NODESZELOSS

COOP-CT-2004-513117

NODESZELOSS

NOVEL DEVICE TO STUDY PULP SUSPENSIONS BEHAVIOUR IN ORDER TO MOVE TOWARDS ZERO ENERGY LOSSES IN PAPERMAKING

Horizontal Research Activities involving SMES
Co-operative research

Final Activity Report
(D18)

Period covered: from Oct. 11th 2004 to Jan. 10th 2007

Date of preparation: Jan. 2007

Start date of project: October 11th 2004

Duration: 24 months (+3 months extension)

Project coordinator name: Carlos Negro
Project coordinator organisation name: University Complutense of Madrid

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Publishable executive summary

1. Project execution

Project summary

The flow properties of the pulp suspensions are important for the optimal functionality of most unit operations in pulp and papermaking.

However, pulp suspensions are different from other solid-liquid systems because of the **unique interactions** between the different components of the fibre furnish: fibres, fines, fillers, additives, DCM, etc. Fibre-fibre interactions, fibre-water, fibre-fines, fibre-additives, fines-additives, etc., are very important in these **heterogeneous samples giving rise to complex shear mechanisms that are different from classical slurry systems.**

Fibres in the suspension have a strong tendency to become entangled forming connected networks which are highly stable for concentrations over 2 g/L The flow dynamics of fibre suspensions have been discussed by many authors; however, the best way to measure and to define their rheological properties is still under discussion. At this moment, there are no standard methods for measuring the rheological behaviour of pulp suspensions under typical papermaking conditions. The problem is that fibres are not short compared to the dimensions of the measuring device. The small gap of conventional viscometer geometries may lead to anomalous response due to bridging of the gap by fibres. On the other hand, the orientation of the fibres around the measurement elements without interacting with them will make the measurements approach the viscosity of the water.

Therefore, the existing theoretical and experimental work regarding fibre mobility during papermaking is limited. **The aim of this project was to develop a novel device** to study pulp suspensions behaviour and t**o explore two potential uses** for the new device: the improvement of equipment design and wet end chemistry optimisation.

The new device developed in the project allows characterising, through coefficients and models, the rheological behaviour of the pulp under papermaking conditions, from low to high consistencies. This goes beyond the state-of-art and it can greatly contribute to the benefit of the scientific and technical community in papermaking.

The identified benefits are: **pumping energy cost saving of 19%; maintenance cost reduction by 2%; performance improvement in pulp processing**, which also improves **product quality; and potential cost reduction by means of wet end optimisation**.

The paper value chain has a strong influence on the European economy. Only in the EU countries (not including the eastern countries) the **total annual turnover** represents **73 billion euros**, with an average **growth of 3%**. There are 895 companies with **1257 mills**, the **capital investment** is **4.5 billion euros a year**, the sector **employs 251.000 people directly** and **3.5 million people indirectly** and the **total paper production** is **91 million tones, representing one third of the world production. SMEs represent a substantial part of this sector** being one of the industrial sectors where consolidation takes place at slow level compared with other important European industrial sectors, and it is expected that **at the end of the consolidation process 500 SMEs will still continue in market** niches based on a recent study carried out in 2003 by Price Waterhouse consultancy services. This demonstrates that **any action to reduce cost** in papermaking will have a **significant direct impact on the SMEs.**

This project addressed the specific problem of cost saving of a group of SMEs paper mills, specially related to energy and maintenance costs and chemical program evaluation, to optimise the wet end of the paper machine. It was carried out by a multinational consortium formed by **8 SME and 3 RTD from 5 European countries**.

Project objectives

The **general objective** of this project was **to develop a novel device to study pulp suspensions behaviour** in order **to move towards zero energy losses in papermaking**, which is a specific need of a group of SMEs from different countries for cost reduction. This objective was addressed by a group of **RTD performers** (with complementary expertises) that carried out the majority of the required **scientific and technological research** while **SMEs** took care of the **validation and application** of the new device. The new device could be **applied to reduce costs and to improve process performance** at the mills (SMEs) which will contribute to **increase** its **competitiveness**. This objective:

- **Supported SMEs** to respond to the pressures for **continuous innovation and technological** adaptation by delivering a new device that will be used at the mills to reduce costs, energy, maintenance and retention aids costs mainly, and to improve their performance.
- **Facilitated co-operation** in research activities between SMEs and RTD performers at **national and international level.**
- Enabled SMEs to benefit from the advantages **of networking for innovation**.
- The publication of the results, after being protected, contributes to increase the potential impact of the project.

The specific objectives of the project were:

- To develop a novel device to study pulp suspensions behaviour and built a pre-commercial prototype.
- To generate knowledge on pulp suspension flows. The goal was to determine the fluid dynamics behaviour of different pulp suspensions.
- To explore the potential application of the new device to improve equipment design and avoid over sizing.
- To explore the potential application of the new device to optimise wet end chemistry.
- To disseminate and exploit the results obtained in the project through a plan for using and disseminating knowledge.

Contractors involved

Table 1 shows the contractors list and indicates their main characteristics.

Table 1. List of Participants

Partic. Role	Partic. Type	Partic. no.	Participant name	Participant short name	Country	Date enter project	Date exit project**
CR	SME	1	Juan Romaní Esteve, S.A.	JURESA	Spain	month 1	month 27
CR	SME	2	Papelera del Principado, S.A.	PAPRINSA	Spain	month 1	month 27
CR	SME	3	Papelera del Jarama, S.A.*	PDJSA	Spain	month 1	month 18
CR	SME	4	Millvision B.V.	MV	Netherlands	month 1	month 27
CR	SME	5	PAKA Glashuetter Pappen- und Kartonagenfabrik GmbH	PAKA Glashuetter	Germany	month 1	month 27
CR	SME	6	Gruenperga Papier GmbH	GRUENPERGA	Germany	month 1	month 27
CR	SME	7	AQUA+TECH SPECIALTIES S.A.	AQUA+TECH	Switzerland	month 1	month 27
CR	SME	8	GOPACA-Fábrica de Papel e Cartão S.A.	GOPACA	Portugal	month 1	month 27
CO	RTD	9	Universidad Complutense de Madrid	UCM	Spain	month 1	month 27
CR	RTD	10	Technische Universität Dresden	TUD	Germany	month 1	month 27
CR	RTD	11	Facultade de Ciências e Tecnología - Universidade de Coimbra	FCTUC	Portugal	month 1	month 27

* PDJSA shut down its mill operation in April 2006 and as consequence the partner withdrew from the project.
** The project has been extended three months and annex 1 of the contract was updated in September 2006.

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Work performed, results achieved and intentions for use and impact

As this project is the first step towards a possible commercialisation of the new device, the work started with a market research and the definition of proper routes for dissemination and exploitation of the results obtained during the project. This task required strong collaboration and commitment between the SMEs. At the same time, four laboratory devices were built by JURESA and UCM to be used in parallel by RTDs performers. An important result of this task was a patent deposition.

The rotational viscometer for fibre suspensions (Figure 1) consists of a cylindrical vessel whose diameter is 200 mm with three fix segmented plates that contains the fluid to study and a rotor with three segmented plates whose diameter is 150 mm, which is suspended into it and spun around its axis by a motor at a given rotational speed, thus producing the shear action on the

fluid. This design maintains a uniform distribution in heterogeneous fibre suspensions and avoids the formation of a fibre plug between the measuring elements.

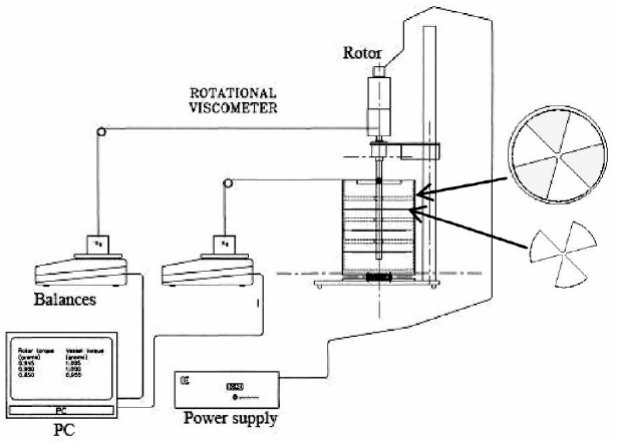

Figure 1. Rotational viscometer for fibre suspensions.

Although the device can be used for many applications in which pulp suspensions behaviour is important, in order to demonstrate the usefulness of the new device only two potential applications were studied: the potential applications in equipment design; the design of pumps and pipes and the potential application for wet end optimisation. The effect of different variables on pulp rheology and pressure drop was studied and the influence of flocculant properties and dosage on pulp rheology was determined. A technical report for the design of pumps and pipes for papermaking that could be used as a reference document for a new standard in Europe and a design abacus were prepared and protected trough the correspondent copyrights.

