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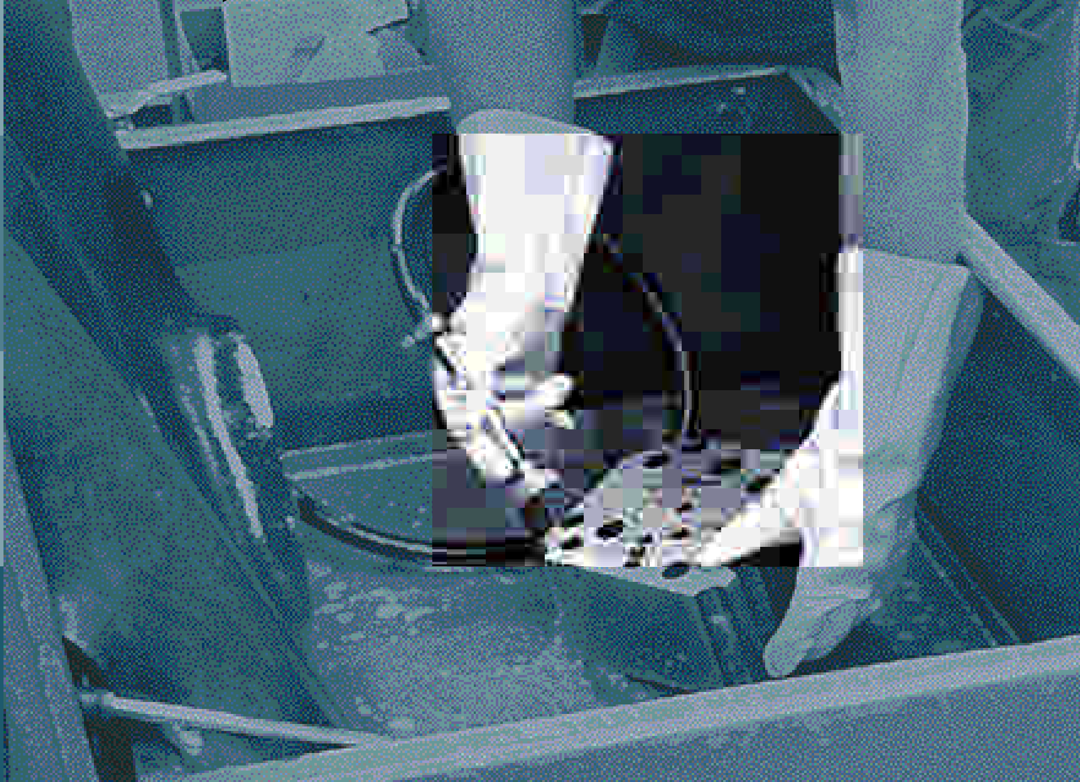
International Conference on

Metal Surface Cleaning Processes

– Optimisation and Assessment



Hamburg November 10, 2003

PROCEEDINGS

Contents

Programme

10:00
Lothar Lißner (Kooperationsstelle Hamburg)
Introduction to the aims of CLEANTOOL

10:10
Lecture 1: Need for a project and database like CLEANTOOL

Charles Darvin (US Environmental Protection Agency)
The Solvent Alternatives Guide for Metal Surface Cleaning (SAGE) of the US EPA

10:30
CLEANTOOL Consortium: Presentation of cleaning case studies in relation to the CLEANTOOL methodology and the cleaning situations in the specific countries

Klaus Kuhl (Kooperationsstelle Hamburg)
CLEANTOOL database

Prof. F. La Roca, Graciela Ferrer (Universitat de Valencia, Spain)
Hidden costs: a source for a win-win initiative

Hermann Thordarsson (IceTec, Iceland)
Cleaning in fish processing industry

Theodorus Chryssanthopoulos, Dr. Christos Maltezos (Public Power Corp., Greece)
Substitution, the Greek experience; cleaning of electric motors

Dr. Anne Randmer, Juhan Ruut (EMI-ECO, Estonia)
Estonian experience in metal cleaning

13:00
Lunch

14:00
Lecture 2: The cleaning market, cleaning technologies and agents in the EU.
User needs regarding the CLEANTOOL database

Reiner Grün (DGO, German Association for Electoplating and Surface Technology)
Main cleaning technologies in Germany

14:20
WS 1:
Evaluation of cleaning processes
Networking and databases in metal surface cleaning, user needs
Introduction: Klaus Kuhl (Kooperationsstelle Hamburg

14:20
WS 2:
Manual cleaning,
Lothar Lißner (Kooperationsstelle Hamburg)
BREFS with relevance to cleaning operations and other regulations
Introduction: Dr. Jutta Geldermann (Universität Karlsruhe)

16:10
Panel discussion:
New technologies, trends and ideologies in the metal surface cleaning

Dr. Carole LeBlanc (Toxics Use Reduction Institute, TURI, Massachusetts)
Introduction to new metal cleaning technologies and methods
Participants: Prof. Panagiotis Siskos, Reiner Grün, Prof. Brigitte Haase, André van Raalte

17:00
Final lecture:
Experiences with databases in enterprises

Charles Darvin EPA
Good practice and innovation databases as basis for information and communication between practitioners and researchers

17:30
Closure

Press release, 14.11.2003
Conclusions of the International Conference on Metal Surface Cleaning Processes, Optimisation and Assessment, Hamburg

November 10th the Cooperation Centre Hamburg organized in collaboration with its European partners an international conference on metal cleaning in Hamburg.
More than 50 cleaning specialists from the USA, the Netherlands, France, Norway, Spain, Greece, Estonia, Iceland and Germany came together to have an intense exchange of views around the introduced CLEANTOOL metal cleaning database.

Charles Darvin, Sr. Mechanical Engineer from the US American Environmental Protection Agency EPA, presented SAGE: an internet based selection system for alternative cleaning methods. In comparison to these procedure proposals, CLEANTOOL offers best-practice cleaning processes, which are actually applied in enterprises. These two instruments complement each other very well.

Members of the project consortium and the national advisory boards described the situation in their countries: Professor la Roca and Graciela Ferrer explained methods of cost analysis using practical examples from Spanish companies. Hermann Thordarson from the Technological Institute of Iceland presented the development of cleaning agents with minimum environmental impact. Dr. Christos Maltezos und Theodorus Chryssanthopoulos illustrated the substitution problems in that large Greek power company. Dr. Anne Randmer and Juhan Ruut highlighted the situation in Estonia and finally Reiner Grün from the Surface Technology Association briefed the participants about the German cleaning techniques.

Two different workshops were set up, in which the evaluation method, integrated in CLEANTOOL, was perfected and the EU initiated „Best Available Techniques Reference Documents“, presented by Dr. Jutta Geldermann, were discussed.

At the following panel discussion Dr. Carole LeBlanc from the Toxic Use Reduction Institute, University Lowell, Massachusetts gave an initial statement, describing the manifold difficulties enterprises encounter when trying to change procedures in metal cleaning. Thereafter Professor Panayotis Siskos, Reiner Grün, Professor Brigitte Haase and André van Raalte argued about their different approaches. Other conference participants also gave their views and presented interesting aspects.

In his final speech Charles Darvin looked backed on many years of experience with databases in enterprises and described using the example of SAGE how this instrument was adapted bit by bit to the requirements of the practitioners.

The atmosphere among participants was excellent, besides some improvement proposals, participants commended the conference. Many new contacts were established, which will also in European context further enhance metal cleaning.

Presentations and minutes can be viewed or downloaded soon under www.cleantool.org.

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Introduction

Lothar Lissner, Kooperationsstelle Hamburg, Germany

Dear participants of our Conference on Metal Surface Cleaning Processes - Optimisation and Assessment.

Welcome in Hamburg in the name of the Kooperationsstelle and all CLEANTOOL partners. Sorry that we invited you in this late time of the year, the last leaves are falling from the trees and darkness comes early. Today we have the opportunity to see all these things very well - due to the view from this room - but hopefully we will not realise it.

My hope is that the cleaning of metal surfaces is such a wide spread and interesting issue that we will forget anything else.

We have here a mixture of persons interested in the topic of cleaning of metal surfaces. From Washington and Boston in the West to Tallinn and Athens in the East. Thank you for taking this opportunity to discuss for one day the situation and the possibilities for improvement. Thanks to all the members of our Advisory Circles, special thanks to all the speakers who took the extra burden to tell us their view in a presentation. Thanks in the name of the Kooperationsstelle to the four CLEANTOOL partners who are working with us now since more than two years and are still on board. For this mixed group we have to use English as lingua franca, unfortunately this choice excluded many interested practitioners. I am not sure whether a probably not very precise but surely very expensive translation would have helped here very much

I hope not only for good professional discussions but also for a lot of interesting personals contacts which improve further communication and co-operation

As you know CLEANTOOL is the abbreviation for “Innovative evaluation and design of industrial surface cleaning processes”. The major instrument of CLEANTOOL is a best-practice online database for the cleaning of metal surfaces.

It is one of the major aims of this conference to enable discussions between all parties and persons concerned about the usefulness of such a database and the usability of our CLEANTOOL approach. We developed this database in a consortium together with four partners:

DEI (PPC), Training Department (Greece)
    Electrical power company
EMI-ECO (Estonia)
    Environmental consultant
ICETEC (Iceland)
    Technological Institute of Iceland
UNIVERSITAT DE VALENCIA (Spain)
    Department for Applied Economics

The idea for his project we had in mind since 1996 when we detected SAGE (already developed 1992) – the Solvent Alternatives Guide form from US EPA and the RTI. SAGE was developed by the Surface Cleaning Program at Research Triangle Institute in cooperation with the U.S. EPA Air Pollution Prevention and Control Division (APPCD).

We connected this idea with our experience in solvent reduction and substitution projects in the printing, metal and construction industry.

In 2000 the EU accepted in their Innovation program a project proposal from our side and since that time we can work to implement our idea.

In short the project CLEANTOOL aims to develop a database which supports industries with metal surface cleaning tasks in five aspects:

Orientation
Giving orientation in a hardly transparent and wide spread market
Time saving
Allowing the fastest possible access to solutions
References
Showing not only theory but an easy understandable presentation of good practice examples from reference companies
Interactivity
Allow interactivity to reduce the variety to the needed information.
Use interactivity to assess and benchmark a cleaning process
Neutrality
Organising a peer review of best practice approaches

The database will finally cover 250 different cleaning processes from five European countries in text, image, and video format and seven languages. All processes have been evaluated under five aspects:

Technology
Quality
Cost Effectiveness
Environmental Impact
Health and Safety.

You will have an overview about the first version by Klaus Kuhl this morning.

That's it form my side up to now . We will go into detail in the following presentations of this morning, prepared by those persons with experience in development of such databases (Charles Darvin) and the groups who really develop our CLEANTOOL database now.

Thank you

SAGE, Solvents Alternatives Guide

A Guide to Selection Low Polluting Surface Cleaning Processes

Charles H. Darvin, U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Research Triangle Park, NC, USA

Elizabeth Hill, Research Triangle Institute, Research Triangle Park, NC, USA

Outline

1. Background and History of SAGE
2. SAGE System Design Philosophy
3. SAGE Example
4. Additional Features in SAGE
5. Technical Information Sources

Development of SAGE

Formation of a steering committee in 1991consisting of representatives from the Agency; industry; academia; and Federal, State, and Local government.

Objective to identify surface cleaning options that could replace solvents being phased out by the Montreal Protocol.

Identified in 1991 as highest priority need by focus group made up of industry, State, Federal, and EPA representatives.

Initially aimed at identifying substitutes for the 33/50 compounds and that comply with the Montreal Protocol.

Background and History of SAGE

1. System matured to include information useful to the selection of all alternatives including information on regulatory issues, alternative's cost, equipment requirements, case studies, vendors, etc.

2. Initially distributed via mail with over 2000 copies of version 1.0 and 2.0 mailed to requestors.

3. Converted to a Web-based guide due to the demand for the system.

Goal for SAGE

Development a handbook of surface cleaning alternatives

SAGE System Design Philosophy

SAGE is designed to mimic analytical process used by a process engineer tasked to identify and design an alternative surface cleaning process and its installation.

Design Philosophy

1. Must allow user to quickly identify solvent cleaning alternative.
2. Must contain factual and verifiable information about solvent alternatives.
3. Provide credibility to vendor-supplied information.

4. Identify health, safety, waste disposal, and technical requirements for implementing alternatives.
5. Identify sources of technical assistance.
6. System must be straight-forward and user-friendly.

Approach

SAGE identifies potential process alternatives by asking a series of questions that determine which processes are compatible with product requirements including:

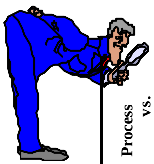
- part size
- item material
- item geometry
- surface chemistry
- processing rate requirements
- auxiliary equipment and utility availability

Example Scenario

1. Surfaces: Cu, PVC, silicon rubber
2. Assembly
3. High production rate
4. Blind holes, and complex geometry
5. Withstand high static and impact pressures
6. Cannot accept abrasion
7. Contaminants oil, grease, and fibers
8. Expensive

Approach

First Iteration



Process vs. Surface	Abrasion	Acidic Aqueous	Alkaline Aqueous	Acetone	Chelating Agents	Inhibiting agents	NMP	Turpines	CO_2 Pellets	Neutral H20	Supercritical gases	Surfactants	CO_2 Snow	Wiping
H.C. Steel	0	-1	0	0	0	+1	+1	+1	0	0	0	0	0	0
Cu	-1	0	+1	0	-1	+1	+1	+1	-1	+1	0	+1	0	0
Mg	0	-1	+1	0	0	0	+1	0	0	+1	0	+1	0	0
Ti	0	-1	+1	0	0	0	0	0	0	+1	0	0	0	0
Brass	0	0	0	0	0	+1	-1	+1	0	+1	0	+1	+1	+1
PVC	0	-1	0	-5	0	0	-5	0	0	0	-5	0	0	0
Silicon Rubber	0	0	-1	-5	0	0	0	0	0	0	0	0	0	0

Matrix 1. Matrix to select or deselect surface vs. process

Approach

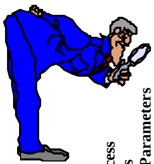
Second Iteration

Process vs. Surface	Abrasion	Acidic Aqueous	Alkaline Aqueous	Acetone	Chelating Agents	Inhibiting agents	NMP	Terpines	CO_2 Pellets	Neutral H_20	Supercritical gases	Surfactants	CO_2 Snow	Wiping
Oil	-1	-1	+1		0	-1		0	-1	0		+1	-1	+1
Fibers	-1	0	0		-1	0		0	-1	+1		+1	0	0
Grease	0	0	+1		0	0		0	0	0		+1	-1	+1

Matrix 2. Matrix to select or deselect process options vs. contaminant.

Approach

Third Iteration



Process vs Operating Parameters	Abrasion	Acidic Aqueous	Alkaline Aqueous	Acetone	Chelating Agents	Inhibiting agents	NMP	Terpenes	CO_2 Pellets	Neutral H_20	Supercritical gases	Surfactants	CO_2 Snow	Wiping
Assembly, y	-1	0	0		0	0		0	-1	0		+1	-1	-1
Pressue, N	0	0	0		0	0		0	0	0		0	0	0
Production H.	0	0	0		0	0		0	0	0		0	+1	-1
Blind Holes	-1	+1	+1		0	0		0	-1	+1		+1	+1	-1

Matrix 3. Matrix to select or deselect process options vs. product physical properties.

Approach

Cleaning Recommendations

	Abrasion	Acidic Aqueous	Alkaline Aqueous	Acetone	Chelating Agents	Inhibiting agents	NMP	Terpenes	CO_2 Pellets	Neutral H_20	Supercritical gas	Surfactants	CO_2 Snow	Wiping
Totals	-5	-1	+3	No	-2	+2	No	+1	-5	+3	No	+6	-1	-1
Results	No	No	Yes	No	No	Yes	No	Yes	No	Yes	No	Yes	No	No

Approach

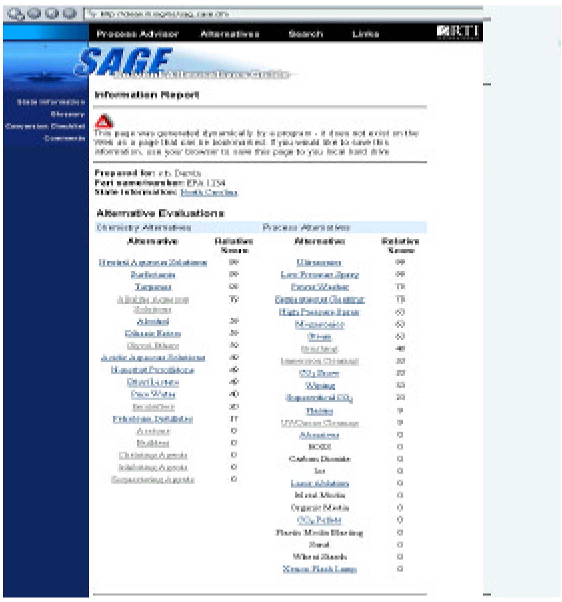
Provides a ranked list of chemistry and/or process alternatives.

Chemistry Alternatives

- Aqueous solutions
  - neutral
  - alkaline
  - acidic
- Semi-aqueous solutions
- Lactate esters
- Alcohol
- Acetone
- NMP
- Terpenes
- Dibasic esters
- Glycol esters
- Petroleum distillates

Mechanical/Electrical Alternatives

- No clean
- Sprays and power washing
- Immersion
- Ultra and megasonics
- Laser
- UV/Ozone
- Wiping
- Plasma
- CO2 snow
- CO2 ice
- Liquid and supercritical gaseous fluids
- Abrasive systems
- Steam
- Xenon flash lamp



Additional Features of SAGE

- Process conversion checklist
- State agency contacts
- Expert contacts
- MSDS
- Process cost calculator
- Important related Web site links
- Glossary
- References.

Data Sources

- Equipment catalogs
- INTERNET advertisement
- Nine direct vendor contacts
- User contacts and case studies
- EPA technology evaluation programs

References Sources

Richardson's Engineering Cost Manuals
OAQPS Control Cost Manual
AACE Seminars
Open Literature
Industry Web Sites

SAGE Facts

1. Selected as solvent selection system for ENVIRO$ENSE
2. Resides on the Internet in both the EPA and RTI Web sites.
3. Usage averages more than 20,000 per month via the Internet.
4. Selected as outstanding Web sites by two Web rating services.
5. Linked from a number of Web sites including the UN, State agencies and state technical assistance Web sites.

Locations

- WWW.EPA.gov/TTN/CATC/

  or
- WWW.clean.rti.org

Concept of the CLEANTOOL Database

Klaus Kuhl, Kooperationsstelle Hamburg, Germany

Main Idea

- Real processes
- Best practice
- Documented by means of questionnaire
- Filled out together with plant technician
- So far 50 processes in database
- Aim: 250 – 300 processes

Access

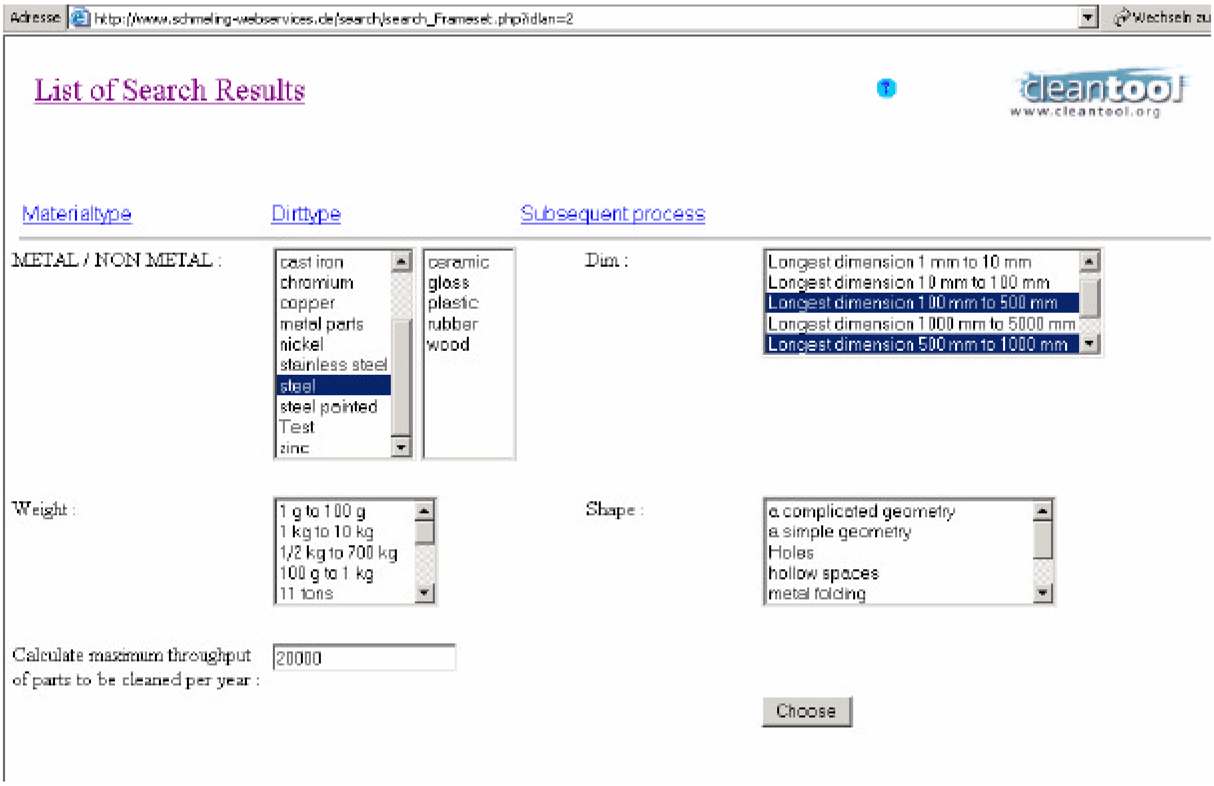
Through internet

www.schmeling-webservices.de (test-site)

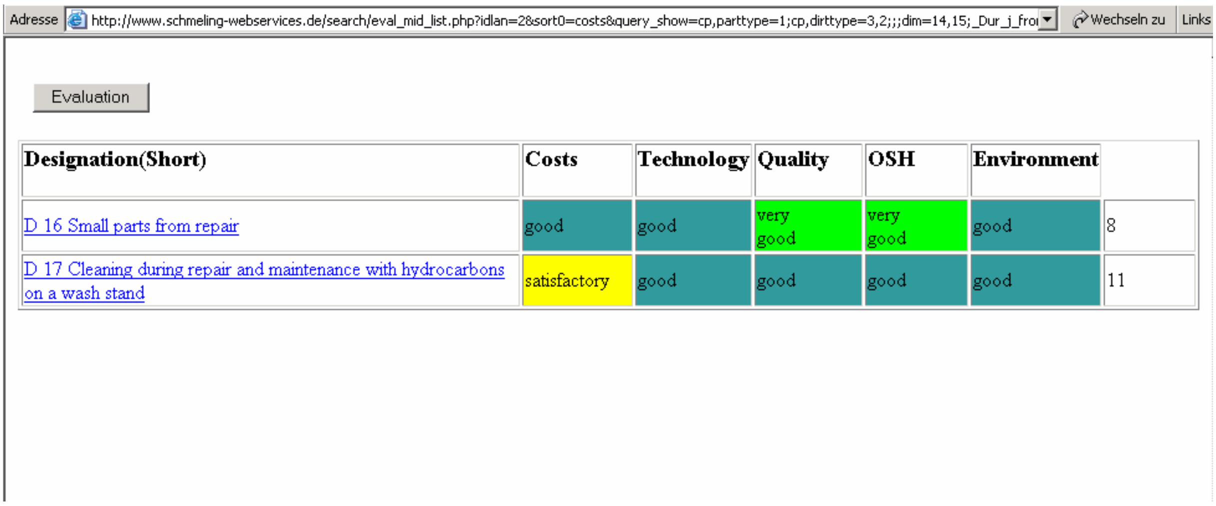
www.cleantool.org

Examples:

1. Users enter all individual requirements via a comprehensive search interface. This may include parameters for material, dirt, size, geometry, amount and subsequent process.

