TOWEFO

(Toward Effluent Zero)

EVALUATION OF THE EFFECT OF THE IPPC APPLICATION ON THE SUSTAINABLE WASTE MANAGEMENT IN TEXTILE INDUSTRIES

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N°	Institution/Organisation	Street name and number	Post Code	Town/City	Country Code	Title	Family Name	First Name	Telephone N°	Fax N°	E-Mail
1	ENEA	Via Martiri di Monte Sole 4	40129	Bologna	I	Mr.	Mattioli	Davide	+39 051 6098342	+39 051 6098309	mattioli@bologna.enea.it
2	ENEA	Via Martiri di Monte Sole 4	40129	Bologna	I	Mr.	Giordano	Andrea	+39 051 6098782	+39 051 6098309	giordano@bologna.enea.it
3	ENEA	Via Martiri di Monte Sole 4	40129	Bologna	I	Mr.	Bastianutti	Cristiano	+39 051 6098779	+39 051 6098309	bastian@bologna.enea.it
4	ENEA	Via Martiri di Monte Sole 4	40129	Bologna	I	Mr.	Petta	Luigi	+39 051 6098759	+39 051 6098309	petta@bologna.enea.it
5	ENEA	Via Martiri di Monte Sole 4	40129	Bologna	I	Mr.	Travaglini	Nedo	+39 051 6098586	+39 051 6098789	trava@bologna.enea.it
6	ENEA	Via Martiri di Monte Sole 4	40129	Bologna	I	Mr.	Gambaro	Luigi	+39 051 6098500	+39 051 6098789	gambaro@bologna.enea.it
7	ENEA	Via Martiri di Monte So le 4	40129	Bologna	I	Mr.	Ranieri	Daniele	+39 051 6098719	+39 051 6098789	ranieri@bologna.enea.it
8	ENEA	Via Martiri di Monte Sole 4	40129	Bologna	I	Mr.	Tarantini	Mario	+39 051 6098429	+39 051 6098280	tarantin@bologna.enea.it
9	ENEA	Via Martiri di Monte Sole 4	40129	Bologna	I	Ms.	Buttol	Patrizia	+39 051 6098726	+39 051 6098280	buttol@bologna.enea.it
10	ENEA	Via Martiri di Monte Sole 4	40129	Bologna	I	Ms.	Scalbi	Simona	+39 051 6098466	+39 051 6098280	scalbi@bologna.enea.it
11	Ecobilan S.A.	Tour AIG 34, Place des Corollles	92908	Paris La Défence 2	F	Senior Manag	Osset	Philippe	+33 1 5657 1484	+33 1 56 57 16 36	Philippe.osset@fr.pwcglobal.com
12	Ecobilan SA	Tour AIG 34, Place des Corolles	92908	Paris La Défence 2	F	Staff	Mamier	Claude	+33 1 5657 1460	+33 1 56 57 16 36	Claude.mamier@fr.pwcglobal.com
13	Ecobilan SA	Tour AIG 34, Place des Corolles	92908	Paris La Défence 2	F	Staff	Zgraja	Franck	+33 1 5657 8013	+33 1 56 57 16 36	Franck.zgraja@fr.pwcglobal.com
14	Ecobilan S.A.	Tour AIG 34, Place des Corollles	92908	Paris La Défence 2	F	Staff	Vayn	Capucine	+33 1 5657 5859	+33 1 56 57 16 36	Capucine.vayn@fr.pwcglobal.com

N°	Institution/Organisation	Street name and number	Post Code	Town/City	Country Code	Title	Family Name	First Name	Telephone N°	Fax N°	E-Mail
15	Ecobilan SA	Via Viminale 11	20131	Milano	I	Staff	Regalini	Emanuele	+39 02 7785 429	+39 02 7785 240	Regalini@libero.it
16	Inland and Marine Waters Unit, IES-JRC, Ispra	Via Enrico Fermi	21020	Ispra	I	Dr.	Hanke	Georg	+39-0332-78-5586	+39-0332-78-6351	georg.hanke@jrc.it
17	Inland and Marine Waters Unit, IES-JRC, Ispra	Via Enrico Fermi	21020	Ispra	I	Dr.	Loos	Robert	+39-0332-78-5243	+39-0332-78-6351	robert.loos@jrc.it
18	Inland and Marine Waters Unit, IES-JRC, Ispra	Via Enrico Fermi	21020	Ispra	I		Tilio	Roberto	+39-0332-78-5491	+39-0332-78-6351	roberto.tilio@jrc.it
19	Lettinga Associates Foundation (LeAF)	Bomenweg 2	NL-6703 HD	Wageningen	NL	Mr.	Spanjers	Henri	+31 317 483202	+31 317 482108	Henri.Spanjers@wur.nl
20	Lettinga Associates Foundation (LeAF)	Bomenweg 2	NL-6703 HD	Wageningen	NL	Ms.	Bisschops	Iemke	+31 317 485873	+31 317 482108	Iemke.Bisschops@wur.nl
21	Lettinga Associates Foundation (LeAF)	Bomenweg 2	NL-6703 HD	Wageningen	NL	Mr.	van Lier	Jules	+31 317 483243	+31 317 482108	Jules.vanLier@wur.nl
22	Lariana Depur SpA	Via Laghetto, 1	22073	Fino Mornasco	I	Mr.	Bianchi	Roberto	+39 031 920518	+39 031 921880	robertobianchi@lariana.it
23	Lariana Depur SpA	Via Laghetto, 1	22073	Fino Mornasco	I	Mr.	Bergna	Giovanni	+39 031 920518	+39 031 921880	giovannibergna@lariana.it
24	Lariana Depur SpA	Via Laghetto, 1	22073	Fino Mornasco	I	Mr.	Andreoli	Stefano	+39 031 920518	+39 031 921880	ricercida@lariana.it
25	Centexbel	Technologiepark 7	9052	Zwijnaarde	B	ir	Cattoor	Tine	+32 9 220 41 51	+ 32 9 220 49 55	tine.cattoor@centexbel.be
26	Centexbel	Technologiepark 7	9052	Zwijnaarde	B	ir	De Vreese	Ilse	+32 9 220 41 51	+ 32 9 220 49 55	ilse.devreese@centexbel.be
27	Centexbel	Technologiepark 7	9052	Zwijnaarde	B	lic	Vander Beke	Bob	+ 32 9 220 41 51	+ 32 9 220 49 55	bob.vanderbeke@centexbel.be
28	Centexbel	Technologiepark 7	9052	Zwijnaarde	B	dr	Van Parys	Marc	+32 9 220 41 51	+ 32 9 220 49 55	marc.vanparys@centexbel.be

N°	Institution/Organisation	Street name and number	Post Code	Town/City	Country Code	Title	Family Name	First Name	Telephone N°	Fax N°	E-Mail
29	Vito	Boeretang 200	2400	Mol	B	Dr.	Genné	Inge	+32 14 335635	+32 14 3321186	inge.genne@vito.be
30	Vito	Boeretang 200	2400	Mol	B	Ir.	Schiettecatte	Wim	+32 14 335626	+32 14 3321186	wim.schiettecatte@vito.be
31	Vito	Boeretang 200	2400	Mol	B	Ing.	Helsen	Joost	+32 14 335638	+32 14 3321186	joost.helsen@vito.be
32	Vito	Boeretang 200	2400	Mol	B	Ir.	Brauns	Etienne	+32 14 335636	+32 14 3321186	etienne.brauns@vito.be
33	Vito	Boeretang 200	2400	Mol	B	Dr.	Witters	Hilda	+32 14 335213	+32 14 582657	hilda.witters@vito.be
34	IPTS/JRC/EC	Inca Garcilaso, s/n	41092	Sevilla	E	Mr	Aguado	Miquel Angel	+34-954488284	+34-954488426	miguel.aguado@jrc.es
35	IPTS/JRC/EC	Inca Garcilaso, s/n	41092	Sevilla	E	Mrs.	Dulio	Valeria	+34-954488284	+34-954488426	valeria.dulio@jrc.es
36	IPTS/JRC/EC	Inca Garcilaso, s/n	41092	Sevilla	E	Mrs.	Mayer	Rita	+34-954488284	+34-954488426	rita.mayer@jrc.es
47	IPTS/JRC/EC	Inca Garcilaso, s/n	41092	Sevilla	E	Mr	Sorup	Per	+34-954488284	+34-954488426	per.sorup@jrc.es

SECTION 1: Management and resource usage summary, related to the reporting period

The TOWEF0 Project comprises fourteen workpackages (WP). Each WP represents a main work field and is subdivided in job cards (work tasks). Each job card has been conceived as a well defined activity assigned to a single partner.
Each job card is identified by an alphanumeric code: the first four digits represent the work package, the following two digits represent the progressive number of the job card in the WP and the last one represents the partner in charge of the activity. The numbers associated to each partner are defined in the annex 1 of the contract (Description of Work).
The objectives of the period and the progress in the activities here presented reflect the detailed planning agreed during the kick-off meeting and based on the division of the workpackages in job cards.
A WP0 has been created to collect all the planning activities of the project, it was not in the work programme originally submitted to E.C.. All the management work needed at the beginning of the project has therefore been moved from WP12 to WP0.

OBJECTIVES OF THE REPORTING PERIOD

Workpackage 00 - Project Management (part 1)

The activities are concluded with the only exception of WP00.03.1.

Workpackage 01 – Qualitative survey on GEP application in the textile finishing industry

All the activities are concluded with the exception of the following one:
WP01.10.2 Workshop on the state of the art involving end users and stakeholders

Workpackage 02 – Quantitative evaluation of GEP application. Case studies in the synthetic fibres and silk industries

The activities WP02.01.3 and WP02.02.3 are concluded.
The following activity is being carried out:
WP02.03.3 Collection and elaboration of process data

Workpackage 03 – Quantitative evaluation of GEP application. Case studies in the cotton industries

The activities WP03.01.8 and WP03.02.8 are concluded.
The following activity is being carried out:
WP03.03.8 Collection and elaboration of process data

Workpackage 04 – Water Pinch technology in textile finishing industries (silk, synthetic fibres and cotton)

The activities WP04.01.4, WP04.02.4 are concluded.

The following activities are being carried out:
WP04.03.4 Definition of the criteria for identification of water reuse options
WP04.04.4 Definition of the criteria for the collection and elaboration of process data
WP04.05.4 Design of water reuse scheme and definition of necessary water quality
WP04.06.4 Design of database of allowable inlet concentrations of textile processes

Workpackage 05 – Characterisation and design of wastewater

The activity WP05.01.5 is concluded
The following activities are being carried out:
WP05.02.5 Development of on line wastewater characterisation techniques
WP05.03.6 Microcalorimetric tests
WP05.04.5 Respirometric on-line tests
WP05.05.3 Tests for water reuse
WP05.06.8 Tests for water reuse

Workpackage 06 – Wastewater treatment

The activities WP06.01.1 WP06.02.5, WP06.03.1 and WP06.04.1 are concluded
The following activities are being carried out:
WP06.05.5 Tests by anaerobic bioreactors to maximise biodegradation of pollutants and toxic compounds and enhance treatability of wastewater
WP06.06.1 Tests to evaluate the aerobic treatability of final effluents
WP06.07.1 Treatment tests by membranes to produce permeates suitable for reusing
WP06.08.1 Operational data to design treatments
WP06.09.1 Workshop on wastewater design

Workpackage 07 – Effluent characterisation

The activity WP07.01.6 and WP07.03.4 are concluded
The following activities are being carried out:
WP07.02.6 Monitoring and physical-chemical characterisation of textile industry effluents
WP07.04.4 Eco-toxicological characterisation of textile industry effluents
WP07.05.4 Protocol for eco-toxicological characterisation of the wastewater streams in the textile industry

Workpackage 08 – Application of LCA to support optimisation processes

The activity WP08.01.1 is concluded.
The following activities are being carried out:
WP08.02.1 The LCA inventory and application in the selected textile industries
WP08.04.1 Database supporting the LCA software

Workpackage 09 – Development of an LCA software tool

The activities WP09.01.7 and WP09.02.7 are concluded.
The following activity is being carried out:

WP09.03.7 Development of the LCA software tool

Workpackage 10 – Regulatory Policy

The following activity is being carried out:
WP10.01.1 Collection of information on European Economic regulation experiences for industrial use of water resources

Workpackage 11 – Multicriteria integrated GEP for textile finishing industry

No activities planned in the period considered

SCIENTIFIC/TECHNICAL PROGRESS MADE IN DIFFERENT WORK PACKAGES ACCORDING TO THE PLANNED TIME SCHEDULE

Workpackage 00 - Project Management (part 1)

Technical problems of the web-site continue, problems are encountered in the maintenance and updating of the website.

Workpackage 01 – Qualitative survey on GEP application in the textile finishing industry

WP01.10.2 The first of the two workshops with the industrial representatives concluding the WP1 activities has already been held in Belgium. The date of the similar Italian workshop has to be agreed between IPTS and the Italian Textile Association.

Workpackage 02 – Quantitative evaluation of GEP application. Case studies in the synthetic fibres and silk industries

WP02.03.3 Collection and elaboration of process data is proceeding. The data collected in three of the Company selected the related documents (PIDACS) are complete.

Workpackage 03 – Quantitative evaluation of GEP application. Case studies in the cotton industries

WP03.03.8 Collection and elaboration of process data is proceeding. The data collected in four of the Company selected the related documents (PIDACS) are almost complete.

Workpackage 04 – Water Pinch technology in textile finishing industries (silk, synthetic fibres and cotton)

WP04.03.4 Definition of the criteria for identification of water reuse options is concluded
WP04.04.4 Definition of the criteria for the collection and elaboration of process data is concluded
WP04.05.4 Design of water reuse scheme and definition of necessary water quality is proceeding
WP04.06.4 Design of database of allowable inlet concentrations of textile processes is proceeding

Workpackage 05 – Characterisation and design of wastewater

WP05.02.5 Development of on line wastewater characterisation techniques is almost concluded.
WP05.03.6 Microcalorimetric tests are completed and finalised in a report.
WP05.04.5 Respirometric on-line tests are almost completed and have to be finalised.
WP05.05.3 Tests for water reuse. The modality of the tests has been decided. LARIANA, CENTEXBEL, LeAF and ENEA have agreed a protocol and a programme to carry out the reusability tests.
WP05.06.8 Tests for water reuse. The modality of the tests has been decided. LARIANA, CENTEXBEL and ENEA have agreed a protocol and a programme to carry out the reusability tests.

Workpackage 06 – Wastewater treatment

WP06.05.5 Tests by anaerobic bioreactors to maximise biodegradation of pollutants and toxic compounds and enhance treatability of wastewater are completed.
WP06.06.1 Tests to evaluate the aerobic treatability of final effluents are proceeding on real concentrates.
WP06.07.1 Treatment tests by membranes to produce permeates suitable for reusing were started are proceeding on various process effluents.
WP06.08.1 Operational data to design treatments are being obtained by elaboration of the tests results
WP06.09.1 Procedures for the preparation of the Workshop on wastewater design have started.

Workpackage 07 – Effluent characterisation

WP07.02.6 Monitoring and physical-chemical characterisation of textile industry effluents. The first experimental campaign to identify organic micro-pollutants concentration in textile effluents and in the recipient water bodies in Italy is completed. A similar campaign has to be started in Belgium.
WP07.04.4 Ecotoxicological characterisation of textile industry effluents. The first experimental campaign on textile effluents and on the recipient water bodies in Italy is completed. A similar campaign has to be started in Belgium.
WP07.05.4 The preparation of a Protocol for eco-toxicological characterisation of the wastewater streams in the textile industry has started.

Workpackage 08 – Application of LCA to support optimisation processes

WP08.02.1 The LCA inventory and application in the selected textile industries is proceeding.
WP08.04.1 The data collection for the Database supporting the LCA software is proceeding.

Workpackage 09 – Development of an LCA software tool

WP09.03.7 Development of the LCA software tool. The beta version of the LCA software tool is ready to be put on a server.

Workpackage 10 – Regulatory Policy

WP10.01.1 Collection of information on European Economic regulation experiences for industrial use of water resources is proceeding

MILESTONES AND DELIVERABLES OBTAINED

Deliverable list

No	Deliverable Title	Date planning	Date obtained
1	Manual for technical/economical evaluation of GEP data collection	6	6
2	Workshop (Wo) on the state-of-the-art qualitative survey	9	12
3	Report on the GEP survey	18	18
4	Material and resources data input of the synthetic fibres and silk industry	12	13
5	Report on quantitative evaluation of GEP in synthetic fibres and silk industries	24	draft
6	Material and resources data input of the cotton industry	12	13
7	Report on quantitative evaluation of GEP in the cotton industry	24	draft
8	Data source on relaxation possibilities of process inlet water quality	24	draft
9	Optimal water re-use procedures applicable in the synthetic/silk/cotton industry	30	
10	An on-line textile waste water characterisation technique	34	
11	A framework for the application of microcalorimetry in the characterisation of biological textile waste water treatment process	34	24
12	Unified Wo in collaboration between WP5 and WP6 on design of waste water for the textile and waste water industry	30	
13	A protocol to determine the optimum composition of the waste water streams of the different process units	34	
14	Integrated methodology for Water Pinch and Waste Water Design	34	
15	Operational data to design treatment for increasing biodegradability, decreasing toxicity and for re-use and recycling water in textile finishing process	34	
16	Protocol for the evaluation of treatability of mixed finishing textile process waste water.	34	
17	Compendium of analytical methods for organic micropollutants	18	18
18	Protocols to characterise and screen for ecotoxicity in effluents of textile industry	30	
19	Final report on effluent characterisation from selected textile refining industries	34	
20	Technical report on LCA application in the textile finishing industry	28	
21	Database on paper/magnetic support for decision support software	34	
22	Peer review Wo on the LCA software tool	30	
23	A software tool complete with a dedicated user's interface and related databases	34	
24	Report on economic regulations and best European practice experience	18	draft

25	Sustainable tariff systems for industrial water usage. A benchmarking analysis	28	
26	Wo on regulatory policy for the water management in the industrial sector	28	
27	Final report on the practical prototype for a water management regulatory policy in the textile finishing industry	34	
28	Wo “Integrated Waste Water Management in textile finishing industry”	34	
29	Final report “ Evaluation of the effect of the IPPC application on the sustainable waste water management in textile industries”	36	
30	Management reports	Every 6	
31	Periodic reports	Every 12	
32	Internet Page	3	3
33	Technical publication in three languages	36	
34	CD ROM	36	

Milestone list

No	Milestone Title	Date planning	Date obtained
1	Submission of Manual for technical/economical evaluation of data collection	6	6
2	Submission of the report on the Workshop on the state-of-the-art qualitative survey	12	12
3	Submission of report on the GEP survey	18	18
4	Industry selection and textile process identification	12	12
5	Draft report and data delivery.	18	18
6	Report and data delivery	24	draft
7	Industry selection and textile process identification	12	12
8	Draft report and data delivery.	18	18
9	Report and data delivery	24	draft
10	Report on water pinch technology. Specific problems for the application in the textile industry	6	6
11	Definition of necessary water quality	18	18
12	Guidelines for an optimal reduction of water usage and discharge in the synthetic, silk and cotton industry	30	
13	Literature review on textile wastewater characterisation procedures	6	6
14	First results on respirometry characterisation	12	12
15	Respirometry and other techniques set up, integration of the measurement techniques	18	18
16	Set up microcalorimetry	24	18
17	Protocol for waste design	30	
18	Selection of the textile treatment bench and pilot scale plant (0.5%)	3	3
19	Start-up of laboratory and pilot plants	6	6
20	Report on first experimental results	12	18
21	Draft report on operational data to design treatment for increasing biodegradability	24	24
22	Evaluation of treatability of mixed finishing textile process waste water	30	
23	Literature review on micropollutants and toxic compounds in textile wastewater	6	18
24	Selection of compounds to be monitored for the different industries and setting up of analytical methods	12	12
25	Data evaluation and reporting	24	draft
26	Reports on the data base for LCA applied to textile wastewater treatment	12	12
27	Issuing of deliverable: Technical report on LCA application in the selected textile finishing industry	28	
28	Issuing of deliverable: Database on paper/magnetic support for decision support software	34	
29	LCA software specification	12	12
30	Enabling assessment of alternative recycling options for the textile industry from the environmental perspective	24	24
31	Collection of information on the European Economic regulation's experiences for water resources' industrial uses	12	12

32	Theoretical and practical prototype of a new sustainable tariff structure in textile-industrial water using inclusive of environmental externalities	30	
33	? Evaluation of data, information and methodologies set up in the WPs	33	
34	Collection, elaboration and integration of the contribution and remarks gathered in the Workshop	35	

DEVIATIONS FROM THE WORK PLAN OR / AND TIME SCHEDULE AND THEIR IMPACT TO THE PROJECT

WP0
The activities are concluded with the only exception of WP00.03.1 because of problems encountered in the maintenance and updating of the website. The delay has not affected the timing of other activities

WP1
All the activities are concluded with the exception of the WP01.10.2 Workshop on the state of the art involving end users and stakeholders. A workshop restricted to the members of the project as requested by the contract was held respecting the timing scheduled. In addition two workshops with the industrial representatives were agreed. The first of them has already been held in Belgium. The date of the similar Italian workshop has to be agreed between IPTS and the Italian Textile Association.

WP2 - WP3
WP02.03.3 – WP03.03.8 The collection of data in the companies has been affected by a delay related to:

· Number of required data higher than originally planned due specific requests from various partners;

· Necessity to take into account the company availability (it's not possible to fill the PIDACS without company auditor and processes samples could be collected only respecting the production timings largely affected by market requirements).

· Scarcity of already available and well structured data in the companies and necessity to carry out interviews with various people to gain the missing informations and to make data elaborations.

The delay affected the timing of various activities of the following workpackages.

WP4
WP04.05.4 Design of water reuse scheme and definition of necessary water quality. and WP04.06.4 Design of database of allowable inlet concentrations of textile processes are in delay.
The general scheme of how different SME's should be evaluated has been worked out but the different cases however are still under development. Not all PIDACS are yet completed.
Difficult to make generalizations for the textile industry, due to important variation in processes however an overview of average values has been made. Throughout the further case studies and after discussion during future meetings, this should be worked out more in detail. The delay will be recovered by putting more resources in third year. The inputs necessary to the related activities in other worckpackages have anyway been given so this will not affect the rest of the project.

WP5
WP05.04.5 Respirometric on-line tests: The activity planned was on schedule, but some extra time will be withdrawn from WP05.08.5, as agreed with partners.
WP05.05.3 and WP05.06.8 (Reuse tests): The schedule will be respected.

