FIBRE SUSPENSION FLOW – MECHANISM, MODELS and MEASUREMENTS

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Fibre suspensions are different from conventional, non-settling, non-aggregating particulate suspensions. Wood pulp fibres, certain polymeric filaments, and some high aspect-ratio particles develop 'suspension structure' which alters the nature of the suspension and hence the flow characteristics. The *state* of the suspension and factors such as fibre flexibility may overrule particle size and distribution. There are four different 'particles'; fibres, flocettes, flocs and networks. Each exhibits unique features. Fibres can 'connect' with neighbouring eddies and either transmit momentum or can bend and deflect to absorb energy. This 'competition' leads to the drag reducing character (friction loss below water) which can be quite large. As fibre population increases, free fibre movement is inhibited and small unstable aggregates form that allow other mechanisms to come into play. These new 'particles' (called flocettes) interact dynamically with the liquid as well as themselves, resulting in visco-elastic effects which are significant. At slightly higher concentrations the flocette fibre bundles develop coherence and mechanical structure (flocs). It is not just a crowding phenomenon but a mechanical linkage of fibres giving the flocs plastic-elastic characteristics. These agglomerates may have a range of sizes but take on a mean value depending on fibre type and fibre characteristics. This leads to a third type of 'particle' called flocs which dominates in many practical applications and governs many processes. The fourth network 'particle' is made up of these flocs and usually takes the shape of the vessel or conduit. To make matters more complex, there are many situations where all four 'particles' co-exist and their individual contributions lead to some very important shear mechanisms.

Various aspects of fibre suspension flow behaviour will be discussed and illustrated. Some unique features of fibres suspension flow will be described. The raft of flow models that are presented in the literature will be reviewed and realistic models based on experimental observation and evidence will be presented. Various flow mechanisms will be elucidated based on the addition of polymers and other additives to the suspension. The special flow case in small conduits (tubes, gaps and screens) will be described and two novel screening techniques will be presented. The visco-elastic character and drag reducing behaviour of fibre suspension will also be covered as well as some interesting techniques to quantify fibre characteristics and hence suspension flow behaviour. Other methods will also be reviewed briefly and practical design procedures will illustrate the value of understanding why fibre suspensions are so different from conventional slurries.