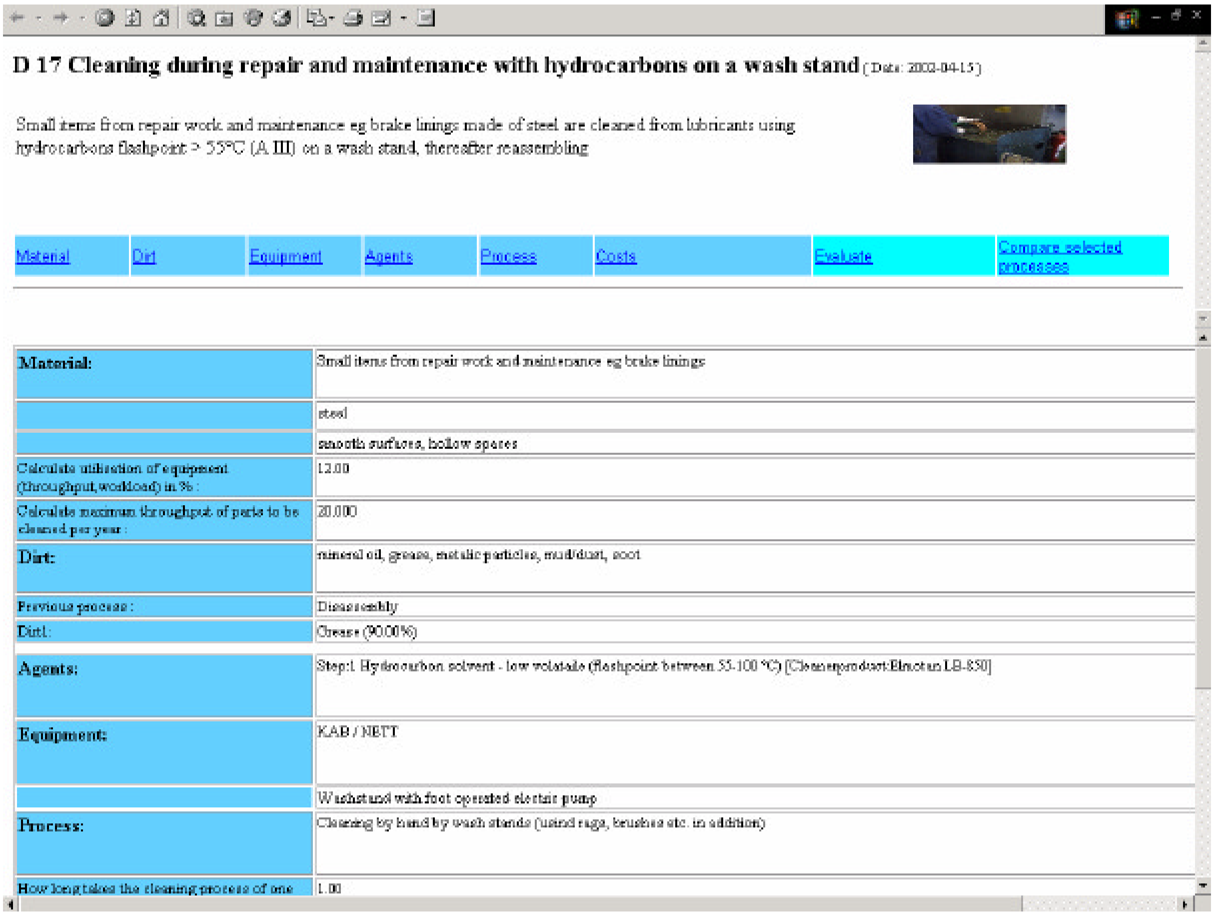


2. The search results will appear in a list along side a rough basic evaluation. From this list the interesting processes can be selected.



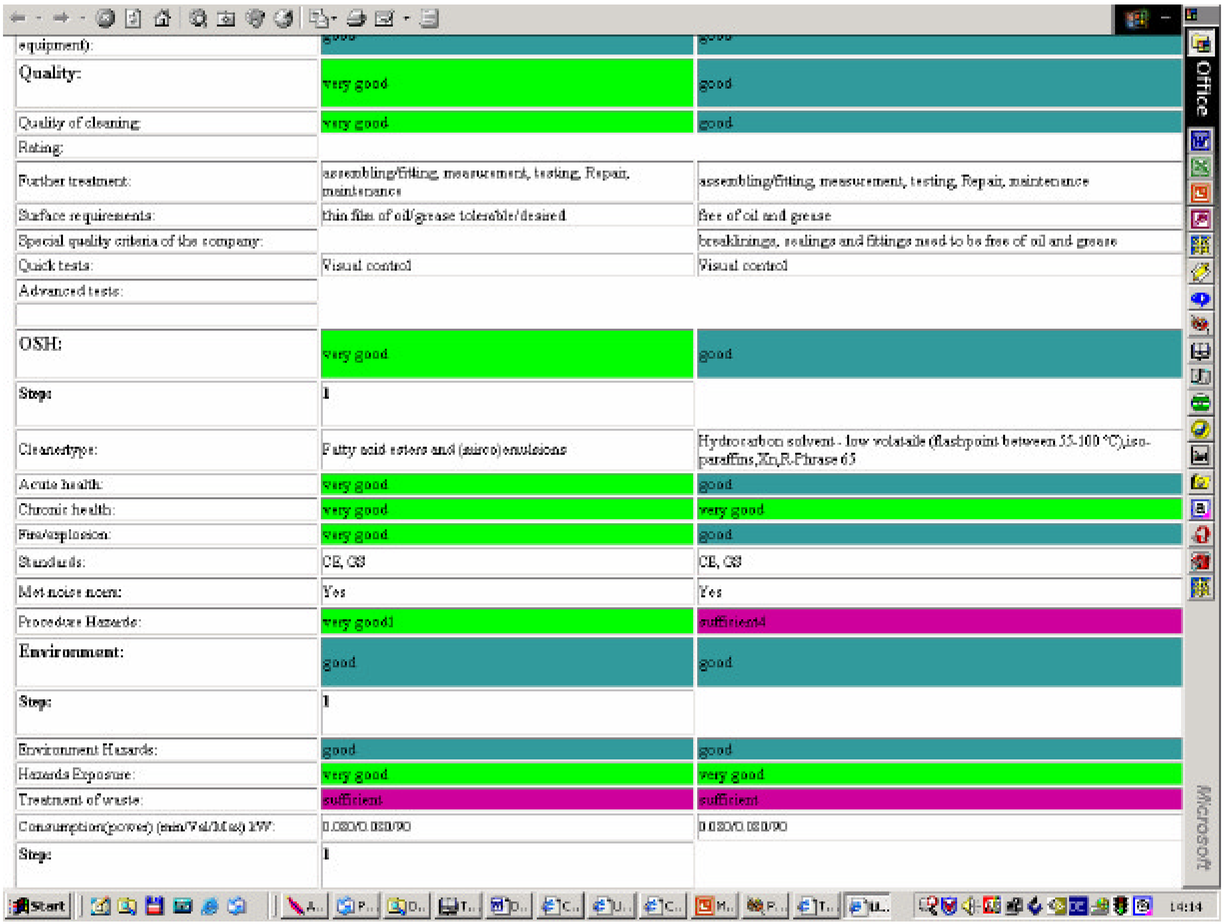
Designation(Short)	Costs	Technology	Quality	OSH	Environment	
D 16 Small parts from repair	good	good	very good	very good	good	8
D 17 Cleaning during repair and maintenance with hydrocarbons on a wash stand	satisfactory	good	good	good	good	11

3. The respective technical sheet shows almost all stored process data in extra screens and include e.g. removed dirt, all process steps and the agents used in these steps, the type of equipment and the cleaning procedure in detail.



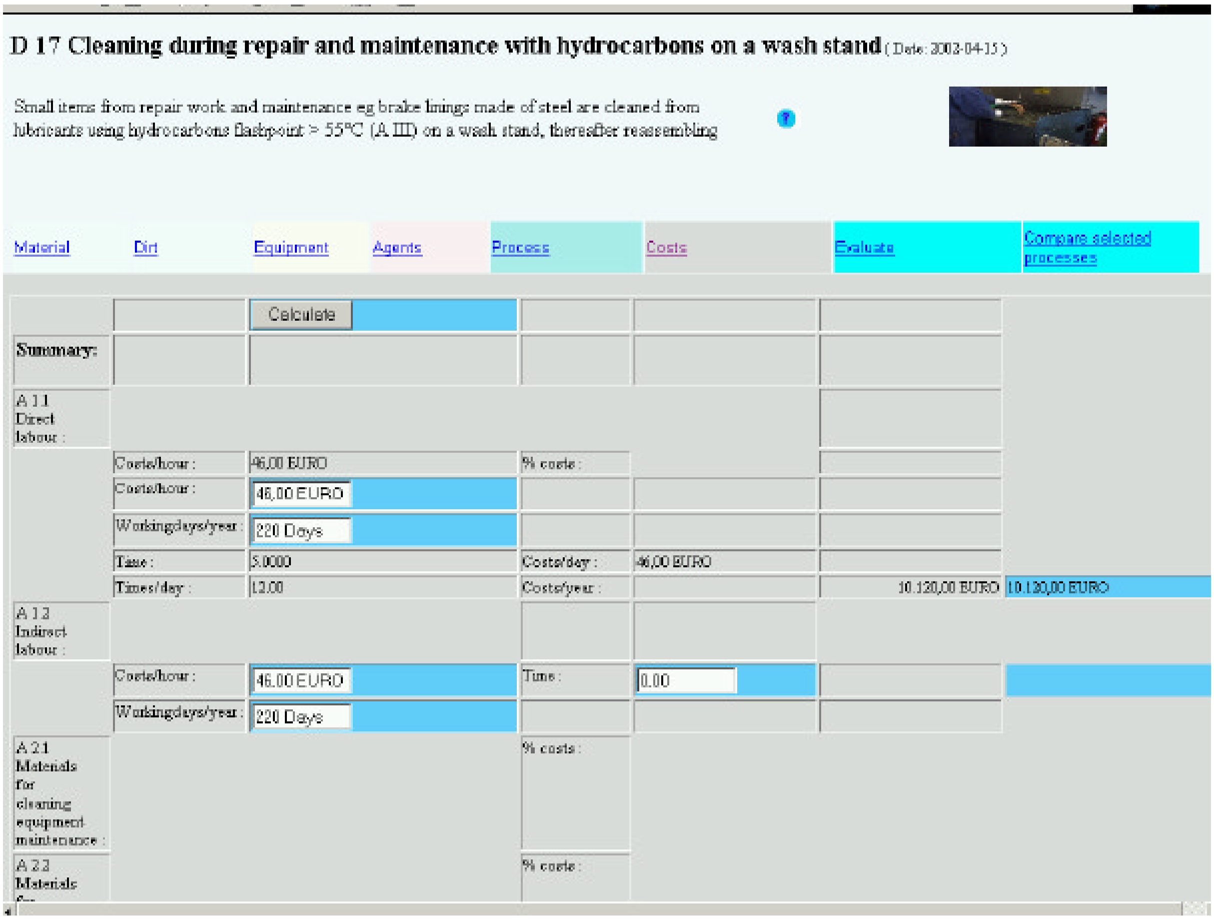
Material:	Small items from repair work and maintenance eg brake linings
	steel
	smooth surfaces, hollow spaces
Calculate utilisation of equipment (throughput, workload) in % :	12.00
Calculate maximum throughput of parts to be cleaned per year :	20.000
Dirt:	mineral oil, grease, metalic particles, mud/dust, soot
Previous process :	Disassembly
Dirt1 :	Grease (90.00%)
Agents:	Step:1 Hydrocarbon solvent - low volatile (flashpoint between 55-100 °C) [Cleanerproduct:Elmotan LB-850]
Equipment:	KAB / NETT
	Washstand with foot operated electric pump
Process:	Cleaning by hand by wash stands (usind rags, brushes etc. in addition)
How long takes the cleaning process of one	1.00

4. Search results can be evaluated by the system according to the individual requirements be they technological, quality, environmental, health and safety or cost considerations. Thereby all criteria will be further subdivided, in order to avoid coming up with a summarized score, which will have little meaning to the practitioner. The users are to decide how to weigh the different categories according to their individual requirements. This tool gives out evaluations on a scale of one to five and marks the different grades by related colours.



equipment):	good	good
Quality:	very good	good
Quality of cleaning:	very good	good
Rating:		
Further treatment:	assembling/fitting, measurement, testing, Repair, maintenance	assembling/fitting, measurement, testing, Repair, maintenance
Surface requirements:	thin film of oil/grease tolerable/desired	free of oil and grease
Special quality criteria of the company:		breaklinings, sealings and fittings need to be free of oil and grease
Quick tests:	Visual control	Visual control
Advanced tests:		
OSH:	very good	good
Step:	1	
Cleanertype:	Fatty acid esters and (micro)emulsions	Hydrocarbon solvent - low volatile (flashpoint between 55-100 °C),iso-paraffins,Xn,R-Phrase 65
Acute health:	very good	good
Chronic health:	very good	very good
Fire/explosion:	very good	good
Standards:	CE, GS	CE, GS
Met noise norm:	Yes	Yes
Procedure Hazards:	very good1	sufficient4
Environment:	good	good
Step:	1	
Environment Hazards:	good	good
Hazards Exposure:	very good	very good
Treatment of waste:	sufficient	sufficient
Consumption(power) (min/Val/Max) kW:	0.080/0.080/90	0.080/0.080/90
Step:	1	

5. Evaluation of costs for cleaning processes poses a special challenge. Even within one country the prices for energy, water, agents etc. may vary, not to mention variations between different countries. To overcome these problems, CLEANTOOL provides an interactive feature, encouraging users to enter their individual labour-, energy-, water- etc. costs into the calculation interface and get back a customized estimation of cleaning costs.



Hidden Costs: A source of opportunities for win-win initiatives

Prof. Dr. Francesc La Roca, University of Valencia, Dept. of Applied Economics, Spain

Graciela Ferrer, University of Valencia, Dept. of Applied Economics, Spain

Cleaning processes in Spanish firms

- Cleaning is considered as a secondary or auxiliary task in the framework of the production process: cleaning operations account for (far) less than 10% of the total cost of the production process
- Attention is not paid to the cleanliness quality while problems do not arise in the subsequent step: overcleaning is frequently preferred
- There is a lack of technical auditing and quality monitoring of cleaning processes: insufficient technical information
- Current cost accounting in firms works by departments or plants but not by processes

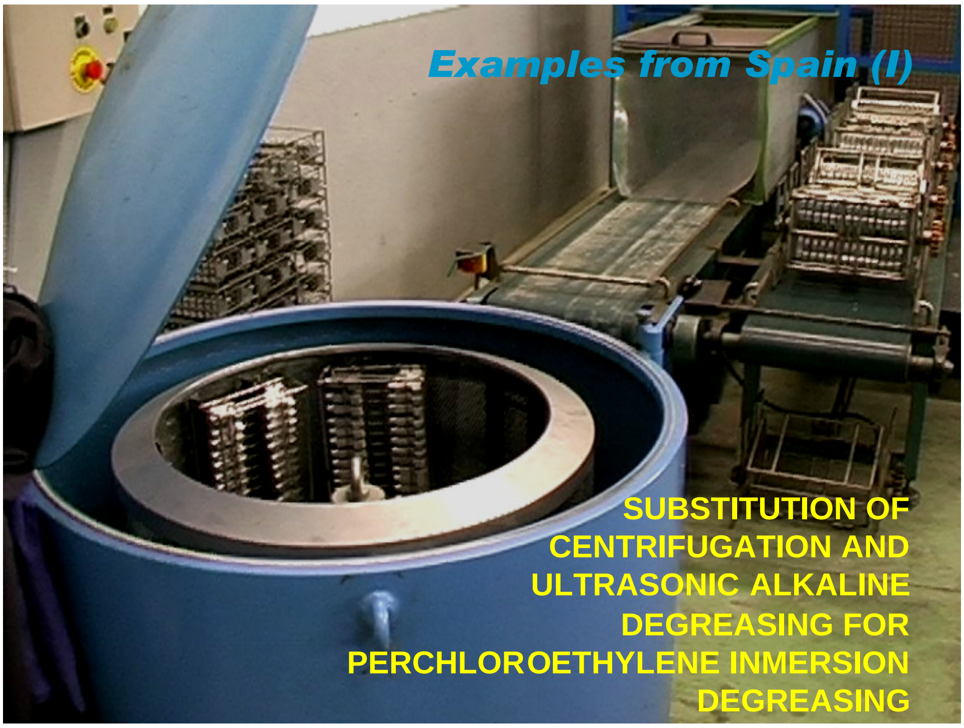
As a consequence, there is not reliable information on cleaning costs.

Costs related to cleaning processes

- Labour costs: although the cost of a labour hour is known, there are problems to know how many labour hours are invested in the cleaning process:
  - Direct labour (i.e. Multitask operator),
  - Indirect labour (i.e. control of chemicals, quality control (analyses), etc.)
- Cost of the agent: although the price of an agent unit is known, problems arise in calculating the quantity used if the agent is applied sporadically, in several processes, or no rules are set for additions and renewing.
- Energy cost: it is calculated for the whole firm or plant but imputation of direct and indirect energy consumption is difficult due to the lack of information about the energy consumed by the process.
- The same is applicable to water cost.
- Non-conformity cost: re-cleaning cost due to cleaning failures should be accounted.
- Waste management costs: they are generally related to the whole volume of wastes and wastewater generated by the firm or plant, but not segregated information per process is available.
- Occupied floor cost: this cost is usually not taken into account for cleaning processes (expect when there is a shortage of plant space).
- Equipment cost: not only amortisation cost should be considered, but also maintenance service costs. These kinds of costs use to be calculated for the whole plant's equipment but not per process.
- Health and safety costs: current and capital costs of measures taken for protecting workers must be included in the calculation of cleaning cost. Usually, these costs are accounted aggregately, not per process or even department.
- Air emission costs: implementation and maintenance of installations for preventing / controlling emissions into air should be accounted following a point-of-emission logic, that is to say, as an additional cost for the process that causes them.

Limited internal, technical and economic information obstructs innovative practices and a faster adaptation to new legal requirements, impacting negatively on industrial long-run competitiveness.

Examples from Spain



Parts to be cleaned:

gas regulation valves (gas fires)

Part's features:

extruded aluminium; blink holes; holes; interconnected interior conductions; complicated geometry 50 gr.; 7cm*7cm*1.2cm;
400000 parts/year

Dirt to be moved:

oils and drilling oil (495 l/year); metallic particles (6 kg/year)

Cleanliness quality required:

free of metallic particles, oils and dust; and dry

Preceding process:

machining

Subsequent process:

storage for further assembling

Former cleaning process:

degreasing by immersion in perchoroethylene

New cleaning process:

Centrifugation + ultrasonic alkaline degreasing by immersion

Motivation for changing the process:

increasing H&S and environmental legal pressure on chlorinated solvents

Centrifugator

Ultrasonic alkaline degreasing by immersion

Oven

COST COMPARISON (annual basis):

Items	PER process	Centrif + aqueous process
Labour costs	31680.00 €	31680,00 €
Cleaning agent	761.10 €	565.00 €
Energy	2060.00 €	2100.00 €
Water (complete cycle)	0.00 €	34.5 €
Reuse of oils	0.00 €	– 620.00 €
Waste management	1800.00 €	6.00 €
Indirect costs related to H&S and Environmental laws	500.00 €	0.00 €
TOTAL OPERATIVE COSTS	36801.10 €	33765.50 €
OPERATIVE ANNUAL SAVINGS		3035.60 €
INVESTMENT REQUIRED		16830.00 €
INVESTMENT RETURN TIME		5.5 years

Parts to be cleaned:

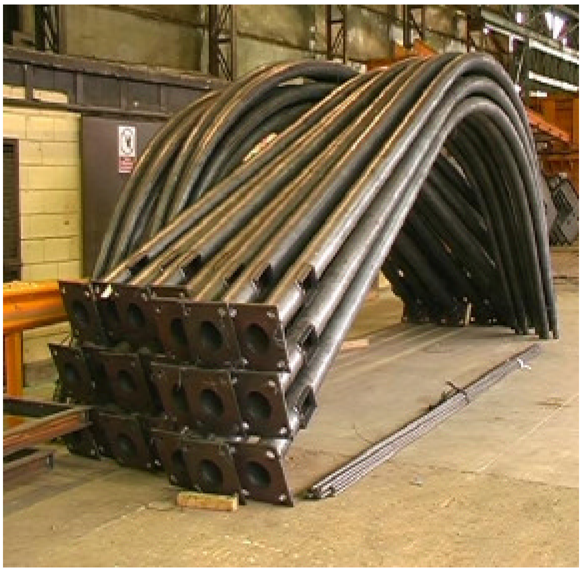
Infrastructure metal parts (street lamps, metal/wire fences, etc.)

Part's features:

cold and hot rolled steel; from middle to big size (up to 12.5 m length, 1.8 m width, 3.2 m depth); very heavy; holes and complicated geometry

Dirt to be moved:

rust and mill scale (99%); machining mineral oils (1%)



Cleanliness quality required:

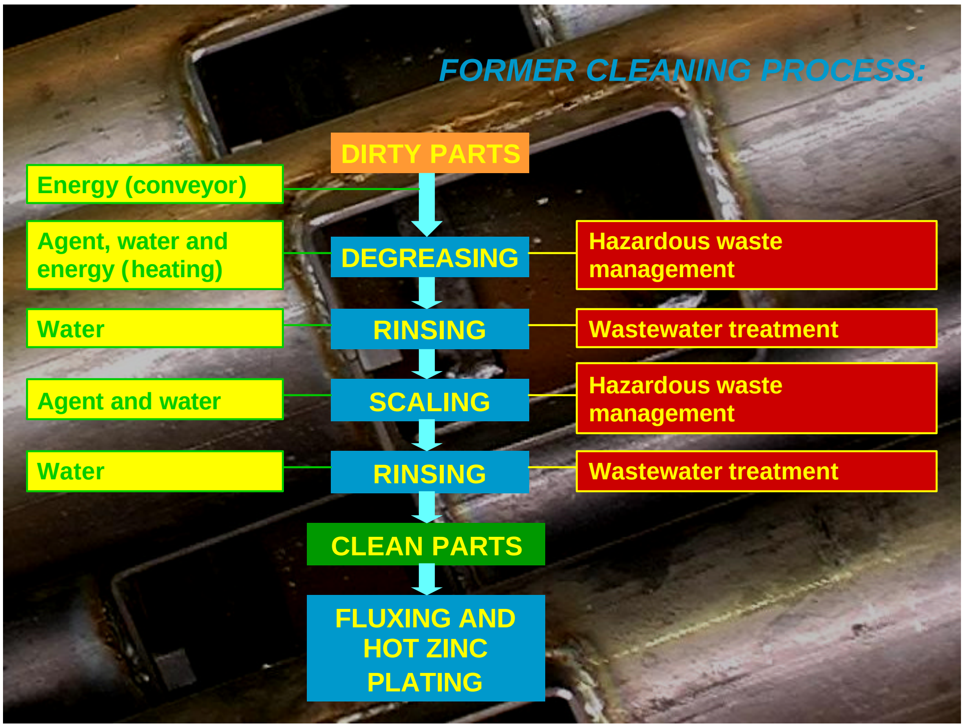
white steel (Sa 3)

Preceding process:

(external) machining

Subsequent process:

fluxing and hot zinc plating



Modifications in the new cleaning process:

Separation of plated material from non-plated material. Amount of dirt of parts is controlled to accept or refuse parts to be cleaned.