WP6
WP06.05.5 (Tests by anaerobic bioreactor): in fact completed, in agreement with the planning, but some additional work is being done.
WP06.06.1, WP06.07.1 and WP06.08.1 related to the membrane treatment of process effluents, the toxicity evaluations and the operational data collection are in delay due to the complex organisation of the expeditions of the samples collected in the Italian and Belgian companies. This will not cause delay in the activity WP06.10.1 that can anyway start in time. Therefore WP6 activities are expected to be completed as scheduled.

WP7
WP.07.03.4: to set up and optimise methods for detection of estrogenic activity, additional time was needed to get an optimal sample extraction technique for textile waste waters. The latter is high of organic content and appeared to interfere with the method which was in use for surface waters.
The three work-packages WP07.02.6 “Monitoring and physical-chemical characterisation of textile industry effluents”, WP 07.04.4 “Ecotoxicological characterisation of textile industry effluents” and WP07.06.6 “Effluent characterisation in the selected textile finishing industries” are in fact one consistent work and are being run simultaneously. For practical organisation at two distinct field sites (Italy and Belgium) some more time was needed for logistics organisation The final objectives and timing of the WP7 will be anyway reached by putting more resources in the last year.

WP8
Only minor delay related to delays in WP2 and WP3. The final timing will be respected.

WP9
No delay.

WP10
Part of the activity was planned to be subcontracted by ENEA to Nomisma. Due to administrative problems of both ENEA and Nomisma this subcontract was signed later than expected therefore causing a shift in all the activities. The final timing will be anyway respected according to the schedule agreed between the parts in the contract. No effects on other activities are expected because the workpackage is independent.

WP11
No delays expected

In the table below the summary of the man-months that each partner planned to invest in each work package (extracted from the description of work) and that actually invested during the first two year of project is stated.

Partner		WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	WP11	WP12	WP13	Tot
1	Plan	1	1	1	1	1	23	1	25		6	3	9	1	73.3
	Done	**0.7**	**0.8**	**0.6**	**0.4**	**0.5**	**26.3**	**0.5**	**21.3**		**4**		**4.7**	**0.5**	**60.3**
2	Plan	19.75											0.5	0.25	20.5
	Done	**14.26**											**0.25**	**0.10**	**14.61**
3	Plan	6	12			8.3							0.5	0.25	27
	Done	**3**	**16.7**			**1.2**							**0.4**	**0.2**	**21.5**
4	Plan		1	1	8.5	4.5	0.5	10				1	0.5	0.25	26.75
	Done		**1**	**1**	**5.5**	**2**		**6.5**							**16**
5	Plan					33	7						0.5	0.25	40.8
	Done					**22**	**7**						**0.33**	**0**	**29.33**
6	Plan					2.5	1	30					0.5	0.25	34.3
	Done					**2.5**		**20**							**22.5**
7	Plan								5.3	30			0.5	0.25	36
	Done								**2.3**	**34.18**			**0.3**	**0.1**	**36.88**
8	Plan	6		13		10							0.5	0.25	30
	Done	**6**		**11**		**4**							**0.3**		**21.3**
Tot	Plan	32.75	14	15	9.5	60	32	41	30	30	6	4	12.5	2.75	289
	Done	**23.96**	**18.5**	**12.6**	**5.9**	**32.2**	**33.3**	**27**	**23.6**	**34.18**	**4**	**0**	**6.28**	**0.9**	**222.42**

CO-ORDINATION OF THE INFORMATION AMONG PARTNERS AND COMMUNICATION ACTIVITIES (E.G. ORGANISED MEETINGS. CONFERENCE ATTENDANCE. CO-OPERATION WITH OTHER PROJECTS/NETWORKS.…)

Several collaborations have been set up and are currently running in order to carry out the activities of the project. The most relevant are the following:

WP1

All partners cooperated in the preparation of the questionnaire on Good Environmental Practices in the European Finishing Textile Industry conceived by IPTS. IPTS, Lariana and Centexbel collaborated in the distribution, data collection, analysis and elaboration of the questionnaires and in the selection of the ten companies to be involved in the following activities of the project.

IPTS and Centexbel organised and held a workshop in Belgium together with the Belgium Textile industry association.

WP2 – WP3

All the partners contributed to the preparation of the PIDACS "Manual for process identification and data collection in the textile industries" and had continuous interactions with Lariana and Centexbel during the data and samples collection phases.

WP4 - WP5 – WP6
VITO and Leaf are coordinating their activities in various sectors as reported in the minutes of the strict meeting held in Mol (annexed to the present document). The characterisation of the effluents by Leaf and IES is going on in cooperation with Lariana and Centexbel who are taking care of the samples collection. Leaf and ENEA are carrying out in cooperation the test for the treatment and reuse of the effluents and for the assessment of the toxicity of the final concentrates. Lariana and Centexbel are collecting the samples and are coordinating the interactions of the partners with textile companies. They are also testing the reusability of the treated effluents produced by ENEA.
(See project meeting minutes annexed to the present document)
A workshop will be organised on wastewater design in Paris on 1st October 2003. Representatives of other EU projects on industrial wastewater treatment will be invited.

WP7
IES and VITO are carrying out sampling campaigns in Italy and in Belgium for chemical and eco-toxicological characterisation of final textile effluents and recipient water bodies in cooperation with Lariana and Centexbel.

WP8 – WP9
ENEA and Ecobilan are cooperating in the elaboration of the database supporting the software tool developed by Ecobilan and based upon the Life Cycle Assessment (LCA) methodology.

DIFFICULTIES ENCOUNTERED AT MANAGEMENT AND CO-ORDINATION LEVEL AND PROPOSED / APPLIED SOLUTIONS.

The poor functionality and updating of the project's web-site is creating various problems. The consortium agreed that Henri Spanjers on behalf of the partners writes a letter to the partner ENEA to ask the website updating and to make it available in its full functionality as soon as possible.
ENEA will identify a new responsible of the web site.

SECTION 2: EXECUTIVE PUBLISHABLE SUMMARY. RELATED TO REPORTING PERIOD

Contract n°	EVK1-CT-2000-00063	Reporting period:	1/3/2002 – 28/2/2003
Title	EVALUATION OF THE EFFECT OF THE IPPC APPLICATION ON THE SUSTAINABLE WASTE MANAGEMENT IN TEXTILE INDUSTRIES (TOWEF0)		

Objectives of the period:

1. *Process data collection for the quantitative technical and economical evaluation of the application of environmental practices in the selected companies.*
2. *Definition of the criteria and performing the water pinch analysis in the selected textile companies. Definition of the criteria for identification of water reuse options. for the collection and elaboration of process data. Design of water reuse scheme and definition of necessary water quality and of allowable inlet concentrations of textile processes.*
3. *Development of on-line characterisation techniques for textile industry wastewater.*
4. *Characterisation of textile wastewater streams in terms of tractability and re-usability. Microcalorimetric and respirometric tests.*
5. *Membrane treatment of significant process effluents to produce permeates suitable for reusing. Operational data to design treatments. Assessment of anaerobic bioreactors as alternative effluents treatment technology.*
6. *Measure of the concentrates toxicity to estimate the aerobic treatability of final effluents*
7. *Monitoring and physical-chemical characterisation of textile industry effluents. Eco-toxicological characterisation of textile industry effluents.*
8. *The LCA inventory and application in the selected textile industries. Database supporting the LCA software.*
9. *Development of the LCA software tool.*

Scientific achievements:

1. *Based on the manual conceived the data collection in the selected companies has been carried out and is almost completed. the main processes were identified in all the companies and an overview of the most important processes for each machinery was elaborated. Details of the different processes were collected: pH and temperature of the process. amount and type of chemicals used. quality requirements of the process water. amount and quality of the waste water generated in the most important processes. specific water use etc.*
2. *The process data collected in one of the companies have been used as a test case to evaluate the applicability of the water pinch software. Taking into account both practical restrictions for handling large data sets and technological process restrictions. various scenarios were evaluated both for continuous operations and for batch mode*
3. *A pH- and temperature controlled batch reactor and automatic respirometer was set up for the characterisation experiments. and a methodology was devised to test the textile wastewater. A concept has been described to perform the test on-line. that is: automatically and directly at the textile operation process.*
4. *A series of respirometry experiments was done with two samples of mixed textile wastewater. Ten separate process streams (four from Belgium and six from Italy) were tested as well. An activated sludge model for textile wastewater characterisation based on respirograms was developed and implemented in Matlab. Calorimetric measurements were carried out in a calorimeter whose sensibility was gradually improved up to 5 mW/l in order to detect the small amount of heat involved in biological reactions. A comparison between calorimetry and established respirometric techniques for wastewater characterisation was investigated. These techniques provided the same information in terms of biodegradability and toxicity. A literature study on the application of infrared spectroscopy as a wastewater characterisation technique was completed. A calibration procedure was worked out that was targeted at the specific characteristics of the textile wastewaters. A number of samples were analysed using the infrared technique.*
5. *Membrane treatment tests were performed on seven different process effluents selected by focusing on the most important effluent streams. Laboratory scale tests were carried out to select the proper membrane for each effluent. The following membrane trains were tested at pilot scale on a plant using spiral wound polymeric membranes:*
   - ? *UF+NF and UF+RO for effluent from polyester scouring. double scouring. disperse dyeing and printing washing*

? UF+NF(DK) for effluent from silk polymer charge. scouring and silk yarn reactive dyeing.

Operational data have been obtained for each effluent tested to have indications for a full scale design. Effluents from cotton sizing scouring. bleaching and black sulphur dyeing were tested in batch experiments for their biodegradability. and sizing effluent was also treated in UASB reactors. Two EGSB type anaerobic reactors have been constructed to treat cotton reactive and acid dyeing effluents as pre-treatment step for membrane filtration.

6. *A methodology was set up to measure the inhibition of the nitrifying activity of the concentrates. Inhibition was measured on feed. UF concentrate and NF concentrate from the treatment silk yarn reactive dyeing effluent.*
7. *The developed analysis methods for organic micropollutants in textile wastewaters have been tested by analysing different water samples like effluents from wastewater treatment plants (WWTPs), and the corresponding receiving water bodies. SSPE-LC-MS analysis were performed for the polar to medium-polar compounds. Various pollutant types were identified in the water samples: phenols, alkylphenolethoxylate surfactants and their metabolites with endocrine disrupting potential (nonylphenol), different aromatic sulfonates, LAS surfactants, dyes (colorants), pesticides, and pharmaceuticals. Special attention was attached to the detection of endocrine disrupting compounds. Four dye compounds (colorants) were detected in the water samples. In addition, a headspace (HS) GC-MS analysis method for the water analysis of 60 volatile organic contaminants (VOCs) was developed and validated. Water samples were analysed for VOCs by this HS-GC-MS method, and for unpolar semivolatile contaminants by C18-SPE-GC-MS. Complementary to chemical characterisation, ecotoxicological methods have been selected which allow to evaluate the environmental impact of textile effluents on receiving waters. A battery of ecological relevant tests has been selected, as they cover biological responses of 4 organisms (bacteria, green algae, invertebrate, fish) which represent different levels in the aquatic trophic chain. Effluents of textile companies and WWTPs were evaluated by acute and chronic toxicity tests. In addition, biological screening methods were applied for the measurement of estrogenic activity caused by contaminants present in textile effluents and released into the environment. The data obtained were in agreement with chemical-analytical results.*
8. *LCA methodology was applied to three companies after defining a set of methods and assumptions to be applied. The TEAM models of the companies were implemented. LCA studies for selected products were completed including different manufacturing alternatives for estimating their environmental impact and their relative contribution to the total of manufacturing operations. The review of existing public available inventory data on textile process chemicals has been completed. Several LCA commercial databases (TEAM. SimaPro. KCL Eco. IVAM. Boustead model) were investigated in order to find relevant information. The data investigation has been extended to the main textile chemicals manufacturers and to existing LCA projects performed on the municipal water cycle.*
9. *The software tool was developed based upon the Life Cycle Assessment (LCA) methodology. It will provide technical and non-technical people alike in the European textile industry with a tool enabling environmental impact assessments of process and waste water closed-loop recycling options. with a view to reducing water consumption as well as reducing the environmental burden associated with water treatment.*

Socio-economic relevance and policy implications:

The results obtained will contribute to set up a methodology able to improve the social objectives of the Community as follows:

Lower consumption of high quality water. such as groundwater. through the maximisation of water re-use and recycling.

Protection of recipient water bodies and therefore amelioration of the quality of life of the citizens. Particular attention will be given to persistent organic pollutants with potential to disturb the endocrine system of humans and animals. and thus with adverse effects for human health and ecosystem integrity.

Assessment of the impact on the environment as a whole. avoiding to spread pollution on the other environmental compartments (air. soil).

Regulators should also benefit from the facilities and the approach provided by the project in the way of progressing environmental friendly policies for the textile sector.

Conclusions:

The parts that will have to be integrated in the multicriteria integrated methodology for the implementation of Good Environmental Practices (GEP) and water saving strategies in textile finishing industries are being realised.

Keywords:

Good environmental practices. textile industry. wastewater minimisation. wastewater reuse. pinch analysis. Life Cycle Assessment. wastewater characterisation. respirometry. membrane separation technology. anaerobic treatment. organic micropollutants. eco-toxicology.

Publications (cumulative list)

Peer Reviewed Articles:

Authors	*Date*	*Title*	*Journal*	*Reference*
D. Mattioli. F. Malpei. G. Bortone and A. Rozzi	*02.2002*	*Water minimisation and reuse in the textile industry*	*Water Recycling and resource recovery in industry. IWA Publishing*	
Bisschops I. and Spanjers H.	*To be submitted March 2003*	*Literature review on textile wastewater characterisation*	*Environmental Technology*	
R. Loos. G. Hanke. S. J. Eisenreich	*Accepted but not published yet*	*Multi-Component Analysis of Polar Water Pollutants Using Sequential Solid-Phase Extraction Followed by LC-ESI-MS*	*Journal of Environmental Monitoring*	

Non refereed literature:

Authors / Editors	*Date*	*Title*	*Event*	*Reference*	*Type1*
Bisschops I.	*04-2002*	*Literature review: Textile wastewater characterisation*			*Report*
Spanjers H.		*An on-line textile wastewater characterisation technique*			*Report*
Bisschops I.	*06-2002*	*Literature search for publications on the application of IR spectrometry in wastewater characterisation*			
Bisschops I.	*09-2002*	*Infrared Spectrometry for Textile Wastewater Characterisation – Trial experiments with Infrared Technique developed at INRA*			*Report*
Bisschops I.	*10-2002*	*Respiration experiments – Textile wastewater*			*Report*
Nguyen L.	*11-2002*	*Anaerobic degradation of textile process wastewater*			*Report*

Daverio E. and Ligthart J.		*Simultaneous calorimetric and respirometric measurements for textile wastewater characterisation*			*Report*
Witters H.	*12-2002*	*Ecotoxicologische karakterisatie van afvalwaters van textielbedrijven*	-	*VITO-report. 2002/TOX/ R066*	*Report (in Dutch)*
R. Loos. G. Hanke. S. J. Eisenreich	*06-2002*	*Organic Priority Compound Multi-Component Analysis for Environmental Water Analysis by Sequential Solid Phase Extraction (SSPE) followed by LC-ESI-MS*	*26th International Symposium on High Performance Liquid Phase Separations and Related Techniques. Montreal (Canada)*		*Poster*
Valeria Dulio and Miquel A. Aguado-Monsonet	*12-2001*	*Manual for technical and economic evaluation of the data collected on good environmental practices*			*Report*
Valeria Dulio	*11-2002*	*Reference Document on Best Available Techniques for the Textile Industry*			*Report*
Arianna Guarnirei *Correlatore: Davide Mattioli*	*07/2002*	*Trattamenti a membrana per il riutilizzo delle acque reflue nell'industria tessile (Poliestere)*			*Master Thesis (in Italian)*
Massimo Bergami *Correlatore: Davide Mattioli*	*02/2003*	*Trattamenti a membrana per il riutilizzo delle acque reflue nell'industria tessile (Seta)*			*Master Thesis (in Italian)*

Others: (Patents. CD ROM's. videos.…)

Planning of future publications: (type. date. contents. …)

Type: International publication
Date: 02/2004
Content: Applicability of WaterPinchTM methodology to textile companies

Type: International publication
Date 2004
Content: Treatment and reuse of process effluents in the textile industry

SECTION 3: DETAILED REPORT ORGANIZED BY WORK PACKAGES INCLUDING DATA ON INDIVIDUAL CONTRIBUTIONS FROM EACH PARTNER. RELATED TO THE REPORTING PERIOD (12 S)

Workpackage 00 - Project Management (part 1)

3.1. Objectives

WP00.03.1 (ENEA) Updating and restructuring of the web site. Implementation of the literature database.

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

No scientific achievements

3.3. Socio-economic relevance and policy implication

Not applicable.

3.4. Discussion and conclusion

WP00.03.1 (ENEA) The activities were not concluded.

3.5. Plan and objectives for the next period

WP00.03.1 (ENEA) Updating and restructuring of the web site. Implementation of the literature database.

Workpackage 01 – Qualitative survey on GEP application in the textile finishing industry

3.1. Objectives

WP01.10.2 (IPTS) The main objective of the second year was to conceive. prepare. organise and participate in workshops for the European Finishing Textile Industry in order to diffuse the results of WP01.

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

WP01.10.2 (IPTS) Two meetings were foreseen in order to accomplish this task. During this period a meeting was organised in Belgium the December 9th. 2002. The meeting was organised together with

Belgium Textile industry. More than 75 people attended the meeting. The meeting was organised around five presentations from TOWEF0 partners and Belgium Textile association.
The information gathered during the first part of this workpackage has been used for the determination of BAT. All that information is available in the BREF on Textiles.

3.3. Socio-economic relevance and policy implication

WP01.10.2 (IPTS) The Belgian textile companies were very interested in the knowledge of the good environmental practices as well as the Best Available Techniques determined under the exchange of information between Member States and Industry concerned. Environmental permit writers. also present during the workshop. showed also great interest because it affects directly their work. Now. permit writers and textile industry need to discuss the renewal of the environmental permit for the production installations (IPPC directive).

3.4. Discussion and conclusion

WP01.10.2 (IPTS) The main tasks of this Work Package has been covered and done on time as was initially planned. This WP has demonstrated that it is going to be the basis for the development of the rest of the project as well as it has been achieved a high level of good results.

3.5. Plan and objectives for the next period

WP01.10.2 (IPTS) This WP is almost finished. It is the intention of the team of this project to organise another meeting in Italy. The team group is organising the meeting. identifying people interested to participate in such a meeting.

Workpackage 02 – Quantitative evaluation of GEP application. Case studies in the synthetic fibres and silk industries

3.1. Objectives

WP02.02.3 and WP02.03.3 (LARIANA) continue with the process identification and data collection for the selected industries (I09;I02;I15;I04)

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

WP02.02.3 and WP02.03.3 (LARIANA)

Methodology: Use of "Process Identification and Data Collection Sheet (PIDACS)" to collect data and samples for the selected industries.

Achievements: Manual for process Identification and data collection sheet" was presented during Sevilla meeting with the result for the I06 company.
I09 and I02 company PIDACS were issued. sent to all partners and presented during Como meeting.
Water consumptions. discharges and COD loads were confronted.
I15 and I04 company audits started on January 2003 and works are still in progress.

LCA scheme of I06 company. which PIDACS was completed during the first period and presented during Sevilla meeting. was discussed and agreed with P1; results were presented and agreed during Como meeting: .I09 and I02 companies LCA scheme was issued and submitted to P1 for proper developments.
Strict collaborations with other partners were carried out: I06. I09 and I02 process discharges were collected at different times and sent to P1 and P5. Two samples collection campaigns were carried out with P6 and WWTPs samples were sent to P4.

3.3. Socio-economic relevance and policy implication

No consideration or remarks about.

3.4. Discussion and conclusion

WP02.02.3 and WP02.03.3:

I09 company:
I09 manufacturing activity is grouped in 4 department:

- ? General Facilities (6 processes);
- ? Preparation (11 processes);
- ? Dyeing (46 processes);
- ? Finishing (7 processes);

Production is split in yarn and fabric manufacturing; silk yarn manufacturing is the relevant item.
Water consumptions are reported in the table below:

I09 company water consumptions

Fabric (yarn)	Process	Meters total	Kg total	W3 m^3 tot	W4 m^3 tot	W5 m^3 tot	W6 m^3 tot	Total Water consumption m^3 tot	m^3 [%]	l/m	l/kg
-	**General Facilities**	1929774	1079764	6497	23796	0	5688	**35982**	12,34	18,65	33,32
SY-SF-PY-AY-NY-SOF	**Preparation**	1061376	1681256	0	43199	58541	56142	**157883**	54,15	148,75	93,91
SY-SF-PY-AY-NY-SOF	**Dyeing**	1064162	912225	0	26177	36238	24011	**86425**	29,64	81,21	94,74
SY-SF-PY-AY-NY-SOF	**Finishing**	1929774	1066592	0	11280	0	0	**11280**	3,87	5,85	10,58
TOTAL:		1929774	1079764	6497	104452	94779	85842	**291570**	100	151,09	270,03

Preparation are the most important water requiring processes:
HT scouring is the main yarn scouring process (66% on total processed silk yarn: 32% on total scouring process with 14.5 l/kg as specific consumption); polymer charge is used to process 26% of total silk yarn with 10 l/kg as specific consumption.
20% on preparation water consumption is used for silk fabric continuous scouring (41% of total processed fabric with 123 l/kg as specific consumption); continuous working mode equipment (used for fabric pre-treatments) is more water expensive (16.5% on total) than batch mode working equipments (12.68% on total for yarn pre-treatments).
Dyeing water is 55% required for yarn dyeing (95% on total preparation processed yarn) and 37% for fabric dyeing.
Acid dyeing is the most important dyeing process (45% on total dyed yarn - 21% on total dyeing water consumption with 14 l/kg as specific consumptions - and 85% on total dyed fabric- 32% on total dyeing

water consumption with 64 l/kg as specific consumptions -): dark acid dyeing is 24% on total acid dyeing for yarn and 37% on total for fabric.
Finishing water is 95% required for yarn finishing: softener finishing is used to process 98% on total processed yarn.
Water discharges and COD loads are reported in the tables below:

I09 water discharges and organic loads

Fabric (yarn)	Process	Meters total	Kg total	Discharge type D1 m^3 tot	m^3 [%]	COD [mg/l]	COD [kg]	COD [%]
-	**General Facilities**	1929774	1079764	**17170**	6,44	**2410**	41386	8,43
SY-SF-PY-AY-NY-SOF	**Preparation**	1061376	1681256	**152255**	57,11	**2523**	384199	78,29
SY-SF-PY-AY-NY-SOF	**Dyeing**	1064162	912225	**86425**	32,42	**672**	58058	11,83
SY-SF-PY-AY-NY-SOF	**Finishing**	1929774	1066592	**10757**	4,03	**659**	7092	1,45
TOTAL:		1929774	1079764	**266608**	100,00	**1841**	490735	100,00

Discharge type D2 m^3 tot	COD [mg/l]	COD [kg]	Discharge type D4 m^3 tot	COD [mg/l]	COD [kg]	Discharge type D5 m^3 tot	COD [mg/l]	COD [kg]
0	0	0	4922	8227	40493	12248	73	892
52914	4602	243534	0	0	0	99341	1416	140665
36238	1241	44971	0	0	0	50188	261	13088
0	0	0	0	0	0	10757	659	7092
89151	3236	288505	4922	8227	40493	172535	937	161737

Preparation processes discharges are the highest in volume and in COD loads (57% and 78% respectively):
HT scouring process is 5.63% on preparation load (21587 kg); polymer charge process load is 11.41% on total (43770 kg).
Acid dyeing processes load is lower: 15725 kg for yarn dyeing (27% on dyeing load) and 7142 kg for fabric dyeing (12% on dyeing load)
HT scouring process first bath discharge (discharge type D3) is sent to membrane ultra-filtration system for sericine recovery. involving a discharged organic load decrease of 60.100 kg (59.7% of potential discharge).
Recovered sericine is used for experimental purposes.
On available data basis. a silk yarn manufacturing chain was issued and proposed as LCA scheme.

