Development of a chemical-free water treatment system through integrating fibre filters, ultrasound and UV-C

CHEM-FREE

A Co-operative Research Project (CRAFT)
funded within the EU 6th Framework Programme
Horizontal Research Activities involving SMEs

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BOKU – University of Natural Resources and Applied Life Sciences, Vienna
Institute of Sanitary Engineering

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CHEM-FREE consortium contacts

Short name	Organisation	Name	Phone / e-mail
BOKU	Universität für Bodenkultur Wien	Günter Langergraber	+43-(0)1-36006-5814 Guenter.Langergraber@boku.ac.at
UOP	University of Portsmouth Higher Education Corporation	Claire Hellio	+44 23 9284 2073 claire.hellio@port.ac.uk
UNICT	Università degli Studi di Catania	Guiseppe Cirelli	+39-095-7147544 giuseppe.cirelli@unict.it
TBH	Technisches Büro Hauer UmweltwirtschaftGmbH	Helga Goldschmid	+43-(0)2262-62223 Goldschmid@tbhauer.at
LG	LG Sound	Caroline Lems	+31-(0)70 36 22 046 c.lems@lgsonic.com
DRE	DREMA Waterbehandeling BV	Andre W.E. Van den Bogaert	+31 (0) 78 618 40 11 andre@drema.nl
LIMNOS	LIMNOS Company for Applied Ecology Ltd.	Tjasa Griessler Bulc	+386-(0)1-5057472 tjasa@limnos.si
ISO	Saint-Gobain Isover Austria GmbH	Karl Zlabinger	+43 (0)2266 606 256 k.zlabinger@isover.at

Publishable Summary

The CHEM-FREE project develops a process instrument to integrate and optimise three well known water treatment devices: Fibre filters, ultrasound and UV-C. The devices are expected to restrain suspended solids as well as dissolved nutrients, to counteract algae growth and care for disinfection. Both lab-scale and field-scale research and validation will be performed to combine, arrange and steer efficiency of physical and biological processes. The resulting integrated technology must combine the economic and ecological advantages of all the individual devices. Additionally, it must allow the application for the treatment of different water qualities without the use of chemicals.

CHEM-FREE is a Co-operative Research Project (CRAFT) funded within the EU 6th Framework Programme Horizontal Research Activities involving SMEs (Contract No. COOP-CT-2006-032719). The project started in July 2006 and lasts for 2 years. CHEM-FREE is coordinated by the University of Natural Resources and Applied Life Sciences, Vienna (BOKU), Austria, and involves 4 SMEs:

- TBH (TB Hauer), Austria,
- LG Sound, The Netherlands,
- DREMA, The Netherlands and
- LIMNOS, Slovenia

and 3 Universities besides

- BOKU, Austria
- UOP (University of Portsmouth), UK, and
- UNICT (University of Catania), Italy,

as well as the other partner

- ISO (Saint-Gobain Isover Austria), Austria.

Lab-scale experiments regarding reduction of microbiological decontamination, removal of algae and nutrient restraint in a controlled environment result in a better understanding of the principal removal mechanisms to decrease the contamination for the applications using a) the individual devices and b) their combinations to determine the optimal operational parameters for the field-scale experiments.

The CHEM-FREE system is tested for four specific applications:

- swimming pools (Figure 1),
- polishing wastewater for irrigation of crops (Figure 2),
- fish farming (Figure 3), and
- groundwater recharge (Figure 4).

Legal regulations, technical standards, market and operational requirements of the potential uses were analysed for integration into the prototype development process.



Figure 1: Field-scale experiments in Austria regarding swimming pool in Gerasdorf

The results for the field-scale experiments can be summarised as follows:

Application 1: Swimming pools:
The results from the experiments show that water in the pool is neither turbid nor greenish. It has appeared transparent and clear for the entire period of experiments also with the water temperature close to 30°C. The main findings for swimming pools can be summarized as follows:

- with CHEM-FREE treatment a stable water quality as required for bathing water in the European regulations for inland waters and the Austrian regulation for bathing ponds can be achieved for physicochemical and microbiological parameters.
- For private households CHEM-FREE swimming pools are therefore an alternative compared to chlorinated system.

Application 2: Reuse of treated wastewater for irrigation of crops:
For the experiments one main goal set was to achieve a design flow rate of the system to guarantee the availability of water for irrigation. Removal efficiencies have been high and constant for chemical parameters. The main problem regarding legal requirements are the strict maximum concentrations required in the Italian standards for irrigation water for ammonium nitrogen and E.coli that could not be met.



Figure 2: Field-scale experimental site regarding irrigation in San Michele di Ganzaria, Sicily

Application 3: Fish farming:
There is a clear effect of the CHEM-FREE treatment system on the water quality in the pond with regard to colour and parameters such as nitrite, TOC, total suspended solids. The water in the recirculation fish pond with CHEM-FREE treatment was clear whereas the water in the reference flow through fish pond was green from algae (Figure 3).



Figure 3: Field-scale experiments regarding fish farming in Ajdovscina, Slovenia: Fish pond without (left) and with (right) CHEM-FREE treatment.

The CHEM-FREE system was efficient for fish-farming, because in the reference pond one has reached the lethal conditions for fish population, while the CHEM-FREE pond can be additionally loaded with fishes. According to Slovenian legal standards for cyprinid surface waters concentrations in the CHEM-FREE pond only the average value of nitrite did not meet the standard, while in reference pond TSS, BOD_5, Total P, nitrite and NH_4 were above the limits. Concentrations of nitrite and Total P in CHEM-FREE pond were at first above limit values, but gradually decreased and at the end of experiment reached the limit values according to legislation. Additionally, higher fish production could be achieved in the CHEM-FREE pond compared to the reference pond. CHEM-FREE proved to be new innovative way to solve fish farm water treatment.