New linear and branched flocculants were developed by AQUA+TECH and the influence of flocculant characteristics and dosage on flocculation, floc properties and pulp rheology was determined, using the focused beam reflectance measurement (FBRM), light diffraction spectroscopy (LDS) and the viscometer developed. The rheograms obtained with the new device were sensitive to the flocculant properties and dosage; therefore, it could be used for wet end optimisation. WP 4 was carried out by UCM and TUD at laboratory scale, and mill trials were done at SME sites with the close collaboration of AQUA+TECH.

Once the equipment had been developed at laboratory scale and the potential applications had been demonstrated, a **pre-commercial prototype** was built mainly by **Millvision,** with the collaboration of all the partners**.** This device was validated in SME sites in order to cover a broad range of different industrial situations.

The following expected end results of the project have been achieved:

- Creation of knowledge in flow properties of pulp suspensions that will open opportunities for applying these concepts in the pulp preparation stages in the paper industry in the future.
- Creation of knowledge in flow properties of complex suspensions systems that could be applied to other important industrial sectors: food processing, cosmetic, polymer science, etc.
- Generation of friction-loss curves for different pulp suspensions that could be used for the development of software tools to design pipes and pumps for the paper industry.

- Evaluation of chemical strategies for wet end control. Specifically, new flocculants, in both powdered and inverse-emulsions forms were tested.
- Three laboratory prototypes and one pre-commercial prototype of a novel device to study the behaviour of pulp suspensions.

Furthermore, the results achieved so far were:

- The construction of two additional prototypes of the new device
- Generation of knowledge on pulp suspension flows. Articles on pulp rheology and the effect of flocculation on it have been published.
- Programs for calculating friction loses and optimising diameter have been developed.
- Training seminars on the new device have been accomplished at FCTUC and TUD.

Part of the project results can be used directly by the SME paper mills involved in the project in their own industrial plants, with the benefit of cost saving, maintenance cost saving and other related cost saving.

The direct expected applications and potentially patentable ideas from the obtained results are:

- A novel device, one of the SMEs will have the task to commercialise this device worldwide. The CA will define the share in the patent and benefits of the other SMEs. It will be protected by a patent application.
- Chart for technical design with friction factor for pulp suspensions. It will be protected by copyright. An edition of 1000 units is expected to be edited and sold worldwide.
- Technical information for pump and pipe design. It will be protected by copyright. An edition of 1000 units is expected to be edited and sold worldwide (Deliverable of WP3).

To ensure that the SME contractors will assimilate and exploit the results of the project, different actions were carried out as follow:

- A market analysis to define adequate routes to guarantee successful exploitation and dissemination results.
- Training seminars were accomplished to the partners to understand the operation of the new laboratory device.
- Pre-commercial device were used in mill sites and an in-mill training seminar were accomplished. The manual operation of this new device were prepared and explained in seminars to the mill personnel.
- Engineering seminar has been accomplished to ensure that they can use the data from the technical report and the abacus design.
- Part of the results have been presented in several congresses and published in journals. Furthermore, more results will be published in form of articles and in congresses.

2. Dissemination and use

The **knowledge arising from the work** carried out under the NODESZELOSS project is **the joint property of the SME** contractors according to the CA that includes the agreement among them on the allocation and the terms of exercising the ownership of the knowledge.

A project web-page was made immediately after approval of the proposal. This was an efficient way to disseminate the existence and objectives of NODESZELOSS project (supported by the EU Commission) to the EU Scientific Community and Industrial Sector. The NODESZELOSS web-page has also facilitated the rapid exchange of information with a potential interest for all project partners. Advantage of the facilities provided by the UCM servers were taken for maintenance of this web-page, whose link is http://www.ucm.es/nodeszeloss

In order to disseminate the fundamental and technical knowledge generated during the project **advanced technical and scientific papers have been published** in several sources for papermaking specialist and chemical engineers, mainly by the universities involved in the project.

A **full series of technical presentations** are held trough Europe, USA, Canada, Asia and South America in different papermaking forums. This is a marketing strategy **to increase potential exploitation for the new products developed** during the project with the aim to link knowledge of the owners to users.

All the deliverables have been already accomplished in order to guarantee the protection of knowledge and the adequate dissemination:

- Draft version of the Plan for using and disseminating knowledge, D2, month 12.
- Patent deposition, D3, month 4.
- Operation manual for lab device, D4, month 5. ISBN 84-689-5278-8.
- Design abacus copyright, D7, month 26. ISBN 84-690-3351-4.
- Technical report for pipes and pumps design, D8, month 27. ISBN 978-84-690-4376-9.
- Operation manual to evaluate polymers reactivity, D9, month 12.
- Viscometer for fibre suspensions. Instructions manual, D11, month 25. ISBN-978-84-690-4377-6.
- NODESZELOSS presentation brochure, available in four languages, D13, month 1.
- NODESZELOSS web page. (http://www.ucm.es/nodeszeloss), D14, month 2.
- Final version of the Plan for using and disseminating knowledge, D17, month 27.

Furthermore, onsite training actions have been undertaken by UCM, FCTUC and TUD.

There has been also disseminated scientific and technical results through different actions, being important examples, the following ones:

- A PhD Thesis was defended at UCM in July 2005 in relation of the project.
- A Master Thesis was defended at UCM in July 2006 in relation of the project.
- Poster of the project was presented in the 6th ANQUE International Congress of Chemistry held in Tenerife in December 5th-7th.
- Two workshops and one conference were presented by AQUA+TECH.

- A paper titled “Effect of chemical flocculation mechanism on rheology of fibre pulps suspensions”, has been published in Nordic Pulp & Paper Research., and another paper titled “Rotor selection for a searle-type to study the rheology of paper pulp suspensions” has been published in Chem. Eng. Process. Both papers were published by UCM.
- FCTUC, together with UCM, has submitted three publications. One of them, titled “Modelling pulp fibre suspension rheology” has been accepted for publication in Tappi J., and the other two titled: “The use of LDS as a tool to evaluate flocculation mechanisms” and “Evaluation of flocs resistance and reflocculation capacity using the LDS technique” are in revision process by Chem. Eng. Process.
- FCTUC has also presented a communication in relation with WP4 at PARTEC 2007, Nuremberg, Germany, entitled “The Use of LDS to Assess Flocculation Dynamics”.
- Two communications have also been submitted by FCTUC to TECNICELPA 2007, Portugal, October 2007, reporting achievements of the project to an audience with interests in the pulp and paper production. They are entitled: “Effect of water cationic content on PCC flocculation induced by CPAM” and “The flow dynamics of pulp fibre suspensions”, in relation, with the applications of the new device to optimise wet-end and to design of pumps and pipes.

Section 1. Project objectives and major achievements

Main project objectives and project's current relation to the state of the art:

The general objective of this project is to develop a novel device that is able to study pulp suspensions behaviour in order to move towards zero energy losses in papermaking, which is a specific need of a group of SMEs from different countries in order to reduce costs. This objective is addressed by a group of RTD performers (with complementary expertises) that will carry out the majority of the required scientific and technological research while SMEs will take care of the validation and application of the new device. The new device can be applied to reduce costs and to improve process performance at the mills (SMEs) which can contribute to increase its competitiveness.

Pulp suspensions are different from other solid-liquid systems because of the unique interactions between the different components of the fibre furnish. Furthermore, during papermaking many process and product additives are added which may produce changes in the suspension behaviour and affect fibre processing.

Fibres in the suspension have a strong tendency to become entangled forming connected networks which are highly stable for concentrations over 2 g/L The flow dynamics of fibre suspensions have been discussed by many authors; however, the best way to measure and to define their rheological properties is still under discussion. At this moment, there are no standard methods for measuring the rheological behaviour of pulp suspensions under typical papermaking conditions. The problem is that fibres are not short compared to the dimensions of the measuring device. The small gap of conventional viscometer geometries may lead to anomalous response due to bridging of the gap by fibres. On the other hand, the orientation of the fibres around the measurement elements without interacting with them will make the measurements approach the viscosity of the water.

Therefore, the existing theoretical and experimental work regarding fibre mobility during papermaking is limited and the new device developed in the project to study the flow of pulp suspensions and characterise, through coefficients and models, their rheological behaviour under papermaking conditions, from low to high consistencies, goes beyond the state-of-art and it can greatly contribute to the benefit of the scientific and technical community in papermaking.

Specific objectives

The specific objectives of the project were:

- To develop a novel device to study pulp suspensions behaviour and built a pre-commercial prototype improving the lab devices.
- To generate knowledge on pulp suspension flows. The goal was to determine the fluid dynamics behaviour of different pulp suspensions.
- To explore the potential application of the new device to improve equipment design and avoid over sizing.
- To explore the potential application of the new device to optimise wet end chemistry.
- To disseminate and exploit the results obtained in the project through a plan for using and disseminating knowledge.

Summary of the work performed

This project is the first step towards a possible commercialisation of the new device. Therefore, the work started with a market research and the definition of proper routes for dissemination and exploitation of the results obtained during the project, WP1. This task was led by MV.