I02 company

I02 manufacturing activity is grouped in 5 department:
General Facilities (2 processes);
Printing (traditional and ink-jet: 32 processes);
Steaming (2 processes);
Fabric washing (9 processes);
Finishing (2 processes);
Printing department includes printing pastes preparation processes (colour kitchen) and printing equipments washing.

Water consumptions are reported in the Table below:

Fabric	Department	Meters	Kg	W1	W2	Total Water consumption			
		total	total	m^3 tot	m^3 tot	m^3 tot	m^3 [%]	l/m	l/kg
-	**General facilities**	2188265	415770	3960	3611	**7571**	5,50	3,46	18,21
CF-SF-WF-PF-PAF-VF -SAF	**Printing**	2188265	415770	56275	995	**57269**	41,61	26,17	137,74
CF-SF-WF-PF-PAF-VF -SAF	**Steaming**	2188265	415770	495	270	**765**	0,56	0,35	1,84
CF-SF-WF-PF-PAF-VF -SAF	**Fabric washing**	2188265	415770	70527	1187	**71713**	52,10	32,77	172,48
CF-SF-WF-PF-PAF-VF -SAF	**Finishing**	1422372	270251	0	318	**318**	0,23	0,22	1,18
		2188265	415770	131256	6380	**137636**	100	62,90	331,04

I02 company water consumptions

Printing pastes production water consumption is 0.7% on total (995 m3): 98% on printing water consumption is charged to printing equipment washing.
Fabric washing processes are the highest in total (52% on total) and in specific water consumption (172 l/kg): 62% on total is charged to rope system washing and 33% to open width system.
Steaming and finishing consumptions are less than 1% : wet finishing is used only for 20% on total processed fabric.
Water discharges and COD loads are reported in the Table below:

Fabric	Department	Meters	Kg	Discharge type D1				
		total	total	m^3 tot	m^3 [%]	COD [mg/l]	COD [kg]	COD [%]
-	**General facilities**	2188265	415770	**4653**	3,52	**93**	431	0,29
CF-SF-WF-PF-PAF-VF -SAF	**Printing**	2188265	415770	**56275**	42,63	**1955**	110023	74,97
CF-SF-WF-PF-PAF-VF -SAF	**Steaming**	2188265	415770	**495**	0,38	**50**	25	0,02
CF-SF-WF-PF-PAF-VF -SAF	**Fabric washing**	2188265	415770	**70527**	53,43	**513**	36159	24,64
CF-SF-WF-PF-PAF-VF -SAF	**Finishing**	1422372	270251	**47**	0,04	**2550**	121	0,08
		2188265	415770	**131996**	100,00	**1112**	146758	100,00

75% of discharged organic load is due to printing equipment washing (printing pastes equipment washing processes are the highest in COD: Mixer washing > 10.000 mg/l - Tubs washing > 3.000 mg/l).
Fabric washing processes discharge is about the 25% on COD load in front of 50% on total discharged volume.
General facilities. steaming and finishing discharges are neglectable.

I06. I09 and I02 water consumptions have been confronted as per the Table below:

Water consumptions

Company	Meters	Kg	Total water consumption			
	mt/yr	kg/yr	m^3 tot	m^3 [%]	l/m	l/kg
I06	2400000	516000	***94035***	100	39,18	182,24
I09	***1929774***	***790298***	***291570***	100	***86,24***	***180,78***
I02	2188265	415770	***137636***	100	62,90	331,04
I15						
I04						

Differences between calculated and measured consumptions are neglectable.
Referring to processed fabric (apart from yarn manufacturing). I09 water specific request is 2.5 time greater than I06 request. in front of a production 20% less.
For processed yarn (I09 company) water specific consumption is 2 time than the fabric one.
Also water discharges and COD loads have been confronted as per the Table below:

Water discharges and loads

	Meters	Kg	Total discharge (type D1)				
Company	mt/yr	kg/yr	m^3 tot	m^3 [%]	COD [mg/l]	COD [kg]	COD [%]
I06	2400000	516000	85599	100	1097	93889	100,00
I09	1929774	1079764	266608	100	1841	490735	100,00
I02	2188265	415770	131996	100	1112	146758	100,00
I15							
I04							

Maximum differences between calculated by PIDACS and measured discharge volumes are +/- 0.4%: COD concentration is 15-18% more than values reported in companies declaration.
I09 has the greatest values. related to silk manufacturing processes; I02 company load is due mainly to printing pastes production residuals.
Plan and objectives for the next period
WP02.02.3 and WP02.03.3 (LARIANA) the data collection will be completely closed within the end of May 2003; and the final report (Deliverable n°5: Report on quantitative evaluation of GEP in synthetic fibres and silk industries) submitted within the end of June 2003.

Workpackage 03 – Quantitative evaluation of GEP application. Case studies in the cotton industries

3.1. Objectives

WP03.03.8 (CENTEXBEL) continue with the data collection for the selected industries (B01-B05)

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

WP03.03.8 (CENTEXBEL)
During the first project year 5 textile companies were selected. mainly finishing cotton and applying good environmental practices. In a second phase the main processes in these selected companies were identified. This formed the basis for the work in the second project year. i.e. collection and elaboration of process data.
The collection of detailed process data had to be carried out in different companies and in two different countries. In order to be able to make comparisons between the data and also to be sure that the other partners receive the information they need to perform their task (i.e. Pinch analysis by VITO and LCA analysis by ENEA and Ecobilan) the elaboration of a structured document was necessary. This document was made by Lariana. Centexbel and IPTS. after consultation of VITO and ENEA concerning the data needed for water pinch analyses and LCA. A close collaboration and consultation via email was necessary to reach a consensus about the kind of data (concerning machinery. processes and products). level of detail of the information. structure of the document. etc.
Next to global information concerning production. machinery. water sources. steam production. quality of waste water. energy consumption. much more detailed information was collected in the annexes of the PIDACS forms (Process identification and data collection sheet). Concerning the different processes which are carried out in the companies. process schemes have been worked out. An example has been added. Differences have also been made for continuous and discontinuous treatment steps.

Department	Dyeing
Fabric (Yarn. …)	Pes+mix
Process	Light colour dyeing (Direct dyestuffs)
Equipment	Jigger
Item	J1
Run time (h)	6
Number of run/yr	21
Processed fabric (kg/yr)	55000
Processed fabric per run (kg)	2620

Example of data collection of single textile process

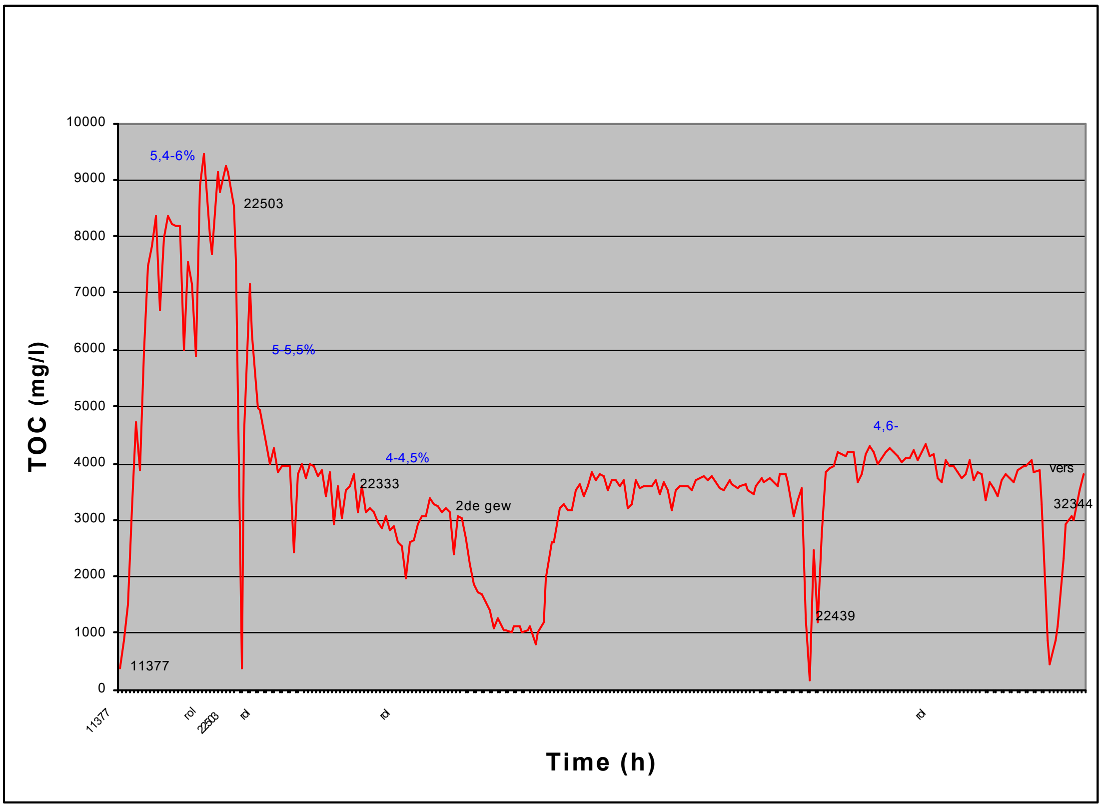
Water type 1: 2000 l Direct dyestuffs<0.05% Sodium sulphide 40 g/l dispersant: 1 g/l	Step 1 (i.e bath) T1=40°C; t1=10 min T2=70°C; t2=40min…..	Discharge type 1: 2000 l T [°C]=65 pH [-]=9 Conductivity [mS/cm]=3000 COD [mg/l]=1500 SST [mg/l]= 200
Water type (2): 2000 l	Step 2	Discharge type l: 2000 l T [°C]=30 pH [-]=8 Conductivity [mS/cm]=800 COD [mg/l]=450 SST [mg/l]= 50

Together with the responsible persons of different production departments these process schemes were completed. Next to the information available in the companies. also samples have been taken (in collaboration with the companies) of the waste water which is discharged in the different process steps. Analyses of COD. SST. conductivity. pH and temperature have been executed and reported in the PIDACS.

The work in the five companies has started almost at the same time. Depending on the complexity of the activities. size and the structure of the company. the collection of data followed a varying scheme and could be elaborated with a different speed. For the moment four of the five companies are completed. Of the fifth one some additional data are still missing.

An on line TOC meter is a very helpful instrument to monitor the pollution level during a certain period of time on a continuous production line. TOC (Total Organic Carbon) is a measure for the organic load of the discharged waste water. The TOC data are combined with data collected in the company concerning the type and quality of the fabric. the type and concentration of the used chemicals. the stand still hours. etc.

These data are furthermore put together in a graph and interesting conclusions can be drawn from it. together with the participating company.



Example of TOC data collection

In most of the selected companies an on line TOC meter has already been used temporary. In the last year of the project the equipment will be installed in the remaining companies and most probably the on line TOC meter will finally be re-installed in all of the companies once they have analysed their results in detail.

3.3. Socio-economic relevance and policy implication

It is clear that knowing more about the pollution level of the different processes. surprising conclusions could be drawn from it. In most of the companies process streams have been identified which have a much higher or a much lower pollution level than expected. The generated waste water has to be treated or a tax must be paid to discharge it untreated in the sewer.
Having more knowledge concerning the source of the pollution. makes it possible to calculate an environmental cost for each of the performed processes.

3.4. Discussion and conclusion

The PIDACS (Process identification and data collection sheet) has been made up through a collaboration with several partners.
By using the PIDACS it has become clear that it is a very useful instrument for the collection and inventory taking of data. Not only the partners in the project but also the responsible persons in the companies agreed that a filled in PIDACS was a very useful and practical instrument.

The on line TOC meter is a practical instrument for an on line control of the discharged pollution on a continuous production line. Combination of the TOC data and the production related data. makes it possible to have an idea about the most polluting activities and gives input to questions concerning the optimal use of process water.

3.5. Plan and objectives for the next period

(CENTEXBEL) The objective was to finish WP03.01.8 and WP03.02.8 in the first project year. This was more or less performed as foreseen. The five companies. finishing cotton and applying GEP. were selected and the main processes were identified in co-operation with the environmental co-ordinator of the respective companies. In the second project year the process identification has been extended.
WP03.03.8 was planned to be finished in the second project year. but we have seen that this takes more time. As a consequence this task will be continued in the third year and will be finished in the first half of the third project year.
Also in the second project year the on line TOC meter will be used for the elaboration of process data in the selected companies.

Workpackage 04 – Water Pinch technology in textile finishing industries (silk. synthetic fibres and cotton)

3.1. Objectives

(VITO) The global objective of WP4 is the design of an optimal water re-use scheme that reduces costs related to the water usage and discharge.
The first year of the project was focussed on the specification of the criteria for process identification (WP04.02.4) and for collection and elaboration of process data (WP04.04.4). required to enable the application of Pinch technology.
For the second year. progress was made in the following tasks :
- Elaboration of the definition of the data criteria (WP04.04.4)
- Completion of the definition of the criteria for the identification of water re-use options (WP04.03.4)
- Start of design of water re-use scheme and definition of the necessary water quality (WP04.05.4)
- Start of design of database of allowable inlet concentration of textile processes. (WP04.06.4)

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

WP04.04.4. WP04.03.4. WP04.05.4. WP04.06.4 (**VITO**)
As a first step towards the evaluation of the applicability of the WaterTargetTM software for the textile finishing industries. all relevant and required data for the Pinch-study has to be extracted from the PIDACS (documents providing process identification and data-collection) composed by partners 3 and 8 (Lariana and Centexbel) in WP02 and WP03.

To handle these large amounts of data. the information will be summarized in extensive Excel data sheets. The table below illustrates a limited extract from one of the sheets. as they are already completed for companies I09. I06. B04 and B05.

Different Steps in **Batch** process

Different Water **Supplies**

Different Water **Discharges**

Batch-process number	Batch-process name	Sub-sequence number	Sub-sequence name			D2 tn/yr	D3 tn/yr	D4 tn/yr	D5 tn/yr	COD ppm	TSS ppm	Cond mS/cm	Hardness °F
G1.1	**Light disperse dyeing**		Bath		147					4	0	0,19	0,5
			Discharge			147				1480	20	0,18	
			1st washing	147						4	0	0,19	0,5
			Discharge						147	264	30	0,15	
			2nd washing	147						4	0	0,19	0,5
			Discharge						147	49	10	0,157	
			Warm washing		147					4	0	0,19	0,5
			Discharge						147	100	20	0,18	
			3rd washing	147						4	0	0,19	0,5
			Discharge						147	50	5	0,18	
G1.2	**Acetate light disperse dying**	1	Bath		133					4	0	0,19	0,5
			Discharge			133				1350	30	0,27	
		2	1st washing	133						4	0	0,19	0,5
			Discharge						133	750	15	0,21	
		3	2nd washing	133						4	0	0,19	0,5
			Discharge						133	300	10	0,2	
G2.1	**PES medium disperse dyeing**	1	Bath		49					4	0	0,19	0,5

Extract from data summarization

In order to have a good understanding of the functioning of the specific textile processes. a close contact with partner 8 (Centexbel) was established. During several meetings the available process data was extensively discussed and thoroughly evaluated.

In the second step towards a Pinch analysis. the summarized information can directly be used for balancing the water flow system and contamination of the different streams in the **WaterTracker®** software. This package can be used to balance waterflows in a waternetwork and to calculate unknown concentrations of mixed effluents. side streams.…
Furthermore. after completion of the selection of possible reuse opportunities. the resulting scenarios can be evaluated by using the software tool. For each water saving scenario. the new water balance and the corresponding changes in levels of contamination are calculated.

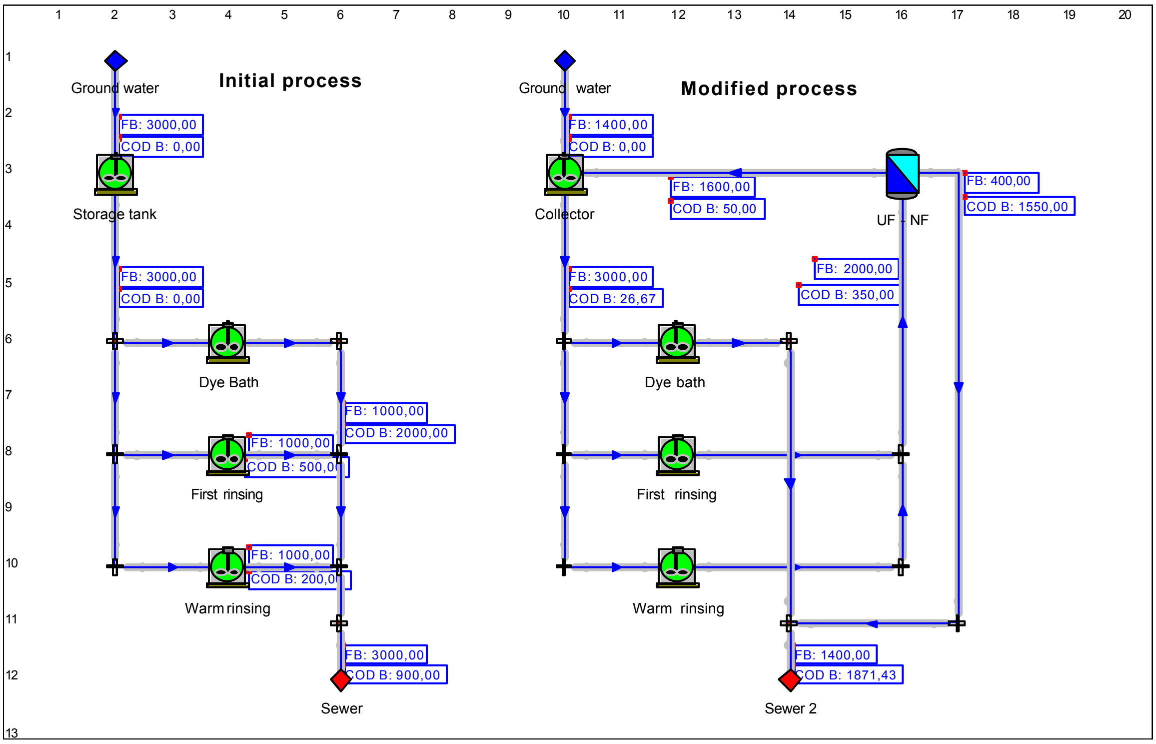


Illustration of the use of WaterTracker

The figure above gives a simplified overview of some of the possibilities of this software tool. It illustrates a case in which two out of three steps of a discontinuous batch process are regenerated. using a combined ultrafiltration – nanofiltration technology. The permeate is mixed with the fresh inlet water and then used as modified water source to the processes.

The identification of reuse/recycle options of process effluents. possibly after regeneration. implies a knowledge of the maximum tolerated relaxation of the inlet water quality. The table below gives a non-exhaustive. qualitative list of possible relaxation –of the inlet water qualities- and reuse for different steps in a textile finishing company. Some quantitative ranges are given as well. This data is based on literature data and discussions with partner 8 (Centexbel).

Discussion of different process steps

Process	***Effluent***	***Relaxation***
Desizing	Possible product recovery. Permeate recyclable.	Low quality water accepted.
Prewashing	Possible regeneration.	Low quality water accepted
Bleaching	Possible reuse of rinsing waters. Regeneration could be required.	High quality required (COD<60mg/l and S.S.<5mg/l)
Mercerising	Recovery of NaOH	
Dyeing	Possible reuse of rinsing waters. Regeneration could be required.	High quality required (COD<60mg/l and S.S.<5mg/l)
Printing	Possible reuse of rinsing waters. Regeneration could be required.	High quality required (COD<60mg/l and S.S.<5mg/l)

Due to the vast variation in textile processes and related effluents it is very hard to generalize the required inlet concentrations of the different steps. Based on experience. partner 8 (Centexbel) uses the values of Table 2 as a general requirement for process water in the Belgian textile industry.
As the required quality is. of course. subjected to for example the product colour (light or dark). the type of rinsing (first or final). the kind of dyestuff that is being used. … extensive testing is still required for every possible new case.

Requirements for process water

pH	6.5 – 9
Hardness (°F)	< 5
Conductivity (µS/cm)	< 1500
COD (mg/l)	< 60
Fe (µg/l)	< 100
Mn (µg/l)	< 100
Colour	No visible colour or suspended solids

As a central step in the development of a water saving scenario the software tool **WaterPinch®** is used. For every group of selected processes. this software tool offers the possibility to generate scenario's for an optimal water circuit. taken several contaminants into account. as well as costs related to water use. effluent discharge. use of equipment.…

These solutions can then be used again to redraw the water-circuit in the WaterTracker® software and re-balance. as mentioned before. the total process for water and contaminants.

Most textile companies are making use of both continuous and batch processes. In several different process steps. waste water of different quality is produced. These streams can roughly be subdivided in three levels of contamination:

? High loaded waters: coming directly from baths containing chemicals in high concentrations. e.g. dye bath. bleaching water.…
? Medium loaded waters: rinsing waters of the different process steps. containing significant concentrations of contaminants. Not possible to reuse directly.
? Low loaded waters: last rinsing waters of the processes. Possible direct reuse as contamination is very low.