Degreasing and rinsing:

Eliminated

Scaling:

HCl + surfactant and inhibitor additive. System for drained cleaning agent recovery. Exhausted scaling bathes (non-galvanized parts) are neutralised.

Rinsing:

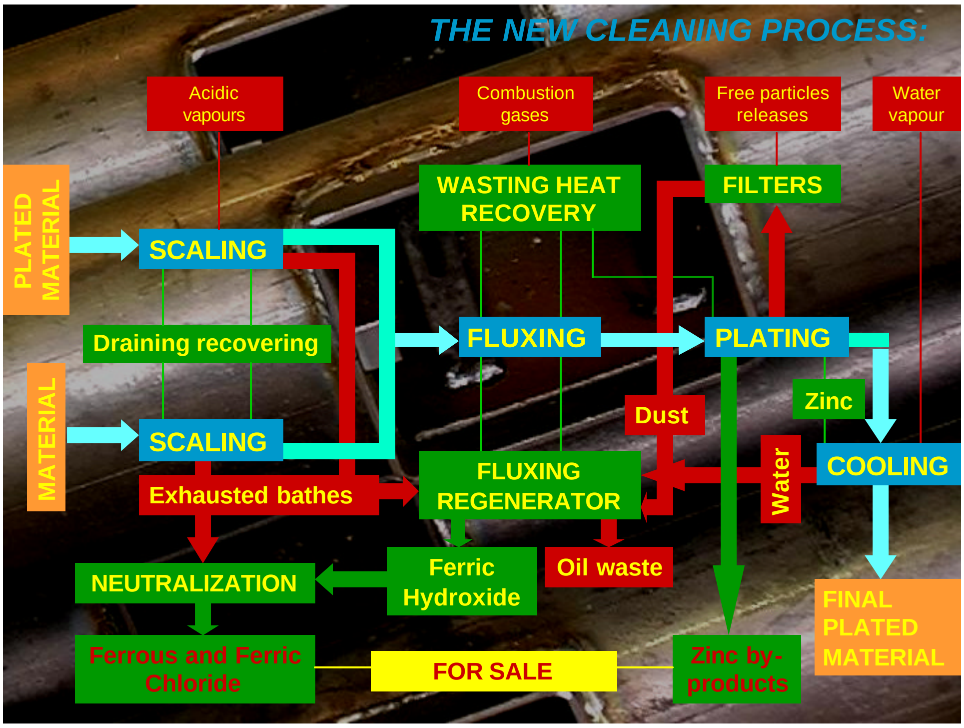
Eliminated

Fluxing:

Connected to a REGENERATOR that also treats exhausted de-galvanizing bathes generating ferric hydroxide, which is used for neutralising exhausted scaling bathes for non-galvanized parts.

Neutralization:

The process gives rise to the production of ferric and ferrous chloride as by-products commercialised by the firm.



Advantages of the new cleaning process:

- Segregation scaling bathes → increase of cleaning agent operative life
- Reduction of air emissions. Free of particles air emissions
- Recovery of combustion gases
- Recovery of cleaning agent from draining
- Valorization of process wastes (now by-products)
- Elimination of rinsing water consumption
- Liberation of operative indoor floor
- Increase of cleaning agent efficiency
- Time and conveyor/heating energy savings

Concluding remarks

Information on hidden costs makes possible an optimal evaluation of opportunity costs. This improves the quality of decision making and reinforces innovative processes, launched usually for environmental or Health and Safety reasons.

Cleaning of machinery in fish processing industry with fatty acid ester based semifluid detergents

Hermann Thordarson, IceTec, Reykjavik, Iceland

Ragnar Johansson, IceTec, Reykjavik, Iceland

“Environmentally friendly choice from sheep tallow”

"Vistvænni kostur úr kindamör"
kynlega þykir mér hljóma Hvað með sýru og nýstrokkað smjör selspik, lýsi eða rjóma?

Background

- Subsprint
- Technology transfer project of using vegetable oil esters as cleaning agents in the printing industry instead of conventional solvents
- Vegetable oil esters are good solvents for oils and lipophilic substances
- Polyol from fish oil
- Biodiesel from meat wastes

Project – product development

- research project/product development of making a cleaning agent from cheap fat, such as sheep tallow, first intended to clean cars in winter
- fat from the meat processing industry is a waste product generating waste management costs
- result of the project was a fatty acid ester cleaner that had good uses as a tar remover for cars, paint brush cleaner that could replace solvents such as turpentine or white spirit and general cleaner for fat/oil/grease

Uses in the fish processing industry

- as the cleaner seemed to be of good use the small Icelandic market forced the producer to try to sell it to the fish processing industry and it was used in cleaning fish meal factories and of fish lines
- the next step was testing it in the fish processing lines where food for human consumption is produced

Specific problems in cleaning in the fish processing industry

- the most difficult task is to remove the bio fouling film formed by bacteria as a defence mechanism against cleaning and washing
- this film can e.g. be seen as a yellowish film on conveyor belts
- bio film formation is a mode of bacterial survival common to many different environments

Biofouling films

- steps of the biofilm development process have recently been elucidated
- attachment of planktonic cells to surface
- gene expression for biofilm formation
- production of exopolysaccharides and glycoproteins for protection
- a highly organized structure evolves with channels for nutrients and wastes

Conventional cleaning agents used

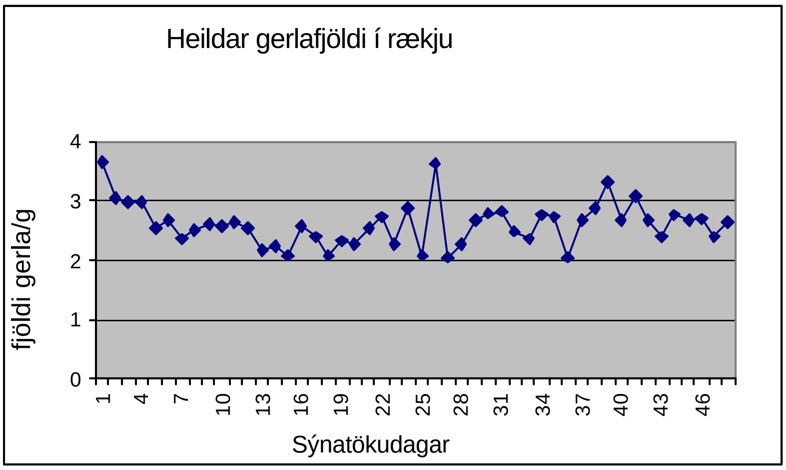
- Conventional cleaning agents used in the industry are alkaline, bactericidal, turning fats into soap for removal
- they are good at killing the bacteria and general cleaning but not necessarily for removing the film
- their alkalinity is harsh to equipment and machinery – matting of surfaces or corrosion of steel and aluminium follows

Advantages of fatty esters

- Microemulsions such as fatty ester cleaning agents may penetrate the biofilm better than conventional cleaning agents
- the biofilm is more easily removed by the following washing
- they are neutral agents, so corrosion is prevented

Tests in factories

- Test results from a shrimp factory
- Cleaning ability is equally good or better with yellow film disappearing with time
- Bacteria counts are low



Corrosion tests - prevention

- Corrosion tests and comparisons are being carried out by IceTec and a producer of fish processing equipment in Iceland
- The same producer wants to use fatty esters as corrosion prevention material during transport

Fatty acid ester cleaners and the fish processing industry

- Fatty acid ester cleaners are a new and good option in the fish processing industry
- Most likely there possibilities of improvement of the cleaner properties
- The FAE cleaners tested are environmentally safe and partly made from waste material

The choice of an agent after the substitution of 1,1,1-trichloroethane The Greek experience

Dr. Christos Maltezos, Public Power Corporation S.A., Testing Research and Standards Center, Greece

The PPC S.A.

The Public Power Corporation (PPC S.A.) is the largest producer of electricity in Greece with almost 30.000 employees. It has 100 self-owned power stations. One third of them (thermal and hydroelectric) is connected to main land's power network. The rest two thirds are independent (39 thermal, 2 hydroelectric, 20 wind parks, 5 photovoltaic parks) power stations, which are located throughout the Greek islands.
It produces 48.000 GWh per year and possesses 11.000 km of transmission lines and 196.000 km of distribution network. Its annual lignite production at its self-owned mines is 66,2 million tons. This is the 2^{nd} largest production of electricity from lignite in Europe.

The old agent

The agent 1,1,1-trichlorethane is eliminated law in order tom protect the ozone layer. This agent was almost exclusively used for cleaning PPC's equipment and installations and degreasing surfaces before painting, because of its very good physicochemical characteristics:

1. Advantages
No flammable, good degreaser, high evaporation speed, low surface tension, high dielectric strength, compatibility with metals, compatibility with non-meltas, low toxicity, soft odor, ability to be recycled, no residues left, easy to handle.

2. Disadvantages
Low bio-degradability, photochemical reactivity.

The substitution

Six years ago, the PPC management appointed a committee in order to proceed with issuing specifications for substitutes of the 1,1,1-trichloroethane. The steps taken by the committee were:

1. Market research for industrial cleaners on the basis of:
Chemical composition, physiochemical characteristics, hygiene and work safety, environmental impacts, cleaning equipment, handling and disposal.

2. Testing at PPC/TRSC Laboratories for determination of:
Alkalinity, foaming, evaporation speed, solid residue, compatibility with metals and non metals, cleaning ability, flash point, dielectric strength.

3. Comparison of tests results with suppliers' data and relative references.

4. Grouping and characterizing agents
They were grouped into the two main categories:
Water based cleaners and Paraffin based solvents

Advantages

Water based:
Non flammable, no residues left, bio-degradable, easy to handle.

Paraffin based:
Good degreasers, high electric resistance and dielectric strength, compatibility with metals, low toxicity.

Disadvantages

Water based:
Bad degreasers, low electric resistance, low evaporation speed, possibly incompatible with metals.

Paraffin based:
Flammability, residual film, need care for disposal, low evaporation speed, possibility incompatible with non metals, acute odor.

5. Small scale usage of substitutes on the job

The committee made questionnaires and interviewed a large sample of the company users. They also planned pilot cleaning procedures which were audited and filmed in video.

6. Main parameters were considered for the agent substitution

- The personnel had to change its mentality and attitude towards the new agents and cleaning procedures.
- Technical information and training were required for the personnel.
- Application difficulties such as water cleaning for vehicles and paraffin cleaners would not dry easily.

7. Technical specifications for two kinds of cleaners

Were issued on the basis of all the above

8. Training

Training seminars are planned to meet personnel needs for the new cleaning products requirements after the substitution.

Presentation of cleaning processes in various units of PPC (Lignite Centers and Steam power Stations, etc.

Maria Tolaki, Public Power Corporation of Greece (PPC) S.A., Director of Health and Safety Department

Theodore Chryssanthopoulos, Public Power Corporation of Greece (PPC) S.A., Health and Safety Department, Head of the Surveying Safety sub sector

1. PPC / West Macedonia, Lignite Center, Central Machinery Maintenance Station, Sector of Rollers Maintenance

Equipment to be cleaned: Accessories of rollers(cylinders for conveyor belts)

Dirt: Dust, mud, grease

Cleaning equipment: Washing machine (own-construction)

Cleaning process: Dismantling of rollers and cleaning by immersing them into a bath Duration: 2 hours.

Cleaning agent: Aqueous cleaner, moderate alkaline “Ecowash” with hot water (temperature 90°C).

Total cost: 50.000 € per year

2. PPC / West Macedonia, Lignite Center, Central Mechanical

Equipment to be cleaned: Bearings, gears, couplings,etc.

Dirt: Dust, mud, mineral oil, grease

Cleaning equipment: Cleaning basins

Cleaning process:

First step: Internal cleaning by hand using only brushes and wad

Second step: Cleaning by Diesel oil

Cleaning agent: Diesel oil

Total cost: 40.000 € per year

3. PPC / West Macedonia, Lignite Center, Sector of Diesel Engines Repair and Maintenance

Equipment to be cleaned: Motors, gear-boxes, etc.

Dirt: Dust, mud, mineral oil, grease, soot

Cleaning equipment: Spray washing machine (own-construction) 31 kW.

Cleaning process: Dismantling of motors and gear-boxes and cleaning of each mounting separately by automation cleaning facilities

Duration: 2 hours

Cleaning agent: Aqueous cleaner, moderate alkaline “Ecowash” with hot water (temperature 90o C)

Total cost: 8.2000 € per year

4. PPC / Megapolis, Lignite Center, Central Electrical

Equipment to be cleaned: Rotors of electric motors,

P=132kW

Dirt: Dust, mud, grease

Cleaning equipment: Spraying high-pressure washing machine (p=200bar) ELLESSE and furnace P=12kW

(own construction)

Cleaning process:

First Step: Degreasing the rotors by mechanical treatment

Second Step: Spray-washing under high pressure (Duration: 1 hour)

Third Step: Drying into the furnace (Duration: 5 hours)

5. PPC / Steam Power Station of Megapoli, 4th Unit (300 MW), Maintenance Sector / Electrical Workshop

Equipment to be cleaned: Winding of electric motors (Medium Tension 6kV, 2.2MW)

Dirt: Dust, mud, grease

Cleaning equipment: Special brushes

Cleaning process:

First step: Use of special brushes and compressed air for dust removing

Second step: Degreasing using the below cleaning agent

Third step: Drying

Cleaning agent: “Chesterton 274”

Duration:1 hour

Frequency of windings’ maintenance: Once every 8 years

Total cost: 600 € per year

6. PPC / Steam Power Station of Megapoli, 4th Unit (300 MW), Maintenance Sector

Equipment to be cleaned: Bearings of fans and other devices of the Steam Power Station machinery (filters, etc.)

Dirt: Dust, mud, mineral oil

Cleaning equipment: Spraying high-pressure washing machine (p=200bar, P=5.7kW) MAER L 800(Italy)

Cleaning process: Spray-washing under high pressure 200bar

Cleaning agent: Hot water (temperature 90ºC)

Total cost: 1.400 € per year

7. PPC / Steam Power Station of Megapoli, 4th Unit (300 MW), Maintenance Sector

Equipment to be cleaned: Turbine's cooler

Dirt: Dust, mud

Cleaning equipment: Gun of high speed firing (type CS-300)

Cleaning process: Inserting pressurised air and water after firing special "brushes" into the tubes of the cooler by the gun

Duration: 400 hours per year

Frequency of cooler's maintenance: Once a year

Cleaning agent: Air, water

Total cost: 12.000 € per year

8. T.E.K. L.L.C. (Limited Liability Company), (Private Company in Northwestern Greece near the cities of Ptolemais and Florina)

Equipment to be cleaned: Various mechanical equipment, iron-sheets, etc.

Dirt: Dust, mud, grease, mineral oil, anticorrosive substances, lubricants

Cleaning equipment: Sandblast cleaning apparatus P=90kW with nozzle diameter 11mm and p=7,5bars

Cleaning process: "Dry" sand-blast cleaning

Duration: 4 hours per day

Cleaning agent: Sand for sandblast

Total cost: 22.000 € per year

Estonian Experience in Cleaning of Metal Surfaces

Juhan Ruut, Emi-Eco, Tallinn, Estonia

Anne Randmer, Emi-Eco, Tallinn, Estonia

Paper discusses some issues of cleaning processes of metal surfaces in Estonia.

Background: Estonian chemical industry

Production of chemicals and chemical products comprises 4,4 % of Estonian industrial production, production of rubber and plastic materials 3,2 % (in 2001).

The dynamics of production capacity of most common products is as presented in table below:

Product group	Unit	1998	1999	2000	2001
Ammonia	Ktons	174,8	145,5	127,5	
Mineral fertiliser (nitrogen based, as 100 % N)	Ktons	x	41,4	37,5	39,0
Mineral fertiliser mixtures	Ktons	x	x	x	55,8
Resins and plastic material	Ktons	21,4	20,3	27,1	x
Benzene	Ktons	23,8	14,5	13,6	6,5
Toluene	Ktons	4,6	4,5	4,6	1,5
Formaline	Ktons	31,9	14,3	21,3	x
Coagulants	Ktons	11,2	10,2	10,5	x
Sealing mixtures, etc.	Tons	x	368,9	508,0	x
Medicinal products	Million EEK	147,0	126,7	170,5	x
Synthetic cleaning agents	Ktons	x	0,76	0,68	3,4
Paint products	Ktons	x	14,70	16,97	15,10

X – data not available

Production of cleaning chemicals in Estonia:

Non-specific cleaners, including car service, agricultural applications and some others are produced in Estonia.

Main client groups for specific cleaners are food industry and medicine – disinfection properties of cleaning agents are essential for these applications.

Mostly aqueous alkaline cleaners are produced, solvent based cleaners <10 %, chlorinated solvents are not used in formulations

Total number of producers is ~10 in Estonia, larger ones are Flora Ltd. and Estko Ltd. (Estko is presented in Estonian Advisory Circle of CLEANTOOL Project).

There is at least one company known that specialises on cleaners containing only non-hazardous substances or additives.

Production of metals, processing of metals

Metal engineering industry share in industrial production is 22, 3 %. There is a relatively large number of companies in the branch, but most of them have number of employees less than 10 (see annex I). Number of companies having more than 50 employees is ~125.

Approximately 80 companies are members of the Federation of Estonian Engineering Industry. Major representatives in the federation are from following branches:

Participation in CLEANTOOL Project

Machine building	14	-
Production of transportation equipment	4	2[1] (Norma, BLRT Group)
Various metal products	17	2 (Tartu Instrument, Vasar)
Agriculture and Forestry machinery		8 -
Special tools	8	-

Norma is presented in Estonian Advisory Circle of CLEANTOOL Project.

II Cleaning processes practiced in Estonia

Based on the stages of cleaning, the processes cleaning of metal surfaces could be divided into categories as following:

1. Primary applications - processing of metals are used further as raw material:

Metal surface cleaning processes are incorporated in the main production cycle and usually are not a separate or stand-alone operation, production is usually designed as “high-throughput” system (e.g. cold or hot rolling in production of sheets etc. of ferrous metals). Typically these installations are subject to the integrated environmental permit, including requirement to implement Best Available Techniques (as specified in IPPC Directive 96/61/EC). Requirements to the quality of the products are high and subject to standardisation. There are only few applications of BAT in Estonia, e.g. production of continuous hot-dip zinc coated steel sheets in Galvex Estonia Ltd. [2]
These applications are out of the scope of CLEANTOOL Project.

2. Secondary applications – processing of metals to final products

Processes of that type are presented in Annex II
Some applications have series of cleaning processes in line, especially in electroplating: details from casting or other forming processes are vibro-treated to remove casting channels, oxides, etc., then treated by ultrasonic or alkaline to remove oil, followed by acid pickling, electrochemical treatment with presence of alkaline or neutral agents.

3. Tertiary applications – cleaning metal surfaces in maintenance routines.

Processes dealt with in the frame of CLEANTOOL Project are presented in Annex III

Some conclusions from experiences gained in Estonia

There are no known cleaning equipment producers in Estonia. Some companies have used in-house applications to implement simple techniques (rotation drums, baths).

Considering cleaning in processing of metals as final products (secondary applications) no local know-how on agents neither R&D activities exist in Estonia. Most agents commercially used are imported.

Usually, enterprises perform tests of different agents before choosing the optimal chemical.

Local production of cleaning agents for tertiary applications is rather well developed. Mostly aqueous agents are produced, but for some specific applications, especially in car care also non-chlorinated solvents are used in formulas.

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[1] The actual number of companies is larger as BLRT Group consists of 12 enterprises of which 5 are participating the project.
[2] The company does not participate in the CLEANTOOL Project

Some enterprises are subject to IPPC permitting, i.e. cleaning process should not be evaluated as a 'stand alone' operation.

Annex I. Number of enterprises in the metal processing branch

Activity / (share in industrial production, %)	**Characterisation of enterprises**	
	Number of employees	**Number of enterprises**
Production of metals (see below)	1-9	5
	20-49	3
	> 100	1
Production of metal products, excluding machinery and equipment (7,1 %, including production of metals)	1-9	246
	10-19	96
	20-49	71
	50-99	29
	≥ 100	13
Production of office equipment and computers (0, 4 %)	1-9	3
	10-19	4
	20-49	3
Production of other electrical equipment and apparatuses (2, 0 %)	1-9	36
	10-19	9
	20-49	5
	50-99	8
	≥ 100	8
Production of communication equipment, TV and radio sets (2, 3 %)	1-9	29
	10-19	6
	20-49	8
	50-99	6
	≥ 100	7
Production of medicinal equipment, optical devices, precision tools (1, 4 %)	1-9	55
	10-19	8
	20-49	5
	50-99	4
	≥ 100	6
Production of motor vehicles (1, 9 %)	1-9	1
	10-19	5
	20-49	5
	50-99	3
	≥ 100	2
Production of other transport equipment (1, 6 %)	1-9	21
	10-19	10
	20-49	12
	50-99	6
	≥ 100	4
Production of other machinery and equipment (2, 7 %)	1-9	82
	10-19	19
	20-49	24
	50-99	14
	≥ 100	13

Annex II. Cleaning in processing of metals to final products

Cleaning process	Dirt	Cleaning equipment	Agent	Applications
Vibro-treatment	Oils, fin-gerprints, soot, etc.	Vibro-shaker, manual loading /Germany/	Stone pellets + Aqueous cleaner /Germany/	Prior electro-plating or painting, 2
			Oak pellets + aqueous cleaner /prepared in-house/	Final polishing of cast products, 1
Chlorinated solvent cleaning	Various	Vapour degreaser, closed sys-tem /Sweden/	Trichloroethylene /Finland/	Electronics industry, 1
Ultrasonic cleaning	Various	Ultrasonic bath /Sweden/	Aqueous alkaline cleaner /Finland/	Electronics, electroplating, 2
Aqueous cleaning	Oil, emulsions	Washing machine: spraying-etc.; manual loading	Aqueous neutral cleaner /Sweden/, aqueous alkaline cleaner /Germany/	Electroplating or paintwork, 2
Chemical and electrochemi cal processes	Various	Electroplating line /Sweden/	Aqueous neutral and alkaline agents, /Finland/ hydrochloric acid	Electroplating, 6
	Oil, rust	Treatment vats	Alkaline + acidic treatment	Hot zincing, 1
Blasting, other mechanical treatment	Rust	Blasting chamber, 60 m^3	Steel grains	Hot zincing, 1
	Mold residue, oxides	Blasting chamber, 2 m^3	Steel and pig-iorn grains	Casting, 1
	Oxides, cast edges	Rotating drum, 0.2 m^3	Sawdust added	Casting, 1

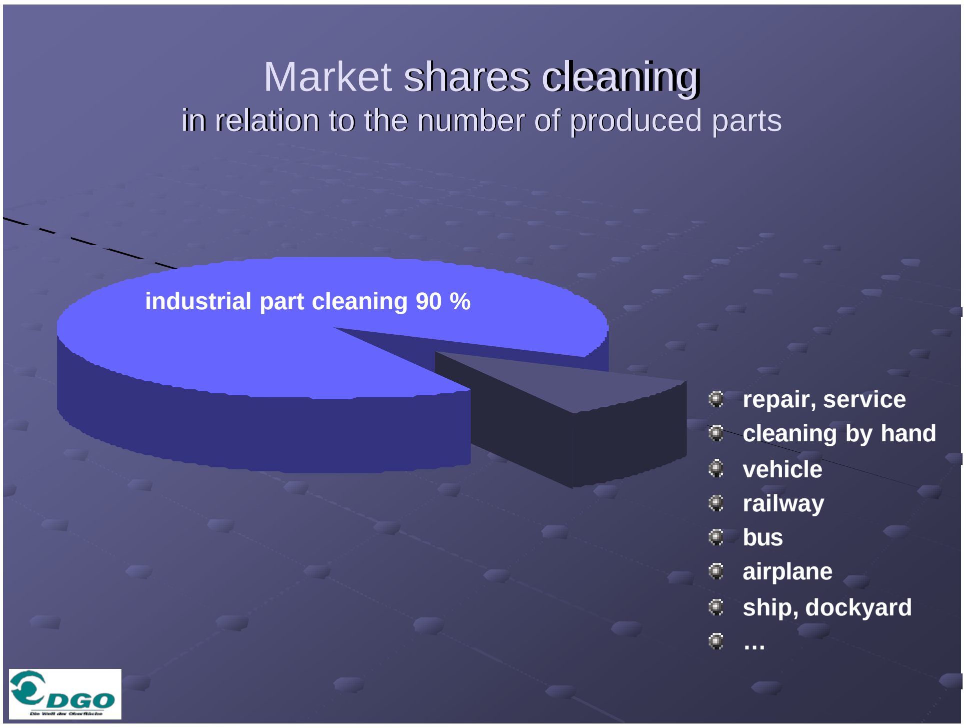
Annex III. Cleaning metal surfaces in maintenance routines.

