About SiOx Machines

SiOx Machines AB:

- Manufacturer of CO_2 machines for textile cleaning and industrial markets
- Design and engineering developed by Electrolux Professional / AGA
- 25 years in-house experience in CO_2 processes and machine design
- SiOx offers machines, technical services, process development
- Office and tech center in Stockholm and Ljungby, Sweden

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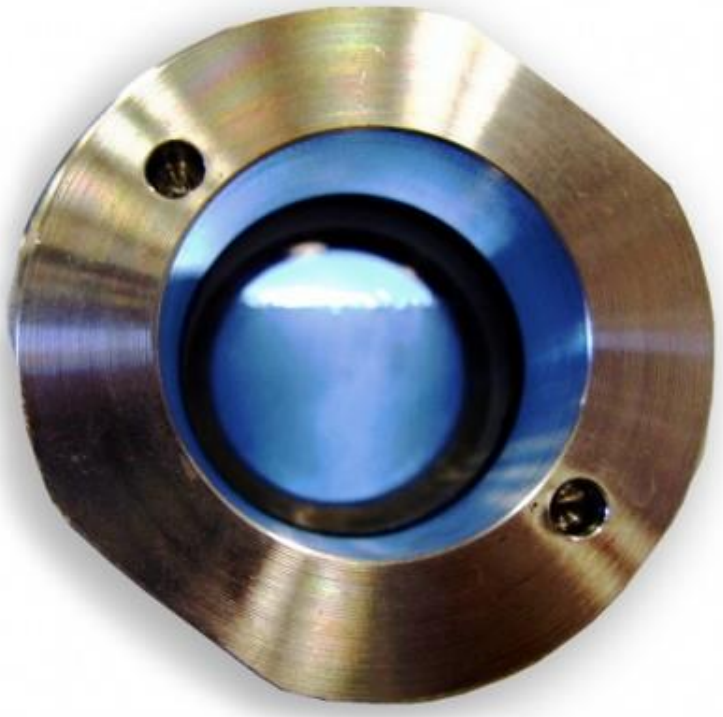
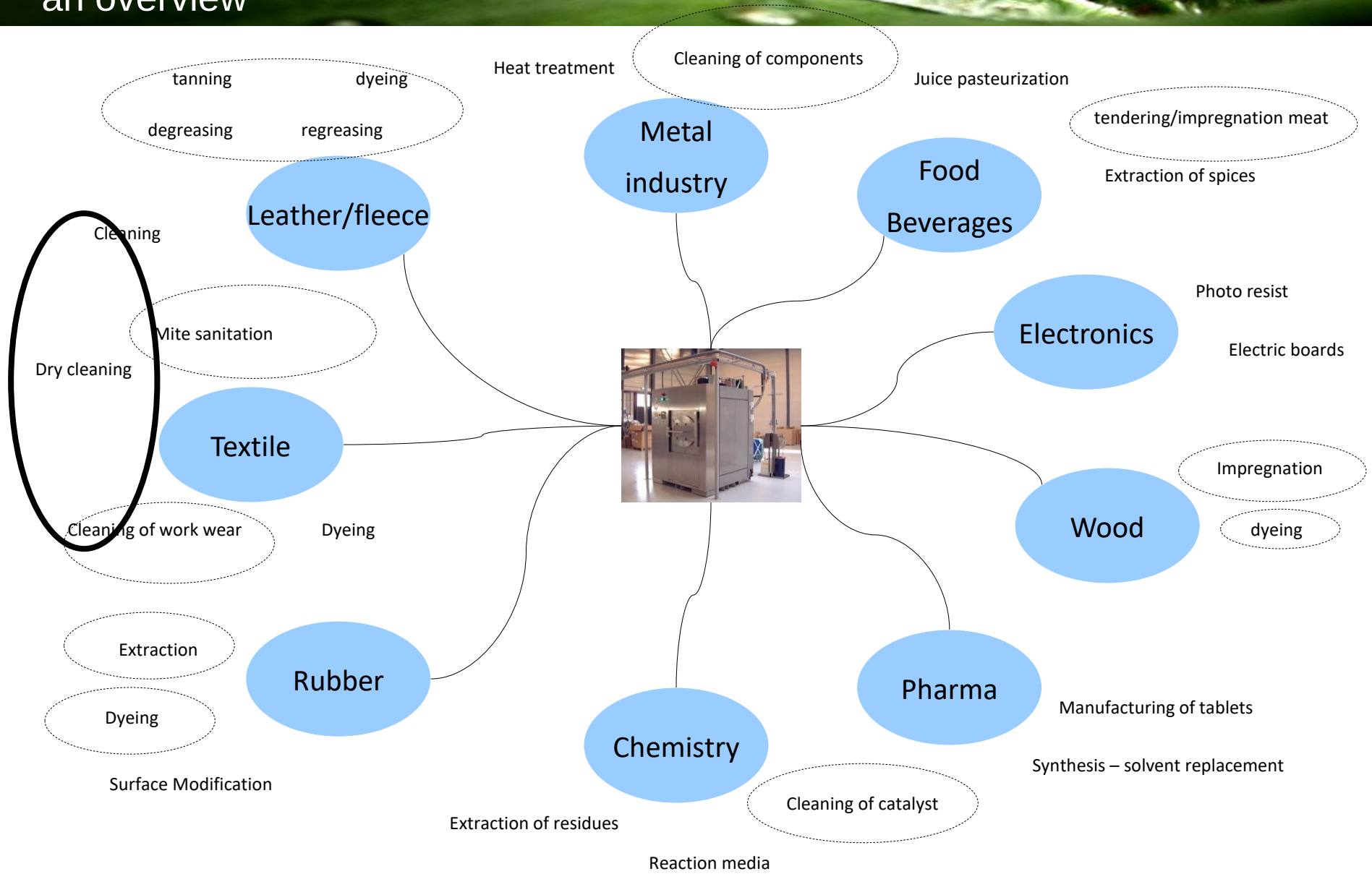
Why use liquid CO_2?