For both types of processes (continuous and discontinuous) following waterpinch scenario's were evaluated:

For continuous operations:

? Possible direct reuse of low contaminated water flows. Due to necessity of case-by-case evaluation. it was decided as a general technical restriction that direct reuse can only be implemented on a one-machine level.
? Regeneration of medium contaminated process effluents for reuse can be foreseen on a group of similar water streams. It should technically be possible to isolate those streams.

? For the continuous processes. all different streams can be considered separately.

For batch mode:

? Due to the restricted possibilities of individual collection of all different batch-effluents. it was decided to evaluate mixed effluent streams: low. medium and high loaded streams.

? As a first exception. only on a one-machine level. a very pure process effluent could be directly reused. This would require only minor technical and automation changes.

? A second exception can be the separation of a highly concentrated dye-bath from the rest of the collected effluent stream. in order to decrease drastically the load of the combined wastewater stream.

The figure in paragraph 3.4 depicts the methodology that forms the key for the continuation of the discussion of the possible WaterPinch solutions for the textile finishing companies. Under Discussion&Conclusions all details are given.
The picture is based on a fictive scenario in which one low contaminated effluent stream is directly reused. as two other effluents are first regenerated using membrane technology. The required input values for the removal efficiencies for this implemented equipment will be based on the reported results of the lab-scale tests carried out by partner 1 (ENEA) in WP06.01.
A second possibility is the implementation of an anaerobic treatment for optimal decolourisation of a selected waste water stream from the dyeing department. An anaerobic process will help in the cleavage of the azo-bond.
Information on realistic removal efficiencies of an anaerobic reactor will be drawn from the lab-tests done by partner 5 (LeAF) in WP06.05.
In order to enable reuse. the effluent will have to be further treated in an aerobic reactor and/or membrane installation.

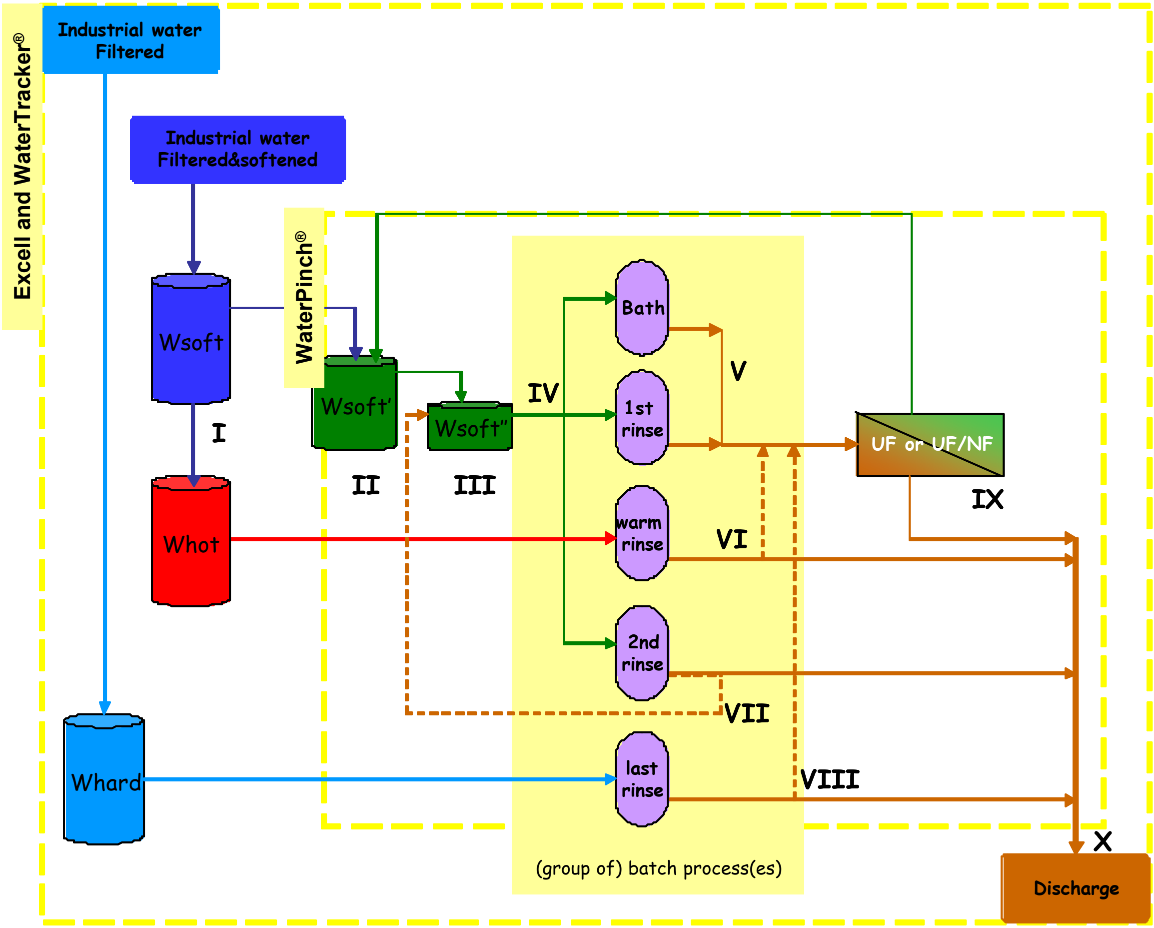
3.3. Socio-economic relevance and policy implication

No considerations or remarks about.

3.4. Discussion and conclusion

WP04.04.4. WP04.03.4. WP04.05.4. WP04.06.4 (**VITO**)

The figure below is an example of a possible scenario for optimal water use. The different modifications are discussed underneath. The purpose of this discussion is to integrate as many solutions as possible in one overview.
For all the evaluated companies a very specific approach is needed. but all of them are based on the method discussed above.



Example of water circuit for explanation

I. The present water scheme contains three main water storage tanks Wsoft (containing softened water). Whot (containing hot water) and Whard (containing filtered. industrial water). These tanks provide all processes of all departments and intermediate storage tanks with required water.

WaterTracker® will be used to balance the initial situation and re-balance the modified configurations. including all re-use and recycle options. It will be possible to draw conclusions on total water consumption. water-savings after modifications. increase of final effluent concentrations as well as process details of the different regeneration techniques being used.

II. Intermediate storage tank for Wsoft' (softened water mixed with regenerated water). This tank is related to one membrane filtration unit. that can belong to a group of processes (this figure represents only one process). If permeate flow of membrane unit is too low. Wsoft water from the main storage tank can be used for additional water supply.

WaterPinch® will be used on the level of a group of similar processes. all sharing same membrane installation. The allowable flow of permeate will be based on the tolerable change of water composition. As well as on the expected performance of the membrane unit.

III. Intermediate storage tank for Wsoft" on machine level. If one of the discharge streams is sufficient low in contamination. direct re-use will be taken into consideration. This will only be evaluated on a one-machine level due to economical feasibility.

As the possible recycle waters will probably be too low in flow. additional water supply from previous storage tanks will be required as indicated.

IV. The allowable flow of direct recycled water is based on the tolerable change in water quality towards the different processes..

V. Similar to the logic behind the identification of the wastewater streams for the sampling campaign of WP5 and 6 (economical feasibility of technical changes to machines) no separation will be made between the water coming from the dye baths and the rinsing waters. Except in case the drain from the bath increases the contamination to a level where regeneration becomes impossible. the collected discharge water will be sent to the regeneration unit as a mixed flow.
VI. Water from the warm processes could be mixed with the other streams if the temperature of the obtained flow remains sufficient low for re-use in the cold steps.
VII. Direct reuse of the low loaded rinsing waters. based on the allowed relaxation of the inlet concentrations. If not allowed or if already too many different discharge directions. this stream could as well be mixed with inlet of membrane-unit.
VIII. Whard is hard water. To be checked if this flow may be mixed with the inlet of the membrane unit. Depending on what regeneration technique is chosen. if hardness is not decreased during regeneration. the Wsoft stream will show an increased hardness level.
IX. Item IX depicts a regeneration unit. Based on the type of stream to be treated. a certain technology will be selected. The regeneration is a relatively small scale process. the logic choice will be a membrane process like ultrafiltration or a combination of ultra- and nanofiltration.
If the selected units for the different groups of similar processes require same operation conditions and performances. the different units could be united to only one single unit. This would of course lead to a lower investment.
X. After re-balancing of the modified process flow diagram in WaterTracker® the final effluent concentration has to be evaluated as it will increase due to the lower water consumption and the equal contaminant discharge. This could be a limitation for the amount of water that may be recycled. The discharge limit for Italy appears to be as high as 2500 ppm COD. This will probably not cause any obstruction.

CONCLUSIONS

? Only water streams providing at least a certain percentage of the total water stream (for example 1%).
? Different departments will be evaluated separately (dyeing. bleaching.…). when it comes to in process regeneration option.
? Effluents containing different types of contamination should be evaluated separately: e.g. different dye-stuffs (soluble and disperse.…).
? Performances of regeneration technologies and water treatment will be based on results from other work-packages.

For example: Criteria for process selection for case I-09:
a) Only those processes. providing at least 1% of the total water use of 300 000 m³/year will be further taken into consideration. (**flow > 3000 m³/year)**
b) The preparation department will be evaluated separately from the dyeing section. Finishing is not further discussed due to too high loaded effluent streams. No sensible options seem possible.
c) A further distinction will be made between the different types of dye-stuff. as they could require a different regeneration technique. (**soluble dyes: acid & reactive. non-soluble dyes: disperse)**
d) For direct re-use only some last rinsing waters will be selected. They should be low in contamination. (**COD < ± 200 ppm. TSS < ± 20 ppm)**

3.5. Plan and objectives for the next period

The WaterTracker® Software will be used for the calculation of the actual global water- and contaminant balance of the different cases. Due to the too large complexity of the cases and the stringent economical and technical possibilities. WaterPinch® will only be used for those groups of processes as selected based on the criteria.
The methodology will be further elaborated and used for the evaluation of the other four Italian companies and the four remaining Belgian Companies. More information on relaxation possibilities and membrane performance is required for II and IV from partner 1 and 8. combined with literature data.
The objective for the third year is to reach the global objective of WP4 by completing tasks WP04.04.4 and WP04.05.4 and to translate the methodology and conclusions to practical guidelines for an optimal reduction of water usage and discharge in task WP04.07.
The design of the database of allowable inlet concentrations (WP04.06) can only be performed in brief since there is only a limited amount of data available with regard to the process restrictions related to changing inlet water qualities

Workpackage 05 – Characterisation and design of wastewater

3.1. Objectives

WP05.01.5 (**LeAF**) Writing a literature review report on analytical and measuring techniques that are being used to characterise single and mixed stream wastewaters in the textile industry.
Providing a searchable literature database on textile industry wastewater characterisation to be implemented on the project's website.

WP05.02.5 (**LeAF**) Development of on-line textile industry wastewater characterisation techniques. In the first instance the characterisation will be based on a biological method (respirometry) and a physical/chemical method (infrared spectroscopy).

WP05.03.6 (**IES**) Application of calorimetry in investigating and better understanding biodegradability and treatability of textile effluents in aerobic activated sludge processes. Comparison between calorimetry and established respirometric techniques for wastewater characterisation.

WP05.04.5 (**LeAF**) Biological characterisation of textile wastewater streams in terms of treatability and re-usability.

WP05.05.3 (**LARIANA**) Definition of tests for water reuse in synthetic fibres and silk processing industries based on available data.

WP05.06.8 (**CENTEXBEL**) tests for water reuse in cotton processing industries.

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

Literature review on textile industry wastewater characterisation (WP05.01.5. LeAF)

Methodology

For the literature research common sources were searched: such as libraries. search engines. personal databases and networks. The database was created in a Microsoft Access database.

Achievements

A comprehensive literature review on textile industry wastewater characterisation has been compiled. and the acquired information is being used in the development of on-line wastewater characterisation techniques (activity WP05.02.5). The report "Textile Wastewater Characterisation" was distributed among the project partners (copy appended). A scientific review paper was drafted for submission to a journal. The literature database on textile industry wastewater characterisation was created but is still pending implementation by Partner 1 (ENEA) on the project's website.

The literature review provides an overview of what is known about the wastewater of the separate processes. and the methods used for characterisation of these streams. Characterisation of the different process streams gives a good overview of important parameters for each stream. The table below compares a few characteristics of different streams. Big differences can be seen between the streams. but also large ranges for the values of each stream. The ranges given are ranges with more average values. peak values indicate the extremities that can occur.

Comparison of the characterisation of different process effluent streams

	Desizing	Scouring	Bleaching	Mercerising	Dyeing
COD	3580 – 5900	3200 – 40000	250 – 6000		550 – 8000
COD peak	11000	90000	13500		40000
BOD	200 – 5200	300 – 8000	80 – 400	45 – 340	11 – 2000
BOD peak		60000	2800		27000
TS	7600 – 42000	1100 – 30000	900 – 14000		200 – 2000
TS peak		65000			14000
SS	400 – 800	200 – 20000	35 – 900	300	25 – 200
SS peak	6000	40000	25000		
TDS	1600 – 6900		40 – 5000	4500	
TDS peak			20000[1]		
Lipids	190 – 750	100 – 9000			
Lipids peak		108000			
pH	6 – 9	7 – 14	6 – 13	6 – 12	3.5 – 12

There are a lot of methods that can be used to obtain information about the presence of compounds in wastewater. Many of these methods. although meant for the same parameter. result in slightly different values. The cause can for instance be a different pre-treatment. For various parameters. comparing textile wastewater is often difficult. An example is comparing colour values. If the colour units are not the same. comparing the data gets very complicated. Next to characterisation methods and –data. the processes themselves are important when considering their wastewater. This seems logical. but many authors do not describe the wastewater they use in terms of the process it results from. With the variety of processing methods and machinery. the exact type of process and the processed fabrics give valuable information on the range of values that can be expected for certain parameters. An improvement in textile wastewater research would be a harmonisation of the used characterisation methods (especially for colour) and the habit to give as much information as possible on the wastewater source.

Development of online wastewater characterisation techniques (WP05.02.5. LeAF)

Methodology

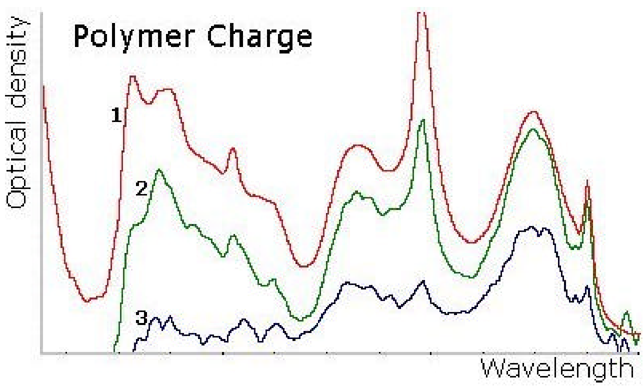
A respirometric technique was developed based on the measurement of the dissolved oxygen consumption rate by activated sludge degrading components in wastewater. The technique consists of adding repeatedly samples of defined substrates and wastewater to activated sludge in a small test reactor. and measuring the oxygen uptake rate using a respirometer.

Achievements

A procedure was worked out to store. prepare and verify (for biomass viability) wastewater and activated sludge received by mail or fetched from remote sites. A pH- and temperature controlled batch reactor and automatic respirometer was set up for the characterisation experiments. and a methodology was devised to test the textile wastewater. A concept has been described to perform the test on-line. that is: automatically and directly at the textile operation process.

A literature study on the application of infrared spectroscopy as a wastewater characterisation technique was completed (copy appended).

A calibration procedure was worked out that was targeted at the specific characteristics of the textile wastewaters. A number of samples were analysed using the infrared technique at the Laboratory of Biotechnology and Environment of INRA. Narbonne. France. Although based on only a few samples. the results of this experiment indicate the possibility of using infrared spectroscopy for measurements of COD in wastewater. The figure below shows spectra of three polymer charge wastewaters from which not only the COD can be deduced but also the concentrations of the various components in the samples.



Spectra of three polymer charge samples

What is clear from these results is the large difference between spectra of samples of different textile processes. Therefore calibration should be done independently for each process. Making a universal textile calibration and using it for different processes would not give usable results. When considering using this technique for a specific purpose. the first step is very important: determining the objective of the measurement. What kind of parameters have to be measured and in what concentrations? Is the objective to measure separate compounds (like normally is done with IR). or COD that is a multi-compound parameter? Also the range of the concentrations is important. As mentioned in the introduction. the more diluted the wastewater. the less reliable are the results for COD.

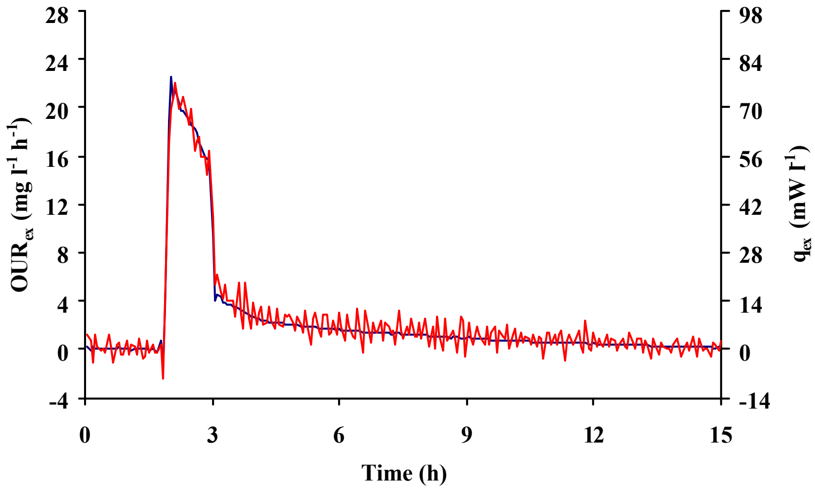
Calorimetric tests (WP05.03.6. IES)

Methodology

Isothermal direct calorimetry has been applied to investigate aerobic biodegradability of mixed final effluents from two textile factories. For this purpose. a bench scale calorimeter (Bio-RC1). especially modified for biological studies and equipped with a dissolved oxygen (DO) probe. has been used. Through pulses of selected substrates (textile wastewaters. acetate or ammonia). aerobic metabolic activity has been assessed for heterotrophic and autotrophic nitrifying bacterial populations in sludge samples from wastewater treatment plants treating domestic and/or textile effluents. Calorimetric data (thermograms) have been compared to DO measurements simultaneously carried out (respirometry). so that wastewater stream degradation has been characterised in terms of microbial heat dissipation and short term biological oxygen demand.

Achievements

A satisfactory agreement was observed between respiration rate (OUR) profiles and power-time curves confirming that. under strictly aerobic conditions. calorimetry and respirometry provide the same information (figure below). Oxycaloric equivalent. defined as the amount of heat released by the culture per mole of oxygen consumed. was estimated when textile wastewaters were the sole exogenous substrate. The values obtained are close to the theoretical value for heterotrophic aerobic metabolism (460 kJ mol O2-1) and to literature data. Additionally. toxicity effect on microbial communities due to raw wastewater additions has been successfully investigated.

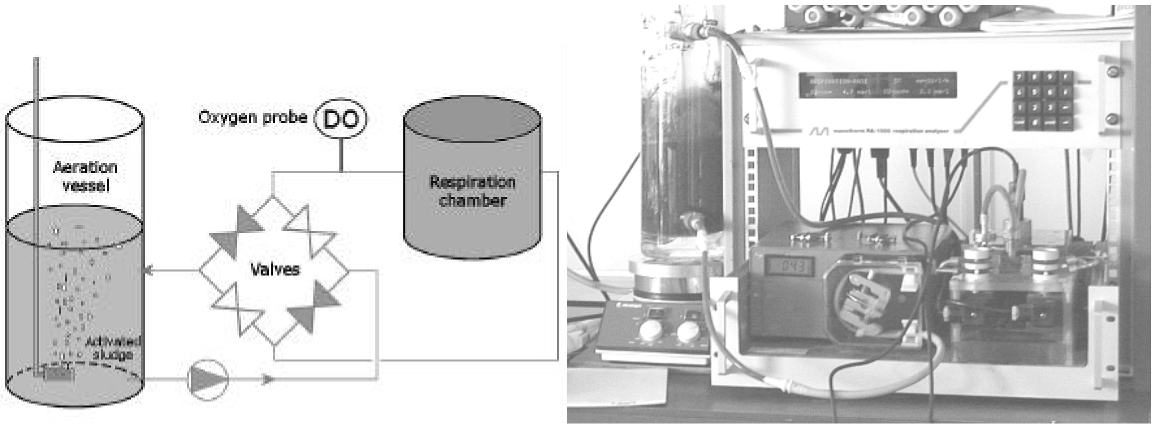


Comparison between OUR (smooth line) and heat production rate (noisy line) profiles simultaneously acquired (raw wastewater B. AS plant biomass).

Respirometric on-line tests (WP05.04.5. LeAF)

Methodology

Textile wastewater is characterised in terms of biological degradability by means of respirometry. This technique is based on the measurement of the dissolved oxygen consumption rate by activated sludge degrading components in wastewater. The technique consists of adding repeatedly samples of defined substrates and wastewater to activated sludge in a small test reactor. and measuring the oxygen uptake rate using a respirometer (see figure). The data are processed using two methods: direct method. by straightforward interpretation of the respirograms. and parameter estimation. by fitting an activated sludge model to the data.