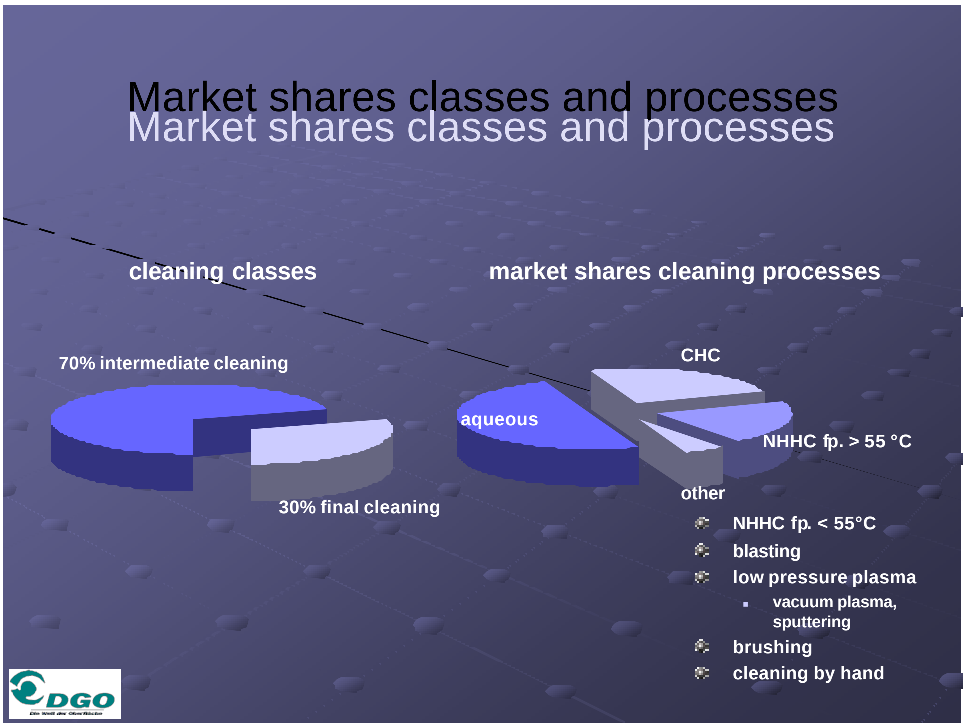
Branch/activity	Dirt	Agent / process	Cleaning equipment	Applications
Food industry	Animal fat, blood	3-step aqueous: alkaline + acidic + disinfectant /Estonia/	spray-cleaning plant /Denmark/	Automated, 3
Cleaning of gas cylinders	Oily resi-due, rust, paint	Outside: mechanical cleaning Interior: mechanically by metal rods, followed by ethanol	Brushing station Rotational shaker /in-house origin/	Manual load-ing, 1
Ship repairing: maintenance of generators	Oily residue	Aqueous, alkaline soaking agent /Estonia/	High-pressure cleaner /Germany/	Manual, 1
	Oil, dust	Solvent-based agent, not hazardous /Norway/	manual application	1

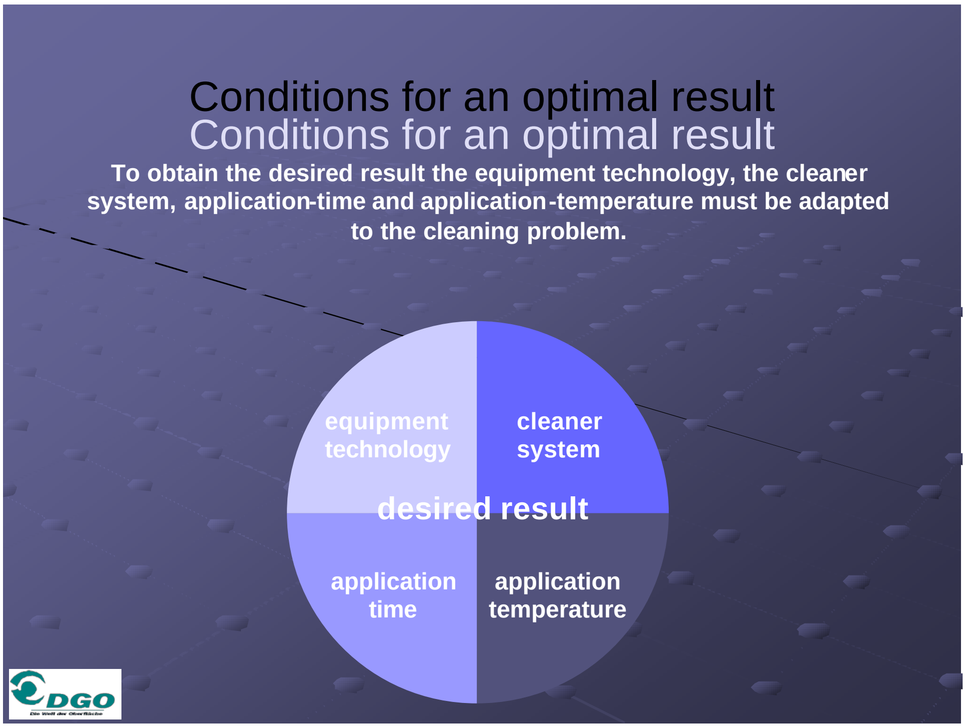
Ship repairing: preparatory works for painting	Marine species	Cleaning by water jet	Jet pump station /Germany/	Manual, 1
	Paint, rust	Blasting granules: silicate /Finland/	Blasting nozzles, Compressor units /Germany/	Manual, 1
Tank cleaning	Sediment, oil, fuel residues	Aromatic-hydrocarbon distillate based soaking agent /USA-International/	Rotating head jet system /Sweden/	Vehicle mounted, 1
			Jet washer /Germany/	Manual, 1
Assembled systems: industrial applications	oil, dust	Aqueous alkaline agents /Finland/	Washing machine (Finland)	Manual loading, 2
	burnt-in oil	Kerosene /Russia/	Bath, 50 L /in-house origin/	Manual, 1
Assembled systems: car-care applications	oily dirt	Pressurised air cleaning + aqueous alkaline agent /Great Britain/	Wheeled jet washing stand /Italy/	Manual, 1
	sintered oily dirt	Pressurised air cleaning + solvent based agent /Netherlands/	spray bottle, “run-off” cleaning	Manual, 1
	rust, oil, oily dirt	Solvent based agents /Netherlands/	spray bottle, manual wiping	Manual, 4
Car / bus maintenance. engine washing	oily dirt	Aqueous neutral agents /Sweden/	Jet washer /Germany/	Manual, 1
		Aqueous alkaline agents /Great Britain/	spray bottle, sponge	Manual, 1
		Industrial gasoline based agent + water /Estonia/	spray bottle, water hose	Manual, 1
Maintenance of cars / buses: washing	Dust, oil, salt, etc.	Aqueous neutral agent /Estonia/	Jet washer /Germany/	Manual, 1
		Aqueous neutral agents /Sweden/	Washing station /Finland/	1
	Bitumen stains	Alcohol-based agent /Sweden/	Jet washer /Germany/	Manual, 1

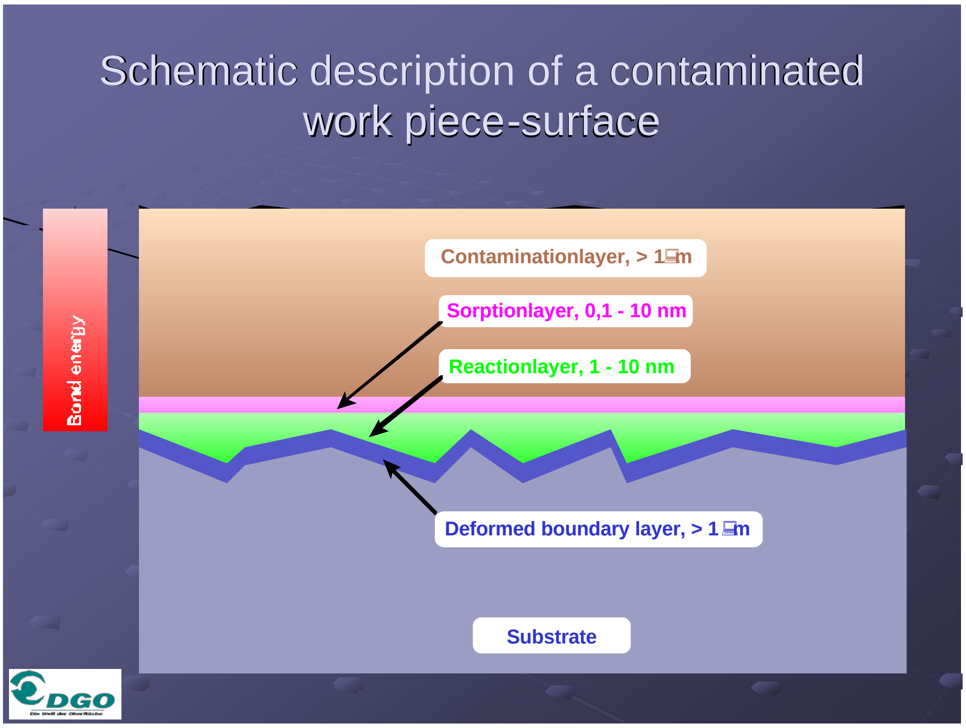
Main cleaning technologies: an overview

Reiner Grün, German Association for Electroplating and Surface Treatment, Zwingenberg, Germany





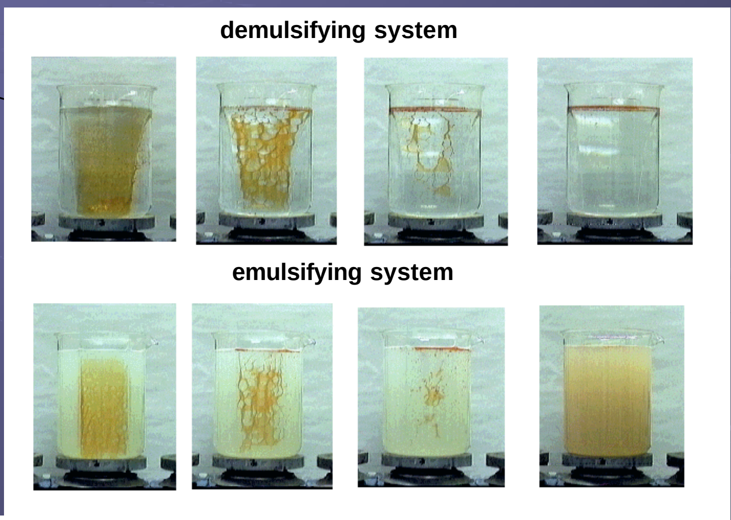

Conditions for an optimal result
To obtain the desired result the equipment technology, the cleaner system, application-time and application-temperature must be adapted to the cleaning problem.
equipment technology
cleaner system
desired result
application time
application temperature
DGO


Schematic description of a contaminated work piece-surface
Bond energy
Contaminationlayer, > 1µm
Sorptionlayer, 0,1 - 10 nm
Reactionlayer, 1 - 10 nm
Deformed boundary layer, > 1 µm
Substrate
DGO

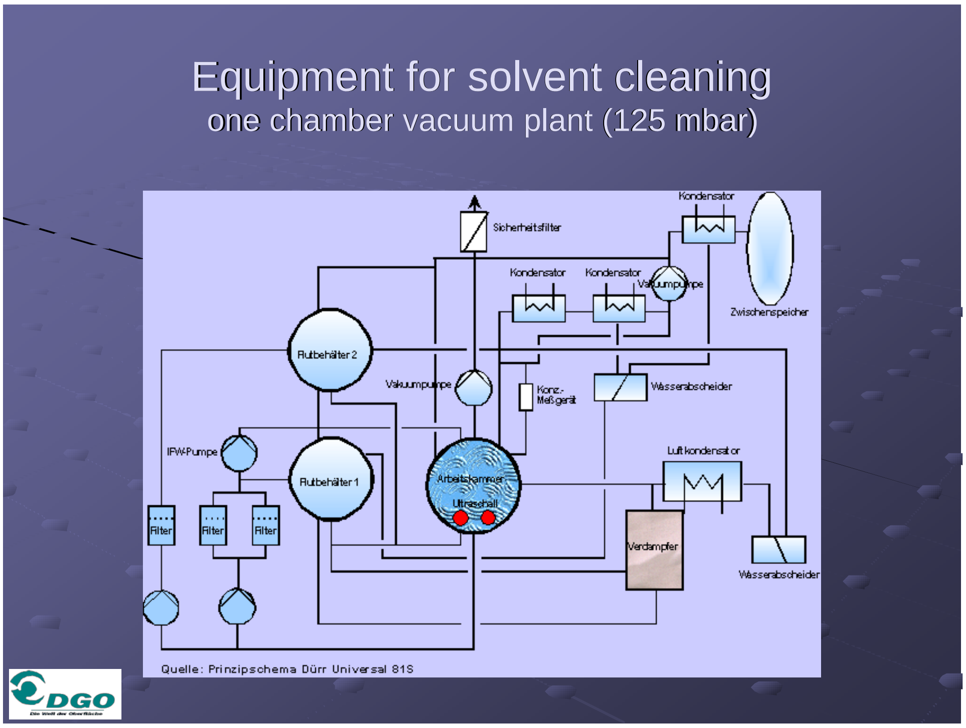
Cleaning systems
Cleaning systems

- solvents
  - CHC
    - TRI, trichloroethylene
    - PER, perchloroethylene
    - MeCl, methylene chloride
  - NHHC fp. > 55°C
    - Isoparaffine
    - hydrocarbons
    - Alkoxy-Propanol (Dowanol)
- aqueous, demulsifying or emulsifying
  - alkaline cleaner
    - pH 9-14
    - powder, liquid
    - spray, immersion, US
    - 1 and 2 components
  - neutral cleaner
    - pH 7 - 9
    - liquid
    - spray, immersion, US
    - corrosion protection
  - acid cleaner
    - pH < 6
    - liquid
    - immersion, US

Aqueous cleaning systems



oil on a lantern slide; 60 °C


Equipment for solvent cleaning
one chamber vacuum plant (125 mbar)
Kondensator
Sicherheitsfilter
Kondensator
Kondensator
Vakuumpumpe
Zwischenspeicher
Flutbehälter 2
Vakuumpumpe
Konz.-Meßgerät
Wasserabscheider
IFW-Pumpe
Flutbehälter 1
Arbeitskammer
Ultraschall
Luftkondensator
Filter
Filter
Filter
Verdampfer
Wasserabscheider
Quelle: Prinzipschema Dürr Universal 81S
DGO

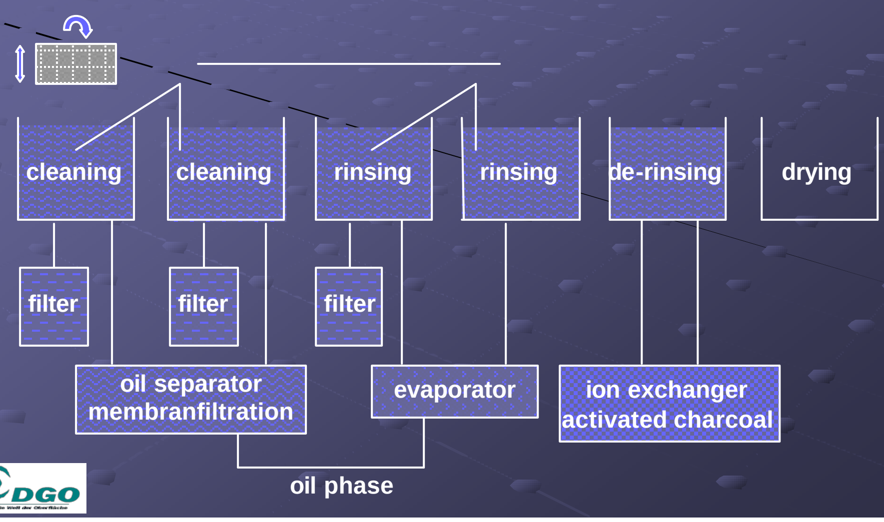

Equipment for solvent cleaning
Höckh
Dürr
Multimatik
DGO

Solvent cleaning

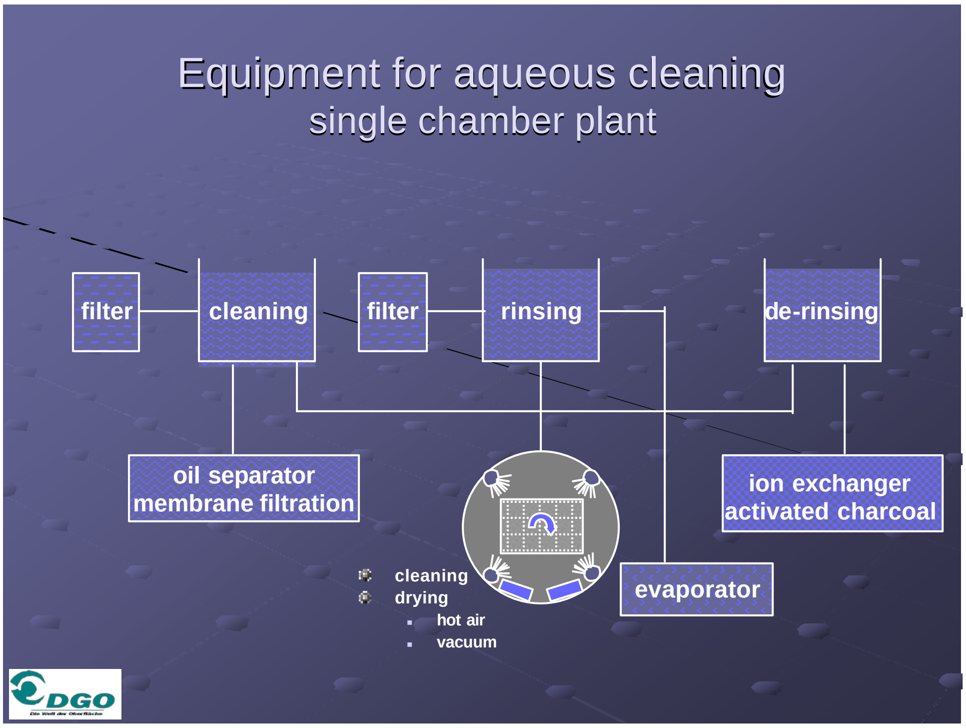
- pressure
  - 100-125 mbar
- application temperature
  - 70-80 °C
- methods
  - spray (1-10 bar)
  - ultrasonic
  - immersion
  - Hydroson©, high pressure flow (5-25 bar)
- chemical analysis
  - oil content
  - water content
  - stabilizer

Equipment for aqueous cleaning

multi chamber plant




Equipment for aqueous cleaning
multi chamber plant
DGO


Equipment for aqueous cleaning
single chamber plant
filter
cleaning
filter
rinsing
de-rinsing
oil separator
membrane filtration
ion exchanger
activated charcoal
evaporator
cleaning
drying
hot air
vacuum
DGO

Single-chamber plant

Aqueous cleaning

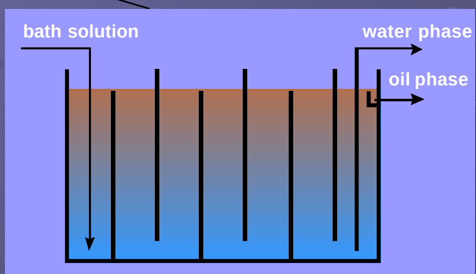
- application temperature
  - 70-80 °C
- methods
  - spray (1-10 bar)
  - ultrasonic (US)
  - immersion
  - Hydroson©, high pressure flow (5-25 bar)
  - high pressure deburring and cleaning (500-1000 bar)
  - Hydrovac©, boiling with vacuum (70-80 °C, 125 mbar)
- chemical analysis
  - builder
  - surfactant
  - water quality
  - corrosion protection

