513th Euromech Colloquium on "Dynamics of non-spherical particles in fluid turbulence"
Udine, Italy, April 6-8, 2011

Fibre suspension flow inside straight and converging channels

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The behavior of rigid and deformable fibers suspended in turbulent flow in a straight channel and a planar contraction will be discussed. The effect of volume fraction and the channel Reynolds number on velocity profile inside the channel will be presented based on Pulsed Ultrasonic Doppler Velocimeter.

The impact of turbulence on orientation anisotropy in a converging channel based on measurement of orientation at different streamwise positions with clearly defined turbulent conditions at the inlet and turbulent flow variations along the contraction will be considered next. First the case of dilute fiber suspension where $nL^3<1$ will be discussed. In this case, fibre–fibre interactions and the effect of the fibres on the flow rheology become negligible. Nearly homogeneous isotropic grid turbulent flow is introduced at the channel inlet and its variation in the contraction is measured. Since the influence of turbulence on orientation anisotropy can be expressed by an orientational diffusion coefficient, the factors affecting this coefficient will be discussed. The effect of inlet flow characteristics in contrast to turbulence produced in the contraction will be presented. Specifically, it will be shown that turbulent intensity decays exponentially with contraction ratio, C, where C is defined as the ratio of the local height and the inlet height . At $C > 4$, turbulent intensity becomes very small but finite due to small production of turbulent energy. However, in this region (i.e., $C > 4$) the effect of turbulence on fibre orientation becomes negligible where the effect of mean velocity gradient on fibre orientation becomes dominant. To effectively represent the competing roles of turbulence and mean velocity gradient on fibre orientation distribution in the contraction, the results will be presented based on the rotational Peclet number.

The effect of fibre deformation on rheology of dilute to concentrated fibre suspension flow will be discussed based on direct computational simulation of fiber suspension in shear flow.

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