General:

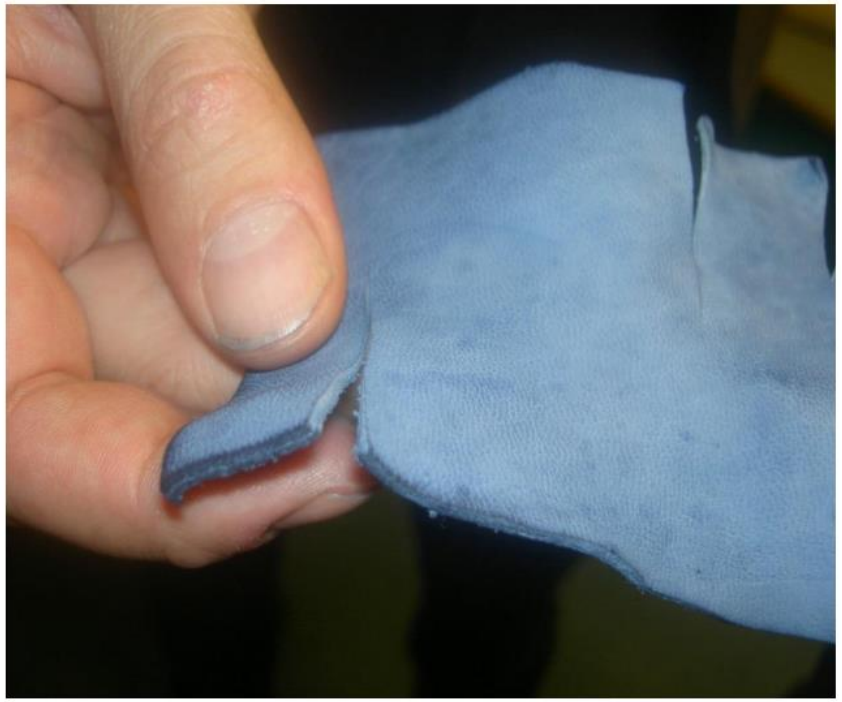
- Solvent comparable with acetone
- Low surface tension - reaches even the smallest pores
- Non-toxic, non-explosive
- Easy to recover / recycle
- No high temperatures
- No or litte waste
- No drying necessary – low energy consumption