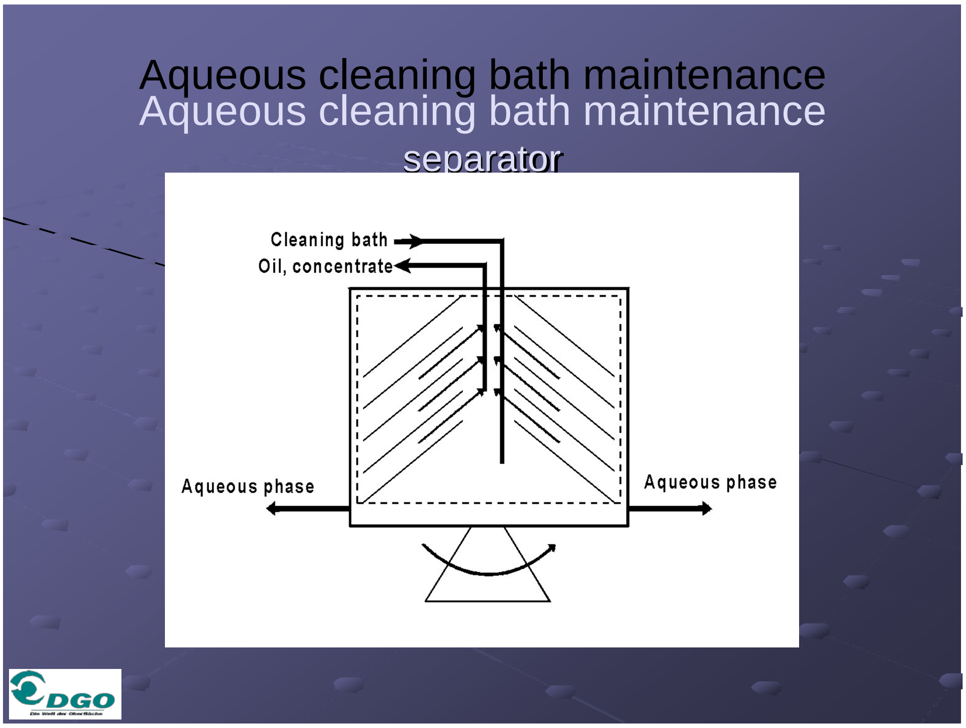
Chemical analysis
Chemical analysis

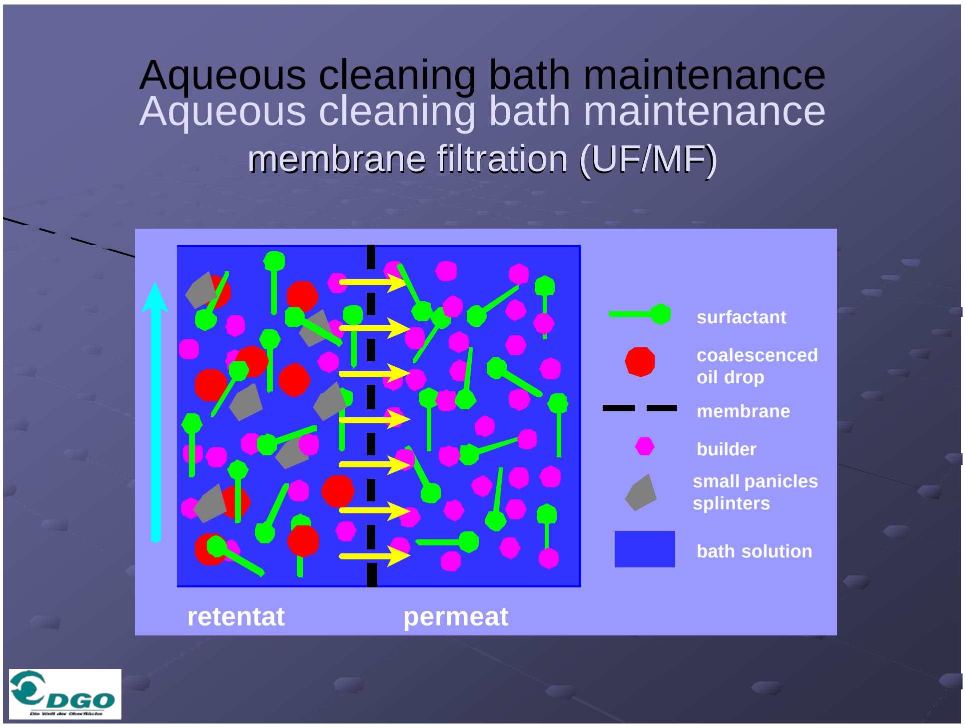
- solvents
  - NHHC
    - oil content
      - refraction index
      - boiling point
  - CHC
    - oil content
      - boiling point
    - water content
    - stabilizer
      - titration
      - pH
- aqueous cleaning
  - builder
    - titration
    - photometry (PO_4)
  - surfactant
    - photometry
    - tensiometer (www.sita-messtechnik.de)
  - water quality
    - conductance
    - photometry (COD)
  - corrosion protection
    - titration
    - DIN-Spänetest

Aqueous cleaning bath maintenance
Aqueous cleaning bath maintenance

oil-separator

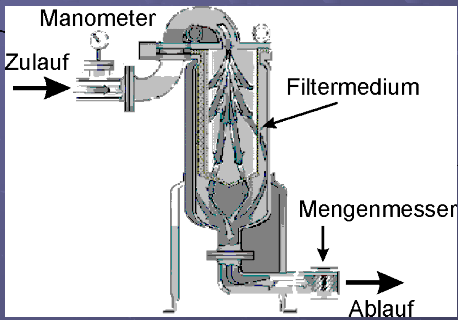



Aqueous cleaning bath maintenance
separator
Cleaning bath
Oil, concentrate
Aqueous phase
Aqueous phase
DGO


Aqueous cleaning bath maintenance
membrane filtration (UF/MF)
surfactant
coalescenced oil drop
membrane
builder
small panicles splinters
bath solution
retentat
permeat
DGO

Aqueous cleaning bath maintenance
Aqueous cleaning bath maintenance

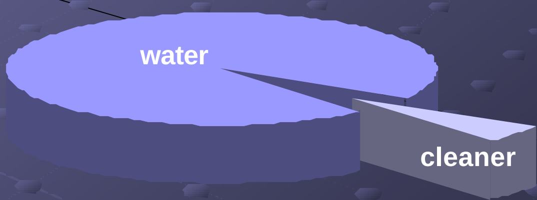
particle filtration



Aqueous cleaning water quality
Aqueous cleaning water quality

tap water ingredients

- calcium, magnesium
  - calcareous spots
- chloride, sulfate
  - rust, corrosion
- sodium
- potassium
- nitrate
- carbonate
- different organic substances




Automatically proportioning
advantages with the use of proportioning units
consistent concentration
less chemical analysis
consistent cleaning quality
smaller share of rejects
smaller rectification of rejects
ProMinent Dosiertechnik GmbH
ProMinent Dosiertechnik GmbH
ProMinent Dosiertechnik GmbH
DGO

Workshop 1, Part 1: Evaluation of Cleaning Processes

Introduction: Klaus Kuhl, Kooperationsstelle Hamburg, Germany

Conference, Hamburg, November 2003

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Evaluation

Overview

Technology	Quality	OSH	Environment	Costs
Throughput, utilization	Eval. by techn. (text)	Acute health hazards (CM)	Envronmental hazards (CM)	Total costs
Size of equipment	Eval. by techn. (grades)	Chronic health hazards	Emissions into air	Total costs per unit
Central/ decentral ...	Subsequent process	Fire, explosion hazards	Waste	Investment costs
Number of steps	Standards	Mechanical, el., etc. hazards	Energy consumption	Operational costs a) Labour b) Energy c) Waste/Water d) Waste e) Maintenance f) Agents
Auxiliary equipment	Analyses	Noise	Water consumption	
Qualification of workers		Procedure hazards	Waste water	
Quality of equipment				

2

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Technology I

- First idea
  Compatibility and tuning of all components
  BUT: limited data, very imprecise, components usually cover a wide range; German AC opposed
- Second idea
  Users view: what is important to him/her, as he/she considers to apply the process
  Not a real assessment but rather selection criteria.

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Evaluation

Technology II

Utilization, maximum and usual throughput	Calculated from questionaire (3.5)	In percent resp. number of parts
Size of equipment (floor space, height)	Length, width, height (3.7)	In meters
Central or decentral	Central/decentral (3.9)	Central/decentral
Simple or complicated procedure	Number of steps (3.8)	Number
Special or multitask equipment	Special/multitask (3.9)	Special/multitask
Auxiliary equipment (distillation, waste processing)	As stated in questionaire (3.12)	Text
Qualification level of workers	As stated in questionaire (6.4)	Text
Quality of equipment as seen by plant technician	As stated in questionaire (3.7, 7.2)	Text

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Evaluation

Quality (Customer‘s Satisfaction)

Evaluation by technician	Statement of users and possibly test records	Text (6.1)
Evaluation by technician	Statement of users and possibly test records	Five grades (6.1)
Subsequent process	E.g. electroplating, painting, repair, ...	Text (3.8.B)
Standards	Which standards are applied	Text (6.2, 3.8.C)
Analyses	Which analytical methods are applied	Text (6.3)

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Evaluation

Column Modell

Risks	Acute health hazards	Chronic health hazards	Environ-mental hazards	Fire and explosion hazards	hazards caused by the exposure potential	hazards caused by the pro-cedures
very high	highly toxic	K1, K2, M1, M2	N; water pollution	extremely flammable	gases, dusts	open
high	toxic, highly corrosive	R1,R2,K3,M3	class: WGK 3	highly flam-mable	highly volatile	
medium	harmful, corrosive	R3	WGK 2	flammable	volatile	closed
low	irritant	chronically affecting	WGK 1	hardly flam-mable	low volatile	
negligible	harmless by experience		not water polluting	inflammable	solids	tightly clo-sed

Klaus Kuhl

Column Modell (II)

- Download as pdf file:
  - German: www.hvbg.de/d/bia/pra/modell/spalte.htm
  - English: .../spaltee.htm
- Electronic version:
  - www.aser.uni-wuppertal.de

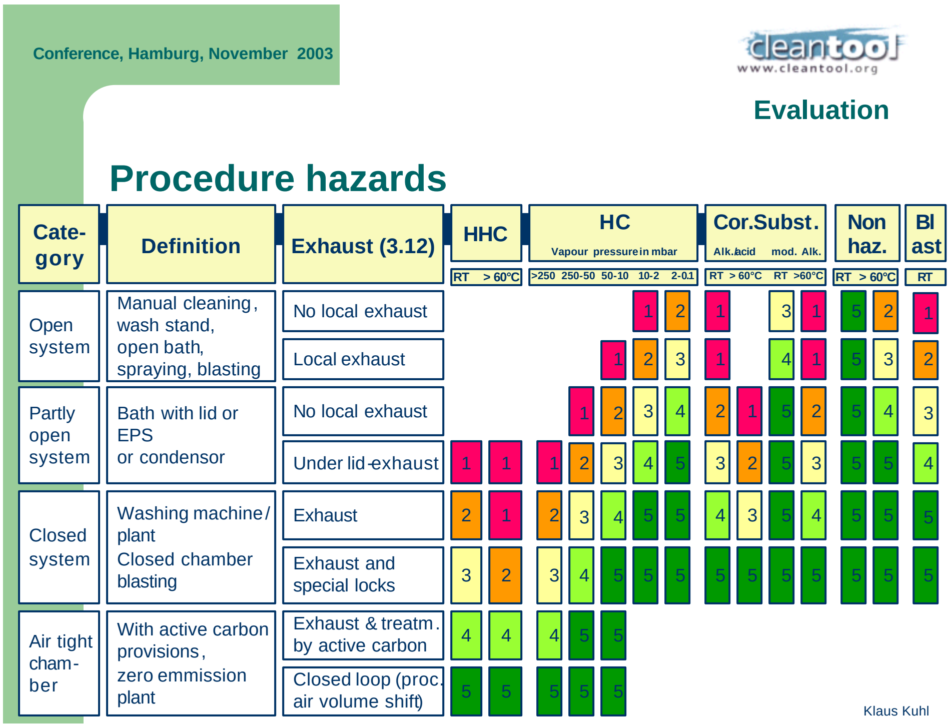
OSH (Concentration)

We rely on SDS especially compiled for the working concentration (agent producers have to surrender SDSs also for the concentration applied in the workshops). We will use these special SDSs to get the information for the column model (R-phrases, ...) etc.

If we would use the SDS with the original concentration of the agent, an agent producer who dilutes his hazardous product with a sufficient amount of water would score good results and another one with the same product who does not dilute that much would get bad results; although the working concentration could be the same.

pr EN 12921

1. Mechanical hazards
2. Electrical hazards
3. Thermal hazards
4. Hazards through noise
5. Hazards posed by consumables and work pieces being processes in the plant
    a. Hazards posed by cleaning agents used in the plant
    b. Fire and explosion hazards
6. Combinations of hazards
7. Hazards posed by failure of energy supply and other function failures
8. Hazards posed by missing or misplaced protective units



Cate-gory	Definition	Exhaust (3.12)	HHC RT	HHC > 60°C	HC (Vapour pressure in mbar) >250	HC 250-50	HC 50-10	HC 10-2	HC 2-0.1	Cor.Subst. Alk./acid RT	Cor.Subst. Alk./acid > 60°C	Cor.Subst. mod. Alk. RT	Cor.Subst. mod. Alk. >60°C	Non haz. RT	Non haz. > 60°C	Blast RT
Open system	Manual cleaning, wash stand, open bath, spraying, blasting	No local exhaust						1	2	1		3	1	5	2	1
		Local exhaust					1	2	3	1		4	1	5	3	2
Partly open system	Bath with lid or EPS or condensor	No local exhaust				1	2	3	4	2	1	5	2	5	4	3
		Under lid-exhaust	1	1	1	2	3	4	5	3	2	5	3	5	5	4
Closed system	Washing machine/ plant Closed chamber blasting	Exhaust	2	1	2	3	4	5	5	4	3	5	4	5	5	5
		Exhaust and special locks	3	2	3	4	5	5	5	5	5	5	5	5	5	5
Air tight cham-ber	With active carbon provisions, zero emmission plant	Exhaust & treatm. by active carbon	4	4	4	5	5									
		Closed loop (proc. air volume shift)	5	5	5	5	5									

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Evaluation

Environment

Envronmental hazards	Column modell, R-phrases, German water pollution class	Five grades
Emissions into air	Column modell, vapour pressure	Five grades
Waste attributed to agent	Processing of waste: evaporation, disposed of, reused, reused in company, no waste	Five grades
Energy consumption	Electric power multiplied by time	kWh
Water consumption	Water consumption	m^3
Waste water	Waste water attributed to cleaning process	m^3

12

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Evaluation

Costs

Total costs	Total cost generally per year	Euros
Total costs per unit	Per parts, per surface, per removed dirt (yearly)	Euros
Investment costs	Equipment etc.	Euros
Operational costs: a) Labour b) Energy c) Water/wastewater (treatment) d) Waste e) Maintenace f) Agents		Euros

13

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Energy, water, sewage, costs

A common scale is needed for:

- Energy consumption
- Water consumption
- Waste water
- Costs

Case 1: Comparison of a limited number of processes, selected by the user on almost identical requirements, parameters.
E.g.: Electric power 100 kWh against 50 kWh,
Water consumption 400 m3 against 500 m3
These figures are to be transferred to a scale between 1 and 5 for comparison purposes.

Case 2: Precise comparison
Related to removed amount of dirt (or number of parts)
100 kWh/10 kg of dirt -> 10 units presented on a scale between 1 and 5
50 kWh/20 kg of dirt -> 2.5 units presented on a scale between 1 and 5

Minutes of Workshop 1 Part 1:

Proposal to alter the "hazards caused by procedures"-table of our evaluation scheme. The selection of substances should be based on the column model. The current selection criteria were seen as inconsistent. The proposal was accepted by the CLEANTOOL staff.

The question of concentration was discussed in detail. As the current evaluation scheme is only based on the working concentration, the hazards of handling the delivered concentrates is not considered. This was due to the fact that most companies have automatic systems installed so that workers hardly come into contact with the concentrates. Nonetheless it was felt that a consideration would be helpful. (Carole LeBlanc: Dilution is no solution! She stressed the transport risks.)

Possibilities of database maintenance were also discussed.

Workshop 1, Part 2: Networking and Databases

Introduction: Klaus Kuhl, Kooperationsstelle Hamburg, Germany

(This introduction was not presented at the Workshop)

Who should be in the Network

- Enterprise technicians
- Specialists-practitioners
- Researchers, labs
- Projects
- EPA and OSHA
- Plant and agent producers/suppliers
- Magazines (archives)
- Consultants

How to Network

How to guarantee that users find the right persons to answer their questions

- Database
- Newsgroup
- Listserv
- Forum
- Community
- Archives

How to Finance Networking

- Sponsors
- Charges
- Integration
- Project
- ....

Workshop 2: Introduction in Manual Cleaning and BREFS

Introduction: Lothar Lißner, Kooperationsstelle Hamburg, Germany

MANUAL CLEANING is a major cleaning technology, wide spread, small size, hard to control

BREFS are prepared res. available for larger installations, fewer uses, large size, well controlled

Typical areas of manual cleaning of metal surfaces

Maintenance and repair in workshops or on site

Cars, trucks, busses, lifts, furnaces, boilers, electric installations, agricultural and construction machinery

Workshops mechanical engineering

Regular daily cleaning in the less automated processes, e.g. parts of the food industry, professional canteens

Removal with blasting processes

e.g. shipyards, corrosion protection of steel constructions

Small workshops

e.g. jewellery

Manual cleaning needs most concern in terms of health and safety, cost effectiveness and quality.

The used methods depend highly on experience due to an often unknown amount and sometimes also unknown type of dirt.

Large installations are better evaluated. Better data about dirt and quality requirements for the further processing are available.

The environment

The huge number of manual cleaning processes cannot be controlled in practice.

The used amounts of cleaning agents are small in relation to large installations, but in total they might be even more important due to the open use.

Large installations are better controlled. The risk is higher is case of an accident or a leakage.

Cost effectiveness and quality

The main strategy in manual cleaning is: take much of an aggressive cleaning agent and you are on the right way.

Control of costs and quality is difficult.

Technology

The technologies are still simple:

Mechanical removal,

Brushing

Wiping

Dipping into open bathes (sometimes heated or ultrasonic)

Blasting

The washing table is the major tool in workshops. Cleaning on site is done by wiping and brushing.

Health and safety

The open uses poses in many cases an unacceptable risks for the workers.

BREFS

BREFS are Best available Techniques reference documents

They are prepared in the frame of an EU-Directive
(the IPPC = Integrated Pollution Prevention and Control)

They have to be taken into account in the licensing process of industrial installations.

Covered are also ‘‘installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating’’

(Mrs Geldermann)

Manual cleaning needs a real improvement

How can the companies be reached?

Is it possible to reach these types of industries with a database?

Can the regulations and technologies in BREFS support smaller manual cleaning operations?

Workshop 2, Part 2: BREFS

Determination of Best Available Techniques (BAT)

Introduction: Dr. Jutta Geldermann, French-German Institute for Environmental Research (DFIU), University of Karlsruhe (TH), Germany

Prof. Dr. Otto Rentz, French-German Institute for Environmental Research (DFIU), University of Karlsruhe (TH), Germany

Determination of Best Available Techniques (BAT)

Overview

- Integrated Pollution Prevention and Control
  as the Aim of the Environmental Policy in the EU
  - IPPC-Directive 96/61/EC
  - Surface Treatment
- Approach for the assessment of cross-media aspects
  for BAT determination at EU-level
- Thematic Network ISACOAT
  Integrated Scenario Analysis in the sector of Metal Surface Coating
- Discussion / Open Questions

Integrated Pollution Prevention and Control as the Aim of the Environmental Policy in the EU IPPC-Directive

- EC-Directive concerning Integrated Pollution Prevention and Control (IPPC-Directive, 96/61/EG)
- Determination of „Best Available Techniques“ (BAT):
  - on an EU level: Description of BAT for the industrial sectors by Technical Working Groups (TWG)
  - on a national level: Orientation towards BAT during the process of granting the permit
- Annex I lists categories of covered industrial activities.
  - TWG on Surface Treatment of Metals and Plastics
    Kick-off Meeting: Sevilla 10 -12 April 2002
  - TWG on Surface Treatment using Solvents
    Kick-off Meeting: Sevilla 27 – 28 March 2003
- http://eippcb.jrc.es/pages/FAbout.htm

Council Directive 91/61/EG on Integrated Pollution Prevention and Control (IPPC) Art. 2 (11)

Definition

- The term „best available techniques“ signifies the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole.

- „Techniques“ include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.
- „Available“ techniques means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator.
- „Best“ means most effective in achieving a high general level of protection of the environment as a whole.

In determining the best available techniques special consideration should be given to the items listed in Annex IV.

Categories of Industrial Activities

Annex I (IPPC-Directive)

- Installations or parts of installations used for research, development and testing of new products and processes are not covered by this Directive.
- The threshold values given below generally refer to production capacities or outputs. Where one operator carries out several activities falling under the same subheading in the same installation or on the same site, the capacities of such activities are added together.
- 1. Energy industries
- 2. Production and processing of metals
  2.1. Metal ore (including sulphide ore) roasting or sintering installations
  2.2. Installations for the production of pig iron or steel ....

  ....

  2.5. Installations

  (a) for the production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes
  (b) for the smelting, including the alloyage, of non-ferrous metals, including recovered products, (refining, foundry casting, etc.) ...

  2.6. Installations for surface treatment of metals and plastic materials using an electrolytic or chemical process where the volume of the treatment vats exceeds 30m³

Categories of Industrial Activities

Annex I (IPPC-Directive)

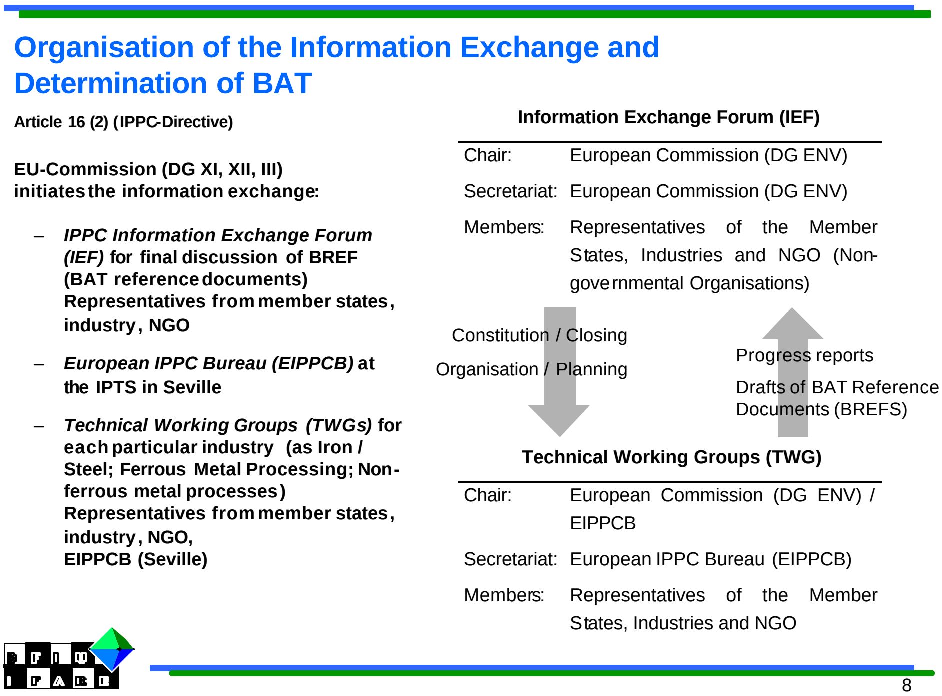
- 3. Mineral industry
- 4. Chemical industry
  Production within the meaning of the categories of activities contained in this section means the production on an industrial scale by chemical processing of substances or groups of substances listed in Sections 4.1 to 4.6

- ......
- 5. Waste management
- 6. Other activities
  6.1. Industrial plants for the production of pulp and paper and board with a production capacity exceeding 20 tonnes per day
  6.2. Plants for the pre-treatment (operations such as washing, bleaching, mercerization) or dyeing of fibres or textiles where the treatment capacity exceeds 10 tonnes per day
  6.3. Plants for the tanning of hides and skins ...
- .....
- 6.7. Installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating, with a consumption capacity of more than 150 kg per hour or more than 200 tonnes per year

General principles governing the basic obligations of the operator

Article 3 (IPPC-Directive)

- Member States shall take the necessary measures to provide that the competent authorities ensure that installations are operated in such a way that:
  - all the appropriate preventive measures are taken against pollution, in particular through application of the best available techniques;
  - no significant pollution is caused;
  - waste production is avoided in accordance with Council Directive 75/442/EEC of 15 July 1975 on waste; where waste is produced, it is recovered or, where that is technically and economically impossible, it is disposed of while avoiding or reducing any impact on the environment;
  - energy is used efficiently;
  - the necessary measures are taken to prevent accidents and limit their consequences;
  - the necessary measures are taken upon definitive cessation of activities to avoid any pollution risk and return the site of operation to a satisfactory state.
- For the purposes of compliance with this Article, it shall be sufficient if Member States ensure that the competent authorities take account of the general principles set out in this Article when they determine the conditions of the permit.