Application 4: Groundwater recharge:
The field site for groundwater recharge has been in operation since May 2007. For the average log removal of the overall system was 2.17 (N =7, stdev. = 0.76) and 3.10 (N =8, stdev. = 0.86) for *E.coli* and Faecal streptococci, respectively. The site specific standards for the chemical and microbial parameters have been met. The highest specific TSS load of all experiments occurred at this site resulting in clogging of the filters.



Figure 4: Field-scale experiments in Austria regarding groundwater recharge

In general, the results from field-scale applications showed promising results for the closed-loop applications (swimming pool and fish farming) whereas the results for the flow-through applications (polishing treated wastewater for irrigation and ground water recharge) show that there is still a demand for optimizing the systems.

The main output of CHEM-FREE is a prototype technical specification allowing integration and optimisation of the three devices as an integral unit. The optimal integration and control of fibre filters, ultrasound devices, and UV-C sets will result in chemical-free water treatment enabling ecological prevention of algae, in decreasing biofilm growth on walls, in pipelines, on fittings and in containers. CHEM-FREE will provide completely new solutions for sensitive water treatment systems where chemicals are an unsatisfying solution like drinking water production from surface waters, groundwater recharge, etc.

Further information http://www.chem-free.eu

Contact:

Dr Günter Langergraber (Coordinator CHEM-FREE project)
University of Natural Resources and Applied Life Sciences, Vienna (BOKU)
Department of Water, Atmosphere and Environment
Institute of Sanitary Engineering and Water Pollution Control
Muthgasse 18, A-1190 Vienna, Austria
Tel.: +43 (0)1 36006-5814; Fax: +43 (0)1 368 99 49; Email: guenter.langergraber@boku.ac.at

Section 1 - Project objectives and major achievements during the reporting period

1.1 General project objectives

The objectives of the CHEM-FREE project, as defined in the Description of Work (DoW), are:

- To integrate three existing water treatment devices into a multi-functional integrated technology displaying all physical water treatment benefits without use of chemicals.
- To test the integrated systems for 4 applications in field-scale (closed-loop water systems, crop irrigation, fish farming and groundwater recharge).
- To develop a prototype and technical specification as basis for patent registration for a process allowing integration and optimisation of the three devices as a single unit.

1.2 Objectives for the reporting period, work performed and the main achievements

The main objectives of the work in the reporting period have been:
- To run the field-scale experiments
- To evaluate the results of the field-scale experiments
- To prepare technical description for the prototype
- To organise 3 stakeholder events

The main work performed in the reporting period was
- Field-scale experiments
- Data evaluation
- Prototyping
- Dissemination and exploitation

Main achievements
- Extensive report that includes a detailed evaluation of the results
- Technical description for prototype
- 3 stakeholder events.

1.3 Problems during the reporting period and corrective actions undertaken

After the amendment of the project for 3 additional months and the new workplan were accepted the work in CHEM-FREE was on time again and no further problems regarding the work flow occurred.

Section 2 - Workpackage progress of the period

WP 1: Project Management (BOKU, month 1 - 27)

Progress towards the objectives:

T1.2 Project coordination and T1.3 Project administration

- Communication with EC:
  1. Langergraber met Mr. Collucio (Scientific officer) and Ms. Decleve (Administrative officer) on 7 September 2007 in Brussels where he was informed that the request for amendment of the duration of the project was accepted.
  2. extensive communication after receipt of review results and after submitting the respond to the review.
- Consortium meetings:
  1. 12 months meeting: 9-11 July 2007, Ljubljana, Slovenia, including a field-site visit in Austria on 7 July 2007
  2. SWOT meeting, 3-5 October 2007, Catania, Italy
  3. 18-month meeting, 28-30 January 2008, Vienna, Austria
  4. Meeting of the RTD partners: 31 March - 1 April 2008, Vienna, Austria
  5. Data evaluation meeting: 21-22 May 2008, The Hague, the Netherlands
  6. Final meeting, 15 September 2008, Vienna, Austria
- Coordination and administration of the project: continuous activity
- SME co-ordination (by TBH) regarding
  - protection of knowledge on combined technologies
  - use of knowledge on combined technologies
  - dissemination of rights on combined technologies

T1.4 Project controlling

- PCT meetings (BOKU+TBH): 04.07., 14.08., 11.09., 16.10., 20.11., 11.12.2007, 22.01., 26.02., 26.03., 29.04., 20.06., 29.07. + 03.09.2008
- Reports for period 1 (1 July 2006 – 30 June 2007) prepared and submitted on 14.08.2007
- together with report a letter regarding the "Request for Amendment to duration of project" has been submitted, request was accepted, duration of project now 27 months → end date: 30.09.2008
- preparation and submission of response to review results for 1st year report
- 2nd pre-financing was announced for early 2008 (received finally on 9 January 2008) and 3rd payment released on 14 January 2008, 4th payment after the 18-month meeting on 31 Jan 2008 as decided by the consortium.
- 3-monthly internal activity and financial reports have been consolidated by the coordinator and distributed among the partners.
- The following table shows the deliverables submitted in reporting period 2:

Del. No.	Deliverable name	WP	Lead participant	Nature	Dissemination level	Delivery date (month/actual)
D4b	12 months reports to EU	1	BOKU	R	CO	12 / 14.08.2007
D5b	Minutes 12-month meeting	1	BOKU	R	CO	12 / 14.08.2007
D26	Plan for using and disseminating knowledge - draft version	7	LG	R	CO	12 / 14.08.2007
D25	Report on market analysis	7	DRE	R	CO	14 / 16.10.2007
D12	Data recorded from the basic configuration of each field-scale experiment	4	resp.*	O	CO	14 / 16.10.2007
D19	Requirements consolidated for SWOT analysis	6	LIMNOS	R	CO	15 / 16.10.2007
D15	Description of synergetic effects and negative impacts for each field application	5	resp.*	R	CO	15 / 06.11.2007
D18	Description of the system limits	6	BOKU	R	CO	15 / 12.12.2007
D16	Evaluation of the optimisation potential and definition of optimised configuration	5	BOKU, UOP	R	CO	16 / 12.12.2007
D20	Report on SWOT analysis	6	TBH	R	CO	18 / 18.12.2007
D4c	18 months reports to EU	1	BOKU	R	CO	18 / 22.02.2008
D5c	Minutes 18 months meeting	1	BOKU	R	CO	18 / 22.02.2008
D27	Flyer	7	DRE	O	PU	18 / 22.02.2008
D13	Data recorded from each field-scale experiment for optimised configuration	4	resp.*	O	CO	22 / 26.05.2008
D31	Minutes data evaluation meeting	5	BOKU	R	CO	23 / 09.06.2008
D14	Operation requirements for each application	4	resp.*	R	CO	22 / 01.09.2008
D17	Description of treatment performance	5	resp.*	R	CO	22 / 01.09.2008
D 6	Minutes of the final meeting	1	BOKU	R	CO	27 / 13.10.2008
D21	Technical description for prototype instrument	6	TBH	R	CO	25 / 11.11.2008
D22	Prototype instrument	6	TBH	P	RE	25 / 11.11.2008
D28	Three Stakeholder events	7	DRE	O	PU	27 / 11.11.2008
D29	First application for patent registration	7	LG	O	CO	27 / 04.12.2008
D30	Plan for using and disseminating knowledge - final	7	LG	R	CO	27 / 04.12.2008
D4d	Final reports to EU	1	BOKU	R	CO	27 / 09.01.2009

* resp. = TBH, UNICT, LIMNOS, BOKU (partners responsible for field-experiments)

T1.4 Project finalization

- the final meeting was held in Vienna on 15 September 2008
- preparation of the final reports (activity and management) by BOKU

Deviations from the work programme:

No deviations from the workplan from the revised DoW dated 04.09.2007

WP 4 Field applications (month 7 - 22)

Progress towards the objectives:

The detailed description of the experiments carried out and the results obtained is available in the joint deliverable D14+17. Therefore here only a brief summary of the main activities in the reporting period is given.

WP 4a - Closed-loop systems (TBH)

- Start of operation: May 2007
- Check of regular operation, regular maintenance and monitoring by TBH.
- Samples were taken on a regular basis by BOKU and analysed in BOKU's lab until end of April 2008.
- Samples for algae analysis sent to UOP (Identification of algae present in the samples collected during the 3 field trips and the samples which have been sent to us by the other partners. Re-growth experiments of the algal samples, to check, if after CHEM-FREE treatment, the algal cells are still alive and/or able to grow again.)
- Experiment on biofilm growth on different materials in pool. The experiment duration was from the week 46 to the week 49. The samples were sent to UOP by BOKU. Surfaces received from Vienna were inoculated in respective medium for the analysis of algae, bacteria and fungi populations present on each surface. 4 times 17 samples were inoculated in duplicate for each medium. Pictures were taken for preliminary observations, analysis and to present them in the next meeting in Vienna.
- Experiment after spring cleaning and operation without UV to test re-growth of biofilm
- End of operation: end of April 2008

WP 4b - Irrigation of crops (UNICT)

- Start of operation: May 2007
- Redesign and reconstruction: July 2007
- Monitoring for physical, chemical and microbiological parameters, and algae was done on the regular base (every week) in the lines "a" and "b". Tests on irrigation pipes, emitters and filters are still on going.
- Maintenance of experimental plants (lines A and B + irrigation field).
- Experiments regarding the operation of the UV device with different flow rates (0.25, 0.50, 0.75, 1 L/s)
- End of operation: end of April 2008

WP 4c - Fish farming (LIMNOS)

- Start of operation: May 2007
- Monitoring for physicochemical and microbiological parameters and algae was done on the regular base as well as recording of environmental conditions (each day), fish conditions, growth and feeding mode.
- Additional experiment was done to evaluate US operational limits. US was switched off for 1 month and installed in the reference pool to observe the re-growth of algae. The operational procedure of the CHEM-FREE system was re-set (frequency of cleaning of UV, roughing filter).
- The problem of clogging of fibre filters were pointed out and necessity of the roughing filter integration into the CHEM-FREE system for fish farms.
- End of operation: end of September 2008

WP 4d - Groundwater recharge (BOKU)

- Start of operation: May 2007
- The system was frequently monitored. It was maintained (UV-C units: replacement of broken sleeves). Samples were regularly collected (BOKU, BM, UOP).
- The test of a basic configuration revealed that the number of filters had to be increased to enable the treatment of water at higher flow rates.
- September 07: Replacement of the 4 filters installed in May by 8 new similar filters. The ventilation pipe used to evacuate potential gases within the filters was closed. Monitoring, maintenance and sampling were regularly done.
- End of operation: end of February 2008, afterwards only 3 US in sedimentation pond were used until end of June 2008. The goal was to observe the effects of the 3 US units on bound chlorophyll-A for a longer period of time.

