

COST

Domain Committee "Forests, their Products and Services (FPS)"

COST Action FP1005

Start Date May 11, 2011

Fibre suspension flow modelling: a key for innovation and competitiveness in the pulp & paper industry

MONITORING PROGRESS REPORT

Reporting Period: from 11 May 2010 – 31 December 2011

This Report is presented to the relevant Domain Committee.
It contains three parts:

- I. Management Report** prepared by the COST Office/Grant Holder
- II. Scientific Report** prepared by the Chair of the Management Committee of the Action
- III. Previous versions of the Scientific Report;** i.e., part II of past reporting periods

The report is a "cumulative" report, i.e. it is updated annually and covers the entire period of the Action.

Confidentiality: the documents will be made available to the public via the COST Action web page except for chapter II.D. *Self evaluation*.

Based on the monitoring results, the COST Office will decide on the following year's budget allocation.

Executive summary (max.250 words):

During the report period, the Action has been successful in achieving its scientific and technical objectives. These include establishing links with other Actions, setting up and running a website, organizing its first joint MC/WG meeting, held in Nancy (France) and attended by 30 delegates. During the meeting 20 scientific presentations (available online) were given, aimed at diffusing awareness of expertise and specific research areas covered by Action participants (currently, 70 scientists from 16 COST countries and 3 non-COST countries, 1 of which is pending). Industrially-relevant test problems, covering each scientific focus area of the Action, were selected during parallel WG meetings. Test problems involve experimental measurements and numerical simulations of fibers suspensions with varying consistencies, targeted at flow configurations common in pulp- and paper-making. Guidelines have been produced and made available online.

The STSM programme for young scientists has been initiated: three STSMs were approved during the report period and are currently under way. It is planned to support at least eight STSM during the first Grant Period.

Another notable success of the Action has been the large involvement of Early Stage Researchers.

Plans for 2012 include a MC/WG meeting in March (aimed at fostering data production within the proposed test problems, establishing the Knowledge Base and stimulating networking among WGs), a training school to be held in Sweden and Finland in late spring/early summer, and an International Workshop on "Non ideal particles and aggregates in turbulence", organized jointly with COST Action MP0806 to encourage dissemination activities.

I. Management Report prepared by the COST Office/Grant Holder

I.A. COST Action Fact Sheet

- **COST Action FP1005** - Fibre suspension flow modelling: a key for innovation and competitiveness in the pulp & paper industry
- **Domain** Forests, their Products and Services (FPS)

- **Action details:**

CSO Approval: 2/12/ 2010

End date: 10/5/2015

Entry into force: 20/01/2011

Extension: -----

- **Objectives** TO PROMOTE AND DISSEMINATE VALIDATED COMPUTER MODELLING AND SIMULATION TECHNIQUES IN PAPERMAKING INDUSTRY.

- **Parties:** list of countries and date of acceptance

Austria 09/03/2011	Greece (date)	Poland 31/01/2011
Belgium (date)	Hungary (date)	Portugal 20/01/2011
Bulgaria (date)	Iceland (date)	Romania 25/08/2011
Croatia (date)	Ireland (date)	Serbia (date)
Cyprus (date)	Israel 21/11/2011	Slovakia (date)
Czech-Rep. (date)	Italy 20/01/2011	Slovenia 12/07/2011
Denmark (date)	Latvia (date)	Spain 20/01/2011
Estonia (date)	Lithuania (date)	Sweden 10/05/2011
Finland 21/01/2011	Luxembourg (date)	Switzerland 06/04/2011
FYR of Macedonia (date)	Malta (date)	Turkey (date)
France 21/01/2011	Netherlands 31/01/2011	United Kingdom 20/01/2011
Germany 20/01/2011	Norway 06/04/2011	

- **Intentions to accept:** -

- **Other participants:**

University of British Columbia – Pulp and Paper Centre, Canada
University of Sao Paulo - Polytechnic School, Brazil

Chair: Cristian Marchioli, International Center for Mechanical Sciences (CISM), P.zza Garibaldi 18, 33100 Udine (Italy), +39 0432 558006, marchioli@uniud.it, marchioli@cism.it

DC Rapporteur: Andras Vig, Hungarian Academy of Sciences Faculty of Chemical Engineering Budapest University of Technology and Economics, Budafoki ut 8.1111 Budapest (Hungary), +36 1 463 2102 avig@mail.bme.hu

Science Officer:

Melae Langbein fps@cost.eu

Administrative Officer:

Cassia Azevedo fps@cost.eu

- **Action Web site:** <http://www.fp1005.cism.it/>

- **Grant Holder Representative:** Antonio Vinicio Turello (Legal Representative)
Mario Pezzetta (Financial Representative) cism@cism.it

- **Working Groups:** (list of WGs and names and affiliations of participants)

WG1: Experimental techniques for fibre suspension flows

WG1 Leader: Juha Salmela (FI)

Members of WG: Wolfgang Bauer (AT), Capone Alessandro (IT), René Delfos (NL), René Eckhart (AT), Benjamin Fabry (DE), Pedro Faia (PT), Paulo Ferreira (PT), Fredrik Lundell (SE), Janne Poranen (FI), Fernando Rosa (PT), Jean-Claude Roux (FR), Martine Rueff (FR), Juha Salmela (FI), William Sampson (UK), Salaheddine Skali-Lami (FR), Alfredo Soldati (IT), Bartek

Stawicki (NL), René van Hout (IL), Angeles Blanco (ES), Florin Ciolacu (RO), Petronela Nechita (RO), Enrico Calzavarini (FR), Pentti Saarenrinne (FI), Johanna Liukkonen (FI), Antti Koponen (FI), Sanna Haavisto (FI), Nejc Zakrajsek (SI), Sergej Medved (SI), Jari Käyhkö (FI), Patrick Huber (FR), Vera Rutar (SI), Erik Dahlquist (SE), Carlos Negro (ES)

WG2: Predicting pulp behaviour with single-phase models

WG2 Leader: Maria Graça Rasteiro (PT)

Members of WG: Andreas Anzel (DE), Matthaus Babler (SE), Angeles Blanco (ES), Florin Ciolacu (RO), Elena De La Fuente (ES), Paulo Ferreira (PT), Fernando Garcia (PT), Patrick Huber (FR), Jari Käyhkö (FI), Pier Luca Maffettone (IT), Amin Moosaie (DE), Carlos Negro (ES), Maria Graça Rasteiro (PT), Jean-Claude Roux (FR), Martine Rueff (FR), Vera Rutar (SI), Salaheddine Skali-Lami (FR), Roland Zelm (DE)

WG3: Modelling fibre suspension flows with multi-phase models

WG3 Leader: Bendiks Boersma (NL)

Members of WG: Sven Altmann (DE), Helge Andersson (NO), Jean Regis Angilella (FR), Andreas Anzel (DE), Dariusz Asendrych (PL), Matthaus Babler (SE), Bendiks Boersma (NL), Sergio Chibbaro (FR), René Delfos (NL), Enrico Calzavarini (NL), Pascal Fede (NL), Harald Grossmann (DE), Jari Hämäläinen (FI), Mohammed Khalij (FR), Gregorz Kondora (PL), Timo Kuntzsch (DE), Cristian Marchioli (IT), Jan Matheas (DE), Gilmar Mompean (FR), Amin Moosaie (DE), Christopher Nilsen (NO), Francesco Picano (SE), William Sampson (UK), Gaetano Sardina (SE), Alfredo Soldati (IT), Erik Svenning (SE), Anne Tanière (FR), Heiko Thoemen (CH), Berend Van Wachem (UK), Micheal Wilkinson (UK), Lihao Zhao (NO)