Schematic representation and photo of the used respirometer

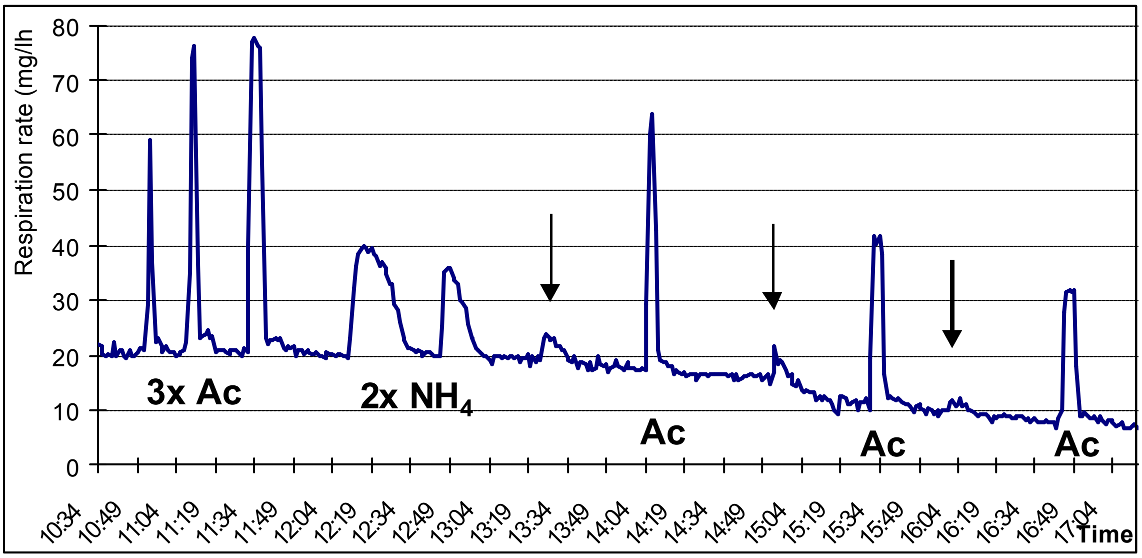
Achievements

A series of experiments was done with two samples of mixed textile wastewater collected by Partner 3 (Lariana) from the I06 textile factory. and sludge from the Alto Seveso wastewater treatment plant where the I06 effluent is treated along with the local sewage. Ten separate process streams (four from Belgium and six from Italy) were tested as well with Alto Seveso sludge and sludge from a Belgian textile factory wastewater treatment plant. The wastewaters that were tested are listed in the table below.

Single textile wastewater streams used for recording respirograms

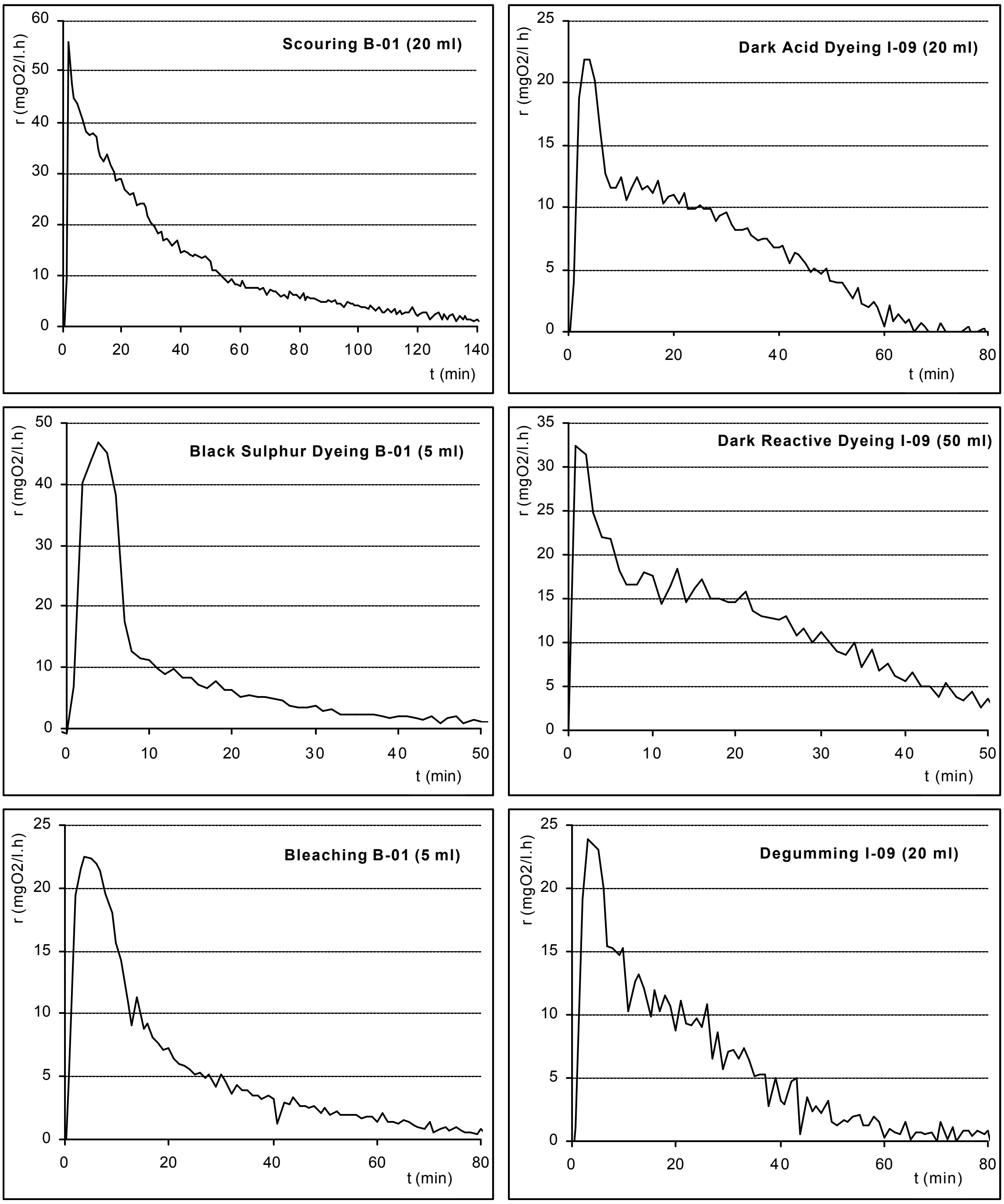
Factory	*Process*	*Process step*	*Material*
I-06	Mixed final factory effluent	-	-
	Double scouring in Torpedo	Bath 1	Cotton/polyester or Silk/polyester
	Double scouring in Torpedo	Bath 2	Cotton/polyester or Silk/polyester
	Light reactive dyeing in overflow	Bath 1	Cotton/polyester or Silk/polyester
I-09	Degumming	Bath 1	Silk fabric
	Dark Reactive Dyeing	Bath 1	Silk yarn
	Dark Acid Dyeing	Bath 1	Silk yarn
B-01	Scouring		Indigo dyed cotton
	Black Sulphur Dyeing		Cotton
	Bleaching		Cotton
B-02	Sizing	Bath	Cotton

Respirogram shapes are different for different types of wastewaters. as well as the maximum respiration rates and the time it takes to return to the endogenous respiration rate. Most wastewaters gave a good response with respect to respirogram height and length. indicating that online measurement using respirometry is a valid option for these waters. Wastewaters that do not give a response (e.g. due to toxicity of the wastewater) are not suitable for online characterisation using respirometry. An example is the I-06 mixed wastewater that was tested (see figure):



Respiration experiment with mixed textile wastewater. arrows indicate additions of 50 ml of wastewater. Ac = addition of acetate. NH4 = addition of ammonium.

It can be observed that after the first wastewater addition the endogenous respiration rate starts decreasing. With each addition of wastewater the endogenous respiration rate decreases further. and also the shape of the acetate peaks is affected: a lower maximum respiration rate and a broader peak. Furthermore. the wastewater itself does hardly show a response. This wastewater is not suitable for respirometric online characterisation. The single streams gave better responses. and did not show toxicity to the extent of the mixed effluent. The figures below are examples of respirograms of the separate streams.



Single respirograms like these have been selected and will be used for parameter estimation. An activated sludge model for textile wastewater characterisation based on respirograms was developed and implemented in Matlab. In cooperation with Partner 6 (EI/JRC) a comparison was made between respirometric and calorimetric experimental results with the same wastewater-sludge combination (WP05.03.6).

Tests for water reuse WP05.05.3 **(LARIANA)**
Methodology: Definition of the criteria for discharges selection and collection with P4 and P1.

Discussion on processes and efficiency tests to be performed

Achievements: Five discharges are selected and works are ready to start.

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Tests for water reuse WP05.06.8 (**CENTEXBEL**) P4 and P1 checked out about water reusability and focused on processes and efficiency tests; practical arrangements are completed and works are ready to start.

3.3. Socio-economic relevance and policy implication

The literature review on textile industry wastewater characterisation (WP05.01.5. LeAF) will support the development of on-line wastewater characterisation techniques (activity WP05.02.5) and provide a reference source for various other activities within the project. and as such contribute to the socio-economic relevance and policy implication of the project output.

The development of online wastewater characterisation techniques (WP05.02.5. LeAF) will provide a technique for the respirometric on-line tests (WP05.04.5) and a physical/chemical test based on infrared measurement. and as such contribute to the socio-economic relevance and policy implication of the project output. The infrared measurement procedure may yield a novel technique for on-line COD measurement of textile wastewaters. and has the potential to be developed for market applications.

The respirometric online tests (WP05.04.5. LeAF) will eventually provide input to the methodology for water pinch and waste design. and as such contribute to the socio-economic relevance and policy implication of the project output. The combination of respirometric and infrared techniques may yield a method to measure the treatability of not only textile wastewaters but also other industrial effluents.

3.4. Discussion and conclusion

The draft literature review on textile industry wastewater characterisation (WP05.01.5. LeAF) was presented and discussed at the project meeting in Sevilla. 21-22 March 2002. and participants provided some amendments. At the meeting the participants agreed with the intention to produce a journal review paper.

Techniques for respirometric and infrared textile wastewater characterisation have been set up (WP05.02.5. LeAF). Although based on a limited number of samples. the results of the infrared spectroscopy experiment indicate the possibility of using this technique for the on-line measurement of COD in wastewater. provided that the calibration be done independently for each textile process. As a start the objective and the needed precision if the infrared technique have to be defined. The values concerning the different processes have to be known. to be able to decide if infrared spectrometry is the right choice. When all requirements are met by the method. an off-line trial for one single process is recommended before trying on-line analysis. Maybe a suitable "test-stream" can be pointed out using the results of this study. This should be a quite concentrated wastewater: the more concentrated a stream is. the better the results will be.

Simultaneous calorimetric and respirometric measurements were carried out like the work description (WP05.03.6. IES). Biodegradation and toxicity were investigated for the characterisation of textile wastewater and compared with the respirometric measurements obtained in Wageningen. A good agreement was observed between the calorimetric and respirometric data. Up till now. to our knowledge. such measurements have never been performed under laboratory conditions with activated sludge and textile effluent. The advantage of the respirometric technique is its applicability for "on-line" use. The final report (copy appended) is published as an EUR report.

For the respirometric online tests (WP05.04.5. LeAF). the viability of the sludge was verified by measuring the respirometric response on substrate additions. and it was concluded that the procedure enables the utilisation of remotely sampled activated sludge for characterisation tests. The tested mixed wastewater samples appeared to be barely biodegradable and were suspected to cause a toxic effect to the sludge (which is in fact a characteristic of the wastewater). With wastewater from the different separate streams different responses could be observed for each wastewater. with respect to possible toxicity effects and short-term biodegradability.

WP05.05.3 (**LARIANA**)
The main criteria used to conceive water reuse test is to reuse discharges coming from company on the substrate manufactured by the company; discharges will be collected. treated and reused them in proper textile chain the way it's processed in the company. using both conventional supply water and treated water.

Suitable fibres. discharges and processes to be performed have been identified on the basis of PIDACS data. LCA elaboration and P1 and P5 according to previous activities results as in the following table.

Company	Discharges	Fibre	Pre-treatment	Dyeing
I09	F1.3 process 2nd bath (HT scouring)	SILK yarn	degumming	light acid dyeing
			polymer charge	dark acid dyeing
I09	G9 process 1st bath+1st washing (dark reactive dyeing)	SILK yarn	degumming	light acid dyeing
			polymer charge	dark acid dyeing
I06	G1.1 process 1st bath+1st washing (light disperse dyeing)	PES fabric	scouring	light disperse dyeing
				dark disperse dyeing
I06	G9 process 1st bath+1st washing (dark reactive dyeing)	PES fabric	scouring	light disperse dyeing
				dark disperse dyeing
I15	1st process to be defined (silk manufacturing)	SILK fabric	degumming	light acid dyeing
				dark acid dyeing
I15	2nd process to be defined (silk manufacturing)	SILK fabric	degumming	light acid dyeing
				dark acid dyeing
I04	1st process to be defined (synthetic manufacturing)	VISCOSE fabric	scouring	light direct dyeing
				dark direct dyeing
				light reactive dyeing
				dark reactive dyeing
I04	2nd process to be defined (sythetic manufacturing)	VISCOSE fabric	scouring	light direct dyeing
				dark direct dyeing
				light reactive dyeing
				dark reactive dyeing

Discharges. fibres. processes. selected for water reuse tests

Efficiency tests have been chosen as per the Table below:

Tests for the process efficiency evaluation

Fibre	Pre-treatment	Pre-treatment tests	Reference	Dyeing	Dyeing tests	Reference
SILK yarn	degumming polymer charge	degumming efficiency charge efficiency	UNI 9275/88	acid dyeing	Colour differences Fastness to washing Fastness to rubbing	ISO 105-J03 ISO 105-C06 ISO 105-X12
PES fabric	scouring	scouring efficency white degree determination		disperse dyeing	Colour differences Fastness to washing Fastness to rubbing	ISO 105-J03 ISO 105-C06 ISO 105-X12
SILK fabric	degumming	degumming efficiency white degree determination		acid dyeing	Colour differences Fastness to washing Fastness to rubbing	ISO 105-J03 ISO 105-C06 ISO 105-X12
VISCOSE fabric	scouring	scouring efficency white degree determination		direct dyeing reactive dyeing	Colour differences Fastness to washing Fastness to rubbing	ISO 105-J03 ISO 105-C06 ISO 105-X12

The minimum number of processes and tests are grouped under the "basic program". composed by 20 processes (10 preparation and 10 dyeing processes) and 46 tests.

The maximum number of processes and tests are grouped under the "complete program". composed by 55 processes (15 preparation and 40 dyeing processes) and 144 tests.

Performed processes will be not less than the ones reported on basic program and will be carried out by Tessile di Como. P3 partner for this workpackage.

Treated discharges will be analysed in order to highlight differences in tests result. whenever they will occur. according to the Table reported below:

Performer	Analysis
P1	426 nm absorbance
	558 nm absorbance
	660 nm absorbance
	Conductivity
	IC
	pH
	TC
	TOC
	TSS
	Turbidity
P3	Alcalinity
	Ammonia
	Chlorides
	Hardness
	Nitrates
	Nitrites
	Sulphates
	Sulphides

Water characterization.

3.5. Plan and objectives for the next period

WP05.01.5 (**LeAF**) Partner 1 (**ENEA**) will be urged to implement the literature database as soon as possible. The review article will be submitted to the journal Environmental Technology. March 2003.

WP05.04.5 (**LeAF**) Some additional respirometric tests will be done with both the influent and effluent of the anaerobic pre-treatment for the reuse tests. Wastewater characterisation by means of activated sludge modelling will be completed.

WP05.05.3 (**LARIANA**) Reusability tests will start the end of March 2003 and will be completed within the end of June 2003.

WP05.06.8 (**CENTEXBEL**) Reusability tests will be done within the end of June 2003.

WP05.08.5 (**LeAF**) The development of a protocol for wastewater design in terms of treatability and reusability will start in June (activity planned for June – October 2003). based on the planning agreed during the preparatory meeting between Vito and LeAF. 14 January 2003 (meeting report appended).

Workpackage 06 – Wastewater treatment

3.1. Objectives

WP06.05.5 (**LeAF**) Tests by anaerobic bioreactor to maximize biodegradation of pollutants and toxic compounds and enhance treatability of wastewaters.

WP06.06.1 (**ENEA**) Tests to evaluate the aerobic treatability of final effluents on real concentrates.

WP06.07.1 (**ENEA**) Treatment tests by membranes to produce permeates suitable for reusing on various process effluents.

WP06.08.1 (**ENEA**) Operational data to design treatments are being obtained by elaboration of the tests results

WP06.09.1 (**ENEA. LeAF**) Procedures for the preparation of the Workshop on wastewater design

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

Tests by anaerobic bioreactor to maximize biodegradation (WP06.05.5. LeAF)

Methodology

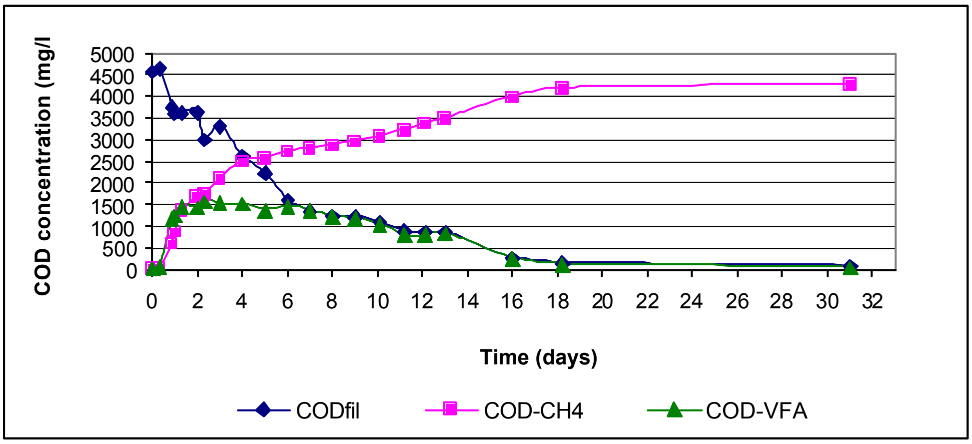
Three lab scale UASB and two EGSB anaerobic reactors were constructed and equipped with the necessary pumps. gas meters. containers for wastewater and effluent. Various single stream wastewater samples were selected in cooperation with Partner 8 (Centexbel) and collected at different textile factories in Belgium. These wastewaters were treated in the reactors under various operation regimes (loading and retention time). and reactor performance was monitored by means of effluent and biomass analysis. and gas production rate measurements. Two anaerobically pre-treated effluents will be sent to Partner 1 (ENEA) for further treatment as part of the tests for water reuse by Partner 8 (Centexbel). The picture below shows one of the reactors.

Bioreactors used for anaerobic tests: UASB (left). EGSB (right).

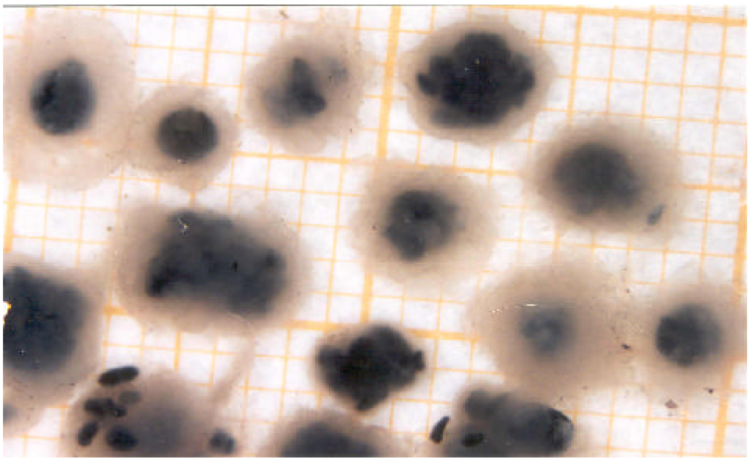
Achievements

The following textile process operation wastewaters were tested: Sizing. scouring. bleaching. black sulphur dyeing. reactive dyeing and acid dyeing. The scouring. bleaching and black sulphur dyeing wastewaters were only tested in batch experiments for their biodegradability. whereas the sizing wastewater was treated in both batch mode and UASB reactor. The sizing wastewater was investigated in terms of biodegradability under various operating conditions. Two EGSB type reactors have been constructed to treat reactive dyeing and acid dyeing wastewaters with the objective of decolourisation. as pre-treatment step for membrane filtration by Partner 1 (ENEA) as part of the tests for water reuse by Partner 8 (Centexbel) (activity WP05.05.3).). The reactors are now running. and it is expected that effluents will be ready to be sent to ENEA for membrane treatment in the beginning of April 2003.

The batch test showed that more for diluted sizing wastewater more than 90% of the COD was degraded. The anaerobic biodegradability of dyeing. scouring and bleaching wastewater appeared to be affected by pH and constitution of nutrient solution. Organic matter in scouring and bleaching wastewater was converted to mainly acetate. propionate and butyrate but not into methane. resulting in significant accumulation of VFA in the medium. The anaerobic biodegradability of scouring and bleaching is most dependent on its initial COD concentration. The CODtotal removal efficiency is lower at the higher COD concentration. As an example. the figure below shows the course of the biodegradation of sizing wastewater during batch test.



Anaerobic biodegradation of sizing wastewater. measured as COD concentrations.



In UASB reactor Sizing wastewater was highly biodegradable at loadings of 3.2. 4.0. and 4.8 kg COD/m3.day. The optimum hydraulic retention time was 12 hour with removal efficiency above 85%. and 80% of the COD was converted to methane. However. a small fraction of lipids in wastewater occasionally caused part of the sludge bed to float. The floating sludge occurred at HRT 8 hour. In order to overcome the problem. HRT or velocity (very high. EGSB conditions) should be increased to completely degrade lipids into methane. The figure shows the anaerobic granules covered with a layer of lipid from the sizing water. Anaerobic granules covered with lipids.

Tests to evaluate the aerobic treatability of final effluents on real concentrates (WP06.06.1. ENEA)

Methodology

A methodology was set up to measure of the inhibition of nitrifying activity caused by increasing effluent addition. The nitrifying sludge used is prepared according International Standard ISO 9509 1989 (E). The sludge. in a solution with nutrients and ammonia. is aerated and maintained at constant pH by automatic titration using alkaline and acid solutions in thermostatic chamber (21.5 °C ±0.1)

The specific nitrifying activity (v = mg N-NH4 (gSSV h)-1) without inhibition is measured by measuring the titration flow rate (mC0). The potentially toxic effluent is added at increasing doses measuring mCi. The percentage inhibition is calculated as:

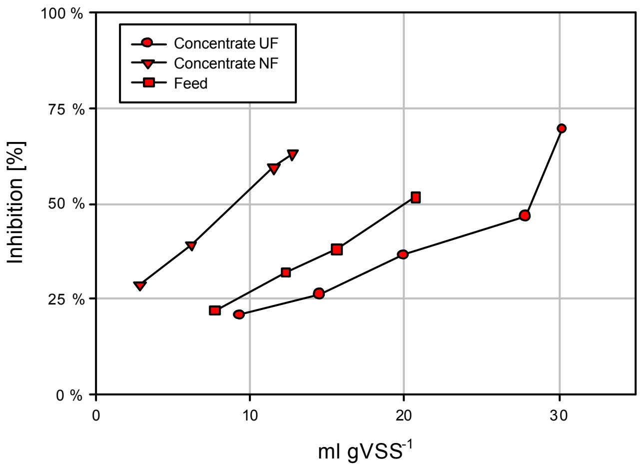
$$I\% = \frac{mC_o - mC_i}{mC_o - m(ATU)}$$

m(ATU) = titrating flow rate with totally inhibited nitrification.