Deviations from the work programme:

No deviations from the workplan from the revised DoW dated 04.09.2007

WP 5 Data evaluation (BOKU, month 4 - 23)

Progress towards the objectives:

T5.1 Collect and consolidate data

- Data have been collected and consolidated before being transferred to the platform by all partners carrying out experiments.

T5.2 Evaluate data

- for preparation of SWOT meeting resulting in D15 (Synergetic effects and negative impacts) as well as D19 (Requirements consolidated for SWOT analysis).
- After SWOT analysis preparation of D16 (Evaluation of optimisation potential)
- Before 18-month meeting: preparation of (draft) reports for all experiments to support presentations at meeting
- At the RTD meeting in Vienna (31 March – 1 April 2008) the way forward towards the final evaluation of the data was discussed and agreed. A second draft of the reports for all experiments was prepared. It was agreed that D14 (Operation requirements for each application) and D17 (Description of treatment performance) shall be one document and shall also include all evaluations from the lab-scale experiments
- Presentation of the draft of the evaluation at the meeting in The Hague (21-22 May 2008)
- Final drafts of the single reports by mid of June 2008
- Editorial meeting for finalisation of the summary for D14+17 on 10-11 July, Catania, Italy

T5.3 Perform lab-scale experiments regarding optimisation

1. *UOP experiments:*

- UV unit were moved from Petersfield to Portsmouth University for UV closed-loop experiments which began in December. We received 3 small Ultrasound units (different frequencies) from LG-Sonic and 2 small filters from BOKU for use in closed/closed-loop experiments. Constructions of the closed/closed-loop system were started and plans made to test the devices in January. The future experiments will be carried out at university in smaller volume, closed/closed-loop and controlled conditions (Temperature, pure culture, light, flow rate) for a better interpretation of the limits and the strength of the treatments.
- Closed-loop experiments have been performed using new US units (high, medium, and low frequencies) and UV: 1) High Frequency US effect on *Chlamydomonas ulvaensis*, 2) Medium Frequency US on *Scenedesmus armatus*, 3) UV effect on *Chlamydomonas ulvaensis*. Chlorophyll a concentration was measured. SEM observations have been done to evaluate potential external damages caused by the devices. Viability tests have been performed. TEM samples are ready.

2. *BOKU indoor experiments:*

- Experiments regarding micro-pollutants: The goal of the experiments is to investigate additional benefits of the CHEM-FREE treatment compared to conventional treatments.

Experiments on the filters and UV-C units were carried out. Their purpose was to study the behaviour of each type of unit with regard to micro-pollutants load at pilot plant scale. MTBE, Benzene, Trichloroethylene and Tetrachloroethylene and PAHs were successively tested.

3. BOKU outdoor experiments (Stallingerfeld):

Experiments started in June 2007: 2 lines of flow-through and closed loop systems, respectively, each with one line with and without US to investigate effect of US

A. Flow-through systems

- The systems, in operation since the 15 June 07, were frequently monitored. They were maintained. Samples were regularly collected and analysed (BOKU, BM).
- September 07: Both filters clogged, replacement of clogged filters.
- October 07: Both filters clogged (very low or null flow rate). The filters were not replaced. Ultrasound transferred from one basin to the other: flow-through system was turned into a flow-through system with ultrasound (and vice versa)
- October/November 07: UV-C units were installed after the (by-passed) filters. The objective was to get again the white thin layer which was previously observed on some sleeves but still unidentified. It failed.
- Investigations on biofilm growth on different materials used for the design of swimming pools in both basins. Goal: to determine if the growth of microorganisms is affected by the type of material and the presence of US.
- February 08 installation of new filters by TBH. Each filter was operated as flow-through filter (gravity flow, 100 l/h) with a water table of around 2m, until end of April. Basin 6 was also used (without filter) in order to evaluate the effect of other natural processes which could occur in the sedimentation pond and affect TSS and particle counting concentrations. Samples were collected from the inflow and the outflow of the basin on 11, 14 and 16/04/08 (flow rate: 100 l/h, 2 m water level).
- Following the meeting end of May 08 in The Hague, it was decided to extend the period of experiment with the same fibre filters but under different operating conditions (increase of the flow rates, water levels decreased).

B. Closed-loop systems:

- End June 07: Start of implementation. Several problems occurred (e.g. leakage in one of the basins.
- July 07: The leakage problem was solved. The implementation of both closed-loop systems was finished. The experiment started on the 23rd of July.
- Problems with the pumps,: no constant flow rates, , electricity failures, etc. → water losses.
- September 07: New configuration of the system to limit the use of pumps.
- October 07: Ultrasound transferred from one basin to the other: Closed-loop system is turned into Closed-loop system with ultrasound (and vice versa) Adding of nutrients in the basins to increase their concentration to trigger growth of algae. Due to unfavourable weather conditions, the results obtained were below those expected.