I.B. Management Committee member list

<i>Name</i>	<i>Country</i>	<i>E-mail</i>
<i>Wolfgang BAUER</i>	<i>Austria</i>	wolfgang.bauer@tugraz.at
<i>Janne PORANEN</i>	<i>Finland</i>	Janne.Poranen@vtt.fi
<i>Jari HAMALAINEN</i>	<i>Finland</i>	jari.hamalainen@lut.fi
<i>Jean-Claude ROUX</i>	<i>France</i>	jean-claude.roux@pagora.grenoble-inp.fr
<i>Salaheddine SKALI-LAMI</i>	<i>France</i>	Salaheddine.Skali-Lami@ensem.inpl-nancy.fr
<i>Sven ALTMANN</i>	<i>Germany</i>	sven.altmann@ptspaper.de
<i>Harald GROSSMANN</i>	<i>Germany</i>	harald.grossmann@tu-dresden.de
<i>Rene VAN HOUT</i>	<i>Israel</i>	rene@technion.ac.il
<i>Alfredo SOLDATI</i>	<i>Italy</i>	soldati@uniud.it
<i>Bartek STAWICKI</i>	<i>Netherlands</i>	bartek.stawicki@gmail.com
<i>Bendiks BOERSMA</i>	<i>Netherlands</i>	b.j.boersma@tudelft.nl
<i>Helge ANDERSSON</i>	<i>Norway</i>	helge.i.andersson@ntnu.no
<i>Dariusz ASENDRYCH</i>	<i>Poland</i>	darek@imc.pcz.czest.pl
<i>Maria Graca RASTEIRO</i>	<i>Portugal</i>	mgr@eq.uc.pt
<i>Fernando ROSA</i>	<i>Portugal</i>	a.rosa@pradocartonboard.com
<i>Petronela NECHITA</i>	<i>Romania</i>	petronela.nechita@ceprohart.ro
<i>Florin CIOLACU</i>	<i>Romania</i>	florinciolacu@yahoo.com
<i>Nejc ZAKRAJSEK</i>	<i>Slovenia</i>	Nejc.Zakrajsek@minet.si
<i>Sergej MEDVED</i>	<i>Slovenia</i>	sergej.medved@bf.uni-lj.si
<i>Angeles BLANCO</i>	<i>Spain</i>	ablanco@quim.ucm.es
<i>Fredrik LUNDELL</i>	<i>Sweden</i>	fredrik@mech.kth.se
<i>Erik DAHLQUIST</i>	<i>Sweden</i>	erik.dahlquist@mdh.se
<i>Heiko THOEMEN</i>	<i>Switzerland</i>	heiko.thoemen@bfh.ch
<i>William SAMPSON</i>	<i>United Kingdom</i>	w.sampson@manchester.ac.uk
<i>Berend VAN WACHEM</i>	<i>United Kingdom</i>	b.van-wachem@imperial.ac.uk

I.C. Overview activities and expenditure

(year) Budget

Total Action Budget: 90,000 €

Remaining Action Commitment: 61855.02 €

Meetings

Meeting Type	Date	Place						Cost	Total
Joint MC/WG Meeting	13-14 October 2011	INPL Nancy						24548.68	24548.68

STSM

Beneficiary	Date	Place						Cost	Total
									0

Workshops

Title	Date		Place						Cost	Total
	From	To	From	To						
										0

General Support Grants

Beneficiary	Date							Cost	Total
									0

Schools

Title	Date	Place						Cost	Total
									0

Dissemination

Title	Date	Place						Cost	Total
									0

Others

Title	Cost	Total
FSAC	3596.30	3596.30

Action Total : 28,144.98

II. Scientific Report prepared by the Chair of the Management Committee of the Action, describing results achieved during the Action operation in this period, in no more than 3 pages (the report is “cumulative”). All items listed in Sections A, B, and C, below, must be addressed.

Additional documentation such as extended scientific reports, proceedings of workshops, seminars or conferences may be provided separately as an annex to this report, and should be referenced in the report.

II.A. Innovative networking

- *Innovative knowledge resulting from COST networking through the Action. (Specific examples of Results vs. Objectives)*

During the first 7 months of activity, innovative knowledge has been provided both in the field of numerical simulations of fiber suspensions (and in particular in the characterization of pulp suspensions in pipe flow through CFD software) and in the field of experimental measurements of fiber orientation and deformation in dilute suspensions. The advancements just highlighted have been achieved through collaborations developed within the Action and during the MC/WG meeting (not pre-existing) and have brought to 3 ERS's applications for STSMs in the period January-May 2012.

- *Significant scientific breakthroughs as part of the COST Action. (Specific examples)*

The main scientific breakthrough of the Action obtained during this first period of activity has been the definition of industrially-relevant test problems for experiments and simulations. Test problems have been selected during the Meeting held at INPL in Nancy in October 2012 within each working group: WG1 and WG3 have proposed one test problem for dilute suspensions (fiber motion in fully-developed flow fields – water table and/or closed channel), WG1 and WG2 have proposed one test problem for dense suspensions (parametrization of fiber suspension rheological properties: viscosity, crowding factor, contact number). WG3 has also proposed alternative flow geometries that are commonly encountered in the papermaking process (sudden expansion, headbox converging channel). Test problems have been selected so that users of different experimental methods can compare their methods in specific flow problems, while users of different modelling approaches can carry out comparison of numerical solutions. Users of experimental methods and CFD models include specialist from universities or research institutes, but also specialists from industry and consulting companies. Once available, both the simulated and measured data of the test problems will be stored to a public access-free Knowledge Base.