This task required strong collaboration and commitment between the SMEs, because marketing the new device, in a new market segment and when the concept was new, was not easy, especially because papermakers were not familiar with the concept of pulp viscosity. It was necessary to make to find other applications for the new device in industry and research centres and to explore the possibility to exploit it in other sectors than the pulp and paper industry, finding a clearer exploitation potential with a better market survey.

MV presented the pre-commercial prototype in a stand in the "Headbox Seminar Vapa & Milvision", held in the Netherlands at November 24th, 2006. To prepare this pre-commercial prototype, in WP5, a complete analysis of the product was performed identifying and analysing the weakness and strong points, or benefits, of the device; and the weaknesses were solved.

Contacts were established with participants in other projects in the field of pulp and paper processing, with national and European associations. The new device was presented in the kick-off meeting of the European project SHAKER and, as a result, contacts were established with the Tönnesmann, mill contractor of this project. Furthermore, the viscometer is a key device in the project PROLIPAPEL supported by the Community of Madrid, where it is used to characterise the rheology of recovered and recycled pulp suspensions to estimate the energy savings in these cases and to optimise the pulp mixing processes. This project involves, besides of the UCM, several mills, several research centres, an association and a chemical company:

- Research groups and centres: INIA, CSIC-CIB, CIEMAT, Gerona University, UPC, UDL, PTS.
- Pulp and paper industries: Holmen Paper Madrid, Vidal Gil Papel, JURESA and Papelera del Centro.
- Chemical companies: CIBA.
- Associations: ASPAPEL (Most important Spanish association of Spanish pulp and paper industries).

Some other industries are able to exploit the new device as the glass and synthetic fiber industry like for Aramide (Twaron Teijin in the Netherlands and Dupont) fiber industries which is booming at the moment. The high quality fiber pulps are used to make fabrics for safety products like bulletproof shirts and high temperature applications like within breaks and airplanes. The behaviour of the upgraded fiberpulp, by means of refining, is completely different from cellulose fiber based pulp. The rheological behaviour is different as well. The production will be increase and increase and the used unit operations will increase in size as well. This leads at the moment to very much problems because at higher consistencies (over 0.2 %) the pulp is very difficult to pump/transport. Rheological behaviour must be examined by means of not conventional rheometers as our device. Based on these kind of figures good plant engineering can take place. Another point of interest is the use of the device within the field of computational fluid dynamics. In the mean time Millvision get several questions for performing some pulp trails to asses the device.

The publication of research articles written by UCM, TUD and FCTUC has allowed to extend the knowledge of the existence of this device and to increase the confidence of researchers on it.

Furthermore, UCM presented a poster describing the process and the device in one of the most important international congress on Chemistry in Spain, the 6th ANQUE International Congress of Chemistry. "Chemistry and Sustainable Development", hold in Puerto de la Cruz at December, 5th-7th, 2006.

AQUA+TECH made presentations at a series of international events, aimed, rather, at end users and markets. These include the Pira conferences on Coagulants and Flocculants (2005) and on Wet End Chemistry (2006).

Four laboratory devices were built by JURESA and UCM to be used in parallel by RTDs performers (WP2). An important result of this task was a patent deposition. UCM was the lieder of this task.

Although the device can be used for many applications in which pulp suspensions behaviour is important, in order to demonstrate the usefulness of the new device only two potential applications were studied: the potential applications in equipment design; the design of pumps and pipes (WP3) and the potential application for wet end optimisation (WP4).

The effect of different variables and the beating and bleaching process on pulp rheology was determined using the new device, pressure drop was calculated from the pulp rheograms obtained and the results were compared with the ones from the pilot rig. A technical report for the design of pumps and pipes for papermaking that can be used as a reference document for a new standard in Europe and a design abacus were prepared and protected trough the correspondent copyrights. This task was led by JURESA and UCM.

New linear and branched flocculants were developed by AQUA+TECH and the influence of flocculant characteristics and dosage on flocculation, floc properties and pulp rheology was determined, using the focused beam reflectance measurement (FBRM), light diffraction spectroscopy (LDS) and the viscometer developed. The rheograms obtained with the new device were sensitive to the flocculant properties and dosage; therefore, it could be used for wet end optimisation. WP 4 was carried out by UCM and TUD at laboratory scale, and mill trials were done at SME sites with the close collaboration of AQUA+TECH.

Once the equipment had been developed at laboratory scale and the potential applications had been demonstrated, a **pre-commercial prototype** was built by **Millvision.** This device was validated in SME sites in order to cover a broad range of different industrial situations. This task was led by MV, who prepared also the plan for disseminating knowledge.

The following expected end results of the project were achieved:

- Routes for adequate plan for using and disseminating knowledge.
- Three lab prototypes and a pre-commercial novel device for pulp suspension fluid dynamic studies.
- Insurance of the protection of knowledge through technical chart (design abacus) and technical report copyrights.
- New linear and branched flocculants.

- Validation of the new device for wet end optimisation studies.
- Industrial validation of project results.
- Assurance of the protection of knowledge trough copyright.
- Efficient project coordination.
- Proper exploitation and dissemination plans.
- Generation of knowledge on pulp suspension flows. Articles on pulp rheology and the effect of flocculation on it have been published.
- Programs for calculating friction loses and for optimising diameter have been developed.
- Training seminars on the new device have been accomplished at FCTUC and TUD.

Major achievements are the following deliverables already accomplished:

D1	Market analysis study
D2	Draft version of the Plan for using and disseminating knowledge
D3	Patent deposition
D4	Operation manual for lab device
D5	2 laboratory prototype units
D6	Rheograms for different pulp suspensions
D7	Design abacus, copyright
D8	Technical report for pipes and pumps design, copyright
D9	Operation manual to evaluate polymers reactivity
D10	Technical report on flocculants behaviours
D11	Operation manual, copyright
D12	Pre-commercial prototype
D13	NODESZELOSS presentation brochure
D14	NODESZELOSS web page
D15	Mid-term Activity Report
D16	Mid-term Management Report
D17	Plan for Using and Dissemination of Knowledge
D18	Final Activity Report
D19	Final Management Report

The only deviation has been the extension of the project three months more. Consequently, the Technical Annex was updated in September 2006.

Contractors involved

Table 1 shows the contractors list and indicates their main characteristics.

Table 1. List of Participants

Partic. Role	Partic. Type	Partic. no.	Participant name	Participant short name	Country	Date enter project	Date exit project**
CR	SME	1	Juan Romaní Esteve, S.A.	JURESA	Spain	month 1	month 27
CR	SME	2	Papelera del Principado, S.A.	PAPRINSA	Spain	month 1	month 27
CR	SME	3	Papelera del Jarama, S.A.*	PDJSA	Spain	month 1	month 18
CR	SME	4	Millvision B.V.	MV	Netherlands	month 1	month 27
CR	SME	5	PAKA Glashuetter Pappen- und Kartonagenfabrik GmbH	PAKA Glashuetter	Germany	month 1	month 27
CR	SME	6	Gruenperga Papier GmbH	GRUENPERGA	Germany	month 1	month 27
CR	SME	7	AQUA+TECH SPECIALTIES S.A.	AQUA+TECH	Switzerland	month 1	month 27
CR	SME	8	GOPACA-Fábrica de Papel e Cartão S.A.	GOPACA	Portugal	month 1	month 27
CO	RTD	9	Universidad Complutense de Madrid	UCM	Spain	month 1	month 27
CR	RTD	10	Technische Universität Dresden	TUD	Germany	month 1	month 27
CR	RTD	11	Facultade de Ciências e Tecnología - Universidade de Coimbra	FCTUC	Portugal	month 1	month 27

* PDJSA shut down its mill operation in April 2006 and as consequence the partner withdrew from the project.
** The project has been extended three months and annex 1 of the contract was updated in September 2006.

Section 2.- Work package progress

Introduction

The **activities carried out in this project have been:** a market research study, a laboratory prototype development, the study of two potential applications for the new device, a pre-commercial prototype development and in-mill R&D activities for validation. It has also included management and activities to ensure proper dissemination and exploitation of the obtained project results. This S&T approach has enabled the project to achieve its objectives in research and innovation.

This project was divided in **6 work packages**; all tasks **were integrated** in a **coherent program**. A general overview is given in figure 2.