General boundaries of BREFs

IPPC BREF outline and guide

- Executive Summary
- Preface
- General Information
- Applied Processes and Techniques
- Current Emission and Consumption Levels
- Techniques to Consider in the Determination of BAT
- Best Available Techniques (BAT)
- Emerging Techniques
- Concluding Remarks
- Annexes
  1. Glossary – to define abbreviations and terms used in the document;
  2. Supporting Literature and/or Case studies;
  3. Summaries of existing national and international legislation, as far as submitted by the TWG;
  4. Monitoring of emissions (specific to sector)

Report on Best Available Techniques in the Sectors Paint and Adhesive Application

Rentz, O.; Peters, N. H.; Nunge, S.; Geldermann, J.: Bericht über Beste Verfügbare Techniken (BVT) in den Bereichen der Lack- und Klebstoffanwendung in Deutschland; VDI-Verlag, Reihe 16 (Technik und Wirtschaft) Nr. 158, Düsseldorf (2003); ISBN 3-18-315816-7

Paint application	Adhesive application
Serial coating of passenger cars	Tapes
Coating of busses, trucks and mobile homes	Paper and packaging, composite foils
Coating of agricultural and construction machines	Vehicles
Coating of rail vehicles	Shoes and leather goods
Coating of planes	Wood materials and furniture
Coating of ships	
Coating of plastic and metal workpieces	
Coating of packings	
Coating of furniture	

10

Approach for the assessment of cross-media aspects for BAT determination at EU-level

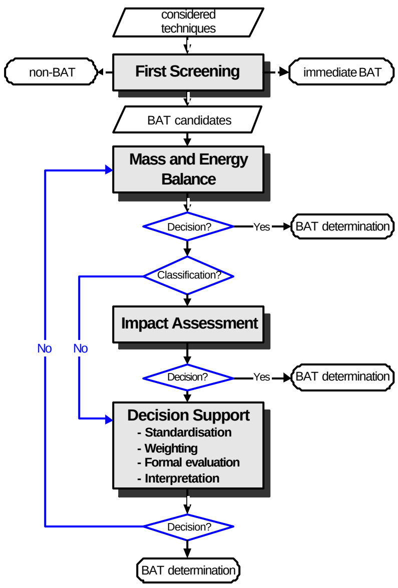
Preconditions:

- Requirements of the IPPC-Directive
- Sufficient data availability assumed
- Economic and technical viability assumed, because considered techniques are tested on an industrial scale

Proposal:

Assessment procedure with a modular structure

- allowing for an iterative application
- focussing the experts' discussion on key issues



12

Objective of the "First Screening"- Module is the Setting of the Assessment Scope and the Selection of "Canditate BAT"

Module 1: First Screening

- Setting of system boundaries
  (main process, sub-processes, associated activities)
- Non-Compliance with relevant emission limit values
  'non-BAT'
- If no relevant environmental impacts is caused
  'immediate BAT'

Objective of the "Mass and Energy Balance"- Module is the Compilation of relevant Mass and Energy Flows

Module 2: Mass and Energy Balance

- Determination of assessment scope
  - Extension is necessary, if significant differences in
    - use of energy,
    - input substances, or
    - waste generation
  - Limitation is possible, if system parts are equal,
    slightly different, or of minor ecological relevance
- Supplementation of mass and energy data as part of the information exchange according to IPPC-Directive

Objective of the „Impact Assessment"- Module is the Modelling of the Potential Environmental Impact

Module 3: Impact Assessment (1/2)

- Assignment of mass and energy flows to respective
  Impact Categories (cf. Life Cycle Assessment LCA)
- Calculation of 'Impact Potentials'

Linear impact assessment factors are not designed for a realistic

modelling of complex interdependencies and toxicological issues,

but some guidance on the cross-media aspects can be given.

Further Research is needed for the different Impact Categories for BAT Determination at EU-Level

Module 3: Impact Assessment (2/2)

Adopted from the LCA:

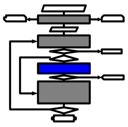
- Global warming
- Ozone depletion (stratosphere)
- Acidification of land and water
- Nutrification of water
- Photochemical oxidants formation

Pragmatically modified:

- Consumption of resources
- Humantoxicity
- Ecotoxicity
- Hazardous Waste

Newly introduced:

- Protection of the marine environment



Objective of the „Decision Support"- Module is the Transparent and Comprehensible Data Preparation for BAT Determination

Module 4: Decision Support (1/2)

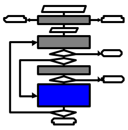
Weighting as the most subjective part of each decision should be based on objective information

Ecological relevance of the impact categories

Quantitative relevance of the impact potentials of the considered techniques (based on 'specific contribution')

Estimation of the **total relevance** with verbal predicates

		Specific contribution				
		100 - 80%	80 - 60%	60 - 40%	40 - 20%	< 20%
		of the maximum				
		very large	large	medium	moderate	low
Ecological relevance	very large	very large	very large	large	large	medium
	large	very large	large	large	medium	medium
	medium	large	large	medium	medium	moderate
	moderate	large	medium	medium	moderate	moderate
	low	medium	medium	moderate	moderate	low



17

Sintering is a process in which fine ore is mixed with coke and additives and agglomerated by heating into larger lumps

Description of the Sintering Process

<u>**Source:**</u> HKM Hüttenwerke Krupp Mannesmann; http://www.hkm.de/produktion-umwelt/index.html

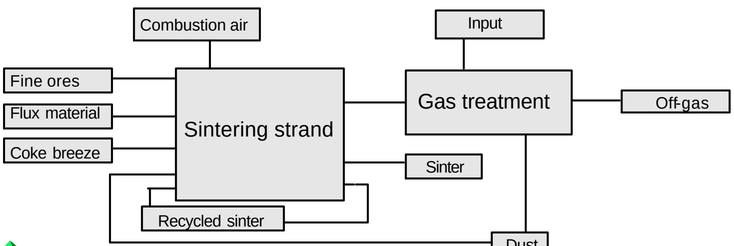
18

The Case Study about the Sinter Production considers four different technologies and the main environmental impacts

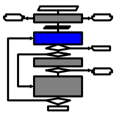
Overview of the System

<u>Environmental Concerns:</u>
Particulate emissions
(Fine and coarse dusts)
Heavy metals
Gaseous emissions
(SO_2, CO, PCDD/PCDF)

<u>Examined Techniques:</u>
Technique A: Electrostatic precipitator (ESP)
Technique B: ESP plus fabric filter
Technique C: Cyclone
Technique D: Airfine process



Mass and Energy Balance

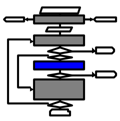


All figures are related to the reference quantity of 1 ton sinter

Relevant input and output	Substance /Energy	Technique A	Technique B	Technique C	Technique D	Unit
Energy	**Fossil fuels**	1700	1560	1650	1600	MJ PE
	Electric energy	395	425	345	410	MJ PE
Atmospheric emissions	Dust	$7.65 \cdot 10^{-2}$	$9.21 \cdot 10^{-3}$	$6.48 \cdot 10^{-1}$	$1.10 \cdot 10^{-1}$	kg
	CO	17.25	31.30	23.76	39.60	kg
	SO_2	0.832	1.311	1.350	0.820	kg
	NO_x	0.410	0.527	0.486	0.400	kg
	NMVOC	$8.61 \cdot 10^{-2}$	$4.60 \cdot 10^{-2}$	$3.05 \cdot 10^{-1}$	$2.50 \cdot 10^{-2}$	kg
	Chloride ions as HCl	$3.62 \cdot 10^{-2}$	$2.86 \cdot 10^{-2}$	$4.54 \cdot 10^{-2}$	$5.90 \cdot 10^{-2}$	kg
	Fluoride ions as HF	$3.52 \cdot 10^{-3}$	$4.60 \cdot 10^{-4}$	$1.14 \cdot 10^{-2}$	$1.29 \cdot 10^{-3}$	kg
	PCDD/PCDF	$3.45 \cdot 10^{-9}$	$1.84 \cdot 10^{-9}$	$6.48 \cdot 10^{-9}$	$0.446 \cdot 10^{-9}$	kg
	As	$1.00 \cdot 10^{-5}$	$3.68 \cdot 10^{-7}$	$4.32 \cdot 10^{-5}$	$1.10 \cdot 10^{-6}$	kg
	Cd	$1.40 \cdot 10^{-4}$	$5.71 \cdot 10^{-7}$	$1.30 \cdot 10^{-4}$	$6.69 \cdot 10^{-6}$	kg
	Cr	$1.21 \cdot 10^{-4}$	$4.42 \cdot 10^{-6}$	$4.32 \cdot 10^{-5}$	$4.46 \cdot 10^{-6}$	kg
	Cu	$3.54 \cdot 10^{-4}$	$1.84 \cdot 10^{-6}$	$1.30 \cdot 10^{-4}$	$3.79 \cdot 10^{-5}$	kg
	Hg	$4.51 \cdot 10^{-5}$	$1.49 \cdot 10^{-5}$	$4.32 \cdot 10^{-5}$	$2.23 \cdot 10^{-5}$	kg
	Mn	$7.18 \cdot 10^{-4}$	$2.03 \cdot 10^{-6}$	$5.44 \cdot 10^{-4}$	$2.01 \cdot 10^{-5}$	kg
	Ni	$9.76 \cdot 10^{-5}$	$4.60 \cdot 10^{-6}$	$7.46 \cdot 10^{-5}$	$1.10 \cdot 10^{-6}$	kg
	Pb	$8.75 \cdot 10^{-4}$	$8.47 \cdot 10^{-6}$	$9.91 \cdot 10^{-3}$	$9.58 \cdot 10^{-5}$	kg
	Sn	$9.18 \cdot 10^{-5}$	$7.00 \cdot 10^{-7}$	$9.44 \cdot 10^{-5}$	$1.30 \cdot 10^{-4}$	kg
	Tl	$1.95 \cdot 10^{-5}$	$2.21 \cdot 10^{-7}$	$1.56 \cdot 10^{-5}$	$4.46 \cdot 10^{-6}$	kg
	Zn	$2.40 \cdot 10^{-3}$	$4.60 \cdot 10^{-5}$	$3.67 \cdot 10^{-4}$	$2.23 \cdot 10^{-6}$	kg
Aquatic emissions	Chloride	0	0	0	$3.06 \cdot 10^{-4}$	kg
	SO_4	0	0	0	$1.55 \cdot 10^{-4}$	kg
	Solid particles	0	0	0	$5.11 \cdot 10^{-7}$	kg
	Fe		0	0	$1.45 \cdot 10^{-8}$	kg
	Cr			0	$5.69 \cdot 10^{-10}$	kg
	Cu				$3.97 \cdot 10^{-9}$	kg
	Zn, Ni, Cd, Al, As, Pb, CN-volatile, Flourides (F), Sulfide (S), NH_4-N, NO_3-N, NO_2-N					
	TOC, COD					
Waste	**Filter cake, dry**	**0**	**0**	**0**	**0.15**	**kg**

20

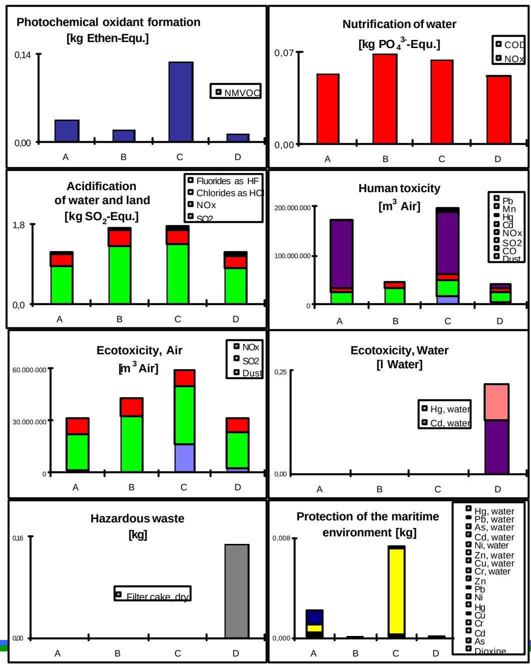
Impact Assessment for sinter technique D



Medium	Substance	Impact category
Air	Dust	Humantoxicity
		Ecotoxicity, air
	CO	Humantoxicity
	SO_2	Acidification
		Humantoxicity
		Ecotoxicity, air
	NO_x	Acidification
		Eutrophication
		Humantoxicity
		Ecotoxicity, air
	NMVOC	Formation of Photochemical oxidants
	Chloride as HCl	Acidification
	Fluoride as HF	Acidification
	PCDD/PCDF	Protection of the maritime environment
	As	Protection of the maritime environment
	Cd	Humantoxicity
		Protection of the maritime environment
	Cr	Protection of the maritime environment
	Cu	Protection of the maritime environment
	Hg	Humantoxicity
		Protection of the maritime environment
	Mn	Humantoxicity
	Ni	Protection of the maritime environment
	Pb	Humantoxicity
		Protection of the maritime environment
	Zn	Protection of the maritime environment
Water	Cr, water	Protection of the maritime environment
	Cu, water	Protection of the maritime environment
	Zn, water	Protection of the maritime environment

21

Impact potentials per ton sinter



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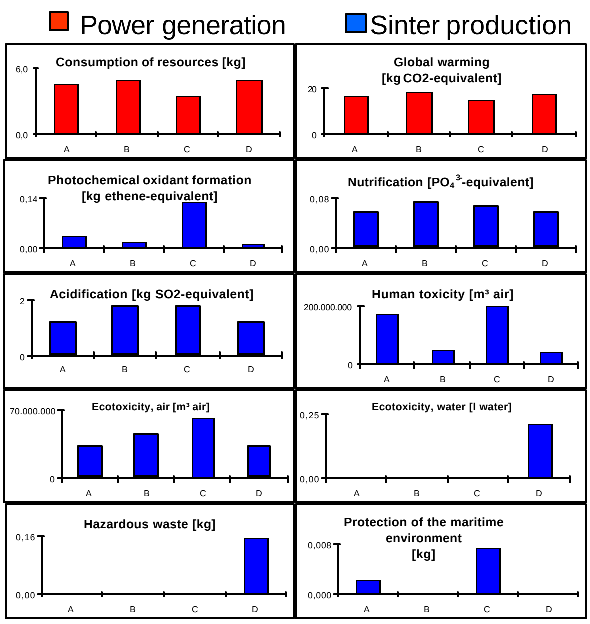
Impact potentials per ton sinter Disaggregation of power generation



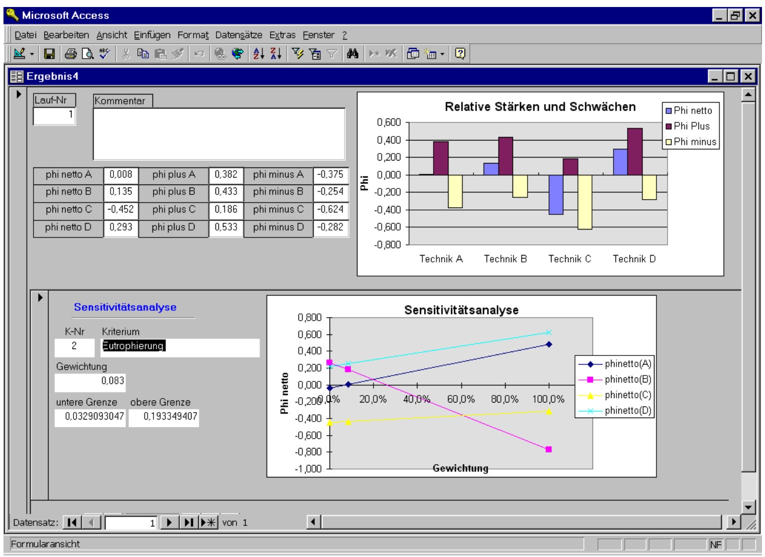
23

Starting Point of the Decision Support Module is the Decision Table based on the Impact Assessment

Decision Table of the Case Study

Criteria / Alternatives	Technique A	Technique B	Technique C	Technique D	Unit per t sinter	Weighting
Photochemical oxidant formation	35.8	19.1	127	10.4	10^{-3} kg Ethene-Equ.	8.3%
Nutrification	53.2	68.4	63.2	52	10^{-3} kg PO_4^{3-}-Equ.	8.3%
Acidification	1.16	1.71	1.75	1.15	kg SO_2-Equ.	8.3%
Humantoxicity	174	47.3	197	42	10^{6} m³ Air	13.9%
Ecotoxicity, air	30.9	43.5	59.7	31.3	10^{6} m³ Air	8.3%
Ecotoxicity, water	0	0	0	0.22	l Water	5.6%
Hazardous waste	0	0	0	0.15	kg	5.6%
Protection of the marine environment	2.24	0.05	7.39	0.11	10^{-3} kg	8.3%
Fossil energy	1700	1560	1650	1600	MJ	8.3%
Electric energy	395	425	345	410	MJ	8.3%
PCDD/PCDF	3.45	1.84	6.48	0.45	10^{-9} kg	11.1%
Aquatic emissions	0	0	0	1		5.6%

Multi-Criteria Decision Support System for Integrated Technique Assessment



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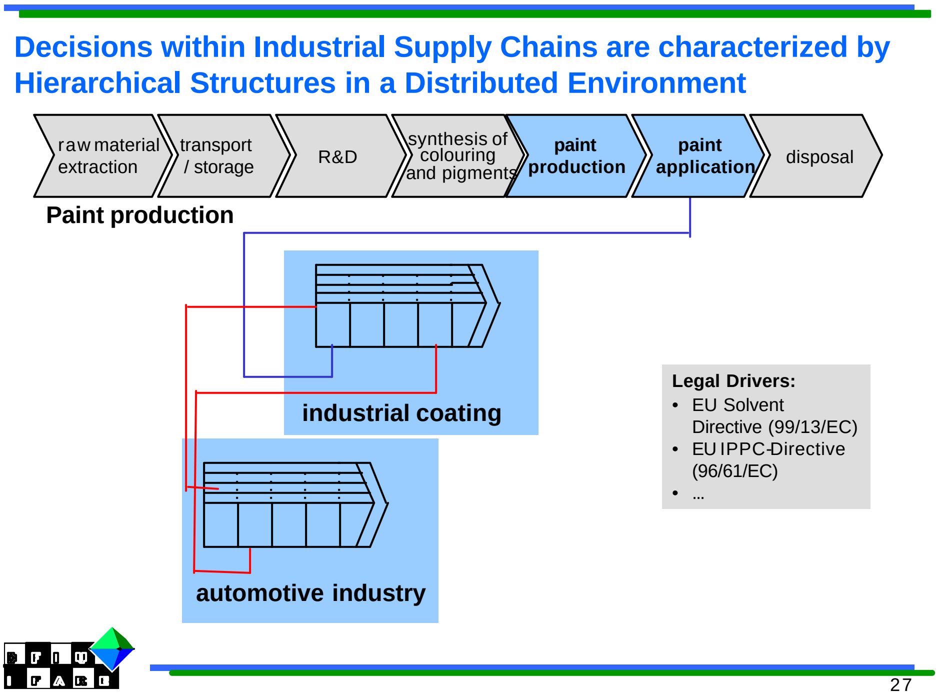
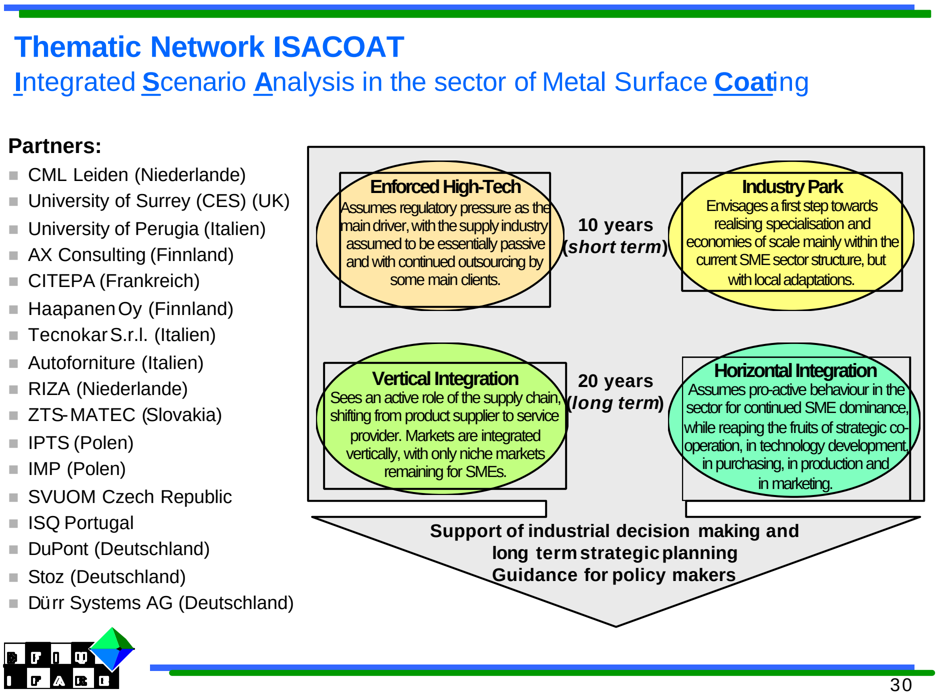


Strategic Planning within the Supply Chain of the Coating Industry

- The value chain of the paint industry involves many heterogeneous companies:
  - on the one hand big suppliers of raw materials (e.g. solvents suppliers or suppliers of pigments), paint producers and producers of painting installations,
  - on the other hand a huge number of various companies of paint applications (SME: small and medium sized enterprises)
- The coating sector still has a substantial contribution to the total VOC-emissions, although new paint products and technologies have already been developed.
- Within an integrated procedure model decision support tools for the paint application sector are presented, allowing a cost–efficient implementation of new paint products and technologies and an assessment method for the estimation of future costs induced by environmental legislations.

Integrated Scenario Analysis

- Possible future scenarios in industrial engineering and in the coating sector are investigated in close co-operation with paint producers, SME in the sector of metal coating and research institutions from all over Europe.
- Different types of scenarios will be developed.
- The envisaged scenarios help to explore future structural changes in organisation and functioning of the sector caused by new environmentally friendly products and techniques.
- As a result, sectoral strategic planning can be improved, taking into account environmental, technical and socio-economic aspects along the complete supply chain and life cycle.
- In this context, existing assessment tools (e.g. Life Cycle Assessment or Substance Flow Analysis) are being used and further developed.



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- Rentz, O.; Hein, J.; Kippelen, C.; Schultmann; F.:
  Assessment of the cost involved with the Commission’s draft proposal for a Directive on the limitation of the organic solvent emissions from industrial sectors, On behalf of the European Commission (DG XI), (1994)

Minutes of Workshop 2:

Mr Lißner gave a brief overview on the current manifold uses of manual cleaning . Manual cleaning still is a major cleaning technology for most of the small cleaning operations, but also for larger works. Subsequently Mrs Geldermann of the French-German Institute for Environmental Research (DFIU) held a lecture on “Determination of Best Available Techniques (BAT)” (see details in Annex 2) concerning IPPC, BREFS and BAT’s.

Adjacent to the presentation the group was given the possibility for discussion. There were different views on whether the basic parameters within IPPC are too complicated for SME to apply or not. One opinion was that IPPC has a more abstract approach to the subject compared to practical oriented databases like CLEANTOOL or SAGE. According to one participant IPPC and databases like CLEANTOOL are depending on each other, because IPPC can only be implemented by SME unless the necessary data are available.

One participant mentioned legislative differences and existing differences in industrial structures within Europe that have to be taken into account when applying IPPC. IPPC seems to be interesting for big companies and leaves the main group of producers within Europe out of focus.

Mrs Geldermann didn’t agree with these statements and pointed out the wide range of possible applications that the IPPC has to cover within Europe and that it has been put into action already several years ago. She pointed out, that IPPC covers all larger installations of cleaning. To her it is not absolutely necessary to gain information from a new database but to use existing sources of information in the internet. She recommended that databases like CLEANTOOL should first of all innovate in an IPPC direction and from there break down the information to a practical basis. That would make CLEANTOOL a useful part of IPPC.