- November 07: Winter configuration of the systems. Instead of using 2 basins for each system, only one is being used.
- December 07: UV-C units out of operation due to maintenance needs followed by unfavourable weather conditions (ice in the pipes preventing any flow). The UV-C units and the components connected to them (pipes, flow meters...) were taken back to the university in order to prevent their degradation.
- In January and February 08, troubles occurred with electricity (short-cuts) and the UV-C units (formation of ice). On the 28 February, the UV-C units were removed. On the 18 March, the filters were removed from the basins (two pressure rolled filters in each basin). New filters were installed by BOKU and TBH (battery of four pressure rolled filters).
- Fertilisation experiment took place in the closed-loop systems from April to June 2008. Following the meeting in The Hague end of May 2008, it was decided to extent the period of experiment with the closed-loop systems. To increase nutrients concentrations, equal amount of chemicals were added to the basins on 07/04/08, 16/04/08 and 02/06/08.

T5.4 Define additional lab experiments and optimised configurations for field applications

The additional experiments for the lab-scale experiments and the optimised configurations for the field-scale applications have been discussed and decided on at the SWOT meeting in Catania and are planned to be revised at the 18-month meeting in Vienna.

T5.5 Perform lab-scale experiments regarding troubleshooting

Biofilm growth in pool has been identified as a severe problem that needs further investigations. Investigations are underway to prevent algae adhering and growing in closed-loop system pipes (covering the pipes).

The experiments carried out under this task are already described in Task T5.3 "Perform lab-scale experiments regarding optimisation".

T5.6 Describe treatment performance

As preparation for the 18-month meeting (draft) reports for all experiments to support presentations at meeting have been prepared and shared between the partners via the platform. These reports will be updated and finally will result in D17 (Description of the treatment performance).

The main outcome of this task is the joint deliverable D14 (Operation requirements for each application) and D17 (Description of treatment performance) which is already described above in Task T5.2 "Data Evaluation".

Deviations from the work programme:

No deviations from the workplan from the revised DoW dated 04.09.2007

WP 6 Prototyping (TBH, month 7 - 24)

Progress towards the objectives:

T6.1 Perform lab-scale experiments regarding system limits

- Experiments regarding system limits (see also T6.1) have been carried out and finalised by BOKU → deliverable D16 (Description of the system limits)
- UOP: Comparison of the results obtained while using different strains of algae showed some important limitation of the systems. For example, filters are not effective in reducing cell numbers of *Fragilaria* and *Cosmarium*, but highly efficient for removal of *Scenedesmus*. Similar results were obtained with US and UV (different effects with different strains).

T6.2 Consolidate requirements

- SWOT matrix (strengths, weaknesses, opportunities, threats) and explanations about the sequence of a SWOT analysis prepared by TBH.
- Preparation of forms for the collection of SWOTs from every partner (data based from research partners and experience based from the SME partners).
- Preparation of forms to show the positive and negative effects of CHEM FREE treatment on water analysis parameters, gathering of the filled in forms and consolidation on a clearly arranged list.
- Hand over the SWOT lists and the SWOT effects lists to the SWOT moderator.

T6.3 Perform SWOT analysis

- SWOT analysis was performed at the SWOT meeting in Catania in October 2007
- Work on finalisation on "Report on SWOT analysis" (D20) by BOKU and TBH

T6.4 Formulate technical specification

- Requirements for prototyping were presented in detail at the 18 month meeting.
- Input has been collected from each partner and evaluated by TBH
- The SMEs decided at the meeting in The Hague in May 2008 that the *fish farming application* to be followed up *for prototyping*. Other applications shall not be considered at the moment.
- Further it was decided that the deliverables D21 "Technical description for prototype instrument" and D22 "Prototype instrument" shall be a joint deliverable.
- Latest versions of the technical specification of single SME technologies were collected and treatment (turn over) capacity was described in the integrated CHEM-FREE system prototype. Calculation of an example for 100 kg fish as CHEM-FREE prototype unit is given
- The final version of D21+22 was submitted to the EC on 11.11.2008.

T6.5 Identify potential product development partners

SMEs have been in contact with several other companies, e.g. for application swimming pool

- Leidenfrost, Austria, leading company for pool construction
- Brand, Austria, leading company for swimming ponds, former TBH customer

for filters development

- ISOVER, Austria, fibre filter producer, participant of the final meeting
- Prodinger, Austria, technical consultant, currently involved in the TBH filters patent description

and for fish farming where operational, maintenance data and specific requirements (area, energy, water consumption, fish load) from the field site Ajdovscina was reported to identify potential partners

Deviations from the work programme:

No deviations from the workplan from the revised DoW dated 04.09.2007

WP 7 Dissemination and exploitation (LG, month 1 - 27)

Progress towards the objectives:

T7.2 Analyse market regarding user requirements

Report on market analysis (D25) has been prepared and finalised by DREMA and was submitted to EC on 16 October 2007 by BOKU.

T7.3 Organise 3 stakeholder events

Discussion on the organisation of the stakeholder events started at the 18-month meeting in Vienna in January 2008.

CHEM-FREE was presented at the following three stakeholder events:

1. 13th IWRA World Water Congress, 1-4 September 2008, Montpellier, France (http://wwc2008.msem.univ-montp2.fr/): Poster and exhibition; UOP and LG were present.
2. Local/regional event for fish farmers, 13 September 2008, Celje, Slovenia: organised by LIMNOS; LIMNOS and TBH were present. Feedback from stakeholders (fish farmers): CHEM-FREE is probably best for fish husbandry before sale. Investments for semi-intensive fish raising plants require subsidy. High interest in high quality fish production.
3. Aquaculture Europe, 8-12 September 2008, Krakow, Poland (http://www.easonline.org/): Presentation and exhibition; LIMNOS and LG were present.