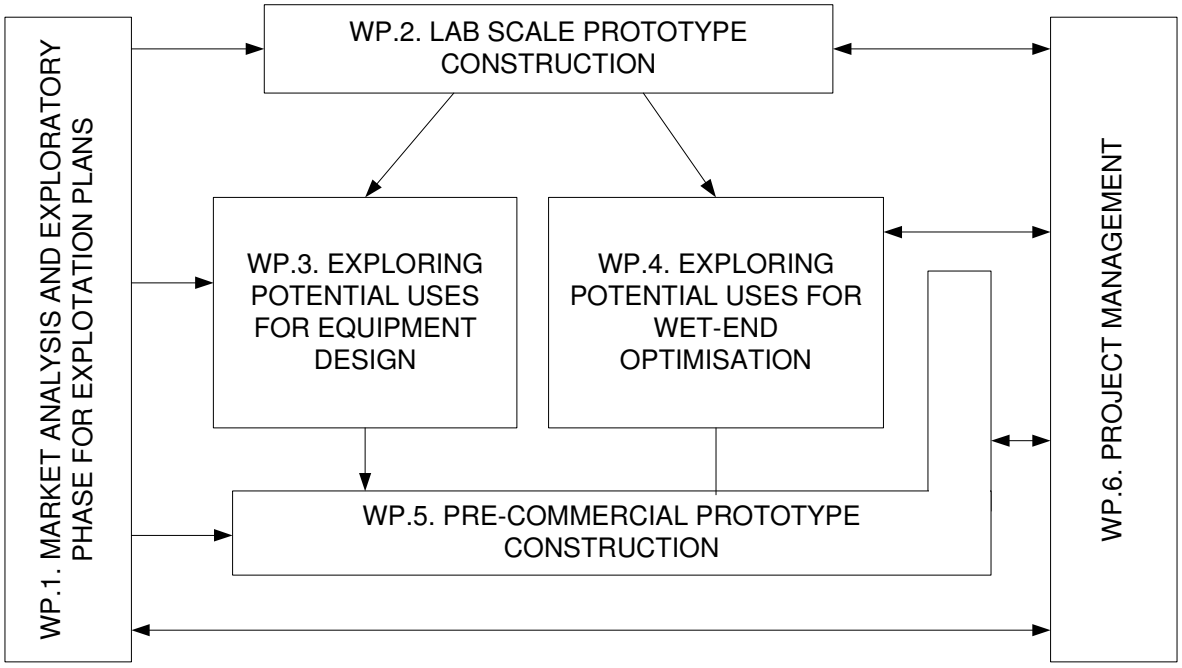

Figure 2. - Project overview. Work packages interrelation.

Overview of the actions carried out

During the first period, WP1 and WP2 were finished and WP3, WP4 and WP6 were started. During the second period WP5 was started and finished, and WP3, WP4 and WP6 were finished as it is shown by the project Gantt diagram, in Figure 3, which includes the updates in red.

The detailed objectives, description of the work, deliverables and expected results are given for all the WP, in the structure table done according to the EU rules. All the work packages and their leaders during the second period are summarised in table 2.

The list of deliverables promised and successfully accomplished for this period is compiled in table 3. The availability of four devices allowed to obtain more results than expected; furthermore, the interest provoked by the effect of polymer properties in pulp flocculation and rheology has caused the generation of more results than planned. Consequently, an extension of

the time planned for some deliverables (D6, D7, D8 and D10) was necessary to improve the results and their interpretation.

WP/month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
WP1.- Market analysis and exploratory phase for future exploitation plans												D1 D2															
WP2.- Lab scale prototype construction				D3	D4	D5						D3' D5'															
WP3.- Exploring potential uses for equipment design																	D6	D7				D8				D7	D6 D8
WP4.- Exploring potential uses for wet end optimisation												D9							D10								D10
WP5.- Pre-commercial prototype construction and validation																									D11	D12	
WP6.- Project management	D13	D14																									D17
Reports for EU Commission												D15 D16															D18 D19
Meetings	X					X						X						X							X		X

D3, D7, D8, D11. Deliverables with protection of knowledge
D1, D4, D6, D9, D10. Deliverables as technical reports
D3, D12. Deliverables as prototypes **D3' Extra 2 prototypes**
D13, D14. Deliverables for dissemination
D15, D16, D18, D19. Mid-term Activity and Management Reports and Final Activity and Management Reports
D2, D17. Deliverables for using and disseminating knowledge (at mid-term and at the end of the project).

Figure 3. – Project Gantt diagram

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Table 2. Workpackage list for the entire project.

Work-package No[1]	Work package title	Lead contractor Short Name [2]	Person-months [3]	Start month[4]	End month[5]	Deliverable No[6]
WP1	Market analysis and exploratory phase for future exploitation plans	MV Cornelia Lumpe Leon Joore	11.4	0	12	D1-D2
WP2	Lab scale prototype construction	UCM Angeles Blanco	20.5	0	12	D3-D5
WP3	Exploring potential uses for equipment design	JURESA/UCM Félix Rocha Elena Fuente	86.2	7	27	D6-D8
WP4	Exploring potential uses for wet end optimisation	AQUA+TECH David Hunkeler	60	8	19	D9-D10
WP5	Pre-commercial prototype construction and validation	MV Leon Joore	22.3	13	27	D11-D12
WP6	Project management	UCM Carlos Negro	12.1	0	27	D13-D19
	TOTAL		212.5			

[1] Work package number: WP 1 – WP n.
[2] Short name of the contractor leading the work in this work package
[3] The total number of person-months allocated to each work package.
[4] Relative start date for the work in the specific work packages, month 0 marking the start of the project, and all other start dates being relative to this start date.
[5] Relative end date, month 0 marking the start of the project, and all ends dates being relative to this start date
[6] Number for the deliverable(s)/result(s) mentioned in the work package planned for this period.

Table 3.- Deliverables list accomplished during the second period.

Del. no.	Deliverable Name	WP no.	Date due*	Actual/Forecast Delivery date*	Estimated Indicative Person-months	Used Indicative person-months	Lead contractor
D1	Market analysis study	WP1	12	12	14	11,4	MV
D2	Draft version of the Plan for using and disseminating knowledge	WP1	12	12	1	1	MV/UCM
D3	Patent deposition	WP2	4	12	1	1	UCM
D4	Operation manual for lab device	WP2	5	12	1	1	UCM
D5	4 laboratory prototype units	WP2	6	12	15	18	UCM
D6	Rheograms of Different Pulps	WP3	17	27	45	50	JURESA/UCM
D7	Design Abacus	WP3	18	26	40	44	JURESA/UCM
D8	Technical Report on Pipes/Pumps	WP3	22	27	1	1	JURESA/UCM
D9	Operation manual to evaluate polymer reactivity	WP4	12	12	0.5	0,5	AQUA+TECH UCM
D10	Technical Report on Flocculants Behaviour	WP4	19	27	45	46	AQUA+TECH
D11	Prototype Operation Manual	WP5	21	25	1	1	MV
D12	Pre-Commercial Prototype	WP5	22	26	22	30	MV
D13	NODESZELOSS presentation brochure	WP6	1	12	0.5	0,5	UCM
D14	NODESZELOSS web page	WP6	2	12	0.5	1	UCM
D15	Mid-term Activity Report	WP6	12	2,5	2.5	2.5	UCM
D16	Mid-term Management Report	WP6	12	2	2	2	UCM
D17	Plan for Using and Dissemination of Knowledge	WP6	24	27	2	2	MV/UCM
D18	Final Activity Report	WP6	24	27	2.5	2.5	UCM
D19	Final management Report	WP6	24	27	2	2	UCM

*Month

Note: all the deliverables planned for the second year have been accomplished during the second period of the project. They are annexed to this report.

Work package 1

Work package 1. - Market analysis and exploratory phase for future exploitation plans

Work package number	WP1	**Start date (end date):**				October –2004 September 2005	
Participant Short Name	JURESA	PAPRINSA	PDJSA	MV	PAKA Glashuette	GRUEN PERGA	AQUA+ TECH
Person-months per particip	0,3	0,4	0,5	5	0,3	0,5	0,4
Participant Short Name	GOPACA	UCM	TUD	FCTUC			
Person-months per particip	0,5	1	0,5	2			

ACTUAL STATUS: Finished on time

Objectives

To ensure the adequate dissemination and the exploitation of the results obtained trough out the project taking into account the needs of the consumers and the end users.

Description of work performed:

This work package was considered as an early action for the future development of the new device, and consequently, for the results obtained in WP 2, 3, 4 and 5. The results obtained in this exploratory phase will guarantee the adequate exploitation and dissemination plans for the project results suitable for the SMEs involved in the project. A complete market analysis and marketing plan has been accomplished.

The potential buyers selected for this study have been identified within the paper and board industry, the chemical industry, pump and motor suppliers and the engineering companies. The study was carried out selecting a specific European region (Belgium, The Netherlands and Germany). This was chosen due to two main reasons, first it is the area where the first buyers will be included due to the fact that the SME in charge of the future commercialization of the device (MV) mainly operates in that region and, second due to the fact that considering the large diversity of the paper and board industry within these three countries the results of this study can be translated to the main European paper industry.

Market research

The purpose of the market research was to develop a detailed profile of the ideal consumer in the market segment. The results provided answers to basic questions like: which are the set of potential uses for the new device? Who will purchase the device? What are the requirements of the consumers? What price will they pay for the product? What advantages can we offer with the new device?, etc.