- *Tangible medium term socio-economic impacts achieved or expected. (Specific examples)*

As the Action has only been in place for 7 months at the time of this report, no socio-economic impact has been achieved so far and it is not clear at present what kind of impacts can be expected.

- *Spin off of new EC RTD Framework Programme proposals/projects. (List)*

There has been no spin off of new EC RTD Framework Programme proposal so far.

- *Spin off of new National Programme proposals/projects. (List)*

There has been no spin off of new National Programme proposal so far.

II.B. Inter-disciplinary networking

- *Additional knowledge obtained from working with other disciplines within the COST framework. (Specific examples)*

Because this is the first year the Action has been set up, The Action has not yet benefited substantially from the input of a wide range of disciplinary expertise. For the time being, the additional scientific knowledge obtained from working with other disciplines during the report period is concerned with the development of modelling techniques for predicting adequately the behaviour of pulp suspensions. It appears necessary to carry out the scientific activity along two different simulation strategies: pulp treated as either single-phase continuum and suspensions with fibres as discrete objects carried by a liquid. With the latter two-phase fluid concept, fibre motion may be modelled using Eulerian as well Lagrangian approaches. Advanced experimental methods for fibre suspension flow are judged mandatory to assess reliability of different modelling approaches and determine material parameters of fibres and suspension.

- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide scientific impacts. (Specific examples)*

During the 1st MC/WG Meeting of the Action, a number of presentations have been given to provide a better picture of the level of inter-disciplinarity potentially allowed by the Action. It turns out that fibre suspension flows can be found in many industrial applications, not only in the pulp and paper sector. Thus, the COST Action is expected to serve as a European forum to share experiences of fibre suspension flow research, both numerical and experimental, in various applications like polymer and textile industries. Other important examples of applications where Action FP1005 can provide significant scientific impact through inter-disciplinary networking are:

- Fibre based insulation materials - in their production the control of fibre orientation and "flocculation" are very important,
- Reduction of CO₂ emission in coal-fired plants by co-firing additive of biomass (fibrelike structure made up of long cellulose chains),
- Fibre-induced drag reduction in turbulent flows.

Moreover, rheological laws applied in pulp flow modelling may also be useful for predicting behaviour of other, than fibre suspensions, fluids (food processing, cosmetics etc.).

- *Evaluation of whether the level of inter-disciplinarity is sufficient to potentially provide socio-economic impacts. (Specific examples)*

For the time being, it is not easy to evaluate the socio-economic impact that the level of inter-disciplinarity can produce. The development of a Knowledge Base is designed to bring industrial partners from different sectors (not only pulp and paper) into the Action. It is intended that this will be the nexus for getting the evidence on best practice arising from the Action into pulp and paper industries rapidly. If this is successful, there will be clear socio-economic impacts.

II.C. New networking

- *Additional new members joining the Action during its life.*

This is the first year of the Action: all members are new. After the Action's kick-off meeting (May 11, 2011), we have had 4 further MC members (P. Nechita and F. Ciolacu from Romania, R. Van Hout from Israel and B. Van Wachem from UK), 2 countries that have accepted the MoU (Slovenia and Sweden) and 2 new countries represented in the MC (Romania and Israel) for a current total of 16 countries.

- *Total number of individual participants involved in the Action work. (Number of participants. Give % of female and of Early Stage Researcher participants)*

The total number of participants currently involved in the Action work is 68.

The percentage of female participants is 14%. It is not easy to increase the percentage due to the scarce involvement of female researchers in the field.

The percentage of ESR is 41%. Efforts have been (and will be) taken to attract more ESRs: one initiative has been to advertise the Action and the possibility of funding STSMs through

the Welcome Office FVG portal:

<http://www.welcomeoffice.fvg.it/news/short-term-mission-opportunities-for-researchers.aspx>

- *Involvement of Early Stage Researchers in the Action, in particular with respect to STSMs, networking activities, and Training Schools. In addition, justification should be provided if fewer than 4 STSMs were carried out during the year.*

Both the Action Chair (Marchioli) and Vice-Chair (Lundell) are ESR, the WG1 leader (Salmela) is ESR, all beneficiaries of STSMs approved so far by the MC (and currently under way as I write) are ESR. The training school approved by the MC and scheduled in June 2012 is organized by ESR (Lundell, Salmela, Poranen).