DREMA was responsible for the preparation of deliverable D28 on the stakeholder events in which more detailed information can be found.

T7.4 Define IPR

TBH (as SME coordinator) lead the discussion amongst the SMEs. LG and DREMA want a 1.5 year standstill agreement. TBH wants immediate protection and market presence.

Agreement on 22.09.08: TBH will apply for a patent but must not refer to the CHEM-FREE results for DREMA and LG technologies. The TBH work on patent and IPR was reduced from a comprehensive modular technology (filters, UV, US) to work for the protection of the mechanical filter treatment technology.

Publication of project results: Data are belonging to SMEs, they should be asked anyway; SMEs will include a paragraph on that in IPR discussion.

T7.5 Prepare patent application and final version of the "Plan for using and disseminating knowledge"

DREMA supported LG with D29: Meeting with Mr. J. van Dop (Dutch Patent Office, Agency of the Dutch Ministry of Economic Affairs) about feasibility of a patent and the involved costs. This information was shared with the other SMEs.

TBH engaged a patent consultant for a patent search and for an invention description for a TBH filters patent and worked out a concept for protection of rights for TBH. The concept foresees a compact water treatment unit integrating, i.e. mechanical filters (roughing and fibre

filter), a measuring and control technology and a energy providing unit (photovoltaic). The unit shall cover a wide and diversified field of applications.

- application for funding from WKNO (chamber of commerce) for patent description without reference to DREMA and LG technology results from CHEM-FREE
- Work out suggestions for using knowledge, data and platform information by RTDs and send the suggestions to DREMA and LG.

According to all additional researches done by LG Sound, DREMA & TBH on this matter, a conclusion has been made in which the system is not innovative enough to claim for patent and it would not be worthy to spend a lot of money on and energy in trying to get patent.

T7.6 Perform dissemination activities (web-site, flyers, …)

Website

- Website is still hosted by BOKU and shall be transferred to LG after the end of the project. BOKU will not pay any more fees for keeping the url "www.chem-free.eu"

Flyer

- a flyer has been developed and submitted as deliverable (D27) to the EC

Conferences

- UOP presented a poster on CHEM-FREE at the 4th European Phycological Congress, 23-27 July 07, Oviedo, Spain.
- UOP presented a poster on CHEM-FREE at the 3rd Congress of the International Society for Applied Phycology in June 2008, Galway, Ireland
- UOP presented a poster on CHEM-FREE at the 13th IWRA World Water Congress, 1-4 September 2008, Montpellier, France
- A general paper on CHEM-FREE (submitted on 09.09.2007) has been accepted for oral presentation at the 6th IWA World Water Congress, 8-12 September 2008, Vienna, Austria. The presentation was held by BOKU.
- LIMNOS presented a oral paper at Aquaculture Europe, 8-12 September 2008, Krakow, Poland.

Other dissemination activities:

- CHEM-FREE is mentioned in the chapter "Implications of algae in the colonisation process of man-made surfaces: adhesion, damages and prevention" of the book entitled " Advances in marine antifouling coatings and technologies" (editor: C. Hellio and D.M. Yebra, publisher: woodhead publishing, will be published 2009)
- Booking for the fair exhibition "Kleingartenmesse", 18-19 Oct 2008, Stadthalle, Vienna, with the first presentation of the new "algae filter" for biotops, swimming ponds, etc. (TBH)
- Booking for the fair exhibition "Vienna-tec", 7-10 Oct 2008, Messe Wien, Vienna, exhibition stand N°220 with "Niederösterreichische Ingenieurbüros" (TBH)

Deviations from the work programme:

No deviations from the workplan from the revised DoW dated 04.09.2007

Section 3 - Consortium management

3.1 Consortium management tasks and their achievement

- Communication with EC:
  - The EC, in particular Mr. Collucio, the CHEM-FREE Scientific officer in Brussels, was informed on problems occurring on a regular basis per phone and email
  - Additionally the coordinator, Günter Langergraber, met Mr. Collucio in Brussels on 21 February 2007 to discuss the delays occurred mainly caused due to the late arrival of the contract.
  - The EC was informed at an early stage that CHEM-FREE might request an extension of 3 month for the project duration

- PCT meetings:
  - As planned the Project Core Team (PCT = Langergraber – Coordinator; Goldschmid – SME Coordinator, Perfler – Scientific Coordinator) meetings took place on monthly basis
  - The tasks performed include co-ordinating the overall activities, controlling of the progress of work, and the planning of the CHEM-FREE meetings

- Internal 3 month reports:
  - Internal project controlling on a 3-monthly basis (activity and financial)
  - Evaluation of first internal reports by BOKU, discussion of the results with the partners.
  - preparation of 6 month report for meeting in Portsmouth and 12 month report for meeting in Ljubljana, respectively

- Web-based project management platform (access for project partners via the project website "www.chem-free.eu")
  - Used for internal reporting (activity and resources spent) as well as for drafting reports to the EU
  - Used as general database of the project
  - The partners have reported that having and using the platform allows easy reporting (e.g. data required for Form C can be extracted easily) and makes exchange of big files easily.