Finally the participants agreed mainly that CLEANTOOL is an environmental instrument that could be of importance for a huge number of European SME because of its design. It gives the possibility to compare cleaning processes on a very practical level. The most important motivation is not to make CLEANTOOL only a tool to improve the environmental performance but to give SME a useful instrument to asses all aspects of their day-to-day cleaning processes.

Panel discussion

Introduction to new metal cleaning technologies and methods

Carole LeBlanc, Ph.D., Toxics Use Reduction Institute (TURI), University of Massachusetts, Lowell, Massachusetts, USA

Presentation Overview

- Background Information
- The Need for a Tool and/or Training
- Results of Using the Tool
- Results of Training Thus Far
- Continuing and Future Work
- Acknowledgements and Contact Information

Background Information

- Metalworking frequently involves surface treatment with greases, lubes, waxes, etc.
- These topical treatments often require removal within the manufacturing process
- Organo/chlorinated solvents traditionally used for this purpose
  - Practice known as ‘degreasing’ or ‘vapor degreasing’
  - Widespread in many global industries, including electronics

Potential Hazards of Solvents

Acute Issues
- Reactivity such as flammability

Chronic Issues
- May deplete the ozone layer (ODP)
- May add to global warming (GWP)
- May contain toxics
  - Volatile Organic Compounds (VOCs)
  - Carcinogens
  - Reproductive Toxins
  - Neurological Toxins

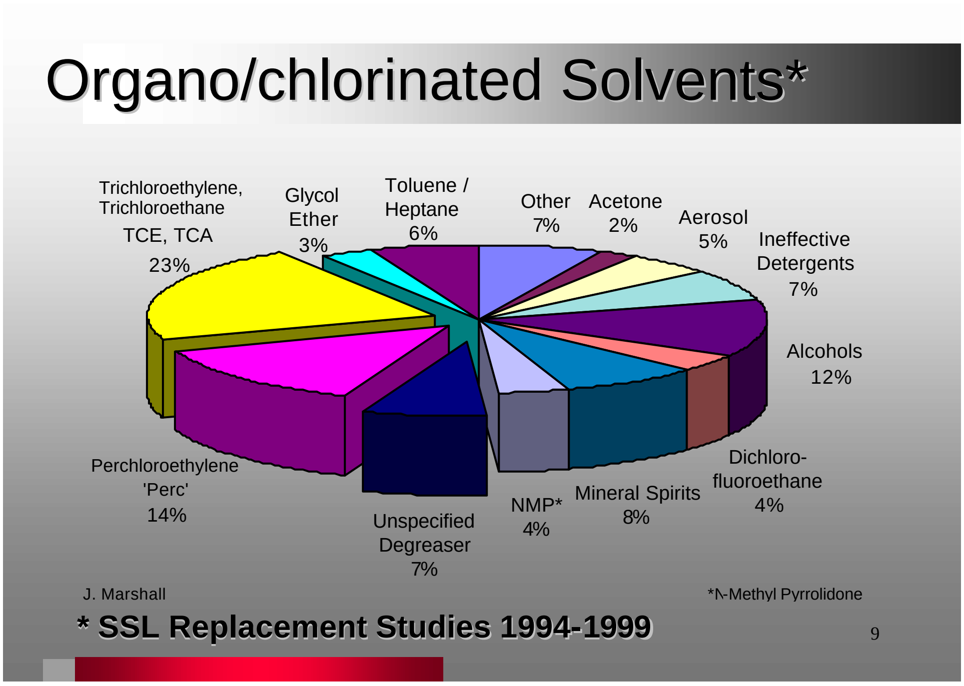
Why a Surface Cleaning Lab in Mass.?

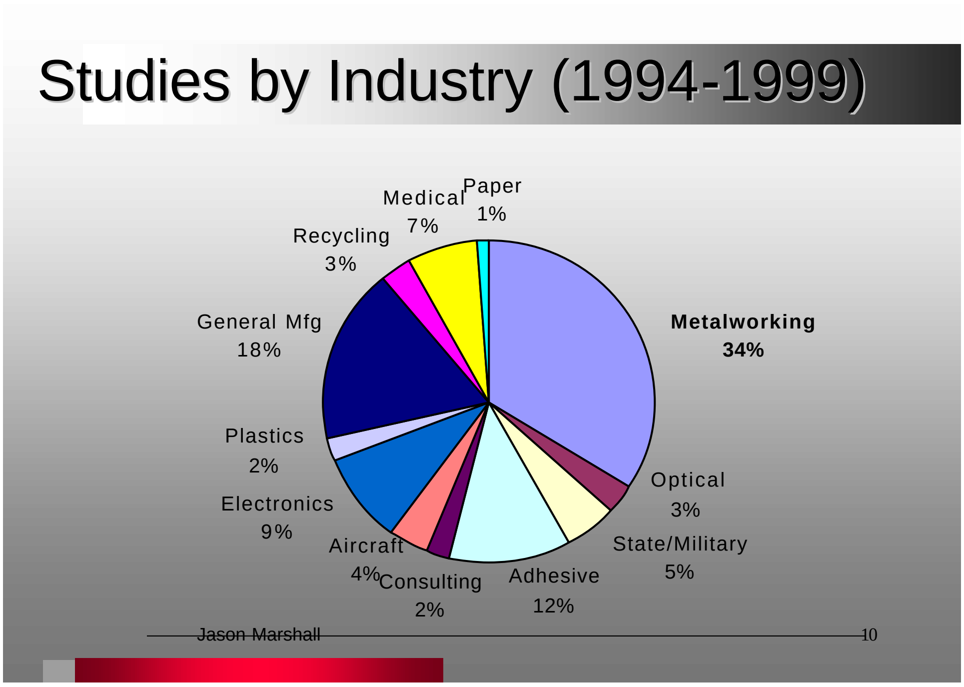
- Many of EPA's Toxic Release Inventory (TRI) chemicals are used, not manufactured, in this state
- Transportation issues are therefore very important
- Some of these toxics are known for their solvency, that is, their ability to dissolve dirt (i.e., clean surfaces)

Top Five TRI Chemicals (1994)

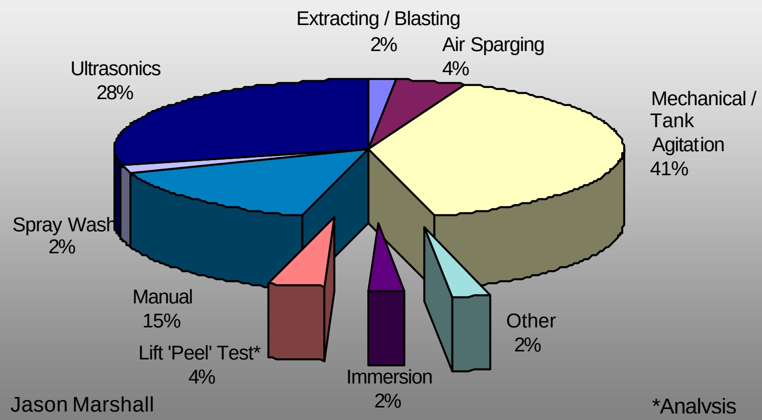
- Toluene
- Methyl ethyl ketone (MEK)
- Trichloroethylene (TCE)
- Dichloromethane
- Methanol

- Approximately six million pounds for total air/water/land releases in Massachusetts


Organo/chlorinated Solvents*
Trichloroethylene, Trichloroethane
TCE, TCA
23%
Glycol Ether
3%
Toluene / Heptane
6%
Other
7%
Acetone
2%
Aerosol
5%
Ineffective Detergents
7%
Alcohols
12%
Dichloro-fluoroethane
4%
Mineral Spirits
8%
NMP*
4%
Unspecified Degreaser
7%
Perchloroethylene 'Perc'
14%
J. Marshall
*N-Methyl Pyrrolidone
* SSL Replacement Studies 1994-1999
9


Studies by Industry (1994-1999)
Medical
7%
Paper
1%
Recycling
3%
General Mfg
18%
Metalworking
34%
Plastics
2%
Electronics
9%
Optical
3%
State/Military
5%
Aircraft
4%
Consulting
2%
Adhesive
12%
Jason Marshall
10

Alternative Cleaning Processes



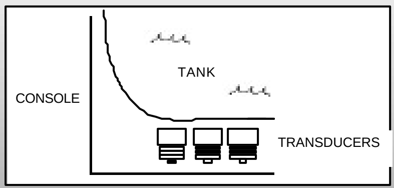
Jason Marshall

*Analvsis

1994-1990

11

Some Examples



Aqueous Ultrasonic Tank

Delivery Device for Sodium Bicarbonate Blasting

12

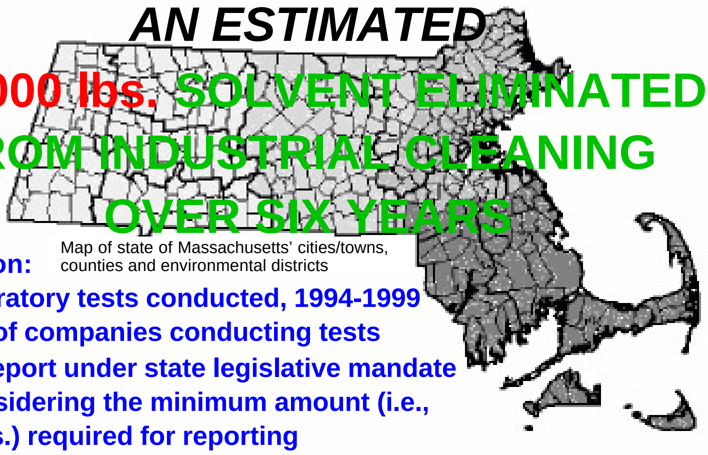
Equipment Comparison

- Studies Confirm: No Single 'Drop-In' solution for high- and low-tech industries
- Vapor Degreasers for Solvents Use vs. Whole Host of cleaning mechanisms: Ultrasonics, Air Sparging, Media Blasting for Non-aqueous Substitutes, etc.
- Process Feasibility is driven by equipment costs, as opposed to chemical costs, but *real savings in treatment, hauling and disposal of foregoing regulated solvents*

USE OF TEST REQUEST SHEET RESULTED IN:*

AN ESTIMATED

100,000 lbs. SOLVENT ELIMINATED FROM INDUSTRIAL CLEANING OVER SIX YEARS



Map of state of Massachusetts' cities/towns, counties and environmental districts

***Based on:**

(1) Laboratory tests conducted, 1994-1999
(2) 60% of companies conducting tests do not report under state legislative mandate and considering the minimum amount (i.e., 5,000 lbs.) required for reporting
(3) Preliminary data from Clark University's survey of client companies in Worcester area
(4) Creation/use of sheet was sole major change to pre-test plan

How Aqueous Cleaners Work

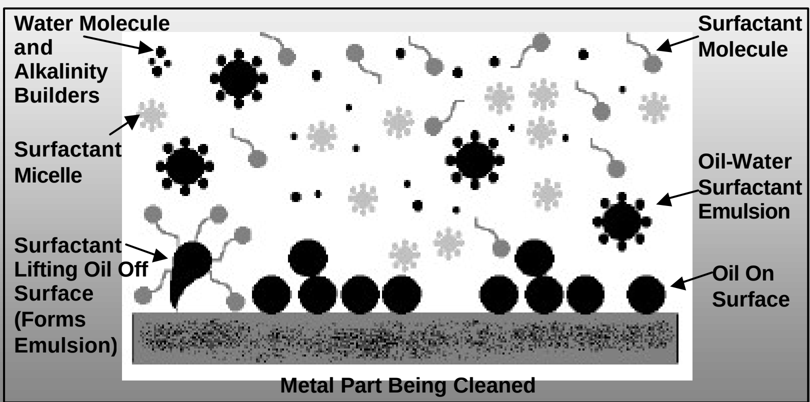


Figure 3.2 MICROSCOPIC DEPICTION OF AQUEOUS CLEANING OF METAL[47]

15

Importance of Surfactants

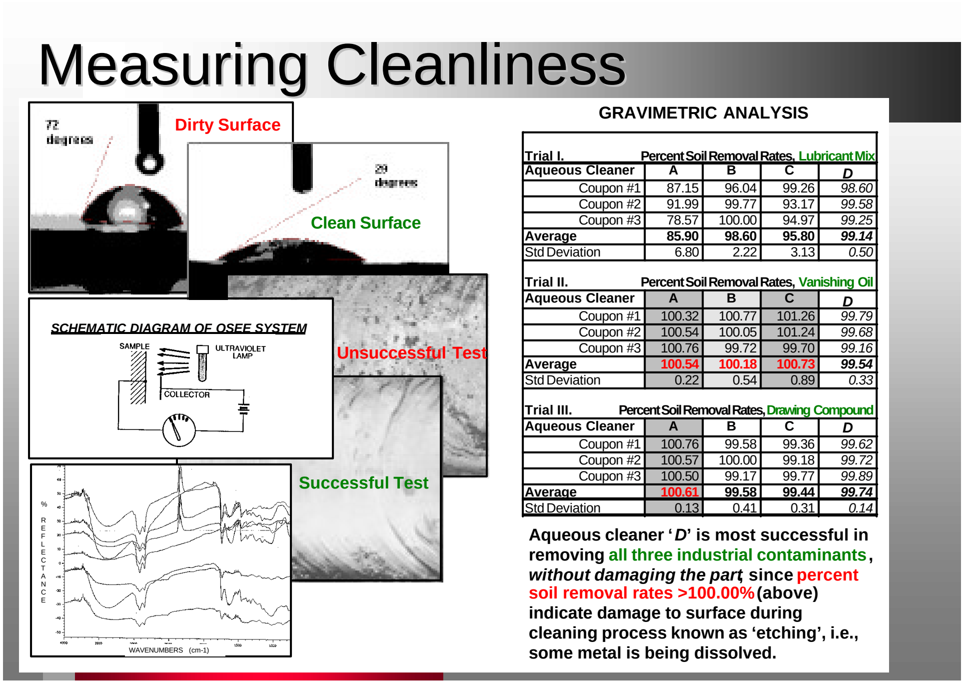
Trade Name	Company	Class and Formula	Form	Conc. (%)	Type	*HLB	Remarks
Icomeen T-2	BASF Wyandotte	Ethoxylated Amines	Paste		Cationic	5.0	Wetting agent, Penetrant, etc.
Scherco-teric MS-2	Scher Chemicals	Coco imida-zolinium deriv. dicarboxylate	Liquid	42	Ampho-teric (acid or base)		Mild for shampoos, Industrial cleaners
Makon 10	Stephan Company	Alkoxylates	Liquid	100	Nonionic		Detergent, emulsifier in hard surface cleaners
Witconate 1240	Witco Chemical	Linear alkylaryl sodium sulfonate	Slurry	40	Anionic		Hard surface Cleaner, laundry

*The Hydrophylic Lipophylic Balance (HLB) is listed only if the company reports it. **McCutcheon's Emulsifier and Detergent Entries**

16

Aqueous Cleaning Systems

Part-Cleaning Equipment	Brief Description
Air Sparging or Activity-Supplying Unit	Immersion/soak tanks fitted with side or bottom aeration; Vibrational and rotational movement also available for agitation
Immersion/Soak Tank	Holding tanks for dipping parts in batch cleaning
Manual Parts Washer/Degreaser	Free-standing sink with pressure at low psi; usually heated storage tank for chemical cleaner recirculation underneath with/without filtration unit
Spray/Cabinet/usually Low-moderate psi	Stationary dishwasher configuration generally in stainless steel; needs low-foaming detergent; may be incompatible with some semi-aqueous cleaners
Spray/Conveyor/usually Low-moderate psi	Spray station with parts moving along on belt for continuous operation; may have integral rinsing and drying stations
Spray/Free-standing, Hand-held units/ Moderate-high psi	Powerwash with hose and nozzle than can be hand-held or automated depending on water pressure (psi); can also be used for removal of some coatings
Ultrasonics	Cavitation of ultrasonically-induced bubbles produces work to clean like a jewelry cleaner; range of KHz and model sizes available for many applications; one of the easier methods to duplicate / scale-up



Trial I.	Percent Soil Removal Rates, Lubricant Mix			
Aqueous Cleaner	**A**	**B**	**C**	***D***
Coupon #1	87.15	96.04	99.26	*98.60*
Coupon #2	91.99	99.77	93.17	*99.58*
Coupon #3	78.57	100.00	94.97	*99.25*
Average	**85.90**	**98.60**	**95.80**	***99.14***
Std Deviation	6.80	2.22	3.13	*0.50*

Trial II.	Percent Soil Removal Rates, Vanishing Oil			
Aqueous Cleaner	**A**	**B**	**C**	***D***
Coupon #1	100.32	100.77	101.26	*99.79*
Coupon #2	100.54	100.05	101.24	*99.68*
Coupon #3	100.76	99.72	99.70	*99.16*
Average	**100.54**	**100.18**	**100.73**	***99.54***
Std Deviation	0.22	0.54	0.89	*0.33*

Trial III.	Percent Soil Removal Rates, Drawing Compound			
Aqueous Cleaner	**A**	**B**	**C**	***D***
Coupon #1	100.76	99.58	99.36	*99.62*
Coupon #2	100.57	100.00	99.18	*99.72*
Coupon #3	100.50	99.17	99.77	*99.89*
Average	**100.61**	**99.58**	**99.44**	***99.74***
Std Deviation	0.13	0.41	0.31	*0.14*

Progress Thus Far

- Professional survey conducted (2001) of companies using SSL services:[3]
  - 1/3 clients fully implement lab recommendations
  - 1/3 clients partially implement lab recommendations
  - 1/3 clients have not implement lab recommendations

What These Results Reveal

- Implementation rate (30-60%) by industry following SSL testing much higher than national average of 10% for similar technical assistance programs[4]
- Successful technical diffusion requires hands-on approach
- Recent increase in SSL tests suggests: *Presence, not just use,* of hazardous chemicals perceived by industry as risk[5]

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[3] Upcoming TURI publication (end of fiscal year, 2003)
[4] Tim Lindsey, Waste Management and Research Center (WMRC), Champaign, IL, http://www.wmrc.uiuc.edu
[5] See also, National Institute of Justice Publication NIJ 195171

Important Terms

- Technical Diffusion[6]
  - Innovation spreads to other firms for *same* purpose/industry (example: cleaning alternatives)
- Technology Transfer[7]
  - Innovation spreads to other firms for *different* purpose/industry (example: internet)
- '*Disruptive Technology'*
  - Innovation *completely and irrevocably* changes industry (example: digital photography)

Consequently…

Who's Ready for Change?

- NOT the current leaders of a technology
  - Polaroid: Instant vs. digital photography
  - Other examples: www.disruptivetechnologies.com
- If *real savings* accompanies *process change* (already mentioned), what's stopping progress?
  - FEAR OF CHANGE
- AND, what are the implications of this for chemical plant safety, after 9/11?
  - More government-sponsored programs should offer hands-on technical assistance for entrepreneurs to speed up development

Assumptions

Targeted Audiences

- Will not all be trained chemists
- Will possess many different levels/kinds of expertise
- Will not control all manufacturing variables

Goals of Any Tool/Training

- Should explain need for solvent substitution, or the need to return to aqueous (water-based) cleaners
- Be based on the scientific method
- But still be 'Stakeholder Friendly'
  - Language Barriers

Cleaning-Up the Cleaning Problem

- Cleaning Necessary for Quality Control (QC), important for ISO 9000 but does not add to product value – costs money!
- Product Re-design Not An Option for Many Cases
- In Identifying Chemicals for Solvent Substitution:
  - There is still no universally accepted method of determining, *'How Clean Is Clean.'*

[6] For more information, contact the National Pollution Roundtable N(NPPR, Washington, DC)
[7] For more information, contact the National Pollution Roundtable N(NPPR, Washington, DC)

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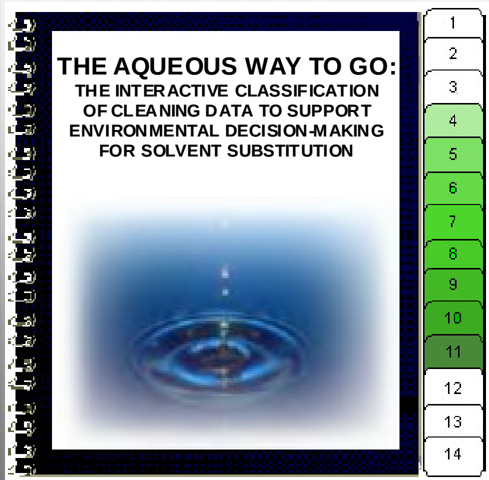
"The MIS <management information system> field deals with all the information and problem solving activity of a modern, successful organization. The MIS discipline brings together the various business areas, computer science, and quantitative analysis techniques. This program provides the theory and methodology to analyze, design, implement, and manage an organization's information technology and systems."

University of Dayton (Ohio)
www.udavton.edu

Three Years Later…The Tool as an Electronic Notebook



1. Introduction
2. Index: Solvents and Detergents
3. Chemical/Physical Properties: Merck Index
4. Health and Safety, Part I
   MSDSs and HMIS/NFPA Ratings
   Handling Requirements
5. Environmental Effects, Part I: Indicators
6. Case Studies and Standards: SAGE, ASTM
7. Process Parameters: Laboratory Databases, Tests and Vendors
8. Results of Application-Specific Testing*
9. Health and Safety, Part II
   TOMES® HSDB, Section 5.0
   Consequences of <Over>exposure
10. Environmental Effects, Part II
    TOMES® HSDB, Section 7.0
    Environmental Fate
11. Sustainability Factors
    TOMES® HSDB, Section 2.0
    Methods and Locations of Production
12. Total Cost Accounting/Worksheet
13. Regulations
14. Advances in Cleaning Technologies*

*For individualized entries.

27

Important Aspects of the Notebook

- Web-linked to related sites / databases
- Chronologically-sensitive to decision-making process
- Built-in continuous improvement similar to life cycle analysis
  - By assessing the ingredients of cleaners for manufacture, *not just their use*

Testing the Tool

- Two Case Studies
  - University of Massachusetts Lowell
  - Chicopee, Massachusetts School System
- WWW Outreach
  - Inquiries from over 20 countries to date, including UNEP
  - www.angelfire.com/band2/greencleaners/doctoralthesis.html
- Reveals
  - Inherent environmental justice issues
  - Need for training component

Two Years Later…

The Tool's Training Module

Example Abbreviated Agenda

- Introduction
  - Historical Discovery of Solvents
  - Effects and Regulation of Solvents
  - The Science Behind Surface Cleaning
- Cleaning Alternatives Research
  - The Role of Environmental Indicators
  - Aqueous and Semi-Aqueous Cleaners
  - Testing Protocols and Analytical Techniques
- Other Important Considerations
  - Non-Aqueous Replacement Cleaners
  - Working with Vendors, Databases and Standards
  - Total Cost Accounting

Training Workshops

- Agenda also changed / developed over time
- Full- and half-day sessions held
- Classroom style (i.e., not 'hands-on')
- University of Massachusetts Lowell sponsoring 1-2 day training session(s) in *Corporate Signature Seminar Series**

* TBA. Pre-publication announcement available.

Results of the Training[8]

1. OVERALL, HOW WOULD YOU RATE THE TRAINING?	3.6
(a) How would you rate the delivery of instruction (i.e. presentation, visual aids)?	3.7
(b) How would you rate the instructional materials (i.e., handouts)?	4.0
(c) How would you rate the depth/level of detail covered?	3.6
2. OVERALL, HOW WOULD YOU RATE THE TOOL?	3.6
(a) How would you rate the organization of its materials?	4.2
(b) How would you rate the usefulness of its contents?	3.9
(c) How would you rate the relevance of its web sites?	3.8
3. HOW WOULD YOU RATE THE LENGTH OF TIME ALLOTTED:	
(a) For Session?	3.4
(b) For Questions?	4.0

Remaining Issues

- Rinsing, Drying and Corrosion
- Testing Protocols
  - Using *'TACT'*
- No Clean / Design for the Environment (DfE) / Alternative Materials and Nanotechnology
- Water and Energy Usage
- Anything Else???

