

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 01 January 2012 – 31 December 2012

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, which encompasses the second half of the first Grant Period (GP1) and the first half of GP2, the Action successfully achieved the following objectives:

- (1) Strengthening links with other Actions, MP0806 "Particles in Turbulence" in particular.
- (2) Updating the website: it now includes a "Knowledge Base" section with data repositories from experiments and simulations of fiber suspension flows of relevance to papermaking.
- (3) Organizing two joint MC/WG meetings, in Brussels (Belgium) and Trondheim (Norway), each attended by 30 delegates. The Trondheim meeting included the 4th Workshop of ERCOFTAC's Special Interest Group on "Fiber Suspension Flows": 20 presentations (available at <http://www.fp1005.cism.it/>) were given on the latest research activities carried out by Action participants (currently, around 100 scientists from 17 COST countries - 1 pending –

and 5 institutions from 3 non-COST countries).

(4) Organizing a Training School on “Experimental Methods for Fiber Suspension Flows” (16 trainees, homepage: http://www.fp1005.cism.it/pages/FP1005_ts2012exp.html)

(5) Organizing the International Workshop on “Non ideal particles and aggregates in turbulence” (21 presentations, homepage: <http://frag2012.le.isac.cnr.it/index.php>)

(6) Empowering STSMs: 5 STSMs were approved during GP1, 7 STSMs have already been approved in the first half of GP2 (6 of which to ESRs or scientists less than 40 years old).

Plans for 2013 include: MC/WG meeting in March (were new additions to the Knowledge Base will be presented and networking among WGs stimulated), training school to be held in Italy in June, and organization of the International Conference “Particles in turbulence” jointly with Action MP0806 to encourage dissemination.

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:** Denmark

- **Other participants:**

University of British Columbia – Pulp and Paper Centre, Canada
 University of Sao Paulo - Polytechnic School, Brazil
 Suny College of Environmental Science and Forestry, USA
 Wesleyan University, USA
 University of California at Davis, USA

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

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- **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: Afshin Abasi Hoseini (NO), Wolfgang Bauer (AT), Marina Camplo (IT),

Alessandro Capone (IT), Asaf Cohen (IL), Carla Cotas (PT), René Delfos (NL), René Eckhart (AT), Axel Eckman (SE), Benjamin Fabry (DE), Pedro Faia (PT), Paul Krochak (SE), Masato Irota (SE), Ari Jasberg (FI), Paulo Ferreira (PT), Fredrik Lundell (SE), Anni Karppinen (FI), Arttu Miettinen (FI), Janne Poranen (FI), Fernando Rosa (PT), Jean-Claude Roux (FR), Martine Rueff (FR), Lilach Sabban (IL), William Sampson (UK), Salaheddine Skali-Lami (FR), Alfredo Soldati (IT), Bartek Stawicki (NL), René van Hout (IL), Angeles Blanco (ES), Bogomil Breznik (SI), 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), Tomas Visktrom (FI), Greg Voth (USA), James Olson (CAN)

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), Bogomil Breznik (SI), Florin Ciolacu (RO), Gaetano d'Avino (IT), Elena De La Fuente (ES), Paulo Ferreira (PT), Fernando Garcia (PT), Patrick Huber (FR), Jari Käyhkö (FI), Paul Krochak (SE), Pier Luca Maffettone (IT), Amin Moosaie (DE), Carlos Negro (ES), Bandaru Ramarao (USA), Jean-Claude Roux (FR), Martine Rueff (FR), Vera Rutar (SI), Salaheddine Skali-Lami (FR), Anna Trubetskaya (DK), Roland Zelm (DE)

WG3: Modelling fibre suspension flows with multi-phase models

WG3 Leader: Bendiks Boersma (NL)