Achievements

Inhibition curves

The results obtained on effluent C1 (feed. UF concentrate and NF concentrate) have evidenced an high level of toxicity towards the nitrifying activity occurring in a standard wastewater treatment plant. a 50% inhibition occurs at very low doses of the samples.
While the NF concentrate results as expected more toxic than the feed. the UF concentrate resulted less toxic than the feed.



Treatment tests by membranes to produce permeates suitable for reusing on various process effluents. WP06.07.1 (ENEA)

Identification of the streams
The effluents to be tested were selected by focusing on the most important effluent streams.
In industry I06:

- Among pre-treatments two operations have been selected for testing: scouring (effl. B) and double scouring (effl. A). accounting respectively 26% and 24% of the total water consumption in pre-treatment operations.
- Among dyeing operations disperse dyeing has been selected (effl. C) accounting for the 38% of the total dyeing operations.
- Among printing operations Devorè washing has been selected (effl. D) accounting for the 50% of the total printing operations.
- No effluents have been selected from finishing operations due to the low water consumption.

In Industry I09

- Among pre-treatments two operations have been selected for testing: HT scouring (effl. B1). accounting for the 24% the total water consumption in pre-treatment operations and Polymer charge (effl A1; 5%) because the quality of the effluent is peculiar.
- Among dyeing operations Yarn dark reactive dyeing (effl. C1) accounting for the 24% of the total dyeing operations.
- No effluents have been selected from finishing operations due to the low water consumption.

Physical-chemical characterisation

For the results of the chemical characterisation compare with the tables below

The SDI tests made on all the effluents have resulted in complete plugging of the filters before the conclusion of the tests. All the effluents require an UF pre-treatment before NF polishing.

Results of the laboratory scale tests

The tests were carried out on SEPA CF by Osmonics a bench equipment that mimics the operating conditions of a spiral wound membrane element. Tests were carried out on real effluent samples (5 l) by flat sheet membranes of 190x140 mm. in conditions of complete recycling of permeate and concentrate at a cross-flow velocity of 0.10 m/s . The characteristics of the membranes used in the tests are reported in the table below:

Membrane:	GH	GK	ER	MW	PW	DL	CK	HL	DK	AD	AE	AG	AK	SC	SE	SG
Type	UF	UF	UF	UF	UF	NF	NF	NF	NF	RO	RO	RO	RO	RO	RO	RO
Material	thin film processo	thin film processo	poly-sulphone	polyacrilo nitrile mod.	polyether sulphone	thin film processo	cellulose acetate	thin film standard	thin film processo	thin film poly-ammide standard	thin film poly-ammide standard	thin film poly-ammide standard	thin film poly-ammide standard	S thin film poly-ammide processo	S thin film poly-ammide processo	S thin film poly-ammide processo
p op.	10.3 bar	4.8 bar	3.4 bar	2.1 bar	2.1 bar	6.9 bar	6.9 bar	6.9 bar	6.9 bar	55 bar	55 bar	13.8 bar	6.9 bar	55 bar	27.6 bar	13.8 bar
p max						41.37 bar		41.37 bar	41.37 bar	82.74 bar	82.74 bar	41.37 bar	41.37 bar	82.76 bar	41.37 bar	41.37 bar
T max	50°C	50°C			50°C	50°C		50°C	50°C	50°C	50°C	50°C	50°C	50°C	50°C	50°C
pH range	1-11	2-11			2-11	2-12		1-10	2-11	4-11	4-11	4-11	4-11	2-11	4-11	2-11
Rejection or MWCO	1000 D	2000 D	15000-30000 D	50000-100000 D	12000 D	98% $MgSO_4$	60-75 % NaCl	98% $MgSO_4$	98% $MgSO_4$	99.5 % NaCl	99.2% NaCl	99.5% NaCl	99% NaCl	99.5% NaCl	99% NaCl	98% NaCl
Permeability	10 $l/(h*m^2)$	20 $l/(h*m^2)$	350-525 $l/(h*m^2)$	>600 l/(h*m2)	500 l/(h*m2)	44 l/(h*m2)	17-26 $l/(h*m^2)$	44 $l/(h*m^2)$	26 l/(h*m2)	6 $l/(h*m^2)$	10 $l/(h*m^2)$	21 $l/(h*m^2)$	38 $l/(h*m^2)$	5 $l/(h*m^2)$	7 $l/(h*m^2)$	14 l/(h*m2)

The selection of the right membrane for each effluent was based on based on the rejection values of the contaminants. on the membrane/effluent interactions and on the permeate flux values.

The following membrane trains were selected to be tested at pilot scale:

- UF (MW)+NF(DK) and UF(MW) + RO (SG) for effluents A. B. C. D
- UF(MW and PW)+NF(DK) for effluent A1
- UF(MW)+NF(DK and DL) for effluents B1. C1

Results of the pilot scale tests

The tests were carried out on a plant using spiral wound polymeric membranes (diameter 4.6 cm. length 30.5 cm. membrane surface 0.3-0.4 m2).

All the tests consisted in the following steps

- Characterisation using de-ionised water. measuring the fluxes at various temperatures (25°C – 45°C) and pressures in operating range to obtain the maximum values achievable and have reference values for variations during and after the tests.
- Test on real effluents in batch (25 l) recycling concentrate and permeate. measuring the flux decay after 60 min and performing a full characterisation of the permeate at the beginning and after 60 min.

- Test on real effluents in batch (25 l) recycling concentrate and discharging permeate with characterisation of permeate at increasing feed concentration (volume reduction of 20%. 40%. 60% and 80%) and of the concentrate. measuring permeate flux at various concentrations.
- Characterisation using de-ionised water after the treatment. and comparison with the initial one to estimate the material accumulation on the membrane.

Quality of the permeates obtained with the best options identified for each effluent are reported in the table below

		pH	Cond. (?S/cm)	Turb. (NTU)	DOC (mg/l)	DIC (mg/l)	Abs. 426 nm	Abs. 558 nm	Abs. 660 nm	SST (mg/l)
Effluent A	feed	6,8	552	59,0	737	19	0,128	0,068	0,047	2
	permeate UF	6,5	375	19,0	239	21	0,014	0,007	0,004	absent
	permeate NF	5,6	61	0,2	51	5	0,001	0,000	0,000	absent
	permeate RO	7,2	14	0,2	4	3	0,000	0,000	0,000	absent
Effluent B	feed	7,3	544	64,0	481	48	0,012	0,004	0,004	15
	permeate UF	8,0	442	0,8	158	53	0,007	0,003	0,004	absent
	permeate NF	6,8	42	0,1	66	6	0,000	0,000	0,000	absent
	permeate RO	7,8	410	2,2	178	57	0,010	0,010	0,009	absent
Effluent C	feed	4,7	747	4,1	300	10	0,093	0,019	0,005	2
	permeate UF	4,8	684	0,1	183	2	0,006	0,000	0,000	absent
	permeate NF	4,6	269	0,1	103	3	0,001	0,000	0,000	absent
	permeate RO	4,0	53	0,1	37	2	0,000	0,000	0,000	absent
Effluent D	feed	10,3	1096	126,0	305	49	0,092	0,023	0,011	658
	permeate UF	10,0	956	2,3	197	48	0,032	0,008	0,007	absent
	permeate NF	10,3	198	0,7	16	5	0,002	0,002	0,004	absent
	permeate RO	9,8	90	0,6	3	3	0,000	0,000	0,000	absent
Effluent A1	feed	3,5	2440	1,2	5699	30	0,006	0,005	0,001	21
	permeate UF	3,3	2360	0,4	2921	3	0,000	0,002	0,001	16
	permeate NF	3,8	935	0,3	441	3	0,005	0,005	0,004	1
Effluent B1	feed	8,0	617	28,0	840	71	0,056	0,024	0,015	11
	permeate UF	7,6	554	0,3	209	79	0,006	0,001	0,001	21
	permeate NF	7,9	95	0,2	59	21	0,002	0,001	0,003	absent
Effluent C1	feed	9,5	39800	0,4	775	753	2,813	3,939	0,022	39
	permeate UF	9,5	37700	0,6	472	644	2,136	3,836	0,022	50
	permeate NF	9,5	31400	1,4	110	292	0,007	0,013	0,001	43

Operational data to design treatments are being obtained by elaboration of the tests results WP06.08.1 (ENEA)

Operational data have been obtained for each effluent tested to have indications for a full scale design. This indications include: Membrane total surface necessary. operational pressure. permeate flux. max concentration of the feed stream. washing frequency.

The cost of the treatment have been calculated taking into account: plants standard versions + installation cost. use of commercial spiral wound modules 25 m2 (UF) and 32 m2 (NF). chemicals. consumables and energy costs. The treatment cost estimated for the single effluents range between 2 and 4 €/m3 of water recovered and depends greatly on the volume of the effluents.

Procedures for the preparation of the Workshop on wastewater design WP06.09.1 (**ENEA. LeAF**)
Procedures for the preparation of the Workshop on wastewater design have started defining the theme and identifying experts who can contribute.

3.3. Socio-economic relevance and policy implication

The activity will eventually provide input to the methodology for water pinch and waste design. and as such contribute to the socio-economic relevance and policy implication of the project output.

3.4. Discussion and conclusion

The tests by anaerobic bioreactor to maximize biodegradation of pollutants and toxic compounds (WP06.05.5. LeAF) were done in batch mode and in continuous mode. In the batch tests all wastewaters were susceptible to anaerobic degradation. though at variable degradabilities. Scouring and bleaching wastewaters show highest toxicity towards anaerobic microorganisms. The sizing wastewater has a high COD (64 kg.m-3) that is mainly due to the high starch and fat content. Sludge flotation problems occurred in the continuous UASB reactor tests one week after start of operation. This was probably caused by the degradation of fat leading to long chain fatty acids (lipids) that covered the sludge granules resulting in flotation. Stopping circulation and application of a low flow solved the problem. Preliminary results for the reactive dyeing and acid dyeing wastewaters indicate that anaerobic decolourisation of these dyeing wastewaters is feasible. provided a carbon source is added.

Despite the very good quality of the permeates obtained RO (WP06.07.1. ENEA)resulted to be scarcely promising because in all cases the fluxes obtained were very low.
The treatment train UF + NF seem in most cases technically and economically feasible with differences for the various effluents:
Effluent A:

- Relevant material accumulation on the membrane surface during the UF. NF processes. Frequent chemical cleaning is needed. Interesting to test a clariflocculation pre-treatment.
- Quality of NF permeate is promising for reuse. most of the residual TOC after NF is probably due to acetate. while SST. turbidity and colour are almost completely removed in UF.
- Concentration up to 80% does not cause relevant flow reduction nor permeate quality decline in UF. As for NF it is better to operate below 70%.

Effluent B

- Low material accumulation on the membrane surface during the UF. NF processes.
- The reuse of the permeate requires testing. it is difficult to find a relationship between the residual TOC and the process recipe.
- SST. turbidity and colour are almost completely removed in UF together with a big fraction of the TOC it is interesting to test possibilities of reusing directly UF permeate.
- Concentration up to 80% does not cause relevant flow reduction nor permeate quality decline in UF. As for NF the quality decline starts at 30-40%.

Effluent C

- Low material accumulation on the membrane surface during the UF. NF processes.
- Quality of NF permeate is promising for reuse. most of the residual TOC is probably due to acetate.
- SST. turbidity are almost completely removed in UF but colour is still quite high.

- Concentration up to 80% does not cause relevant flow reduction nor permeate quality decline in UF. As for NF the flux and quality decline are constant increasing the concentration.

Effluent D

- Low material accumulation on the membrane surface during the UF. NF processes.
- SST. turbidity are almost completely removed in UF but colour is still quite high.
- Quality of NF permeate is very promising for reuse the residual TOC is very low.
- Concentration up to 80% does not cause relevant flow reduction nor permeate quality decline in UF and in NF.

Effluent A1

- High material accumulation on the membrane surface during the UF process. Frequent chemical cleaning is needed.
- The permeate flows obtained in UF are low.
- The reuse of the permeate requires testing. despite the relevant removal obtained on UF and NF membranes the residual TOC is high. (mainly due to salts of the formic acid).
- Concentration up to 80% does not cause relevant flow reduction in UF but the permeate quality decline is constant. On the contrary no quality decline has been detected in NF. but the flow decrease above 50% concentration.
- No advantages using an higher cut-off membrane in UF: PW membrane has given a better quality of the permeates but the permeate flow values are much lower and NF on PW permeate does not work better than on MW permeate.

Effluent B1

- Moderate material accumulation on the membrane surface during the UF no accumulation in NF.
- The permeate flows obtained are satisfactory.
- Quality of NF permeate is promising for reuse. the residual TOC after NF is low (mainly etylen glycole) and SST. turbidity and colour are almost completely removed in UF.
- Concentration up to 80% does not cause relevant flow reduction nor permeate quality decline in UF and in NF.
- NF membrane with higher permeability (DL) has obtained a slightly lower quality of the permeates but the permeate flow values are sensibly higher.

Effluent C1

- Low material accumulation on the membrane surface during the UF. NF processes. The permeate flows obtained are low.
- The relevant salinity of the permeates does not allow the reuse in various processes while could save reactive addictions in case of recycling in similar processes.
- The recycling requires testing. the residual TOC is not high. the colour is almost completely removed in NF. the turbidity is low in the feed while SST removal is strangely low.
- Concentration up to 80% does not cause relevant flow reduction nor permeate quality decline in UF and in NF.
- NF membrane with higher permeability (DL) has obtained a slightly lower quality of the permeates but the permeate flow values are sensibly higher.

3.5. Plan and objectives for the next period

WP06.05.5 (**LeAF**) This activity is completed in terms of the originally planned work. Anaerobically pre-treated water will soon be sent to ENEA. Batch experiments with reactive and acid dyeing wastewater will be conducted to compare the effect of temperature (mesophilic treatment vs. thermophilic treatment) and the use of an electron mediator on decolourisation rates. An additional batch anaerobic treatment test of the membrane retentates from Partner 1 (ENEA) would be very useful. as was approved at the project meeting in Wageningen. 26-28 March 2003.

WP06.06.1 (**ENEA**) Complete the evaluation of the toxicity of the concentrates produced by tests carried on within WP06.07.1.

WP06.07.1 (**ENEA**) Treatment tests by membranes to produce permeates suitable for reusing on four significant effluents from of Belgian companies and on further effluents from Italian companies. Membrane post treatment of two dyeing effluents after biological anaerobic pre-treatment.

WP06.08.1 (**ENEA**) Continue the elaboration of the tests results to obtain operational data to design treatments.

WP06.09.1 (**ENEA**. **LeAF**) Procedures for the preparation of the Workshop on wastewater design

Workpackage 07 – Effluent characterisation

3.1. Objectives

The objective of the IPPC Directive 96/61/EC is to prevent or reduce industrial emissions into the environment. Article 14 demands the monitoring of releases affecting the environment.

In support of the IPPC Directive. chemical analysis methods for organic micropollutants in water samples were developed. optimised. and validated (**IES-JRC**). and ecotoxicological tests to assess hazardous effects developed. Moreover. biological screening methods for endocrine disrupting activity were applied (**VITO**).

(IES) The chemical analysis procedures available can be subdivided in different analytical lines:

Polar water-soluble substances like phenols. acids. sulfonates. dyes. drugs. amines. surfactants. and pesticides are analysed by solid-phase extraction (*SPE*) *followed by liquid chromatography-mass spectrometry (LC-MS) detection.*

(SPE) followed by liquid chromatography-mass spectrometry (LC-MS) detection.

Volatile organic compounds (VOCs) like benzene. toluene. chloroform. methylenechlorid. naphthalene. etc. are analysed by headspace gas chromatography-mass spectrometry (HS-GC-MS).

Unpolar semivolatile contaminants such as unpolar pesticides (DDT). polyaromatic hydrocarbons (PAHs). phthalates. chlorobenzenes. hydrocarbons. and PCBs are analysed by C18-SPE followed by GC-MS detection.

Moreover. physical and sum parameters like pH. turbidity. DOC. TOC. colour. etc. are measured.

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

(**VITO**)

Complementary to chemical characterisation. ecotoxicological methods have been selected which allow to evaluate the environmental impact of textile effluents on receiving waters. A battery of ecological relevant tests has been selected. as they cover biological responses of 4 organisms (bacteria. green algae. invertebrate. fish) which represent different levels in the aquatic trophic chain. The selected test methods. either for acute toxicity (test duration maximum 4 days) or eventual chronic toxicity (test duration between 7 and 21 days) can be performed according to international guidelines (OECD. ISO...). A tiered approach was used for ecotoxicity evaluation. Effluents of textile companies and waste water treatment plants were first evaluated by acute toxicity tests. Only if no acute toxicity could be detected. the evaluation for chronic toxicity was performed. A methodology has been established which allows to rank waste water samples according to the measured acute toxicity. expressed as toxic units. which are derived from dose-response curves and calculated EC50 concentrations (concentration of water sample; at which 50% of the organisms do suffer from toxic effects) for each of the test organisms. The effluents of 3 WWTP in Italy. sampled in June 2002 did not show acute toxicity. Subsequently. a monitoring campaign to assess chronic toxicity was set up in October 2002 for WWTP effluents and receiving waters. Results did show no effects for early life stages of fish. minor toxicity for water flea for only one WWTP. while eutrophication of receiving waters through effluent discharge of all WWTP was demonstrated based on results of algae growth tests and reproduction of water flea. The textile companies in Flanders were also evaluated for acute toxicity in 2002. Except for one company. waste waters were not (or not efficiently) treated but were discharged to municipal waste water treatment plants. The latter might explain acute toxicity of more than 10 toxic units in effluents end-of-pipe. in each of 4 companies (figure).

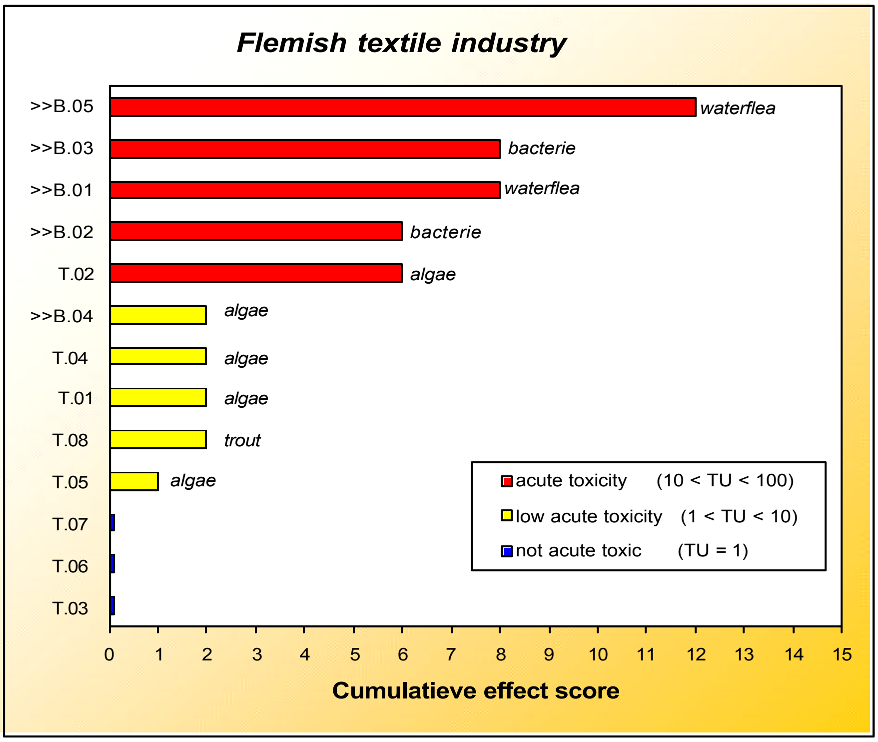


Figure: Acute toxicity (coloured bars in toxic units) and most sensitive organisms for textile companies in Flanders. B- companies are those involved in the TOWEFO project compared to T-companies which directly discharge to rivers after waste water treatment.

In addition. biological screening methods were applied for the measurement of estrogenic activity caused by contaminants present in textile effluents and released into the environment. These biological screening methods do allow to estimate the impact of chemicals on reproductive ability of natural fish populations in rivers. Two validated in vitro estrogen-receptor-based assays. the MVLN assay (human breast cancer cell line) and the YES-assay (yeast cells) were applied to extracts of environmental samples to detect the estrogenicity. The effluents of textile industry do interfere with the detection system due to the complex matrix. resulting from the very high organic content. the background colour and presence of toxic compounds. A sequential extraction procedure has been developed and applied. Sample extracts derived from the SPE methods applied by IES were also. for comparison tested in these in vitro bioassays Measurements on effluents and river waters in Italy do show the presence of estrogenic activity. which was of the same order of magnitude during both monitoring campaigns. These data were in agreement with chemical-analytical data which demonstrated the presence of alkylphenolic compounds. being known for their estrogenic activity.

(IES)

SSPE-LC-MS analysis

For the polar to medium-polar compounds. sample clean-up and group separation are performed with a newly developed sequential SPE procedure using automated SPE with C18 and polymeric sorbent materials. The objective of this method is to analyse as many as possible compounds. The compounds are divided by this procedure in three different polarity classes. More then 90 compounds of environmental interest - comprising the most important chemical and substance classes: phenols. carboxylic acids. aromatic sulfonates. aromatic amines. pharmaceuticals. surfactants. dyes. pesticides. endocrine disrupters - have been chosen for the experiments. The extraction recovery values were determined. they were for most of the compounds in the range of 50-100 %. Analyses are performed by negative and positive electrospray ionisation (ESI) LC-MS using a single quadrupole system.
Moreover. normal SPE of water samples was thoroughly studied for the extraction of dyes. pesticides. phenols. aromatic sulfonates. aromatic amines. and the endocrine disrupting alkylphenolic compounds nonylphenol (NP). octylphenol (OP). bisphenol A (BPA). and nonylphenoxy-acetic acid (NPE1C). C18 adsorbs most of the compounds at neutral pH. however very polar substances are only adsorbed by polymeric sorbents. The importance of the choice of the right elution solvent was pointed out. Ethylacetate was the best suited organic solvent for the elution of nonpolar compounds like alkylphenols (APs). In contrast. methanol and acetone are well suited for the elution of polar compounds.

Headspace GC-MS analysis of volatile contaminants

A headspace (HS) GC-MS analysis method for the water analysis of 60 volatile organic contaminants (VOCs) was developed and validated. The analysis was performed in the scan- (screening analysis) and SIM-mode (target analysis).