This market research was leaded and it was mainly carried out by the SME MV with the collaboration of all partners, when it was necessary. First a questionnaire was prepared and

discussed between all the partners (MV, FCTU, TUD, UCM) and filled out by SME participants (PAPRINSA, JURESA, PDJSA, PAKKA, GRUENPERGA, AQUA+TECH) in the project as a validation step in order to ensure that the questionnaire could be clearly understood. The questionnaire was translated to different languages (Spanish, Portuguese, German, French and Dutch) and it was sent out to different industries (MV, AQUA+TECH).

Deliverable 1 presents the details of this market analysis study and it is included as annex 1 to this report. The responsible of this deliverable has been MV and UCM.

As a summary, the market study includes:

- The buyer analysis, including: paper and board plants, chemical suppliers, engineering companies, pump suppliers and motor suppliers. Results show as main conclusion that paper and board mills will be the most important potential buyers.

- Branch analysis with the aim to get insight in the attractiveness of the market and then the opportunities and threats of the branch.

- Competitor analysis: no direct competitors have been identified so far.

- SWOT analysis: it was also performed a SWOT-analysis in which the Strengths and Weaknesses on one hand has been linked to the Opportunities and Threats, on the other hand, to define strategic options.

Dissemination and exploitation plans

As defined in the consortium agreement, the SME in charge of future exploitation of the new device will be MV. Selection of the best forums to present the new device and the obtained results through out the project with the aim to disseminate useful information in order to attract future end-users was done, it was found that the most attractive strategy for MV will be renting the device to the interested paper and board plants.

TUD, UCM, FCTU have been involved in the dissemination activities of the project through different means: newsletters, specialized magazines and different web pages of related organizations.

A report concerning the first draft of PUDK corresponding to the deliverable 2 has been accomplished and it is included as annex 2 to this report.

DEVIATION

The work plan of this WP has been accomplished without any deviation in the work content and it has been concluded within the planned time schedule. Deliverables and milestones have been successfully accomplished.

As no potential risks were identified on this task it was not necessary to apply the contingence plans defined in the proposal and as a consequence no external subcontractor to carry out the market studies was necessary as it was done by MV with the resources involved in the project.

Deliverables

- Market analysis study, D1.
- Draft version of the Plan for using and disseminating knowledge, D2.

Milestones and expected result

- Identification of market segment for the project results and demands. Accomplished
- Routes for adequate plan for using and disseminating knowledge. Accomplished

Work package 2

Work package 2. - Lab scale prototype construction

Work package number	WP2	**Start date (end date):**				October –2004 September 2005	
Participant Short Name	JURESA	PAPRINSA	MV	UCM			
Person-months per participant	4	2	0,5	14			

ACTUAL STATUS: Finished

Objectives

To design, to build up and to validate a laboratory prototype of a novel device to study pulp suspensions fluid dynamics.

Description of work performed

This task was accomplished in two steps. The first was the design and construction of the lab prototype, and the second, its validation. This work was lead by UCM (RTD) with the close collaboration of the SME JURESA and PAPRINSA, the validation was done in two SME sites (JURESA and PAPRINSA). MV was following this task in order to be prepared for the developing of a pre-commercial prototype in WP5.

1. Design and construction

This work package included all the necessary steps to build up a laboratory prototype: material selection, design plots, workshop, control system selection, data acquisition and assembly.

Adequate software for data acquisition was built by JURESA in order to record in real time the variation of torque in the rotor (action) and the torque in the vessel (reaction). The control unit of the device was built by PAPRINSA.

There was a main deviation to the work planned due to the fact that it was proposed to build two units at the same time in order to be used in parallel by different partners in work packages 3 and 4. This was done on time, but during the first steering committee is was proposed to built two extra units in order to have a prototype at the three RTD and another one at the place of necessity according to WP 3, 4 and 5 needs. The first two units were on time at FCTUC and UCM and the other two were available in month 12 at TUD and UCM.

Finally, an operation manual for using the new device was written, D4. Two guidance seminars at FCTUC and TUD were accomplished in parallel with the project meetings.

2. Validation

Different fluids with a known fluid dynamic behaviour were chosen for validation. A Newtonian fluid with low viscosity, water, and a Newtonian fluid with high viscosity (glycerine at different concentrations). A non-Newtonian fluid, the carboxymethylcellulose (CMC) at different concentrations, was chosen for the validation of different rheological behaviours. The aim of this work was to validate the equipment with fluids of different behaviour and a very large range of viscosities values in order to cover a broad spectrum of possible situations with the new device. Results show that the new device is valid for a very wide range of viscosities.

Once the validation with the known fluids was made, a first set of experiments with pulp suspensions at different concentrations was carried out in order to check the sensitivity of the new device for pulp suspension studies at JURESA and PAPRINSA sites.

A scientific paper with the validation has been written by UCM and it is planned that it will be sent to a scientific magazine.

DEVIATION

The work content was extended in order to build up two more prototypes and therefore a prolongation of 6 months was necessary to finish their construction. This deviation is in favour of the project objectives and goes beyond the proposal as at this moment 4 prototypes are available instead of the two prototypes that were promised in the proposal.

No extra cost was incurred in the total project due to the fact that the saving of the subcontractor in WP1 has been used to build up the extra prototypes.

The deliverables and milestones have been successfully accomplished.

Deliverables

- Patent deposition, D3.
- Operation manual for the new lab device, D4.
- 2 + 2 laboratory prototypes units, D5.

Milestones and expected result

- A novel device for pulp suspension fluid dynamic studies. Accomplished.
- Assurance of the protection of knowledge through a patent deposition. Accomplished.

Work package 3

Work package 3. - Exploring potential uses for equipment design

Work package number	WP3		**Start date**			April –2004	
			End date:			January-2007	
Participant Short Name	JURESA	PAPRINSA	PDJSA	PAKA Glasshuette	GRUEN PERGA	GOPACA	UCM
Person-months per participa	10	2.5	1	2.5	2.4	3.5	15
Participant Short Name	TUD	FCTUC					
Person-months per participa	6	43.3					

ACTUAL STATUS: Finished

Objectives

To explore the potential uses for the new prototype developed in WP 2 for equipment design.

Description of work performed

The new devices were used to obtain the rheograms of different pulps and with different consistencies. This work has been performed by UCM, JURESA and FCTUC. The variables studied so far were:

- Effect of fibre type on pulp rheology: eucalyptus, spruce and pine were tested.
- Effect of pulping process on pulp rheology: Kraft, TMP and DIP were tested.
- Effect of consistency on pulp rheology.
- Effect of filler content and concentration.
- Effect of temperature on pulp rheology.
- Effect of bleaching and bleaching process.
- Effect of the bleaching process temperature.
- Effect of beating on pulp rheology.

The major effect was due to the pulp consistency and type, but the new device showed also sensibility to the differences of pulp temperature and composition and the differences on beating.

Design abacus for pulp suspensions was developed by JURESA and UCM. FCTUC team built the pilot rig; that was used for validation purposes. FCTUC team studied the effect of the pulp and pipe properties on the pressure drop in the pilot rig and they compared the results with the ones obtained with the design abacus developed and with TAPPI correlations. They produced new correlations for pressure drop and for the friction factor using the rheological data.

The validation was carried out at the paper mills sites using process streams with the help of UCM,

TUD and FCTUC

To establish and assure a common procedure, a technical meeting between UCM and TUD was carried out at 16th-20th May, in the UCM, Spain. Some works were carried out on the effect of bleaching on rheology behaviour of the pulp and on viscometer reproducibility. TUD studied the influence of the bleaching process and bleaching temperature on pulp rheology and UCM studied of influence of the refining degree and filler concentration. Therefore all the planned variables were studied.

Furthermore, although it was not planned, a result of this task was a program, based in spreadsheets, to obtain pressure drops from pulp rheogram developed by the UCM.

DEVIATION AND CORRECTIVE ACTIONS

It was a deviation in work carried out by TUD due to the fact that the prototype available at TUD, which had arrived on month 12, had problems with the rotor, and it had to be replaced with a new motor. Furthermore, their prototype was improved by replacing the weights by load cells, during the second period, and they could not start the trials planned in WP3 before the improvement. Therefore, their work on this WP was delayed and the WP was extended until month 27 in order to complete the work plan successfully.

Due to the amount of experimental data on the flow of pulp suspensions that it was necessary to acquire, since it was not possible to obtain that data from the industrial partners as initially foreseen, the step related to the application of CFD to the flow of fibre suspensions (which, in fact, was not essentially for the accomplishment of the project) had to be abandoned. Thus, FCTUC focused on setting up a pilot rig for flow tests, acquiring the experimental data (flow data and rheograms) and developing correlations, based on statistical design, for both pressure drop and friction factor, for both flow regimes (laminar and turbulent) that take in consideration the rheological characterization of the pulp suspensions. It was also possible to obtain a correlation for the transition velocity for fibre suspensions flow (velocity at the beginning of drag reduction).