Members of WG: Sven Altmann (DE), Gustav Amberg (SE), Helge Andersson (NO), Jean Regis Angilella (FR), Andreas Anzel (DE), Dariusz Asendrych (PL), Mustafa Barri (NO), Matthaus Babler (SE), Bendiks Boersma (NL), Luca Brandt (SE), Enrico Calzavarini (FR), Sergio Chibbaro (FR), René Delfos (NL), Minh Do-Quang (SE), Pascal Fede (NL), Christoph Goniva (AT), Harald Grossmann (DE), Jari Hämäläinen (FI), Mohammed Khalij (FR), Gregorz Kondora (PL), Timo Kuntzsch (DE), Matias Kvick (SE), Cristian Marchioli (IT), Jan Matheas (DE), Jean-Pierre Minier (FR), Gilmar Mompean (FR), Amin Moosaie (DE), Christopher Nilsen (NO), James Olson (CAN), Michael Reeks (UK), 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
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I.C. Overview activities and expenditure

(1st GP) Budget

Total Action Budget: 90,000 €

Remaining Action Commitment: 15,457.23 €

Meetings

Meeting Type	Date	Place					Cost	Total
Joint MC/WG Meeting	13-14 October 2011	INPL Nancy					23477.68	23477.68
Joint MC/WG Meeting	29-30 March 2012	COST Office Brussels					15557.44	39035,12

STSM

Beneficiary	Date		Place		Cost	Total
	From	To	From	To		
Ms Carla Cotas (ESR)	15/01/12	15/03/12	University of Coimbra (PT)	Czestochowa University of Technology (PL)	1661.00	1661.00
Mr Grzegorz Kondora (ESR)	22/01/12	18/02/12	Czestochowa University of Technology (PL)	VTT Technical Center of Finland (FI)	1200.00	2861.00
Mr Afshin Abbasi Hoseini (ESR)	06/02/12	06/05/12	NTNU Trondheim (NO)	Royal Institute of Technology, KTH (SE)	2500.00	5361.00
Pr Mike Reeks	18/06/12	30/06/12	University of Newcastle (UK)	University of Udine (IT)	920.00	6281.00
Dr Sergio Chibbaro	24/06/12	30/06/12	Université Pierre et Marie Curie, Paris (FR)	International Center of Mechanical Sciences, Udine (IT)	650.00	6931.00

Workshops

Title	Date		Place				Cost	Total
	From	To						
Workshop on Non ideal particles and aggregates in turbulence	06 June 2012	09 June 2012	CNR, ISAC University of Lecce (IT)				5311,42	5311.42

Schools

Title	Date	Place					Cost	Total
Experimental Techniques for Fiber Suspension Flows	18-21 June 2012	KTH, Stockholm (SE) and VTT, Jyvaskyla (FI)					11490.32	11490.32

Dissemination

Title	Date	Place					Cost	Total
International Innovation Report	04/05/12						2250.00	2250.00

Others

Title	Cost	Total
FSAC	9524.91	9524.91

Action Total : 74,542.77

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 report period, innovative knowledge has been provided both in the area of numerical simulations of fiber suspensions and in the area of experimental measurements.

As far as numerical simulations are concerned, COST networking through the Action proved beneficial in improving current understanding of the following aspects: (i) sub-grid scale modelling of small fibers suspended in a turbulent flow, (ii) development of pdf methods based on simple Stokes drag for spherical particles to non spherical particles of variable geometry and shape factor, (iii) turbulence modulation mechanisms by semi-dilute suspensions of rigid microfibers in channel flow using direct numerical simulation and Lagrangian tracking, (iv) rheology of dense suspensions of elongated non-spherical particles.

As far as experiments are concerned, COST networking allowed significant advancements in: (i) characterization of fiber orientation and deformation in dilute suspensions through optical techniques, (ii) measurements of wall-layer dynamics for fibre suspension flows.

The advancements just highlighted were achieved through collaborations developed within the Action and finalized during the MC/WG meetings (not pre-existing) and have brought to ERS’s applications for 9 approved STSMs in the period January-December 2012. Results from such collaborations have also lead to scientific publications in peer-reviewed journals and contributions to international conferences.