Water monitoring sampling campaigns

Effluents from municipal and industrial wastewater treatment plants (WWTPs) treating the textile industry discharges. and the corresponding receiving waters (rivers and lakes) were analysed with the developed methods. and the good performance has been proven.

Generally. for the assessment of the environmental impact. the treated effluents of the textile industries or the WWTPs treating the appropriate effluents were analysed. and not the untreated or internal waste water fluxes.
The following Table shows the sampling campaigns performed up to now.

Water monitoring sampling campaigns.

No.	Date	Location
1	July 19, 2001	At a textile WWTP in Fino Mornasco, N-Italy.
2	October 23, 2001	At different rivers (Seveso, Olano, Lura, Guisa, Pudiga) north-west and south of Milan, N-Italy.
3	February 12, 2002	Along the River Seveso which runs in the direction north to south from the area of Como to Milan, N-Italy.
4	June 12, 2002	At three textile WWTPs in the area south of Como, Fino Mornasco, N-Italy (together with VITO).
5	July 16, 2002	At the Lake Maggiore, Ispra, N-Italy (after rainfalls).
6	December 16, 2002	In the area east of Milan at the River Lambro.

Urban and industrial pollution was observed in rivers and streams in the areas of Como and Milan. N-Italy. Generally. higher organic contaminant concentrations were found in rivers compared to the effluents of WWTPs.
The Lariana Depur WWTP “Alto Seveso” in Fino Mornasco (Italy) showed good treatment performance. In the effluents of the older WWTPs Livescia and Bulgarograsso slightly higher organic pollutant concentrations were detected.
In June 2002 a big sampling campaign was conducted together with Vito (Belgium) and Lariana Depur (Italy) at three textile industry WWTPs in the area south of Como. In summary. the following pollutant types were identified in the water samples: phenols (nitrophenols. bisphenol A. NP). alkylphenolethoxylate (APEO) surfactants and their metabolites with endocrine disrupting potential (NPE1C. NPE1O. NPE2O. OPE2O. etc.). different aromatic sulfonates. LAS surfactants. dyes (colorants). pesticides. and pharmaceuticals.
Special attention was attached to the detection of endocrine disrupting compounds (EDCs): smaller APEOs. NP. OP. BPA. and carboxylated APEO metabolites (alkylphenolethoxycarboxylates. APECs).

NP and NPE1C were found in all water samples spanning a concentration range of 0.46 ?g /l to 12.5 ?g /l for NP. and 0.58 ?g /l to 14.8 ?g /l for NPE1C. NPECs are relatively water soluble. so that their concentrations in river water are typically higher than that of the short-chain ethoxylated NPEO metabolites or NP. which have lower water solubilities. However. especially high concentrations of NP were found in the Rivers Livescia (5.3 ?g /l) and Lura (12.5 ?g /l. WWTP Bulgarograsso). NP was found in the effluents of all WWTPs (0.54 – 0.88 ?g /l). Besides NPE1C. also NPE2C. and NPE3C were found in all water samples. also the effluents of the WWTPs. Dicarboxylated NPEO metabolites were found in all investigated rivers. but not in the effluents of the plants.
The chemical. physical and toxicological properties of APEOs are governed by the ethoxy chain length. For example. the smaller APEOs (APE1-3O) are more lipophilic and have a higher toxicological and endocrine disrupting potential. Thus. it is important to determine the single APEO oligomers for a correct risk assessment. In the river waters NPE1O – NPE15O and OPE2O – OPE7O were found. However. in the effluents of the WWTPs NPEOs with maximal 4 ethoxy units and no OPEOs were detected. This indicates good APEO removal or degradation in the WWTPs. However. the more toxic smaller APE1-3O were formed or not totally removed during the water treatment process.
Linear alkylbenzene sulfonates (LAS) are commonly used domestic surfactants; C10 – C13 LAS were found in all water samples. LAS are usually well removed in WWTPs by adsorption to the sludge as well as biodegradation. Only small quantities were found for these compounds in the effluents of the plants (0.8 – 2.3 ?g/l). However. surprisingly high concentrations were detected in the Rivers Seveso. Lura. and Livescia (22.8 – 171.8 ?g/l). and even higher concentrations in the rivers of the sampling campaign 6 at the River Lambro (December 16. 2002).
Four dye compounds (colorants) were detected in the water samples: disperse blue 14. disperse red 1 (not in the effluents). acid red 1. and sulforhodamine B. The dye occurring most frequently and in the highest concentrations was sulforhodamine B. The following Table shows the dyes which were found in the effluents of the WWTPs (concentrations in [?g/l]).

Dyes in the effluents of the WWTPs; concentrations in [?g/l].

Compound	Livescia	Bulgarograsso	Seveso
Disperse Blue 14	2.34	0.021	n.d.
Acid Red 1	1.19	n.d.	n.d.
Sulforhodamine B	0.71	0.60	1.1

Aromatic sulfonates were mostly found in the rivers. their concentrations in the WWTP effluents were low. Pharmaceuticals such as benzafibrate. gemfibrozil. diclofenac. ibuprofen. and carbamazepine were regularly detected in Italian rivers in the low ng/l concentration range.

Analysis of unpolar compounds by GC-MS (IES-JRC)

The water samples of the sampling campaigns 4 and 6 were analysed for VOCs by HS-GC-MS. and for unpolar semivolatile contaminants (campaign 4) by C18-SPE-GC-MS. In the effluents of the WWTPs of sampling campaign 4 the VOCs toluene. tetrachloroethylene. and 2-ethylhexanal were detected in the low ?g/l concentration range. In the rivers of sampling campaign 6 more VOCs were identified: cis-1.2-

dichloroethylene. tert-butylmethylether (MTBE). chloroform. trichloroethylene. 1.2-dichloropropane. toluene. tetrachloroethylene. chlorobenzene. 1.2.4-trimethyl-benzene. p-isopropyltoluene. and naphthalene. In the water samples of sampling campaign 4 no unpolar semivolatile compounds were found.

3.3. Socio-economic relevance and policy implication

(**VITO**) A methodology for ecotoxicological characterisation has been developed which might be implemented by government as an effect-based instrument to assess waste water quality and quality of receiving waters. Moreover in vitro screening assays have shown to be a suitable instrument for detection of hazardous compounds with endocrine disrupting activity.
(**IES**) The developed multi-component chemical analysis method for polar organic water pollutants using sequential solid-phase extraction (SSPE) followed by LC-ESI-MS has been accepted for publication in the Journal of Environmental Monitoring. It is a suitable instrument for water monitoring sampling programmes to analyse as many compounds and substance classes as possible. This should help harmonising efforts currently undertaken in the EU in order to provide internationally agreed methods which allow the comparison of analytical results.

3.4. Discussion and conclusion

(**VITO**) Method selection and validation for both acute and chronic ecotoxicity. and for detection of estrogenic compounds was finished and applied for Flemish and Italian textile industry. A successful characterisation of environmental samples in Italy has been performed through 2 monitoring campaigns in 2002. It is demonstrated that discharges of Italian waste water plants had minor environmental impact with regard to the release of toxic substances. On the other hand some evidence was given for eutrophication and the release of substances with estrogenic activity.

(**IES**) The developed SSPE-LC-MS multi-component analysis method was successfully applied to the chemical analysis of the treated effluents of the textile industries (WWTPs) and the corresponding receiving waters. Urban and industrial pollution was observed in rivers and streams in the area of North Italy. Generally. higher organic contaminant concentrations were found in rivers compared to the effluents of WWTPs. Especially the modern Lariana Depur WWTP “Alto Seveso” with advanced ozone treatment in Fino Mornasco (Italy) showed good treatment performance. The results thus show the importance of efficient waste water treatment.

3.5. Plan and objectives for the next period

Pollutant-specific monitoring and physical-chemical characterisation of effluents from textile industries. waste water treatment plants. and the corresponding receiving waters will be organised simultaneously with the eco-toxicological effect-based characterisations by IES-JRC and VITO to assess water quality.

Workpackage 08 – Application of LCA to support optimisation processes

3.1. Objectives

WP08.02.1 (**ENEA**) The aim of this job card is to apply LCA methodology to ten selected textile products for developing a database of processes and chemicals and for analysing a "reference scenario" against which to compare the "improved scenario" in which the company specific water cycle will be optimised.

WP08.04.1 (**ENEA**) The aim of this job card is to develop a database on selected textile wet manufacturing processes and on wastewater treatment processes suitable for being used in the companies for recycling process effluents. Available Life cycle inventories of process chemicals will be included. The database will be coupled to the software to be developed in WP9.

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

WP08.02.1 (**ENEA**)

LCA methodology has been applied to three Process identification and Data Collection Sheets (PIDACS reports) issued by Lariana (companies I06. I02. I09). A set of methods and assumptions to be applied for PIDACS analysis has been defined. They include criteria to assess specific methane consumption (m3 methane/°C*m3 heated water) starting from the annual energy balance of the firm as well as electricity consumption and waste water characterization. These assumption. reported hereafter. will be applied consistently to all Italian PIDACS. because of the good homogeneity in data quality among the selected companies.

Main assumptions within the company boundary:

? <u>Steam production</u>

The annual company methane consumption as well as the annual steam consumption are metered and reported on the PIDACS. The 95% of the methane is used for industrial processes described in the PIDACS. the remaining part is used for heating the factory shed (estimation of the company technicians). To evaluate the specific methane consumption for processes. the specific consumption of steam has been calculated (m^3 of steam/m^3 of heated water* °C). The calculation took in account the volume of water to be heated up and the bath temperature and was based on the metered annual steam consumption. To calculate the emissions of methane burning and the natural resources consumption. the TEAM 3.0 model developed by Ecobilan was used. adjusting the water inlet and the steam outlet temperatures on the actual company data and calibrating the steam generator efficiency to meet 95% of the metered company methane consumption.

? <u>Process specific wastewater effluent</u>

Due to data unavailability the wastewater effluent from the company specific processes has been characterized only with measured COD and TSS concentrations.

? <u>Electricity consumption</u>

The electricity consumption of specific processes has been calculated as absorbed power * run time. The electricity consumption for lighting and general services has been neglected

? Water pre-treatment

The potential impact of the production of the ionic exchange resins. as well as the water consumption for resins bed regeneration have been neglected. due to the very small quantities used. Only the potential impact of the salt production (used for resin regeneration) has been included in the study.

? Solid waste

The annual solid waste production of the company is specified in the PIDACS. The waste has been classified in three main fluxes: recycled waste (divided in packaging. iron and steel. plastic waste). special waste and special dangerous waste. The total waste quantity has been allocated to the analysed product systems on a mass basis. The solid waste treatment has not been included in the systems. because of lack of specific data and the difficulty to identify reference treatment scenarios.

? Airborne emissions.

PIDACS reports specify for each emission source. typically a specific machinery. the chimney flow rate and the contaminants concentration. For LCA purposes the contaminants emissions in the environment have been calculated as: emission source flow rate*machinery run time* contaminant concentration. If the concentration has been indicated as < limit value. the specific limit value has been assumed.

Main assumptions for production of chemicals:

The inventories available in TEAM 3.0 database have been included in the study; the following databases were checked in addition to the TEAM 3.0 one:

? SimaPro;

? KCL Eco;

? IVAM;

? Boustead model;

? Specific industry data.**Main assumptions for Lariana WWTP:**

We assumed that the potential environmental impacts of WWTP processes are mainly due to the production of the energy needed in the plant and to the emission of the treated effluent into the environment; the impact of chemicals production has been neglected. These hypotheses were based on results of previous LCA studies of ENEA.

The potential environmental impacts for treating the waste water of the studied product systems have been considered proportional to effluent mass.

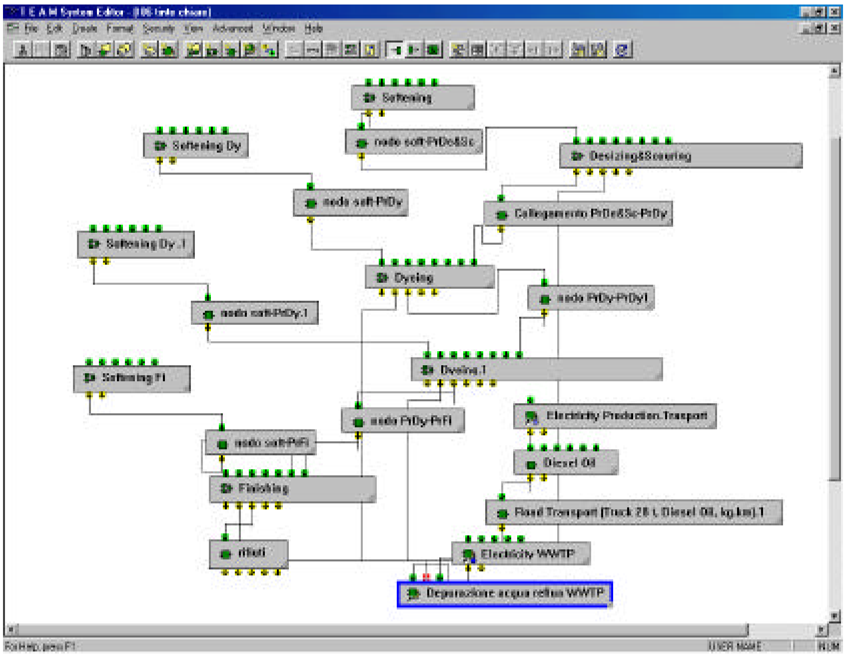
Direct CO2 emissions in the environment from Lariana WWTP processes have not been considered (according to IPPC guidelines).

Because it was not possible to have information on the specific contaminants of the product systems water effluents. the evaluation of the potential impact connected to the release to the environment of the treated water effluent has been calculated considering the effluent mass of the specific product system and the contaminant concentration of the treated WWTP effluent.

Due to Belgian industries specificity it will be verified if it is possible maintain the same assumption for such companies. The analysis and review of the draft Belgian PIDACS report has been started.

The TEAM model of I06. I02. I09 companies has been implemented.

The following figure presents a snapshot of I06 TEAM model



I06 TEAM model

LCA study for selected products of companies I06. I02 has been completed. The reporting of the already performed studies is in course of completion. As an example of the adopted methodology. some findings of the analysis of I06 company are reported here after.
LCA case study on I06 company.
I06 is an Italian company located in the Como area. Its annual production is over 516000 tons of fabric mainly made of cotton/polyester (32%). polyester (30%). flax/polyester (16%). silk/polyester (16%).
In this study three flax/polyester fabric product alternatives were analysed:

? Stuck Flax-Pes Fabric dyed with light colours (System A);
? Stuck Flax-Pes Fabric dyed with dark colours(System B);
? Not Stuck Flax-Pes Fabric dyed with light colours(System C).

The table below shows the textile wet processes of the three product systems; the processes numbers refers to I06 PIDACS classification.

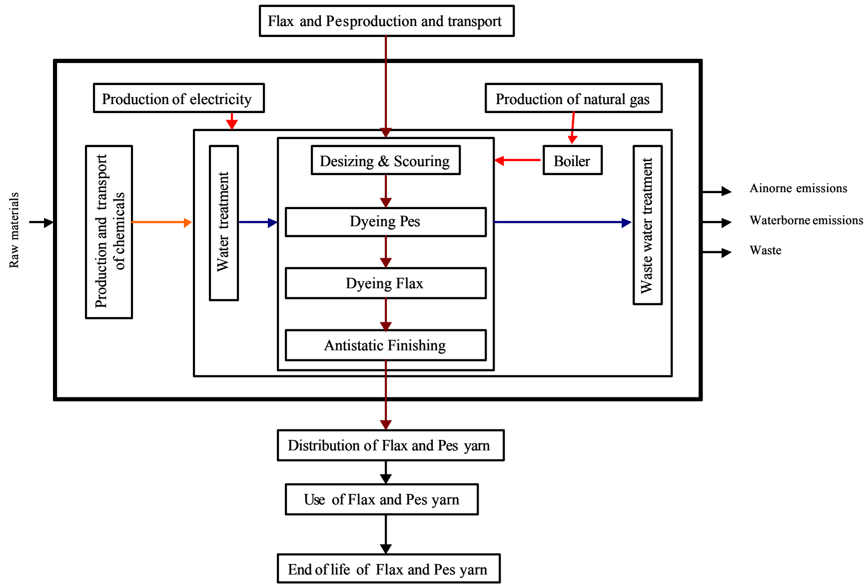
Textile wet processes of the three product systems

Product systems	System A	System B	System C
Desizing&scouring	F.3.2	F.3.2	F.1.4
Dyeing PES	G.1.1	G.3.1	G.1.1
Dyeing Flax	G.7.2.	G.8.1	G.7.2
Antistatic finishing	H4	H4	H4

Light colours dying process compared to dark colour dying uses different type of chemicals and different machinery. The processing of stuck Flax-Pes fabric has a different pre-treatment compared to not-stuck one. because it is necessary to clean the yarn from the glue used in yarn processing: as a consequence. higher COD and TSS are expected in the effluent wastewater.
The system boundaries of the three studied product alternatives are shown in Figure 2; the processes included in the analysis are included in the system bold line. The chosen functional unit is the pre-treatment.

dying and finishing of a weight unit of flax/polyester fabric. processed to reach the required commercial characteristics. respecting the worker safety and the emissions limits according to the law in air. water and soil.

The reference flow is 100 kg of Flax-Pes fabric



System boundaries of I06 product systems

The impact assessment categories used for the analysis of the three product systems are indicated in the following table.

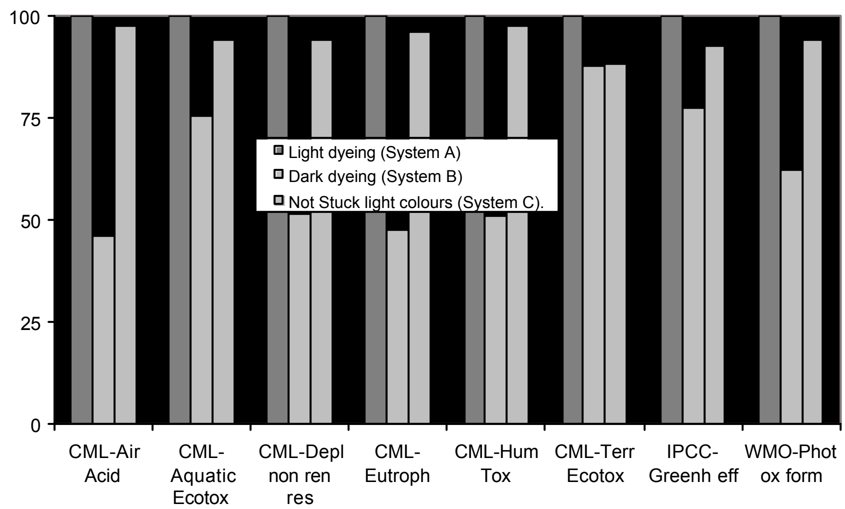
Impact assessment categories

CML 92-Air Acidification	g eq. H+
CML 92-Aquatic Eco-toxicity	1e3m3
CML 92-Depletion of non renewable resources	frac. of reserve
CML 92-Eutrophication	g eq. PO4
CML 92-Human Toxicity	g
CML 92-Terrestrial Eco-toxicity	t
IPCC-Greenhouse effect (direct. 100 years)	g eq. CO2
WMO-Photochemical oxidant formation (high)	g eq. ethylene
Reminders-Primary energy consumption	MJ

For screening the potential impact of chemicals on ecotoxicity. because of project limits (detailed analyses of process wastewaters were not available) and methodological limits (characterization factors are available only for a small part of the manufactured chemicals). the EDIP method proposed by Hauschild has been used.

Figure 3 presents the potential environmental impact categories for systems A. B. and C. The results have been normalized to system A. The systems are characterized by the potential environmental impact associated with steam production (due to the impact of extracting and burning methane) and electric energy production (the production of the Italian energy mix is mainly due to fossil fuels).

Table 3 highlights the relative contribution to selected environmental impact categories of chemicals production. steam and electricity production. the transport of chemicals and sludges of Lariana WWTP and the Lariana centralized WWTP plant direct impacts. Chemicals production impact plays a significant role. due to the high quantities of sodium sulphate. acetic acid and sodium carbonate needed in dyeing the Flax-Pes fabric. For most impact categories. except eutrophication. fossil fuel consumption for steam and electricity production play a dominant role. The relative impact of transport phases are negligible. as well as the contribution of the centralized WWTP (Lariana plant data) except to eutrophication The high contribution of WWTP to eutrophication category comes from the potential environmental impact of the I06 treated effluent when discharged to environment.

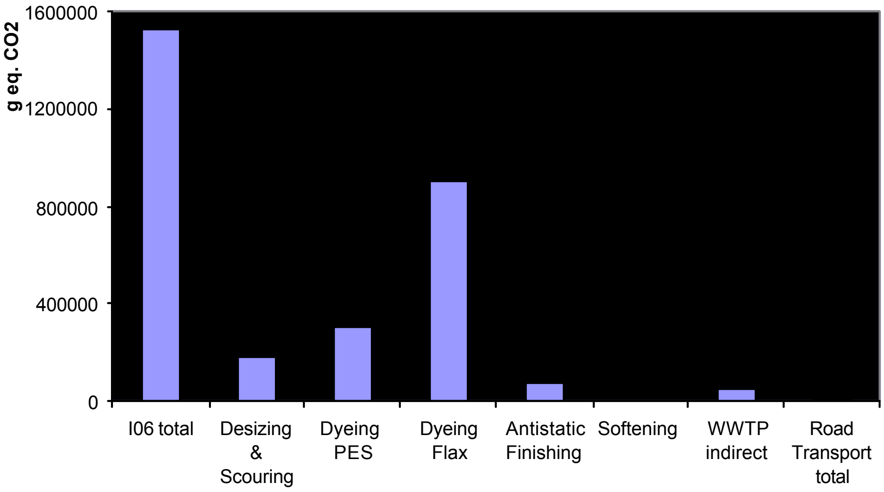


Environmental impact categories for systems A. B. C

Relative contribution to System A environmental impact categories

Impact categories	Units	Chemicals production	Steam production	electricity production	Trasport	WWTP
CML-Air Acidification	g eq. H+	19%	6%	62%	0%	0%
CML-Aquatic Eco-toxicity	1e3m3	19%	28%	52%	0%	0%
CML-Depletion of non renewable resources	frac. of reserve	19%	59%	22%	0%	0%
CML-Eutrophication	g eq. PO4	11%	8%	22%	1%	59%
CML-Human Toxicity	g	33%	5%	65%	0%	0%
CML-Terrestrial Eco-toxicity	t	4%	84%	13%	0%	0%
IPCC-Greenhouse effect (direct, 100 years)	g eq. CO2	15%	45%	41%	0%	0%
WMO-Photochemical oxidant formation (high)	g eq. ethylene	26%	21%	52%	0%	0%

Process specific contribution within systems A.B and C has been assessed for each environmental impact category mentioned in the above *Impact assessment categories* Table. The figure 4 shows the potential contribution to greenhouse effect for System A processes. The reactive dyeing of flax in overflow is the major contributor to the category. In fact. due to the very high liquor ratio. large quantities of steam and chemicals are needed. CO_2 emissions derived from fossil fuels combustion and CH_4 emissions derived from methane extraction processes are the main contributors to the total of the category



System A contribution to Greenhouse effect

The LCA results will be used to evaluate the detail level for which develop the textile processes database Preliminary results showed that the manufacturing equipments characteristics can make the difference: we need to take it in account when building the textile processes database.