Deliverables

- Rheograms for different pulp suspensions, D6. Due date: month 17. Actual date: month 27.
- Design abacus, D7. Due date: month 18. Actual date: month 26.
- Technical report for design of pipes and pumps, D8. Due date: month 22. Actual date: month 27.

Milestones and expected result

- Optimal design for pumps and pipes in papermaking. Accomplished.
- Insurance of the protection of knowledge through technical chart (design abacus) and technical report copyrights. Accomplished.

Work package 4

Work package 4. - Exploring potential use of prototype for wet end optimisation

Work package number	WP4	**Start date:**			May 2004		
		End date:			January 2007		
Participant Short Name	JURESA	PAPRINSA	PDJSA	PAKA Glashuette	GRUEN PERGA	AQUA+ TECH	GOPACA
Person-months per particip	0	3	3.5	1	1	10.9	2
Participant Short Name	UCM	TUD	FCUTC				
Person-months per particip	12	1.7	25.9				

ACTUAL STATUS: Finished

Objectives

To explore the potential use of the new device in wet end optimisation.

Description of work performed

The new device was used in this WP for measuring the effects of typical papermaking additives on the degree of flocculation and the resulting floc's resistance to shear. Sensitivity to product dosage and chemistry was studied as well as correlation with other methods like FBRM (UCM) and LDS (FCTUC).

During the first year, UCM and PDJSA studied chemistry families in order to cover a broad spectrum of chemistries: poly-aluminium chloride (PAC) widely use as coagulant in the paper industry, polyacrylamide, widely used in papermaking for retention in papermaking; polyethyleneimine (PEI), widely used for drainage; PDADMAC and the dual system PFR/PEO. These systems are representatives of important flocculation mechanisms in papermaking. Obtained results showed that the device was able to detect differences on pulp behaviour caused by the flocculation degree and floc properties. A scientific paper was published in Nord. Pulp Pap. Res. J. based on the results obtained.

A seminar was held at PDJSA with the basis of flocculation and the application of the new device for mill personnel.

A instructions manual for mill technicians to evaluate and monitor polymer reactivity with a given furnish using the new device developed in this project was prepared as D9.

AQUA+TECH prepared and distributed a range of polymers with different characteristics: polyacrylamides copolymers with acrylate-based cations with different branches and charge densities. They prepared also, new flocculants named "SnowWhite" inverse-suspension copolymerization of acrylamide and cationic monomers with different charge. These are entirely novel systems, not yet in the market. Furthermore, they prepared AlpineFloc-R series of inverse-emulsions at different cationic charge have been prepared with a new semi-bath redox initiation

system that has permitted higher product molar masses at lower levels of monomer in the initial recipe. These flocculants were tested by UCM using FBRM, DDA and FRET techniques and by FCTUC using LDS. Some results were presented at the Particle Systems Analysis Conference which was held in UK at September 2005.

Furthermore, the new device was tested as a tool for measuring the effects of the flocculation degree and floc's properties obtained with the new flocculants on pulp rheology. UCM studied the effect of charge density and structure on flocculation process and floc properties using FBRM and the effect on pulp rheology using the new device, as planned. The results obtained in the UCM with both techniques showed that the pulp rheogram was affected by the flocculant characteristics and dosage and the new device was sensitive enough to detect it. Several articles with some of these results and will be sent for publication in a journal of Chemical Engineering or a journal of papermaking.

As it was planned, GOPACA and AQUA+TECH studied the behaviour of pulp samples and residual waters at GOPACA mill in order to check the new flocculants developed by AQUA+TECH. The promising obtained results made that one of the tried flocculants were proposed as an alternative for the actual one used in the mill to improve the drainage rate in residual waters treatment. Similar tests were carried at PAKA, Gruenperga and PAPRINSA, to improve waters clarification and sludge dewatering with success.

The contribution of FCTUC to this WP was larger than the initially expected. They studied the effect of flocculant solution age, flocculant characteristics and dosage on flocculation process and floc properties and on retention and drainage process. They also studied the effect of water quality on flocculation process and required polymer dosage. Trials carried out with pulp and PCC showed low sensitivity of the device to the flocculant used. The used device to carry out these trials was the first prototype. It was observed that the retention and drainage processes could be performed increasing the branching grade of the polymer instead the charge density. This would reduce the polymer cost.

DEVIATION

Work performed in this WP was deeper than planned because of the interest in the effect of branched structures of the polymer on flocculation process and floc properties. The additional obtained results were included in the D10 and consequently, this WP was extended to month 27.

Deliverables

Technical report on flocculants behaviour, D10. Due date: month 19. Actual date: month 27.

Milestones and expected result

Validation of the new device for wet end optimisation studies. Accomplished.

Work package 5

Work package 5. - Pre-commercial prototype construction and validation

Work package number	WP 5	**Start date:**			November 2005		
		End date:			January 2007		
Participant Short Name	JURESA	PAPRINSA	PDJSA	MV	PAKA Glashuette	GRUEN PERGA	AQUA+ TECH
Person-months per particip	2	2	0	5.3	2	2	0.5
Participant Short Name	GOPACA	UCM	TUD	FCTUC			
Person-months per particip	1	3	2	2.5			

ACTUAL STATUS: Finished

Objectives

To design, to build up and to validate a pre-commercial prototype of the novel device to study pulp suspensions fluid dynamics.

Description of work

Comparable with WP 2, the work was carried out by MV in two steps: construction and validation. All the partners analysed the strong and weak points of the new device and suggested solutions for the weakness. A more robust unit was constructed by compiling all the recommendations from the previous work in WP2, WP 3 and WP 4 and all the improvements proposed by the partners.

5.1. Construction

The following improvements have been included the on the new prototype:

- Load cells instead of weights
- Software of the load cells
- A new system to remove the fluid from the vessel
- A cleaning-up system of the rotor and vessel
- Vessel better isolated from the external temperature with a cover

5.2. Validation

All the validation work was performed on-site at all SME paper mill locations involved in this project. Results provided confidence that the new proposed technique is robust for a mill environment. Each SME had the support of the university from their country.

An operation manual for the new pre-commercial prototype was written down, D11, and it was protected by copyright.

MV was responsible for the production of the prototype and future manufacture and commercialisation of the product.

DEVIATION

The work plan of this WP was accomplished without any deviation in the work content and it was concluded within the planned time schedule, considering the project extension. Deliverables and milestones were successfully accomplished.

Deliverables

- Operation manual, D11. Due date: month 25. Actual date: month 25.
- Pre-commercial prototype, D12. Due date: month 26. Actual date: month 26.

Milestones and expected result

- Industrial validation of project results. Accomplished.
- Assurance of the protection of knowledge trough copyright. Accomplished.

Work package 6

Work package 6. - Project management

Work package number	WP6	**Start date:**			October 2004		
		End date:			January 2007		
Participant Short Name	JURESA	PAPRINSA	PDJSA	MV	PAKA Glashuette	GRUEN PERGA	AQUA+ TECH
Person-months per particip	0.5	0.5	0.5	0.5	0.5	0.4	0.5
Participant Short Name	GOPACA	UCM	TUD	FCTUC			
Person-months per particip	0.5	7	0.5	0.5			

ACTUAL STATUS: Finished

Objectives

To ensure an efficient project management as well as adequate exploitation and dissemination plans.

Description of work performed

The activities carried out have included **all the necessary activities to obtain an efficient project management and to ensure proper exploitation and dissemination plans** for the obtained results during the project life, including:

- Planning and **coordination of the technical activities of the project**.
- Overall legal, contractual, financial and administrative management.
- Coordination of knowledge management and innovation related activities.
- Communication strategy.
- Meetings organization.
- Reporting

The project has been **managed by Steering Committee (SC) with one representative from each of the partners plus the co-ordinator who will chair the group, this SC was established in the kick-off meeting held in Madrid.**

A brochure for project presentation was written in 4 different languages (Spanish, English, German and Portuguese), D 13.

A **NODESZELOSS web page** was made immediately after approval of the proposal (D 14). This is being an efficient way to disseminate the existence and objectives of the project to the EU Scientific Community and Industrial Sector. The web page facilitated also the rapid exchange of information

with a potential interest for all partners. So far 800 visitors have been recorded in the project web page since its creation.

The SC has prepared the activity and management reports for each period.

The SC updated the Contract, Consortium Agreement and Technical Annex to withdraw the PDJSA from the project when they shut down in April. They also solicited to the UE an extension for three months, with success updating the Technical Annex in September 2006.

NODESZELOSS management has been focused not only towards the RTD work execution, but also towards the protection, publication and utilization of the knowledge generated during the project. All these activities have been compiled in the management report as well as in the plan for using and dissemination the knowledge (PUDK).

A detailed description on project management is provided in section 3 of this document and in the management report.

DEVIATION

The work plan of this WP has been accomplished without any deviation in the work content and it has been concluded within the planned time schedule, considering the project extension. Deliverables and milestones have been successfully accomplished.