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

The main scientific breakthrough of the Action obtained during the report period has been the production of the first batch of experimental measurements and numerical simulations of industrially-relevant test problems. Collected data have been made freely available to interested users through a public access-free Knowledge Base stored on the Action’s website. Test problems include dilute fiber suspensions (in particular: slip velocity and rotation statistics obtained from numerical simulations of fiber motion in fully-developed channel flow, and orientation statistics from experimental measurements of fiber motion past a backward facing step), as well as dense suspensions (PIV-based velocity measurements at the headbox slice channel). The first results obtained using Nuclear Magnetic Resonance (NMR) techniques have also been produced and discussed during the joint COST/ERCOFTAC workshop in Trondheim. It is expected that users of different experimental methods will exploit our access-free Knowledge Base to 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.

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

In the best case scenario the major socio-economic impact that may be expected from the improvement of CFD methodologies applied to pulp and paper making industry is a significant reduction of the energy consumption required by pulp and paper manufacturing. Currently, the pulp and paper industry is one of the most energy-intensive process industries, as also recognized by the Specific Programme for Horizon 2020. Suspensions of elongated

fibers are at the basis of pulp and paper production, where mechanical properties of the final product depend on the mass and orientation distributions of the fibers. Better CFD modelling capabilities would certainly lead to improved design, optimized process operations and, in turn, huge energy savings. Reduction of energy demand from energy-intensive industries would have a beneficial impact of tantamount importance on EU countries in the current frame of worldwide economical crisis.

- *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)*

During the report period, the Action has benefited substantially from the mutual input of disciplinary expertise in computational and experimental fluid mechanics. As already pointed out in the first report (see attachment) cross-fertilization allowed by inter-disciplinary networking has favoured the development of modelling techniques for predicting adequately the behaviour of pulp suspensions in the dilute and semi-dilute regimes. In these regimes, state-of-the-art CFD approaches can be complemented by new finite-size techniques which allow fully-resolved simulation of the flow around individual fibers: these techniques may reproduce very accurately the local interaction between turbulence and fibers, thus providing a perfect background for model development at coarser spatial resolutions. Standard CFD can also benefit from new experimental techniques (alternative to classic optical techniques) based on NMR, Tomography, Ultrasonic Doppler Velocimetry, or Particle Tracking Velocimetry (PTV) and available within the Action. One of the proposed test problems involves precisely the joint use of experimental techniques, finite-size techniques and point-particle techniques (based on Euler-Euler and Euler-Lagrange approaches) to benchmark the relative performance of these tools and establish their range of applicability.

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

The level of inter-disciplinarity comprised within the Action is growing in time thanks to the contribution of new participants in each working group. It appears that current level of inter-disciplinarity can definitely lead to significant improvements in scientific knowledge fiber suspension flows.

As far as CFD is concerned, the expertise covers all areas from DNS to LES to RANS based numerical approaches, as well as Euler-Euler and Euler-Lagrange methods. Recently, experts in finite-size simulations have joined the Action and complemented point-particle simulation experts. As far as experiments are concerned, new measurements techniques based on NMR and Tomography have recently become available (also by virtue of new members from non-COST countries) to the Action's scientific community. Examples of applications where Action FP1005 can provide significant scientific impact through inter-disciplinary networking are:

- Polymer and textile industries
- Fibre based insulation materials
- Reduction of CO₂ emission in coal-fired
- Fibre-induced drag reduction in turbulent flows.

Moreover, modelling the rheological properties of pulp suspension may also be of help for predicting behaviour of suspensions commonly encountered in food processing, cosmetics etc.).

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

During the report period, meetings and workshops have been organized with the precise aim of strengthening the interaction among the different disciplines currently comprised within the Action. It appears that current level of inter-disciplinarity and inter-discipline networking is sufficient to produce socio-economic impact provided that scientific knowledge can be effectively transferred to industry. Granting such knowledge transfer is the major challenge of Action FP1005 in the near-future.