Liquid/supercritical CO_2 applications – an overview

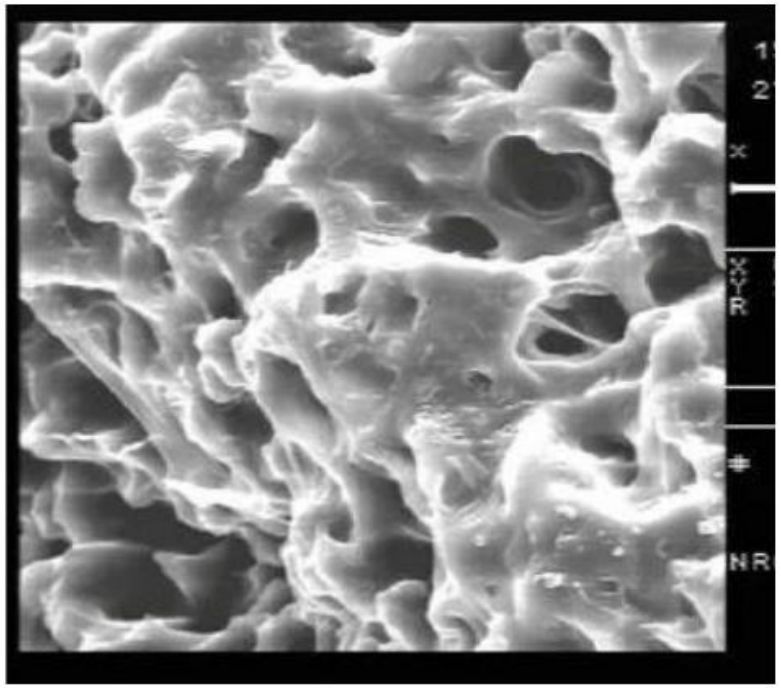


CO_2 applications

Leather tanning



Microporous membranes



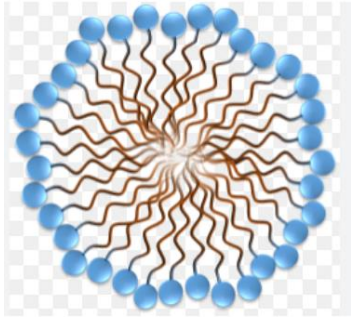
Solubility in liquid CO_2

Table 3. Solubility of organic compounds in liquid carbon dioxide [21]

Compound	Solubility, wt %	Compound	Solubility, wt %
Alcohols		Ethyl benzoate	Unlimited miscibility
Methyl	Unlimited miscibility	Benzyl benzoate	10
Ethyl	Unlimited miscibility	Butyl phthalate	8
Cyclohexyl	4	Phenyl phthalate	Unlimited miscibility
Heptyl	6	Ethyl oxalate	Unlimited miscibility
2-Ethylhexyl	17	Butyl oxalate	1
Cinnamic	5	Ethyl maleate	Unlimited miscibility
Furfuryl	4	Methyl salicylate	Unlimited miscibility
Phenylmethyl	8	Phenyl salicylate	9
Phenylethyl	3	Amides	
Carboxylic acids		Acetamide	1
Formic	Unlimited miscibility	Acetonitrile	Unlimited miscibility
Acetic	Unlimited miscibility	Acrylonitrile	Unlimited miscibility
Caproic	Unlimited miscibility	Phenylacetonitrile	13
Caprylic	Unlimited miscibility	Formamide	0.5
Lactic	0.5	*N,N*-Dimethylacetamide	Unlimited miscibility
Lauric	1	*N,N*-Diethylacetamide	Unlimited miscibility
Oleic	2	Amines	
Phenols		Pyridine	Unlimited miscibility
Phenol	3	Aniline	3
o-Chlorophenol	Unlimited miscibility	*o*-Toluidine	7
p-Chlorophenol	8	*m*-Toluidine	15
o-Cresol	2	*o*-Chloroaniline	5
m-Cresol	4	*m*-Chloroaniline	1
p-Cresol	2	Diphenylamine	1
Esters		*N,N*-Dimethylaniline	Unlimited miscibility
Ethyl acetate	Unlimited miscibility	*N,N*-Diethylaniline	17
Ethyl acetoacetate	Unlimited miscibility		