Deliverables

- NODESZELOSS presentation brochure, D13.
- NODESZELOSS web-page, D14.
- Mid-term Activity Report, D15. (First year periodic activity report)
- Mid-term Management Report, D16. (First year periodic management report)
- Plan for Using and Dissemination of Knowledge. Due date: month 27. Actual date: month 27.
- Final Activity Report, D18. Due date: month 27. Actual date: month 27.
- Final Management Report, D19. Due date: month 27. Actual date: month 27.

Milestones and expected result

- Efficient project coordination. Accomplished.
- Proper exploitation and dissemination plans. Accomplished.

Section 3.- Consortium management

Summary of the management activities

To ensure the maintenance of the consortium agreement the following activities have been carried out:

- Planning and coordination of the technical activities of the project carried out during this period.
- Overseeing science issues related to the research activities conducted within the project.
- The overall legal, contractual, financial and administrative management.
- Coordination of knowledge management and innovation related activities.
- Organizing meetings.
- Reporting.

Main changes carried out by the Consortium management

During the project we had several delays from suppliers that have to provide us with several components for the pre-commercial prototype that was planned in the technical annex, WP5. The contingence plan mentioned in the technical annex was implemented. Therefore, the consortium applied for an extension of 3 months for the project in order to achieve successfully all the project objectives. This extension was approved by the European commission.

Félix Rocha left the company JURESA at the beginning of the second period. He was a member of the Steering committee (SC) and the leader of WP3. The consortium took the decision of replace him by Mr. Antonio Morros whose name was already in the forms. In the 4th meeting, Elena de la Fuente from the UCM was named as the new leader of WP3. The Consortium prepared and sent a recognition letter to Félix Rocha thanking him for his support and active work to the project.

PDJSA shut down in April 2006 and, therefore, they have withdrawn from this Project. The technical tasks were performed mainly during the first year of the project; the remaining tasks were carried out by UCM in collaboration with another paper mill in Madrid where UCM has an advanced flocculation laboratory and where they can easily take samples. Therefore it was not necessary to incorporate a new partner to the project. From the financial aspect, a cost statement was prepared for the second period until March which was also certificated. The consortium requested the amendment to the contract and modified the TA and the CA. These documents were signed again.

Consortium management structure

The project is managed by **a Steering Committee (SC).** Members of the SC during the second period were:

- Felix Rocha, JURESA (until May 2006).
- Antonio Morros JURESA (since May 2006)
- Javier Farré, PAPRINSA.

- Hilario Pérez, PDJSA (until April 2006).
- Leon Joore, MV.
- Christoph-Johannes Klemm, PAKA Glashuetter.
- Ulf Ender, GRUENPERGA.
- David Hunkeler, AQUA+TECH.
- Simão Américo Rocha, GOPACA.
- Ángeles Blanco, UCM.
- Harald Grossmann, TUD.
- Graça Rasteiro, FCTUC.
- Carlos Negro, project coordinator, UCM.

The SC was chaired by the co-ordinator who represented the highest level of decision making within the project. **The SC has met each 6 months** until **April 2006** and the **last meeting** took place in **December 2006.**

Furthermore, the project is organised in 6 work packages, each one has a **WP leader responsible for the performance of the work** conducted in the corresponding WP as well as to ensure the achievement of the deliverables. This **has ensured** that the **work programme** for a task was prepared, and that during the task, the progress was reported to the co-ordinator. WP leaders of the project are summarized on table 3.

There have been three changes in the consortium itself during this period:

- UCM representative, the UCM research vice-rector was changed; the new name is Prof. Dr. Carmen Acebal Sarabia.
- JURESA responsible of the work, Félix Rocha left the company JURESA in March 2005, he was the responsible of this SME work. He was substituted by Mr. Antonio Morros whose name was already in the forms. A new leader of WP3 was named by the SC as indicated in table 4.
- FCTUC representative person changed in December 2006, the new name of the head in FCTUC is Prof. Joao Gabriel Silva.

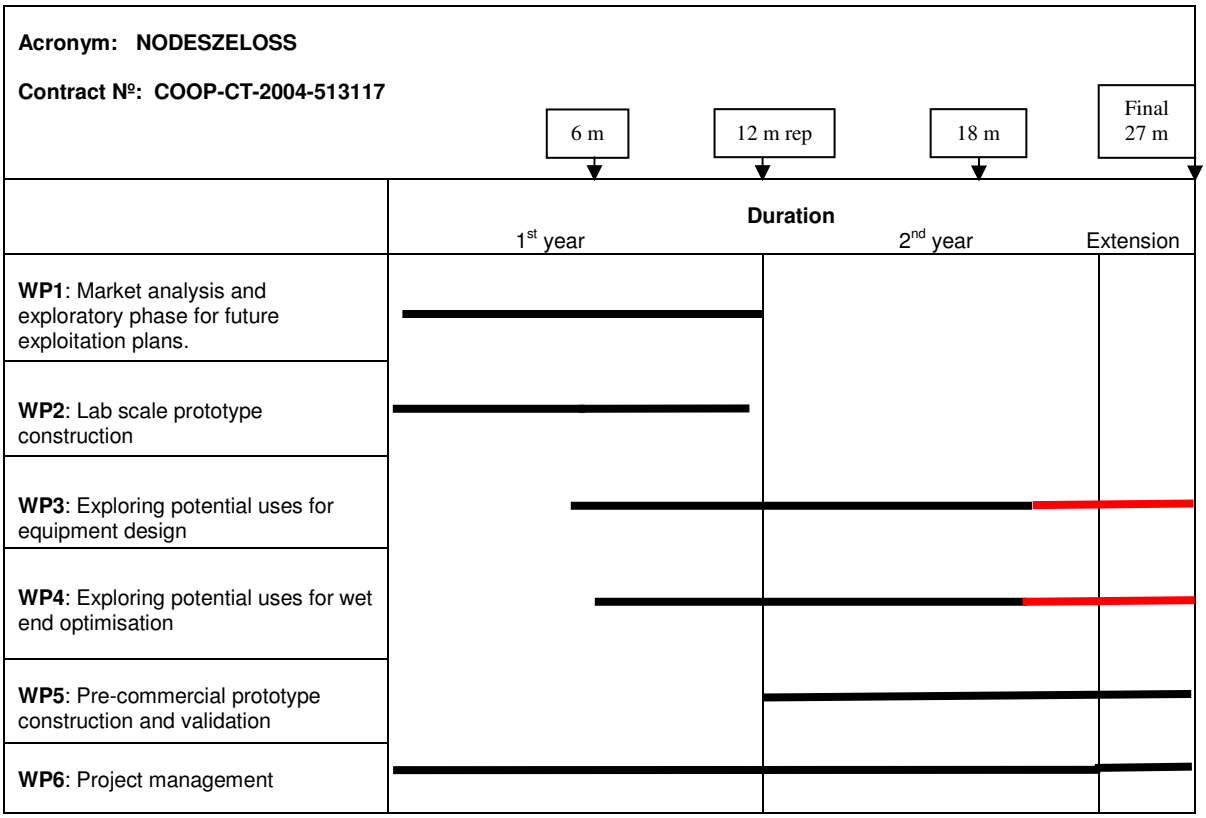
Table 4.- Work packages leaders.

Work-package No	Work package title	Lead contractor Short Name	Deliverable No
WP1	Market analysis and exploratory phase for future exploitation plans	MV Cornelia Lumpe Leon Joore	D1-D2
WP2	Lab scale prototype construction	UCM Angeles Blanco	D3-D5
WP3	Exploring potential uses for equipment design	JURESA UCM Felix Rocha Elena Fuente	D6-D8
WP4	Exploring potential uses for wet end optimisation	AQUA+TECH David Hunkeler	D9-D10
WP5	Pre-commercial prototype construction and validation	MV Leon Joore	D11-D12
WP6	Project management	UCM Carlos Negro	D13-D19

Project time table and status including updates and changes

The project timetable and status including updates and changes are included in the project bar chart and status in table 5.

Table 5.- Project bar chart and status



Communication strategy within the consortium

Interactive management meetings and technical meetings have played **an important role** in the **communication strategy and in monitoring progress of the project**. **Partners** have been kept **fully informed** about the project status and the planning issues which were important to them. All information (minutes of meetings, visit reports, work package reports, relevant publications, etc.) was communicated to the project co-ordinator, who was responsible for transferring this information to other partners.

Since documents and reports have often been compiled from parts that have been provided by different partners it was necessary to **use a common standard for the exchange of software files**. The following formats were used:

- text files Microsoft Word,
- spreadsheet: Microsoft Excel, and
- figures: Microsoft Power Point.

E-mail and fax have been used to exchange documents. The **website** of the **project** (**http://www.ucm.es/info/nodeszel/**) has been a useful tool to further ensure efficient exchange of information**.** The website **is focus on marketing and dissemination** of the progress and results of the project and it summarised many of the technical papers' titles relating to the obtained results.

