EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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COST Action FP1005.

Fibre suspension flow modelling

A key for innovation and competitiveness in the pulp & paper industry

2011 | 2015

Objectives

- The main objective of the Action is to promote and disseminate validated computer modelling and simulation techniques in papermaking industry.
- Establishment of Knowledge Base for simulated and measured data of test problems defined in the Action.
- Preparation and publication of Best Practice Guidelines for modelling fibre suspension flows (including a review of experimental methods).

Training for young researchers via workshops, STSMs, training schools.

- Joint projects launched by Action members.
- Exchange of experience, sharing good practice in using simulation software, experimental methods, development of research tools.
- Survey of state of use of CFD and other numerical methodologies in industry.

Main Achievements

- Rapid set up of effective WG activity through successful meetings.
- Definition of industrially-relevant test problems for each focus area of the Action.
- Rapid set-up of the Action's website which includes (among its features) a dedicated Knowledge Base repository section.
- Development of scientifically homogeneous and quantitatively numerous working groups with significant involvement of young researchers.
- Diffuse awareness of expertise and scientific research areas covered by Action participants.
- Active networking among participants, especially ESRs, through meetings, workshops, STSMs and training schools.
- Production of joint scientific publications already in the first year of the Action.

Forests, their Products and Services (FPS)

Participating countries

AT, CH, DE, ES, FI, FR, IT, IL, NL, NO, PL, PT, RO, SI, SE, UK

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1st Training School on Experimental Methods for Fiber Suspension Flows

1st International Workshop on Non-Spherical Particles (jointly with Action MP0806)

COST is supported by the EU RTD Framework Programme

ESF provides the COST Office through a European Commission contract

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Working Group activities

Working Group 1 - Experimental Methods

Measuring rheological pulp properties and developing related non-Newtonian viscosity models is crucial for high-consistency fibre suspensions. Due to extremely complex non- Newtonian pulp behaviour existing rheometers fail to capture adequately pulp material properties. Information on macroscopic flow properties of fibre suspensions obtained via pressure difference measurements is insufficient as well. This WG will share information between research groups developing experimental methods for dilute/dense fibre suspensions and non-Newtonian media, aiming at combining the best features from different experimental methods to advance current measuring techniques. Measurements will also provide valuable data for: I) non-Newtonian viscosity and multi-phase flow modelling in a wide range of consistencies; II) correlations between fibre properties and pulp macro properties (apparent viscosity); use of non-invasive techniques to evaluate fibre suspensions flow characteristics (Electrical Impedance Tomography, Ultrasonic Doppler Velocimetry, Nuclear Magnetic Resonance, High Speed Imaging).

Working Group 2 - Rheological Modelling

Fibre suspensions may be considered as one-phase flows, when average consistency is high enough and no significant consistency variations occur in the flow. Continuous fibre networks can then be modelled using an "effective medium" approach, i.e. using non- Newtonian viscosity models for the mixture of water and fibres. In this WG pulp behaviour is predicted using single-phase continuum rheology. Critical scientific challenges are: I) development of generalized-Newtonian viscosity models and fully non-Newtonian rheology models; II) determination of model parameters; III) link fibre-level properties to pulp properties; IV) modelling turbulence damping and modifications caused by fibres and flocks; V) application of the single-phase models to complex suspensions made up of fibres, fillers, retention aids and gases. Shear-thinning viscosity models are one example of generalized-Newtonian models applicable to high-consistency suspensions. Model parameters will be derived from fibre properties and fitted using measured data. Relevance and applicability of more complex non-Newtonian models capturing elasto-visco-plastic behaviour of material under shear and normal forces will also be evaluated.

Working Group 3 - Multi-phase flow modelling

Fibre suspensions are multi-phase flows consisting of liquid carrier phase (water), solids (fibres and fillers) and gas (air bubbles). Such flows can be modelled using a Lagrangian or a Eulerian approach. Lagrangian means that all individual fibres and air bubbles are tracked during simulations. Eulerian means that the evolution of all phases is described with averaged phase equations coupled via interaction terms. In this WG: I) Lagrangian simulations are performed to predict fibre orientation and fibre flocculation and to produce data for validation of Eulerian models; II) Eulerian models for fibre-level and floc-level simulations are developed and the influence of fibre properties (shapes, surface, stiffness) on model parameters investigated; III) fibre-fibre, fibre-wall, fibre-turbulence interactions are modelled; IV) Eulerian and Lagrangian approaches are compared.

Industry participation

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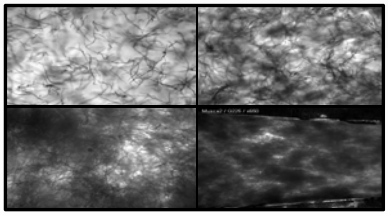
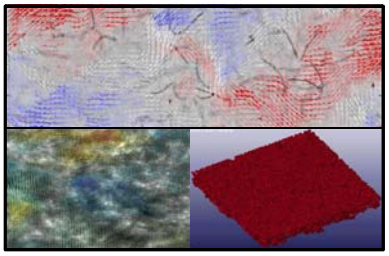


Fiber suspension at varying consistency



CFD simulation of fiber suspension flows

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