\ al.$ is used. The Crank-Nikolson method for the viscous and a third-order Runge-Kutta method for the nonlinear term and the Lorentz force are applied. The resolution was $64 * 65 * 64$ in the streamwise, wall-normal and spanwise directions.
For an electromagnetic actuator consisting basically of a spanwise oscillating force, we analysed the drag reduction and its efficiency for various load numbers κ. It is shown that using the load number $\kappa \sim 1$ leads to a significant increase of the efficiency in comparison to the $\kappa \sim 1000$ case.

Results of this study will soon be submitted for publication.

2. For the flow around a sphere we found an internal alternating electromagnetic field source which leads to a strong drag reduction. The analysis is done in the Stokes approximation analytically and then at Reynolds number $Re \sim 300$ numerically using a pseudospectral code. A simple gradient-type optimization was applied in order to tailor the magnetic field source for the purpose of a reduced drag. We considered the simplified case (decoupling of fluid flow and electromagnetic fields) of large load numbers, with the drawback that the strong drag reductions obtained are certainly inefficient from the energetical point of view.

For detailed results we refer to the paper "Electromagnetic flow control leading to a strong reduction of a sphere" submitted to "Fluid Dynamics Research".