Continuing and Future Work

Feedback from Sessions Like This and Survey of TURI Lab Client Companies:

- Hands-on Workshop Format Required
- Design Traditional Science Curriculum
  - 1-3 Undergraduate Classes per week with one Lab Session (one semester) and/or
  - Certification Program (Community Colleges)
- Eventual Application as Part of Environmental Management System (EMS)
- Environmentally Preferable Products (EPP)[9] Procurement Programs Expand Training to Janitorial Applications
- Not All Aqueous Cleaners Are Created Equal!
  - Endocrine Disrupters

[8] BASED ON THE FOLLOWING SCALE:

POOR		FAIR		EXCELLENT
1	2	3	4	5

[9] http://www.state.ma.us/osd/enviro/enviro.htm

Acknowledgements

- Professor Don Huisingh, Sr Scientist in Sustainable Development
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- Tom Morehouse, Technology and Economics Assessment Panel of the Montreal Protocol
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Introductions of panel members

Presentation of Work and Research

Prof. Dr. Brigitte Haase, Hochschule Bremerhaven and IWT, Stiftung Institut für Werkzeugtechnik Bremen, Germany

Arbeitsgebiet:
Working Field:

Oberflächenmodifikation von Werkstoffen und Bauteilen
Surface modification of materials and components

Bauteilreinigung /*Industrial surface cleaning*

Oberflächenvorbehandlung /*Surface pretreatment*

Oberflächenanalytik /*Surface analysis*

Elektrochemische Verfahren / *Electrochemical processes*

Korrosion und Korrosionsschutz / *Corrosion and corrosion protection*

Arbeitsgemeinschaft Wärmebehandlung und Werkstofftechnik e.V.
Association for Materials and Heat Treatment

Ziel :	Den Kenntnisstand in der Werkstofftechnik, insbesondere der Wärmebehandlung, vertiefen und erweitern
Objective :	*To improve and extend theoretical and practical knowledge of material technology, especially of heat treatment.*

24 Fachausschüsse / *24 Working committees:*

- FA 5 Messen und Regeln in der Wärmebehandlungstechnik
- FA 8 Sicherheit in Wärmebehandlungsbetrieben
- **FA 14 Reinigen/*Surface Cleaning***
- FA 16 Umwelt
- FA 18 Integration der Wärmebehandlung in die Fertigung
- FA 19 Wärmebehandlungsprozeßtechnik
- FA 23 Schleifschlämme

Surface cleaning
... one process out of many in the manufacturing line of a part or component,
... one process out of many to modify surface condition.

Demands
... evaluate surface condition prior to cleaning step,
... evaluate surface condition as required by the subsequent manufacturing step,
... define objective in terms of surface condition to be obtained.

Tools
... methods of surface analysis,
... process analysis,
... reference methods.

Aim
... control of surface condition throughout the manufacturing line.
... reduce number of cleaning processes,
... reduce chemicals and energy consumption.

ENERGY INPUT		
mechanical	thermal	chemical
abrasive • blasting • grinding	reaktive heat treatment T >> 100 °C	abrasive/reaktive • pickling - in liquids - plasma-assisted - sputter-cleaning - elektropolishing
non-abrasive • stirring, mixing - ultrasound - Spritzen	non-reaktive T < 100 °C • bath temperature • vapor phase degreasing	non-reaktive • organic solvents • aqueous solutions • CO_2

Presentation of Work and Research

André van Raalte, IVAM Research and Consultancy on Sustainability, section Chemical Risks, Amsterdam, Netherlands

Mr. Raalte introduced the ***TOPROM project***, in which IVAM is performing trials with cleaning with fatty acid esters. Apart from the already known applications, such as manual removal of conservation layers and cleaning with cleaning tables, IVAM is also looking at new applications, such as cleaning prior to coating.

The project group have had some successes and some failures. The main problem seems to be the smell of some of the products. Workers are used to the smell of the solvents and like it, whereas the smell of the esters is different (“fish and chips”) and not always appreciated.

The REACH programme excludes fatty acid esters from the obligation of registration, which could mean a boost for these products in comparison with the traditional degreasers.

Another important factor in the Netherlands is that the substitution of organic solvents is mainly triggered by occupational health considerations (CTE).

TOPROM
Metal cleaning with fatty acid esters

Traditionally, cleaning and degreasing in the metal industry is done with volatile organic compounds (VOC). Because of the environmental and occupational risks associated with the use of this type of compounds, alternatives should be sought. The TOPROM-project aims to demonstrate the possibilities of fatty acid esters in the metal industry. The Dutch government subsidises the project in which trials are performed in four companies.

The need to replace VOCs

VOC are detrimental to the environment and to the health of workers. Long-term exposure to VOC can result in CTE (Chronic Toxic Encephalopathy). The symptoms of this syndrome include fatigue, loss of memory, and in severe cases, depression and personality changes. VOC also cause skin problems. Environmental effects of VOC are mainly summer smog, and pollution of waterways.

In the European metal industry approximately 280.000 tons of VOC are used per year for the cleaning and degreasing of metal surfaces, products and tools. This amounts to 12,8% of the total use of VOC (EU VOC Directive, November 1999). The Dutch government aims to have these organic compounds replaced by less dangerous chemicals.

In the last decade VOC have been replaced by water based cleaners containing surfactants and acidic or alkaline chemicals. In some cases however, these water based cleaners are not effective enough, or they may cause safety problems when they come into contact with electrical circuits. In those cases fatty acid esters can be a solution.

The use of fatty acid esters results in a reduced emission of VOC to the environment. Fatty acid esters have been proven to be less volatile, readily biodegradable, and more skin-friendly. Moreover, they are based on renewable sources.

TOPROM

Fatty acid esters are based on oils of sunflower, coconut, rape seed and soy bean that have been modified to make them suitable as cleaning agents. They have an excellent solvency power and are less harmful to the environment and hazardous for the health of workers. Vegetable esters have already been proven to be effective as cleaning agents in the following applications:

1. manual parts cleaning in a cleaning table
2. removal of bituminous conservation layers from ship axles and engines

Trials have been successful in both applications. Advantages of the esters are their prolonged life-span compared to the traditional cleaning agents, and the fact that no skin problems are experienced. Moreover, there is no need to install ventilation or extractor systems because the esters have a very low volatility.

Aims of the project

TOPROM aims to replace VOC as cleaning agents with fatty acid esters through the identification and demonstration of additional applications of these vegetable cleaning agents. A number of trials have been instigated in four metal companies, supported by laboratory experiments.

The trials were selected in such a way, that they cover a wide range of applications: cleaning of rollers in sheet manufacturing, of press tools for deep drawing, precision cleaning, and cleaning prior to coating. The project is being carried out in close cooperation with manufacturers and suppliers of cleaning agents.

The design of the project makes it possible to consider all aspects of the cleaning process, including the technical aspects (e.g. solvency power), environmental issues, workers' health, cost effectiveness and waste treatment.

Partners
Consultant: environmental and occupational health aspects, technical aspects, laboratory facilities
IVAM, research and consultancy on sustainability, section Chemical risks TNO-TPD

Manufacturers and / or suppliers of cleaning agents
MAVOM
Hijmeco

Waste treatment
VVM

Metal companies
Philips ETG and Philips PGE
Corus
Damen Shipyards
CompXRegout

Others
AKZO Nobel Coatings

Discussion

Comment from Ms. Brigitte Haase (Hochschule Bremerhaven):
Surface conditions have to be described.
Demands are: 1) to control the cleaning process 2) to evaluate the surface.
Tools are: 1) surface analysis 2) process analysis and 3) reference methods.
Aims are: 1) control of surface condition throughout the manufacture line 2) to reduce the number of cleaning processes 3) to reduce chemicals and energy consumption.

Comment from Andrè van Raalte:
The involved project should use vegetable oils. Problems: fatty acid esters smell (fish and chips). Substitution of organic solvents is stimulated by occupational health mainly in the Netherlands. One target is to get the trade unions to fight for organic solvents. Financial considerations are important (the cost of the product), but not always determinative, contrary to what some say. In the experience of IVAM, workers' acceptance is decisive.

Lothar Lißner said: Is the future 100 % aqueous cleaning?
Mr. Grün (DGO) said: No, you need solvents for cleaning processes. You can rely on chlorinated carbons a little. Another trend is a new business model: specialists in cleaning because companies are no specialists in cleaning.

Other comments and questions were:

Why is more cleaning more expensive?
We need customized solutions. There is a need to help small customers selling solutions to other customers.

Some tools:
Application specification
Data base to increase learning curve

99 % of the processes are aqueous

Mrs. Haase stressed that the term “cleaning” could be misleading as normally part of the dirt is allowed to remain on the surfaces. It is only removed to that degree that the subsequent process is not affected.

Developing Computer Software Tools to Facilitate Pollution Reduction

Charles H. Darvin, Sr. Mechanical Engineer, U.S. Environmental Protection Agency

Research and Development at EPA

- 1,950 employees
- $700 million budget
- $100 million extramural research grant program
- 13 lab or research facilities across the U.S.
- Credible, relevant and timely research results and technical support that inform EPA policy decisions

Making decisions with sound science requires...

- Relevant, high quality, cutting-edge research in human health, ecology, pollution control and prevention, economics and decision sciences
- Proper characterization of scientific findings
- Appropriate use of science in the decision process

Research and development

- contribute uniquely to...
  - Health and ecological research, as well as research in pollution prevention and new technology
  - In-house research and an external grants program
  - Problem-driven and core research

High Priority Research Areas

- Human Health
- Particulate Matter
- Drinking Water
- Clean Water
- Global Change
- Endocrine Disruptors
- Ecological Risk
- Pollution Prevention
- Homeland Security

National Risk Management Research Laboratory

- Waste water treatment research
- Air pollution control research and development
- Industrial technology research and development
- Pollution prevention
- Industrial surface cleaning coating
- Environmental tools development

Discussion Outline

Developing an effective expert system for surface cleaning by?

- Developing a clear understanding of the industry.
- Understanding the capabilities of the audience.
- Provide information on the technical and regulatory requirements of the industry.
- Validation of recommendations

Expert System Development

Understand the industry

Content and presentation of information may be dependent upon the characteristics or the industry such as:

- Solicit industry assistance
- Average business size

- Industry capitalization
- Staff capability
- Industry location

Expert System Development

- Know the Audience
- Education level of typical industry management and staff
- Knowledge of PC manipulation
- The average user understanding of the science of surface cleaning

Expert System Development

Providing information on the technical and regulatory requirements of the industry

Provide process description

- Provide installation and facility requirements
- Provide approximate capital and operating cost information where possible.
- Provide regulatory and legislative cautions
- Provide technical assistance contacts
- Provide system maintenance

Expert System Development

Validation of recommendations

Develop database of case studies to validate viability of recommendations for defined scenario.

Expert System Development Summary

- Know the industry and its processes
- Know the audience
- Develop data base of case studies
- Maintain system

Speakers

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Theodorus Chryssanthopoulos is a mechanical and electric engineer, graduate of the National Technical University of Athens. He has been working in the Public Power Corporation (PPC) of Greece for thirty years approximately.

For the first eighteen years in PPC (1973 – 1991) he has worked in the Training Department of PPC and he was responsible for surveying the laboratories of the Technical Schools of PPC as well as for the programmes. (syllabus of the courses of mechanical and electric specialities in PPC's Technical Schools, e.g. "Power line electricians", "Boiler and Turbine mechanics", etc.)

For the period from 1991 till today he has been working in the "Health and Safety Department" of PPC. He is head of the sub sector of safety audits for the units of PPC.

He has been a trainer in technical schools of PPC and in various seminars for twenty-five years on technical courses (e.g. Strength of Materials, Electrical Measurements, etc.) and on safety matters (e.g. Safety Legislation, Risk Assessment, Harmful Agents, etc.)

He is a member of the "Chamber of Engineers" of Greece.

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Charles H. Darvin is a Senior Mechanical Engineer for the U.S. Environmental Protection Agency's, National Risk Management Research Laboratory at Research Triangle Park, NC. He is a graduate of the University of Evansville, IN, with a B.S. in Mechanical Engineering.

He has extensive experience in volatile organic compound, VOC, and hazardous air pollutant, HAP, emissions prevention and control technology development. His research and development emphasis has been on metal finishing, coating, and surface cleaning process emissions.

Mr. Darvin has received one EPA silver and five bronze medals for his research successes. He has been awarded one patent. He is a retired Lt. Col USAF Reserve and served as technical advisor to the USAF for solvent usage reduction. He has a QEP certification and has authored numerous peer reviewed and technical journal articles. He is a member the ASME, ASTM, and the AESF. He has been with the USEPA for more than 30 years.

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Graciela Ferrer (Mar del Plata, 1973) has a Bachelor degree in Economics (Universitat de València, 1998) and a MSc degree in Ecological Economics and Environmental Management (Universitat Autònoma de Barcelona-UAB, 2002). Nowadays, she is pursuing a PhD degree in Environmental Sciences at the UAB. She is currently working as Research Officer in the European Innovation Project CLEANTOOL, after participating in the European Project SPHERE+.

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Jutta Geldermann is scientific assistant and head of the working group “Integrated Technique Assessment” at the French-German Institute for Environmental Research (DFIU / IFARE) and at the Institute for Industrial Production (IIP), University of Karlsruhe (TH), Germany.

She holds a Diploma in Industrial Engineering (University of Karlsruhe (TH)) and a PhD in Business Administration.

She has conducted and managed numerous research projects on Production Planning, Mass and Energy Flow Management, Determination of Best Available Techniques, and Multicriteria Decision Making.

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Reiner Grün is Sales Manager of SurTec Deutschland GmbH. He is trained at BASF and worked there for 8 years in the departments of quality management , analytics, applications technology and research polymers.

After two years work at Diversey-Novomax in the department research and development surface-treatment he changed to Lever Industrie, later Lever Sutter and finally SurTec GmbH. At first he was 12 years head of the department research and development surface-treatment and for the last 4 years sales manager.

He is also head of the technical committee cleaning of the German association for electroplating and surface treatment and head of the technical committee cleaning of the association for materials and heat treatment.

Prof. Dr. Ing. Haase, Brigitte
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Brigitte Haase is a Professor of Applied Chemistry in the Department of Process Engineering at Hochschule Bremerhaven (University of Applied Sciences). She teaches Chemistry and related subjects including master courses in Electrochemistry and Corrosion.

Her research concentrates on surface technology with a special interest in surface modification processes like surface cleaning, surface activation and analysis. Her research results have been published in national and international journals. The common base of her publications is the view of surface cleaning processes in a line with multiple manufacturing processes performed during the production of a metal part or component. She sees it as a part of her work to better define the specifications of surface condition prior to and after surface cleaning, which are not yet and always well-defined.

Brigitte Haase is a member of the managing committee of AWT (Arbeitsgemeinschaft Wärmebehandlung und Werkstofftechnik, Association for Materials and Heat Treatment) and presides one of its working committees, which deals with problems of surface cleaning and pre-treatment.

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Klaus Kuhl studied physics and chemistry at Kiel University, where he did 1st and 2nd state exams.

His professional experience includes working as a high school teacher, working in a medium sized metal processing enterprise, organizing and conducting vocational training and working as an environmental consultant.

Since 2001 he is a member of the CLEANTOOL project team for the Co-operation Centre Hamburg, where he is mainly responsible for the German part of the project.

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Francesc La-Roca (València, 1956) is Professor at the Department for Applied Economics (Universitat de València). Graduate and doctorate in Economics, he has mainly devoted himself to socio-economic aspects of territorial and ecological problems.

Since 1994 he has participated at the European IRENE network activities, and he directed the Spanish participation in the European Project SPHERE+ (European Substitution Project for Health and the Environment: Lessons from Results and Experiences, 1998-1999).

Currently he is responsible for the Spanish team of the European Project CLEANTOOL.

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Carole LeBlanc is a world-renown expert in hard-surface cleaning. Her doctoral thesis, *"The Search for Safer and Greener Chemical Solvents in Surface Cleaning: A Proposed Tool to Support Environmental Decision-Making"* was completed in 2001. She also holds baccalaureate degrees in both biology and chemistry from Boston College and has several years experience in industry as well as academia. Ms. LeBlanc is the first American woman to complete the environmental studies' program in Sustainable Development and Management offered by Erasmus University, Rotterdam, the Netherlands. This international program specializes in Cleaner Products, Clean Production, Industrial Ecology and Sustainability.

For almost ten years, Ms. LeBlanc has worked at the Toxics Use Reduction Institute (TURI), located at the University of Massachusetts Lowell. She has served as Laboratory Manager, Associate Director and now the Director of the Surface Solutions Laboratory, also known as the Surface Cleaning Lab, a research facility at the Institute. Dr. LeBlanc is author/contributing author to dozens of publications, including *"The Aqueous Cleaning Handbook"* (Morris Lee Publishing, 1998 & 2000); *"Handbook for Critical Cleaning"* (CRC Press, 2000) and *"Surface Contamination and Cleaning"*, Volume 1 (VSP, 2003). She is also president of the New England Institute of Chemists and a local officer for AVS, a scientific society that "promotes…education…to develop new materials and process technology…for the betterment of humanity." She can be reached by phone: 781-248-2520 or email: cleblanc1@comcast.net.

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Born 1955, he graduated in1974 and studied at the Universities of Münster and Bielefeld, obtaining a diploma within industrial sociology in 1980. From 1981 to 1982 he worked in a regional institute for adult's education. In 1983 he was employed by the German Trade Union Federation in a scientific project on the improvement of relations between universities and trade unions. In 1987 he changed to the Head Office and was responsible for the whole research area of the German Trade Union Federation.

In 1989 he went to the Hamburg Ministry for Science and Research, starting at the Kooperationsstelle, a small widely independent department as permanent employee. Since 1990 his main task is to organise and co-ordinate larger international and national projects in the area of substitution of hazardous substances, namely in the construction and metal industry.

Additionally to the issue of chemicals he published about the development of the welfare state in Austria, Sweden and Germany.

From 1997 to 2001 he had to manage two European projects dealing with help tools for intercultural conflicts in European Innovation projects. Since newly he is also dealing with E-Business applications between the aircraft industry and SME's from the craft sector.

His professional idea is to show that successful innovation projects for all concerned parties lead to better results than limited, purely economically driven research and innovation.

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Christos Maltezos is head of the Quality Assurance Department of the Testing and Research and Standards Center (TRSC) of the Greek Power Corporation (PPC S.A.). He has experience as head of the Environmental and Industrial Chemistry Laboratories at PPC/TRSC and executive of the Industrial Engineering and Production Planning Departments at the Colgate Palmolive S.A., Greece.

His work concentrates on the development, application and continuous improvement of TRSC's Total Quality Management (TQM) System as per ISO 9001:2000. This TQM system includes accreditation of testing laboratories (ISO 17025), equipment inspection (EN 45004) and product certification.

He has written and instructed seminars about Work Safety against Chemical Hazards for the PPC S.A. personnel. He has participated in the E:C: Sustainable Energy program "ALTENER AFB" and has been a member of various Committees.

He is an IRCA/IATCA certified Lead Auditor for Qualtity Management Systems and a certified Trainer by the Hellenic Management Association. He is a member of the Technical Committees "Quality Assurance" and "Laboratories Accreditation" of the Hellenic Organisation for Stadardisation S.A. (ELOT) and the Committee "Institutional Projects" of HellasLab / Eurolab.

He is also a member of the Greek Forum and the Association of Greek Chemists.

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André van Raalte is senior consultant at IVAM, Research and Consultancy on Sustainability, formerly Chemiewinkel of the University of Amsterdam, the Netherlands.

He specializes in hazards of dangerous substances in a wide variety of branches, including the metal industry. He has published a study on dangerous substances in the metal industry, e.g. solvents, coatings, welding fumes, solder and metalworking fluids. In his work he focuses on practical solutions for existing risks, including substitution of hazardous substances. In this regard he has been involved in substitution projects whereby organic solvents are replaced by vegetable based cleaning agents such as fatty acid esters.

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Dr. Anne Randmer: Tallinn Technical University (MSc.,Business Administration in Engineering Industry); Russian Academy (PhD., Environmental Management and investment Planning); trained in cleaner production, environmental auditing, feasibility analysis.

Dr. Randmer is Member of the Association of Estonian Consultants, and Chamber of Estonian Environmental Auditors.

Key Qualifications: Management of multi-disciplinary environmental projects, cleaner production and technology assessment (training and consulting); public participation process design and conducting; regional development planning (incl. development of Local Agenda); environmental auditing and environmental management systems implementation (training and consulting); international experience, especially in Russian-speaking countries.

Dr. Randmer established the Pollution Prevention Centre in Estonia (now known as Centre for Development Programs EMI-ECO).

EMI-ECO is a non-advocacy, not-for-profit organization with the mission to facilitate to raise the level of competitiveness of Estonian industries and local authorities. It contributes to sustainable development in Estonia disseminating the experience of eco-efficient management of resources by measurable economic and environmental benefits from cleaner production and environmental management activities providing confidential on-site technical assistance, training and information to industries, government and other institutions. It aims to up-grade local government administration capacity to make them as competitive as private sector in providing public services. It is believed that Estonian industries can compete in any market.

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Principal Consultant, EMI-ECO

Tartu University, Diploma in environmental chemistry, 1992; Wolverhampton University, UK, MSc, Environmental Management, 2001.

Key Qualifications:

Environmental impact assessment, IPPC permitting, chemicals safety, cleaner production: environmental strategic plannning (Local Agenda 21, waste management planning) for local governments.

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Panayotis Siskos is Professor of Analytical Chemistry and head of the Environmental Analysis Group at National and Kapodistrian University of Athenes.

He is his country representative in the "Chemistry and Environment" Division of the Federation of European Chemical Societies (FECS), Co-ordinator of the Commitee on Environment in the Association of Greek Chemists, and member of the Committee "Environment" in the Hellenic Organization of Standardization. He has also served in 1990 till 1993 as a Special Advisor to the Greek Ministry of Environment.

His research focuses on the fields of Atmospheric Environmental Chemistry, Clinical Chemistry and lately with the field of Occupational Exposure and Biological Monitoring. He has published adout 200 scientific and technical papers in research journals, review articles, reports and 6 teaching books

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Hermann Thordarson is the manager of the Center of Chemical Analysis laboratory, which is a joint laboratory for the Icelandic Technological Institute (IceTec) and the Agricultural Research Institute in Iceland. He is a B.Sc.chemist from the University of Iceland and has a M.Sc. degree in chemical engineering from Kungliga Tekniska Högskolan in Stockholm.

His work at IceTec has been mostly concerned with environmental assessment and environmental monitoring projects, water quality and treatment in aquaculture, waste water treatment and in R&D in innovative use of fats and oils.

Tolaki, Maria
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Maria Tolaki is a mechanical and electrical Engineer, graduated of the National Technical University of Athens. She has made post graduated studies in Ergonomics in HUSAT University of Great Britain. She has been working in the Public Power Corporation (PPC) of Greece fot twenty years approximately.

For the first eleven years in PPC she has been working in the Hydroelectric Projects Development Department. Since 1990 until today she has been working in the Health and Safety Department of PPC. She is the Manager of Health and Safety Department of PPC since 2001. She has also been a trainer in PPC and in various seminars on safety matters (eg. Safety legislation, risk assessment, harmful agents etc.).

She is a member of the technical Chamber of Greece and a representative of PPC in EURELECTRIC for safety matters.

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