II.C. New networking

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

During the report period, the Action had:

- no new countries represented in the MC (current number of countries: 16)
- no new MC member
- one new MC substitute (Paul Krochak for Sweden)
- one new COST Participant subject to MoU acceptance (Denmark)

- *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 113 (was 68).

The percentage of female participants is 13.3% (was 14%). It is quite difficult to increase the percentage due to the scarce involvement of female researchers in fields of relevance for the Action (notably technology, engineering and mathematics, where the estimated percentage of female scientists is about 10%).

The percentage of ESR is 27.4% (was 41%). The decrease in percent figures is due to inevitable aging of some of those participants who were classified as ESRs in the previous report period.

- *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.*

Involvement of ERSs in the Action can be summarized as follows:

- Involvement in Action management: the WG1 leader (Juha Salmela) and the WG3 deputy leader (Janne Poranen) are ESRs
- Involvement in STSMs: a total of 12 STSMs have been approved so far (5 in GP1, 7 in GP2), 7 beneficiaries are ESRs, 2 beneficiaries are less than 40 years old.
- Involvement in Training Schools: The training school on “Experimental techniques for fiber suspension flows” held in June 2012 was organized by at-that-time ESRs (Lundell, Salmela) and was attended by 13 ESRs from COST countries and 3 ESRs from non-COST countries.

- *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 5 participants from 3 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 neutral 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.

- University of California Davis (UCDavis) - Department of Chemical Engineering & Materials Science, USA: UCDavis will contribute in the development of NMR (Nuclear Magnetic Resonance) imaging viscometers and implementation of NMR imaging techniques to measure flows of opaque suspensions.
- Wesleyan University (WU), USA: WU will contribute in the area of experimental tracking of rotational and translational motion of anisotropic particles in fluid flows. WU can provide time-resolved experimental measurements of the motion of small rod-like particles in turbulent flow, which allow measurement of orientation and position of rods using Lagrangian particle tracking with images from multiple high speed cameras in dilute flows.
- SUNY College of Environmental Science and Forestry (SUNY) - Empire State Paper Research Institute, USA: SUNY contributes in developing sophisticated DEM-based (Discrete Element Method) simulations of fibrous suspensions

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)*

During the report period, advancement and promotion of scientific knowledge has been promoted through the following publications:

- Papers published in international peer-reviewed journals:

1. L. Zhao, C. Marchioli, H. Andersson “Stokes number effects on particle slip velocity in wall-bounded turbulence and implications for dispersion models”, *Phys. Fluids*, **24**, 021705 (2012); doi: 10.1063/1.3690071
2. L. Zhao, H.I. Andersson, and J.J.J. Gillissen “Interphasial energy transfer and particle dissipation in particle-laden wall turbulence”, *J. Fluid Mech.*, **715** (2013), 32-59.

- Papers submitted international peer-reviewed journals:

1. C. Marchioli, A. Soldati “Rotation statistics of fibers in wall shear turbulence”, *Acta Mech. Under Consideration* (2013)
2. L. Zhao, H. Andersson “On inertial effects of long fibers in wall turbulence: concentration, orientation and fibers stresses”, *Acta Mech. Under Consideration* (2013)
3. L. Zhao, C. Marchioli, H. Andersson “Slip velocity of rigid fibers in wall-bounded turbulence”, *Phys. Fluids*, *In Preparation*.

- Conference papers:

1. 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, Symp. Rheology of Nano- and Natural Composites – Lisbon (PT), August 5-10, 2012*.
2. M. G. Rasteiro, C. A. Ventura, “Rheology of Pulp Suspensions: Identification of the Main Parameters Influencing Rheological Behaviour”, *XVIth International Congress on Rheology, Symp. Rheology of Nano- and Natural Composites – Lisbon (PT), August 5-10, 2012*.
3. L. Zhao, C. Marchioli, H. Andersson “Slip velocity of rigid fibers in a turbulent channel flow” *TSFP8, Poitiers (FR), August 28 - 30, 2013*
4. C. Cotas, D. Asendrych, M.G. Rasteiro “Numerical Simulation of the Flow of Fiber Suspensions in Pipes in the Presence of Drag Reduction Effect”, *PARTEC 2013, Nuremberg (DE), April 23-25, 2013*.