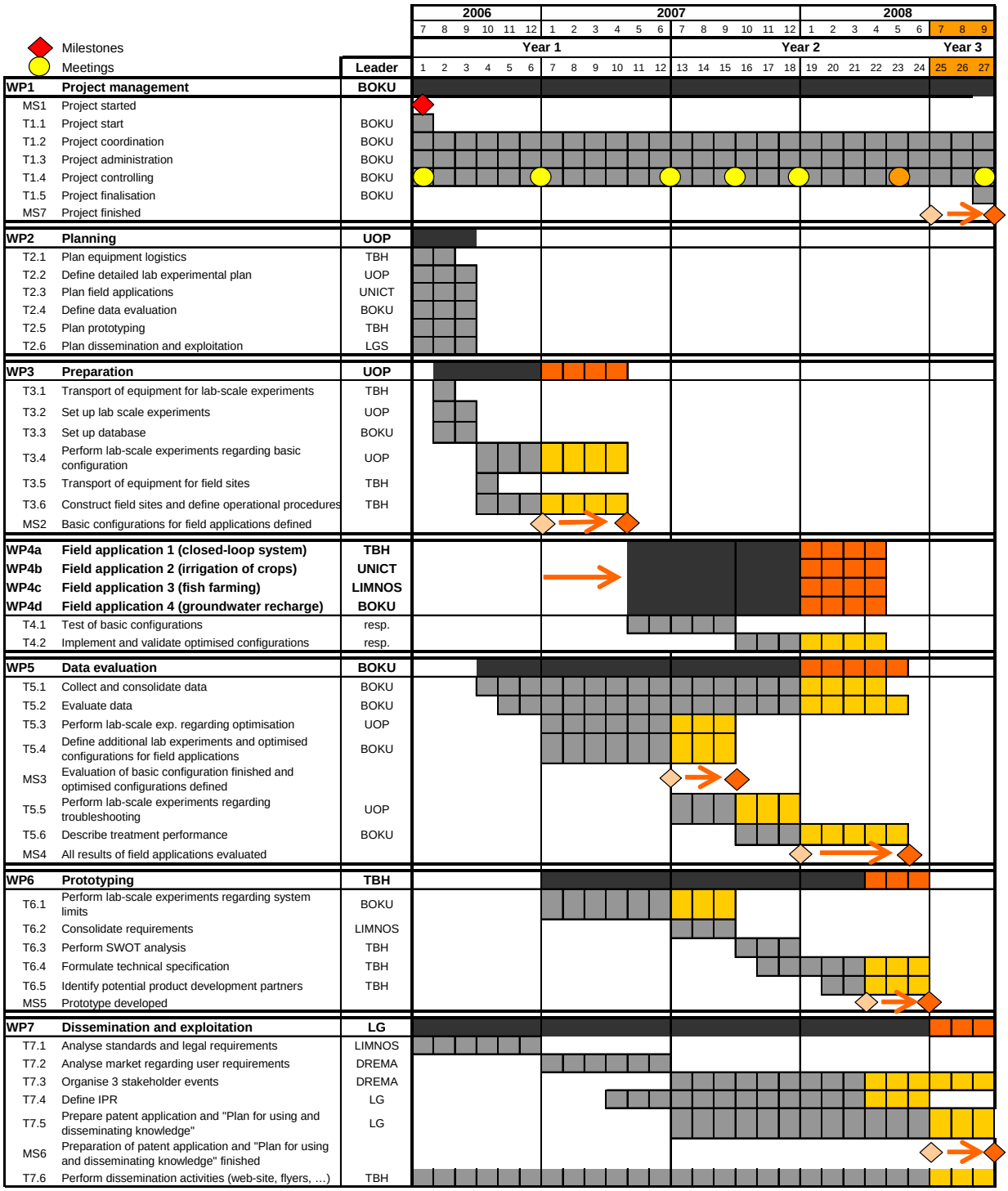
3.2 Contributions of the partners and changes in responsibilities

- All partners contributed to the work in year 2 according to the workplan from the revised DoW dated 04.09.2008, no changes in the consortium occurred
- BOKU has been taking over some responsibilities from TBH regarding the field-site experiments for the swimming pool experiments
- LG and DRE joined forces as Dissemination and Exploitation manager.

3.3 Project timetable and status

Status of the project according the workplan (revised DoW from 4 Sept 2007)

The following chart shows the revised workplan as presented in the DoW dated 04.09.2008 that was the basis for the amendment of the project duration. The project is finished, all tasks have been completed.



Status of the milestones (revised DoW from 4 Sept 2007)

No.	Milestone Title	Month planned (revised DoW)	Status
MS1	Project started	M1	finished / in time / 07.2006
MS2	Basic configurations for field applications defined	M9	finished / **delayed*** / 07.2006
MS3	Evaluation of basic configuration finished and optimised configurations defined	M16	finished / in time / 09.2007
MS4	All results of field applications evaluated	M23	finished / in time / 06.2008
MS5	Prototype developed	M24	finished / in time / 10.2008
MS6	Preparation of patent application and "*Plan for using and disseminating knowledge*" finished	M27	finished / delayed / 11.2008
MS7	Project finished	M27	finished / in time / 09.2008 final reports delayed / 01.2009

* according to original DoW

3.4 Comments and information on co-ordination activities in the period

- Communication between partners
  - Regular information exchange has been increased due to internal progress reporting (see above)