- *Involvement of researchers from outside of COST Countries. (Number of participants from non-COST Countries approved by the CSO. Give % of such participants from countries with reciprocal agreements. Specify their contribution)*

Currently we have 2 participants from non-COST countries that have been already approved by the CSO:

- University of British Columbia (UBC) – Pulp and Paper Centre, Canada: UBC is one of the leading universities worldwide conducting research in the field of fiber suspension flows in all focus areas covered by the Action. In particular, UBC contributes with measurements and simulations of yield stress fluids in a range of natural and industrial settings.
- University of Sao Paulo (USP) - Polytechnic School, Brazil: USP contributes with measurements of fiber and bubble flows for experimental techniques used for fiber suspension analysis and will develop models for multiscale multiphysics flow of fibers in water. In particular, USP will simulate pulp chest agitation.

A third participant (University of California Davis – USA) has been already approved by MC and is waiting for CSO approval.

The percentage of participants from non-COST countries with reciprocal agreements is 0%.

- *Advancement and promotion of scientific knowledge through publications and other outreach activities. (Number of publications and other outreach activities that resulted from COST networking through the Action. Complete list should be given in an annex)*

Since the Action has been set up less than one year ago, promotion of scientific knowledge through publications has been limited. The following publications have been produced:

- L. Zhao, C. Marchioli, H. Andersson “Stokes number effects on particle slip velocity in wall-bounded turbulence and implications for dispersion models”, *Phys. Fluids*, Accepted for Publication
- M. G. Rasteiro, C. Marchioli, F. Lundell, D. Asendrych, J. Salmela, J. Hämäläinen “FPS COST Action FP1005 Fibre suspension flow modelling - a key for innovation and competitiveness in the pulp & paper industry”, *XVIth International Congress on Rheology* – Lisbon, August 5-10, 2012.

More are in preparation and will be included in the next monitoring progress report.

- *Activities and projects with COST network colleagues.*

There has been no common activity with other COST Actions so far. We plan to organize a joint International Workshop on “Non-ideal particles and aggregates in turbulence” (website: <http://frag2012.le.isac.cnr.it/index.php>) together with COST Action MP0806 “Particles in Turbulence”. Among the several sessions of the Workshop, some will be focused on topics related to fiber suspension flow modelling.

- *The capacity of the Action members to raise research funds.*

The capacity of the Action members to raise research funds is being developed. Currently, one of the MC members (H. Thoemen, CH) has submitted a proposal entitled “Modeling heat and moisture flow through a wood-fiber network during calendaring of paper sheets” to the Swiss under the auspices of COST Action FP1005.

II.D. Self evaluation

COST Action FP1005 started 7 months ago, with the kick-off meeting in May 2011 followed by the first MC/WG Meeting was held in October 2011. In such a “short” amount of time, the main successes can be summarized as follows:

- Rapid set up of effective WG activity
- Definition of industrially-relevant test problems for each focus area of the Action
- Development of scientifically homogeneous and quantitatively numerous working groups
- Diffuse awareness of expertise and scientific research areas covered by Action participants
- Active networking among participants, especially ESRs, through meetings, forthcoming STSMs and training schools

Drawbacks:

- The main drawback experienced within Action FP1005 is concerned with the involvement of industrial representatives. It has been hard to get feed-back from the industrial counterparts that have been contacted, especially those from the northern European countries. As a result, only a minor proportion of participants comes from the pulp and paper industry, and none has a role of responsibility in the organization of the Action. Also, the contribution of industrial representatives has been less than expected in the definition of the first test problems selected.

Key difficulties:

- The main difficulty is concerned with management of the Action by an Italian Grant Holder. Italian fiscal laws are different from COST rules in terms of flat rate reimbursements and VAT issues: it took a lot of time to cope with (and overcome) such differences, with the result that the start of the Grant period had to be delayed, making it difficult to organize the first MC/WG Meeting.
- Another difficulty is related to industrial involvement in the Action activities. There is still a significant gap between the extremely complex, real-life problems that the pulp and paper industry must live with and the simplified problems that can be tackled by academia through simulation and experiments: the more complex these problems are made, the less accurate their prediction will be. One of the future challenges of the Action will certainly be to narrow down such gap by producing models that can be actually used by industry. Another challenge, related to the drawback discussed above, will be to stimulate the interest of industrialists in being active characters within the Action.

III. Previous scientific report(s)

Not applicable.