The setting up of a server to be used for testing LCA software developed by Ecobilan has been started.

WP08.04.1 (**ENEA**)

The review of existing public available data on textile process chemicals has been completed. Several LCA commercial databases (TEAM. SimaPro. KCL Eco. IVAM. Boustead model) were investigated in order to find relevant information. The review highlighted the lack of Life cycle inventories data for chemicals used specifically in textile production processes such as dyes and auxiliaries. Data on chemicals used for textile pre treatments (such as sodium hydrosulphite. sodium carbonate. acetic acid. …) and commonly used also in other industrial processes were found in several databases.

The data investigation has been extended to the main textile chemicals manufacturers. While only a couple of Life cycle inventories has been gathered in this way. we got the chemicals manufacturer cooperation in providing the risk phrases of their products for water toxicity characterization.

The review of existing LCA projects performed on the municipal water cycle within ENEA. in order to find out chemicals or processes inventory data. has been completed. In the attachment Example DB-I09Dyeing.xls a draft example of the information to be included for each database process is given.

3.3. Socio-economic relevance and policy implication

No considerations or remarks about.

3.4. Discussion and conclusion

WP08.02.1 (**ENEA**) The LCA results confirmed the importance of equipment characteristics (such as the liquor ratio. absorbed electric power) for the most part of the selected environmental impact categories.

WP08.04.1 (**ENEA**) The work completed till now highlighted a lack of Life cycle inventories data on textile chemical production in LCA commercial databases as well as in public available manufacturers data or in published scientific literature. Inventories of commonly used textile pre treatments chemicals are available in the main commercial LCA databases. Sensitivity analysis will be done for each LCA case study to evaluate the impact of this data lack. Inventories of textiles processes are documented in some research projects but. being relative to specific companies. can suffer for geographic or technological limitations.

3.5. Plan and objectives for the next period

WP08.02.1 (**ENEA**) The activities will continue with the analysis of the other PIDACS and the issuing of the final reports.

WP08.04.1 (**ENEA**) Establishment of a suitable and usable database format. Selection of the relevant data from the performed LCA studies and issuing of the final report.

Workpackage 09 – Development of an LCA software tool

3.1. Objectives

WP09.03.7 (**ECOBILAN**) The objective of WP09 is to design. develop and test (through a set of case studies) a software facility informing and supporting decision-making on process and waste water recycling in textile industries.

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

WP09.03.7 (**ECOBILAN**) The software facility (hereafter "the tool") is based upon the Life Cycle Assessment (LCA) methodology (as referred to by the ISO14040 series of standards) and is designed for use by non environmental experts. Rather. the tool will be geared towards textile companies' process engineers and decision-makers.

The main achievement of WP09 is to provide technical and non-technical people alike in the European textile industry with a tool enabling environmental impact assessments of process and waste water closed-loop recycling options. with a view to reducing water consumption as well as reducing the environmental burden associated with eater treatment.

A "Users guide" and "Software Architecture" are provided together with the tool. in order to describe its content. Those documents are provided in appendix. A full LCA database is provides with the tool. The following lines will focus on:

? the tool architecture.

? the practical achievements and users guide

? the LCA database.

Tool Architecture

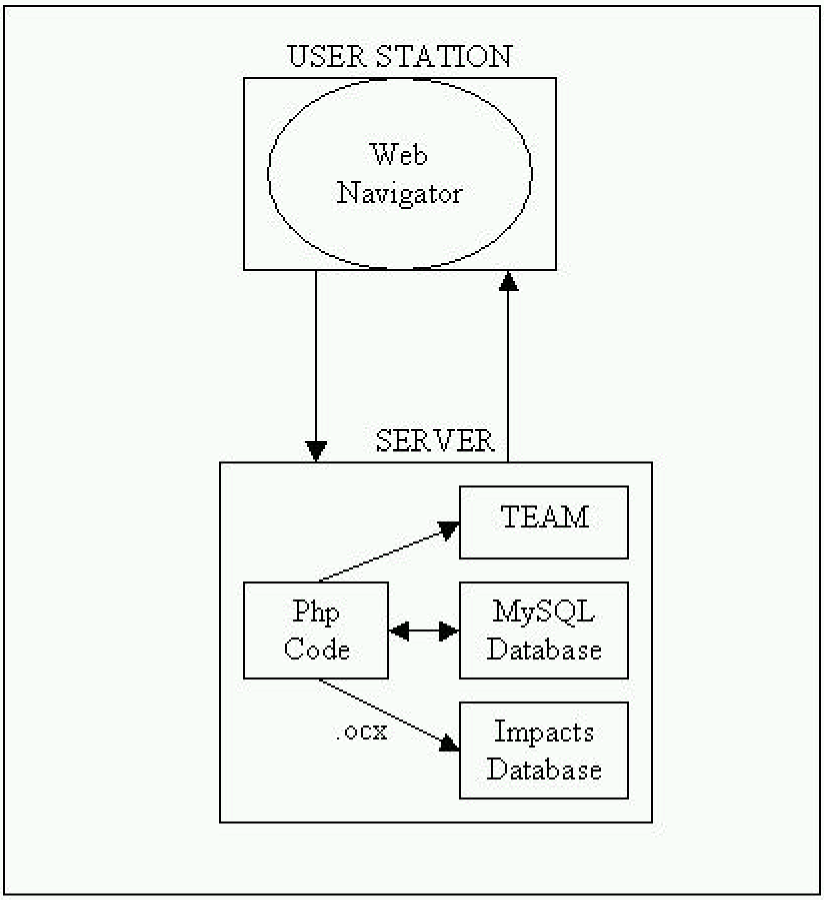
The tool is a Web based application: the user only needs a web browser to access the tool. all the software is located on a server so that many users can access it and use it at the same time. using the same database.

The calculations made on the server are performed by the TEAM software. Ecobilan's LCA software. The TEAM software has to be installed and licensed on the server before Towef0. according to the corresponding installation procedure.

The code of Towef0 is written in 'php'. an up-to-date web oriented language. The 'MySQL' database and 'Apache' web server have been chosen because they are provided with 'php' in 'Easyphp'. a simple. powerful and open source package available for web based applications.

On the server. the Towef0 software directly uses the environmental impacts database provided with TEAM. thanks to an ocx called ImpactDll.ocx. This interface allows Towef0 to obtain the list of available impacts and the list of their contributors. The impacts database is an Access database.

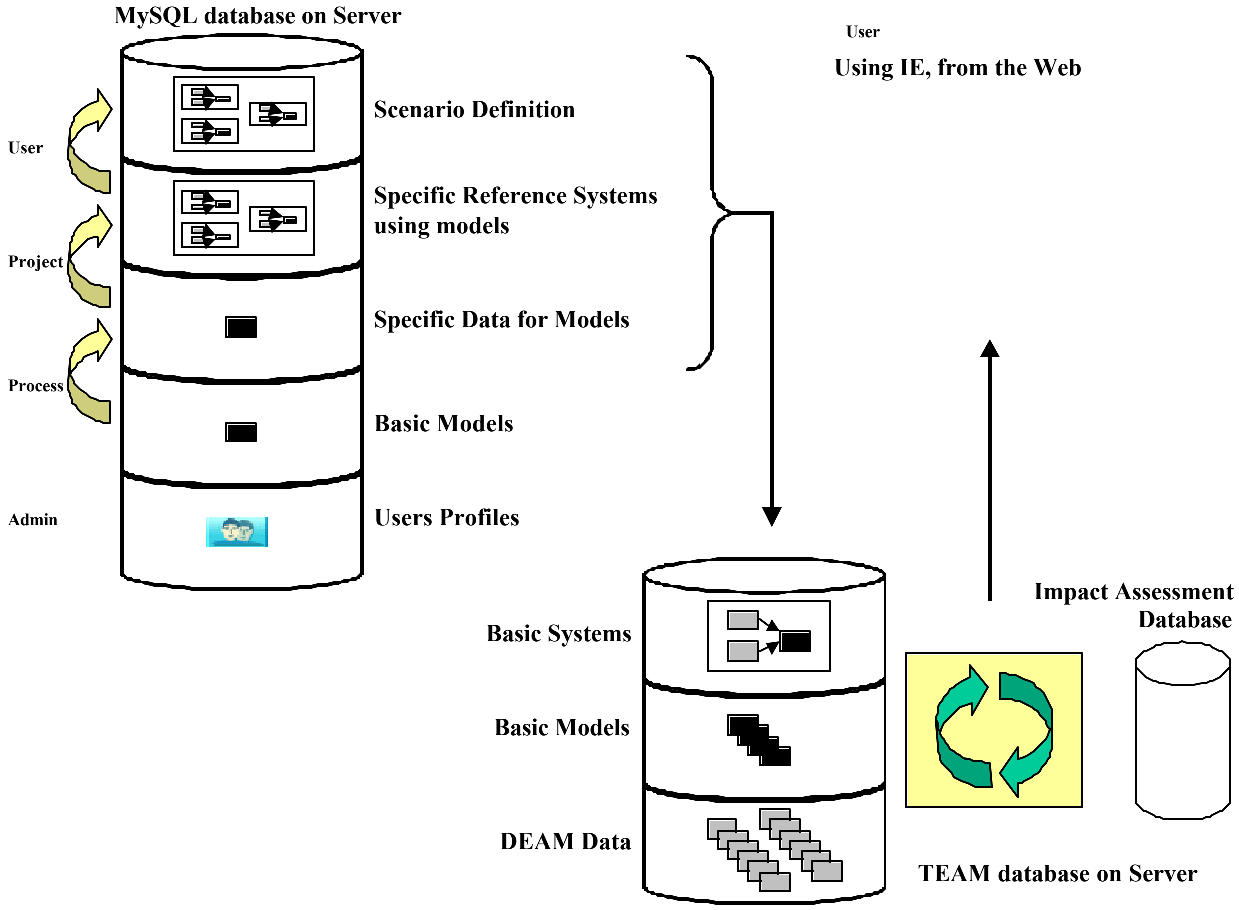
The TEAM calculation engine is launched by a daemon called 'calc.exe'. This daemon checks permanently in the MySQL database if a calculation is ready to be launched. and then provides TEAM with the relevant information. As the TEAM engine cannot be launched twice at the same time. this system allows multiple users to ask for as many simulations as they need. and the calculations will be performed in the chronological order. The TEAM engine produces inventories text files that will be imported by Towef0 in order to display the calculation results.
The Tool Architecture can be summarysed as follows:



Practical Achievement and Users Guide

The tool has been developed. and is now installed on a web server at ENEA. at the following address: http://192.107.65.184.

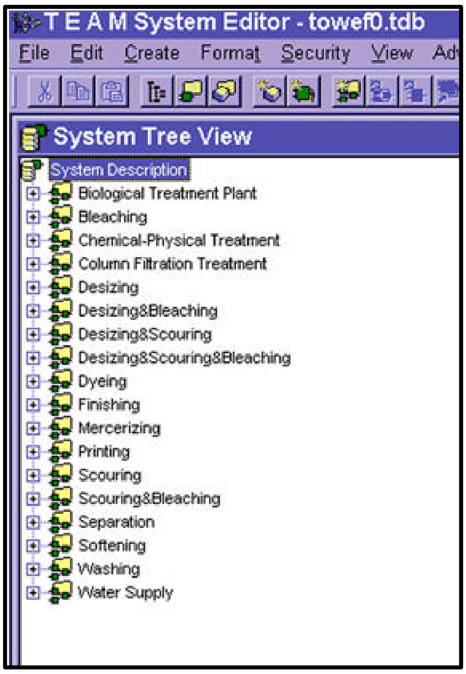
The practical achievement of the LCA tool is detailed as follows:



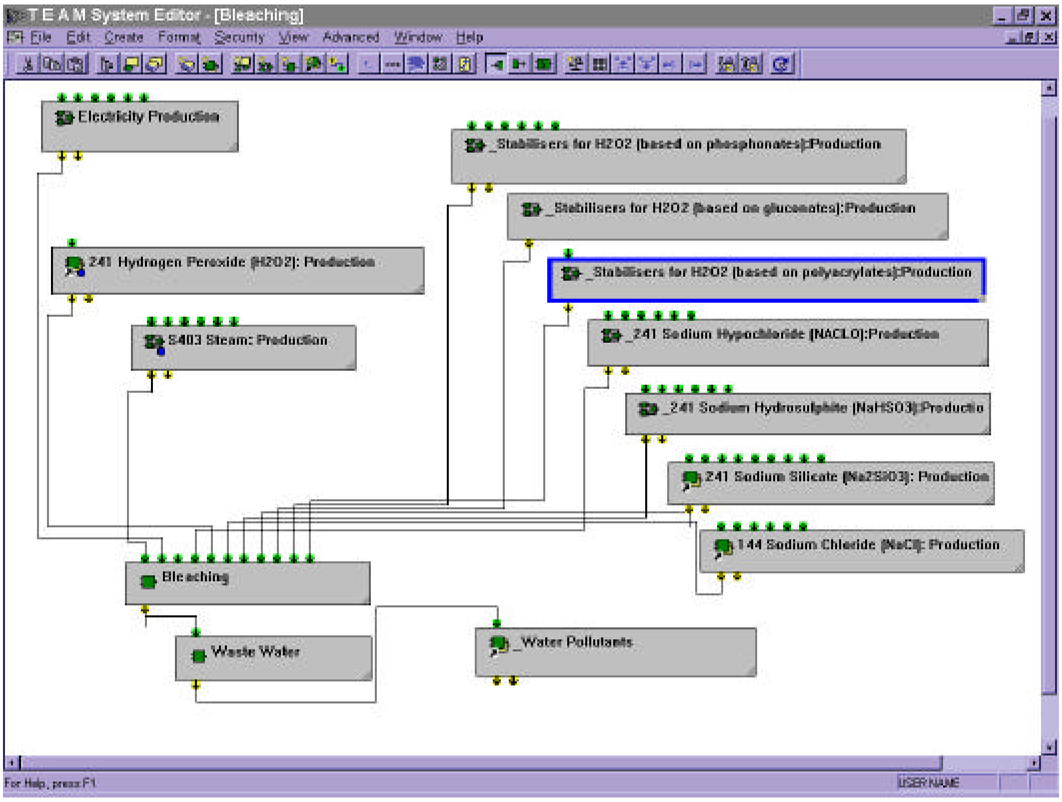
This achievement is the practical application of the tool architecture to the project. The Users Guide details how to use the tool. from different access levels. It is distributed to the members of the project in order they start to practically work with the tool.

The LCA Database

The overview of the content of the database is the following:



Each line in the database covers one textile process for which users of the tool will provide data using the Web interface. Each process is a subsystem in TEAM™. It contains process data plus the upstream (materials and chemicals production. energy supply…) and downstream (water treatment) datasheets covering the environmental impacts associated with the process. Parameters allow handling the processes from the Web tool. The Bleaching subprocess is described as follows:



All subprocesses have been described as this one. which allows flexibility and easy access by LCA practitioners.

3.3 Socio-economic relevance and policy implication

WP09.03.7 (**ECOBILAN**) The socio-economic relevance of WP09 is clearly understood if one considers the economic cost of remedying pollution in the various recipient bodies as well as the negative impacts on living conditions due to a poor environmental record.

WP 09 is aimed at helping textile industries keep the environmental impacts associated with their business under control and possibly reducing them. This is even more important since a great part of the pollution generated by textiles is released into water bodies. which locals depend upon for a whole range of other uses.

Regulators should benefit from the facilities and the approach provided by WP09 in the way of progressing environmental friendly policies for the textile sector.

3.4. Discussion and conclusion

WP09.03.7 (**ECOBILAN**) The development of the tool is keeping up with the scheduled calendar: we are now entering in the final testing process through specific case studies. Debugging has been done.

3.5. Plan and objectives for the next period

WP09.03.7 (**ECOBILAN**) By the end of December 2003. through WP8. data will be entered in the tool. featuring all the main facilities. and practical tests done. Implementation is starting during April 2003.

Workpackage 10 – Regulatory Policy

3.1. Objectives

WP10.01.1 (**ENEA**) Collection of information on European Economic regulation experiences for industrial use of water resources. The main objective of this activity is to collect information about industrial water tariff regulation in European countries. The report include a brief overview of industrial water tariff practices in some European countries. and a more detailed country surveys.

3.2. Methodology and scientific achievements related to Work Packages including contribution from partners

WP10.01.1 (**ENEA**) The Tariff structures for water services from the public system has been analysed for the most important EU countries (AUSTRIA. BELGIUM. DENMARK. FINLAND. FRANCE. ITALY. PORTUGAL. SPAIN. SWEDEN. UK) according to the following characteristics:

I) administrative responsibility

II) Types of industrial water uses

III) Tariff structure for public supply system

In the last point. different features have been considered for:

? water services (tariff structure. full cost recovery. non discrimination. different tariff structure. subsidies);

? sewerage services (as for water services + separate sewerage charge and special tariffs);

? pumping and discharge costs.

3.3. Socio-economic relevance and policy implication

An effective regulatory policy will contribute to the improvement of competitiveness of textile finishing industries and this might contribute to the attenuation of the negative effects of the globalisation in Europe.

3.4. Discussion and conclusion

The economic regulator Authority is usually in charge of setting prices. and may have other responsibilities. such as establishing service performance standards in order to guarantee customers' protection. the main concern here is with price regulation. and with the impact of economic regulation on industrial prices.

Water price regulation is generally exercised at the national level. or at the next level down in decentralised government structures. in most cases. water is treated no differently from other consumer goods. with water price regulation being carried out by the Ministry of Finance. or by the government body in charge of price regulation in general.

In decentralised systems. price regulation is often carried out by the municipalities themselves. although this can create a number of problems. This is particularly apparent in France and in Italy. where institutions have recently been created to try to improve price information and control at the central level.

Environmental regulators are usually responsible for establishing and monitoring surface and ground water quality objectives. as well as for regulating polluting discharges to the water bodies. therefore. in most European countries. where direct pumping by industrial consumers is predominant. environmental regulators are likely to have the greatest impact on water costs for industrial users through the licensing and pricing of direct pumping and direct discharges (where charges are made for pumping and discharges). environmental regulators are sometimes also responsible for water resource management. while in other cases. this responsibility may be held by another institution instead (often a separate ministry within the government).

Environmental regulation generally takes place at the government level within the Ministry of Environment. or in some cases. at the decentralised level.

An increasing number of countries are setting up independent environmental regulatory agencies. which look at different pollution media (on the basis of integrated pollution control policies). These Agencies put pressure on industries to reduce the overall environmental impact of their activities.

It is also important to note the growing role of EU regulation. with several directives having had a large impact on industrial water prices through the setting of tough environmental standards — for example. the urban wastewater treatment directive (91/271/EEC).

In terms of the structure of prices for public water services. there is a clear trend in OECD countries away from fixed charges and towards volumetric charging ; in other word. the more you use. the more you pay. Even where fixed charges still exist. the policy of allowing large free allowances is decline.

To encourage conservation. the trend in volumetric charging is also moved away from decreasing block tariffs and towards increasing block ones.

The pricing systems for wastewater treatment are rather more complicated than they are for water supply. This is partly because responsibility for sewerage. sewage treatment and drainage is typically held by different bodies. each with their own principles and practices. Another complicating factor is that use of water directly from natural sources in the environment represents roughly 75% of total water consumption by industrial sector (on average in OECD countries).

Nevertheless. the basic charges for wastewater services are sometimes linked directly to volumes of water delivered from the public water supply system. Where this is the case. the structure of wastewater charges tends to mirror that of water supply systems.

Overall. however. industrial water consumption levels are actually not a very good proxy for industrial sewerage and sewage disposal costs. a s discharges vary so much from industry to industry. hence. the trend in OECD countries towards separating industrial water use charges from wastewater charges.

In most countries. standard sewerage charges are supplemented by “special strength” charges designed to recover the costs of any extra capacity required to treat particular industrial effluents.

Some “key trends” have been extracted from the analysis of the European experiences

- increasing acceptance of the need for “full cost recovery” in the provision of water services. this is accompanied by significant reductions in both total subsidies and cross subsidies between different user groups. even where subsidies still exist. there is now more emphasis on the need to make these subsidies transparent.

- tendency for industrial water users that draw water from public system (representing 23% of the industrial freshwater used on average in OECD countries. with the rest being direct pumping) to be charged according to the same structure as household users. but with a more frequent use of volumetric pricing.
- common use of special tariff structure and/or rates for large industrial water users. occasionally. these special arrangements may cover water quality variables as well as quantity ones.
- increasing tendency for industrial water consumers to go "off-system" (i.e. to directly abstract water supplies or to recycle and treat their own waste waters before directly discharge them) as these options become more financially viable in the face of increasing charges for publicly supplied water service.

3.5. Plan and objectives for the next period

WP10.01.1 (ENEA) Completion of the Collection of information on European Economic regulation experiences for industrial use of water resources

WP10.02.1 (ENEA) Study of some prototypical tariff structures for industrial water use;

WP10.03.1 (ENEA) Economic and financial methodological instruments of present European regulation;

WP10.04.1 (ENEA) Benchmark analysis on sustainable tariff systems experimented in Europe for industrial water usage;

WP10.05.1 (ENEA) Simulation of different types of prototypal tariff systems in textile industry;

WP10.06.1 (ENEA) Workshop on regulatory policy for the water management in the industrial sector;

WP10.07.1 (ENEA) Final report on the practical prototypal regulatory policy for water management in textile finishing industry.

Workpackage 11 – Multicriteria integrated GEP for textile finishing industry

No activities planned in the period considered

Workpackage 12 - Project Management (part. 2)

No specific activities planned in the period considered

Workpackage 13 – Technological Implementation Plan

No specific activities planned in the period considered