- Consortium meetings

  Already held in reporting period 1:
  - Kick-off meeting, 11-12 July 2006, Vienna, Austria
  - 6 months meeting: 22-24 January 2007, Portsmouth, UK
  - 12 months meeting: 09-11 July 2007, Ljubljana, Slovenia

  held in reporting period 2:
  - SWOT meeting: 03-05 October 2007, Catania, Italy
  - 18 months meeting: 28-30 January 2008, Vienna, Austria
  - Data evaluation meeting: 21-22 May 2008, The Hague, The Netherlands
  - Final meeting, 15 September 2008, Vienna, Austria

- Additional meetings (not the whole consortium) in reporting period 2:
  - TBH visited Sicily for reconstruction of filters after 12 months meeting mid July 2007
  - Field-site visit of BOKU (Langergraber), UOP (Hellio) and LG (Lems) end of July 2007 to decide on the final set-up of the experiments UOP, LG and BOKU visit Sicily end of July 2007
  - UOP visits BOKU and in particular Stallingerfeld for algae sampling and analysis from 16-20 August 2007
  - Meeting of the RTD partners: 31 March - 1 April 2008, Vienna, Austria
  - Editorial meeting for finalisation of the summary for D14+17 by BOKU (Kretschmer), UOP (Hellio) and UNICT (Toscano), 10-11 July 2008, Catania, Italy

Annex – Plan for using and disseminating the knowledge – final

Section 1 – Exploitable knowledge and its Use

Exploitable Knowledge (description)	**Exploitable product(s) or measure(s)**	**Sector(s)** of application	Timetable for commercial use	Patents or other IPR protection	**Owner** & Other Partner(s) involved
Physical water treatment system	*Combination of 3 technologies*	*1. aquaculture* *2. reuse of treated wastewater for irrigation* *3.swimming pools* *4. groundwater recharge*	*2008*	*A patent application is planned for 2008 if results are favourable*	*Owners: TBH, LG, DREMA* *Others: LIMNOS*

Section 2 – Dissemination of knowledge

Dissemination activities carried out within the project duration:

Actual dates	**Type**	**Type of audience**	**Countries addressed**	**Size of audience**	**Partner responsible /involved**
since start of project	*Project web-site (www.chem-free.eu)*	*General public*			*LG, BOKU*
13-16 March 2007	*Oral presentation @ 2nd Pool&Spa conference, Munich, Germany*	*Research*	*mainly European*	*150*	*BOKU, TBH*
March 2007	*1st version of Flyer*	*General public*			*LG, TBH*
23-27 July 2007	*Poster @ 4th European phycological congress, Ovieda, Spain*	*Research*	*European countries*	*200*	*UOP*
23-27 Aug. 2007	*Gartenbaumesse Tulln, Austria*	*end users*	*Austria*		*TBH*
22-27 June 2008	*Poster @ 3rd Congress of the International Society for Applied Phycology, Galway, Ireland*	*Research*	*Worldwide*	*700*	*UOP*
27-31 July 2008	*Oral presentation @ 14th International Congress on Marine Biofouling and Corrosion, Kobe, Japan*	*Research*	*Worldwide*	*300*	*UOP*
1-4 Sep 2008	*Poster @ IWRA World Water Congress, France* ***(Stakeholder event)***	*Research and B2B*	*Worldwide (110 countries)*	*3000 (About 400 research posters presentation has been chosen)*	*UOP, LG*
8-12 Sep 2008	*Oral presentation @ IWA World Water Congress 2008 Vienna*	*Research and Industry*	*Worldwide*	*3000*	*lead: BOKU*
13 Sep 2008	*Fish Farmers Conference, Ljubljana, Slovenia* ***(Stakeholder event)***	*fish farmers*	*Worldwide*	*150 invitation to fish farms* *64 invitation to fish association*	*LIMNOS, TBH*
16-19 Sep 2008	*Oral presentation @ Aquaculture Europe 2008, Krakow, Poland* ***(Stakeholder event)***	*Research and Industry*	*Worldwide*	*200*	*lead LIMNOS, LG*
In progress!	*CHEM-FREE mentioned in book entitled " Advances in marine antifouling coatings and technologies"*	*Research*	*Worldwide*	**In progress!**	*UOP*

Planned dissemination activities after the end of the project with fixed dates:

Planned dates	**Type**	**Type of audience**	**Countries addressed**	**Size of audience**	**Partner responsible /involved**
7-10 Oct. .2008	*Fair "Vienna-tec", Messe Wien, Vienna*	*General public*	*Austria*	*?*	*TBH*
18-19 Oct. 2008	*Fair "Kleingartenmesse", Stadthalle, Vienna*	*General public*	*Austria*	*?*	*TBH*

Prospective

To improve the disseminating of the knowledge, of course more of such an events should be executed Especially more conferences and congress should be attended. For each event in which a certain application is presented, the university responsible for this specific application should do the presentation. It is also recommended that one of the SMEs to accompanied the presenter (in these case the university) at these events. During CHEM-FREE the SMEs started concentrating on Europe than the rest of the world. All the leads gained at each event should be followed up actively. Furthermore, articles should be published in magazines related to similar water treatment application the CHEM-FREE project focused on etc.

Section 3 – Publishable results

General posters/papers on CHEM-FREE have been presented:

- at the *2nd Pool and Spa Conference*, 14-16 March 2007, Munich, Germany, and
- at the *4th European Phycological Congress*, 23-27 July 2007, Oviedo, Spain.
- at the *3rd Congress of the International Society for Applied Phycology*, June 2008, Galway, Ireland
- at the *13th IWRA World Water Congress*, 1-4 September 2008, Montpellier, France
- at the *6th IWA World Water Congress*, 8-12 September 2008, Vienna, Austria.