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

Outreach Activities:

- Publication in the October 0212 issue of Innovation Report, published by Research Media Ltd (see Annex 1)
- Action FP1005 has co-organized the Symposium on Rheology of Nano and Natural Composites within the XVIth Int. Congress on Rheology, Lisbon, August 5-10, 2012.
- Action FP1005 has co-organized the 4th Workshop of ERCOFTAC's Special Interest Group on "Fiber Suspension Flows" (see Annex 2)

- *Activities and projects with COST network colleagues.*

During the report period Action FP1005 has organized a joint International Workshop on "Non-ideal particles and aggregates in turbulence" (all presentations can be downloaded from the workshop's website: <http://frag2012.le.isac.cnr.it/index.php>) together with COST Action MP0806 "Particles in Turbulence" (see also Annex 3). Because of the tight link between FP1005 and MP0806, more activities are planned for the next report period. Specifically:

 1. Training School on "Non-spherical particles and aggregates in fluid flow", June 17-21, 2013, Udine (Italy) – Expected number of trainees: 40
 2. International conference on "Particles in Turbulence", July 1-5, 2013, Eindhoven (The Netherlands) – Expected number of participants: 80

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

The capacity of the Action members to raise research funds is being developed. One of the MC members (H. Thoemen, CH) was awarded a grant by Swiss government for a research project on the "Modeling heat and moisture flow through a wood-fiber network during calendering of paper sheets", submitted under the auspices of COST Action FP1005.

II.D. Self evaluation

COST Action FP1005 is in the middle of its second year. In such a relatively-short amount of time, the main successes of the Action can be summarized as follows:

- Establishment of effective working groups activity
- Efficient networking among participants (especially ESRs) through meetings, workshops, STSMs and training schools
- Production of the first freely-available data repositories from selected test problems in each focus area of the Action
- Successful dissemination of expertise, scientific research areas and activities covered by Action participants through International Innovation reporting, participation to international conferences and workshops

Drawbacks:

- The main drawback experienced within Action FP1005 during the report period is the same already highlighted in the previous report, namely the scarce involvement of industrial representatives. It is quite difficult to get feed-back from industrial counterparts, especially the big ones from northern European countries. It is equally difficult to have industrial representatives attending the Action's workshops and meetings. 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.

Key difficulties:

- The main difficulty is concerned with industrial involvement in the Action activities. As already highlighted in the previous report, there is still a significant gap between the extremely complex, real-life problems that the pulp and paper industry must tackle and the simplified problems that can be solved through simulations and experiments. As a result, industries still do not perceive CFD as crucial for improving design of papermaking machines. The main challenge of the Action will 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. To this aim, a new "Knowledge Transfer" working group, led by those Action participants that are employed in the papermaking industry and/or are in closer contact with industries, has been created (and approved by the MC during the Trondheim meeting). As its name indicates, the objectives of this new WG are (1) to transfer scientific knowledge produced within the Action to industrial practitioners, making them aware of the latest developments in CFD applied to papermaking and (2) to advertise all events organized by the Action to foster industrial participation.

III. Previous scientific report(s)



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IV. Annexes

Annex 1: International Innovation Report



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Annex 2: Scientific Programme of the International Workshop on “Non-ideal particles and aggregates in turbulence” (Lecce, June 6-9,2012)



final_report.pdf

Annex 3: Scientific Programme of the 4th Workshop of ERCOFTAC's Special Interest Group on “Fiber Suspension Flows”



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10_24-26_Programm