Meeting organization:

The following SC and technical meetings have been accomplished to maximise interaction between partners:

- Kick-off meeting: 14th-15th October, Madrid, UCM, Spain.
- SC meeting and Technical meeting WP2: 8th-9th March, Coimbra, FCTUC, Portugal.
- SC meeting and Technical meeting: 10th-11th October, Dresden, TUD, Germany.
- SC: meeting and technical meeting 27th-28th April, Ferney-Voltaire, AQUA+TECH, France.
- SC meeting and technical meeting: 21st-22nd December, Amsterdam, MV, The Netherlands.

During Each meeting, a member of the consortium acted as a **Scientific Secretary** in order **to allow** all the **partners** to have **the minutes of each meeting at its end.** In all the meetings held in the first period **a technical visit** to the RTD **laboratories** and the **SMEs sites** were arranged. In the meeting held in Ferney-Voltaire, during the second period, **a technical visit** to AQUA+TECH installations was carried out. Minutes of the meetings and relevant information were included in the web page.

Beside these project meetings, several technical discussion meetings and works have been carried out at SME sites and Universities (between partners).

Reporting:

The layout and detailed content of the reports has followed the Commission guidance notes and guidelines for project report preparation under VI framework. The co-ordinator, on behalf of the consortium has been responsible to submit to the Commission, by electronic and regular mail, within the period established by the contract, the following reports:

- **A mid term review for the project, composed of an activity report and a management report.**
- **The amendment to the contract and the updated technical annex and consortium agreement in April 2006, as a consequence of PDJSA withdrawn.**
- **The updated of technical annex in September 2006 to apply for a project extension.**
- **The second period activity report.**
- **The second period management report**
- **The final report**: at the end of the project the following final reports has been prepared:
    - **A final activity report.**
    - **A final management report.**
    - A **report on each contractor on the distribution** of the **financial contributions to the community** made after the end of the project.

Management of knowledge and IPR:

NODESZELOSS management has not only been focused towards the RTD and SMEs work, but also towards the protection, publication and utilization of the knowledge generated, which took an **important role in the management** of this consortium during the whole life of the project.

One of the **fundamental activities** in the **NODESZELOSS project has been** the **management of intellectual property and exploitation of results,** which is a **consequence** of the program undertaken in the project and which is a property of SMEs.

To safeguard intellectual protection right the following actions have been accomplished during the second period of the project:

- **1 Patent application**: "A novel device for measuring transport momentum in pulp suspensions". Prototype developed in work package 2. (Deliverable 3).
- **Operation manual, copyright**. For the new devices. (Deliverable 4).
- **Design abacus, copyright**: for WP3. (deliverable 7).
- **Technical report for pipes and pumps design, copyright**: for WP3. (Deliverable 8).
- **Operation manual, copyright**. For the pre-commercial device. (Deliverable 11).

Section 4. Other issues

It is remarkable the involvement of SME in many activities during the project, during the second period it should be specially notice the following contributions:

- MV, leader of WP1 and WP5, so far they have performed mainly the market analysis during the first period. During the second period they have performed the pre-commercial prototype and its operation manual. Furthermore, they have contributed actively to the dissemination of knowledge publishing newsletters and organising a seminar where they presented pre-commercial prototype together with UCM.

- JURESA, leader of WP3 during the first year and the first part of the second period, they have actively contributed the development of the new device including the software development and the performance of tests in the mill with process samples, and to the development of the design abacus and the deliverable 6. Furthermore, they have organised a seminar on Chemistry and Flocculation in December 2006.

- PAPRINSA, they have contributed actively in the development of the control unit for the new device as well as in process samples analysis for WP3 used for the validation of the viscometer, and in the mill trials carried out in WP4 with the collaboration of AQUA+TECH.

- AQUA+TECH, leader of WP4 and highly involved in its development. They have developed new linear and branched flocculants and they have carried out trials in collaboration with PAPRINSA, PAKA, Gruenperga and GOPACA. Furthermore, they actively contributed to the dissemination of knowledge through their participation in seminars and conferences. Two examples were the conference held in Chicago and the one held in Madrid, both referenced in the D10 and D17.

- GOPACA, worked together with FTCUC in WP3 and with AQUA+TECH in WP4.

- PAKA Glasshuetter, has been working with TUD in WP3 and with AQUA+TECH in WP 4.

- GRUENPERGA has been working together with TUD in WP3 and with AQUA+TECH in WP4.

- PDJSA has been working together with UCM mainly in WP 4.

The communication with the SMEs during the project has been assisted by one representative in each country responsible for contacting the different SMEs, as follow:

Prof. H. Grossmann was responsible of the German partners.
Prof. G. Rasteiro was responsible of the Portuguese partners.
Prof. C. Negro was responsible of the Spanish partners.

Plan for using and disseminating knowledge (PUDK)

The NODESZELOSS project considers that there is an **obligation to use and disseminate the results** of the project with the aim **to spend public money effectively** and, at the same time, **to increase** future **competitiveness of the SMEs** involved in the project. **Knowledge arising from the work** carried out under the NODESZELOSS project **is the joint property of the SME** contractors according with the rules of the UE. The CA has included the agreement among them on the allocation and the terms of exercising the ownership of the knowledge.

The results obtained in the **work package 1** provided as important **deliverables:** the **concrete terms for dissemination strategy, the target groups and the strategic impact** of the project **in terms** of improvement of **competitiveness or creation of market opportunities for the SMEs participants.**

A project web-page was built immediately after approval of the proposal. The **project web-page** was an efficient way to disseminate the existence and objectives of NODESZELOSS project during the second period (supported by the EU Commission) to the EU Scientific Community and Industrial Sector. The NODESZELOSS web-page also has facilitated the rapid and efficient exchange of information with a potential interest for all project partners. Advantage of the facilities provided by the UCM servers has been taken for maintenance of this web-page during this period.

The final version of the plan for using and disseminating knowledge has been accomplished as deliverable D17.

Plan for using and disseminating knowledge was also included in the work programme as well as in the management. As summary the deliverables accomplished during the second period of the project in relation with PUDK are:

- Draft version of the Plan for using and disseminating knowledge, deliverable D2.
- Patent application, deliverable D3.
- Operation manual for lab device, copyright D4.
- Operation manual to evaluate polymers reactivity, D9.
- NODESZELOSS presentation brochure, deliverable D13.
- NODESZELOSS web page, deliverable D14.
- Final version of the Plan for using and disseminating knowledge, deliverable 17.
- Design abacus, copyright, deliverable D7.
- Technical report for pipes and pumps design, copyright, deliverable D8.
- Operation Manual of the pre-commercial prototype, deliverable D11.

Furthermore, onsite training actions were undertaken by FCTUC, TUD and UCM.

During the project, scientific and technical results have been also disseminated through different actions, being important examples, the following ones:

- Doctoral Thesis: one was defended at UCM in July 2005. It is remarkable that the PhD student was the representative of one SME, Félix Rocha from JURESA.
- Master Thesis: one has been defended at UCM in July 2006.
- Poster of the project: presented in the 6th ANQUE International Congress of Chemistry held in Tenerife in December 5th-7th.
- Two workshops and one conference have been presented by AQUA+TECH.

- A paper titled “Effect of chemical flocculation mechanism on rheology of fibre pulps suspensions”, has been published in Nordic Pulp & Paper Research., and another paper titled “Rotor selection for a searle-type to study the rheology of paper pulp suspensions” has been published in Chem. Eng. Process. Both papers were published by UCM.
- FCTUC, together with UCM, has submitted three publications. One of them, titled “Modelling pulp fibre suspension rheology” has been accepted for publication in Tappi J., and the other two titled: “The use of LDS as a tool to evaluate flocculation mechanisms” and “Evaluation of flocs resistance and reflocculation capacity using the LDS technique” are in revision process by Chem. Eng. Process.
- FCTUC has also presented a communication in relation with WP4 at PARTEC 2007, Nuremberg, Germany, entitled “The Use of LDS to Assess Flocculation Dynamics”.
- Two communications have also been submitted by FCTUC to TECNICELPA 2007, Portugal, October 2007, reporting achievements of the project to an audience with interests in the pulp and paper production. They are entitled: “Effect of water cationic content on PCC flocculation induced by CPAM” and “The flow dynamics of pulp fibre suspensions”, in relation, respectively with WP4 and 3.
- Two Chemical Engineering Graduate Students developed their final year project, at FCTUC, in relation with NODESZELOSS. One, Joy Lee Iglesias, presented the thesis entitled “Study of the Flow of Pulp Suspension in Pipes”. This thesis was a collaboration with UCM through the Socrates/Erasmus program. The other one, Bruno Reis, presented the thesis entitled “Flocculation Studies of PCC Particles for the OPaper Industry” at FCTUC.
- One of the research students of the project, Elisabete Antunes, has received a fellowship (starting in December 2006) to proceed with research studies at FCTUC, in collaboration with UCM, to prepare a PhD thesis to be submitted to the award of a European PhD.

More details in relation with the PUDK are included in the Deliverable 17, see annex 6 in the volume 2 of the second period activity report.