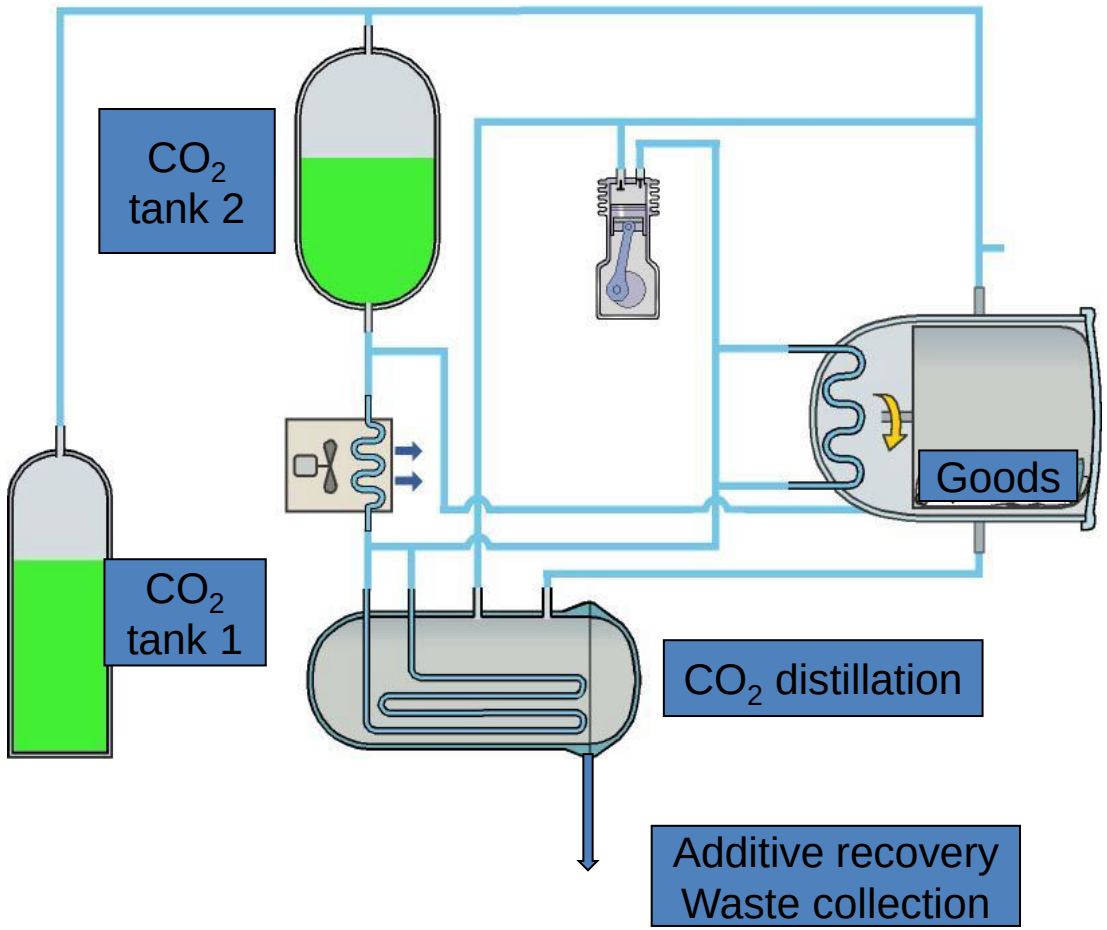
Solubility of compounds decreases with molecular weight.

Water and surfactants: micelles / foam



CO_2 Cleaning: solvent mechanism. Small molecules dissolved, heavy molecules are partly dissolved, partly ”immobilized”.

CO_2 process



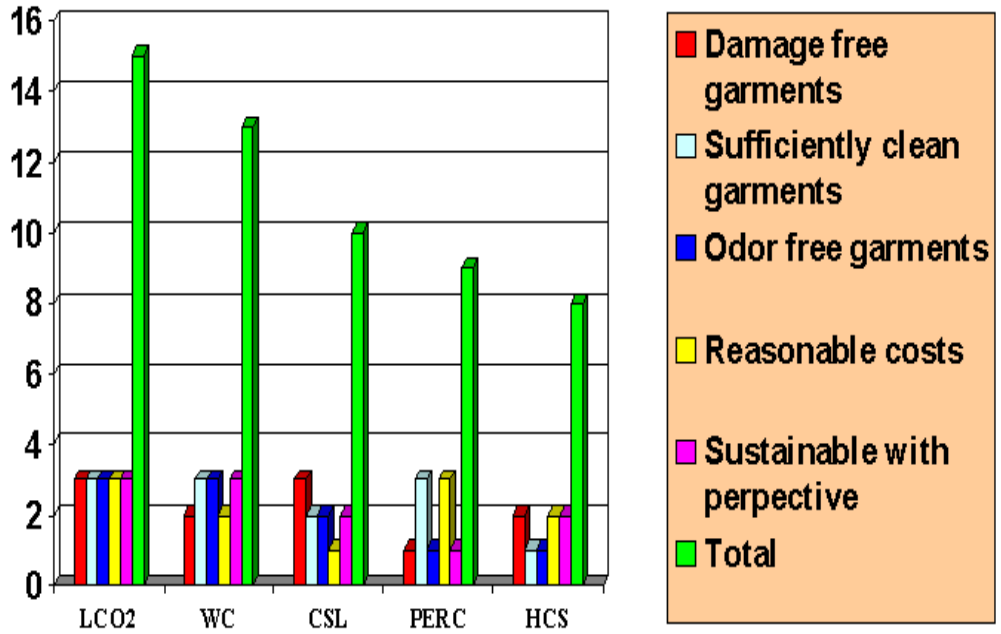
Distillation and cleaning in parallell: saves time → short process cycle:

1 bath process: 27 min

2 resp 3 bath: 34 / 41 min

Loss of CO_2 per process: 2 kg

Dry Cleaning of garments

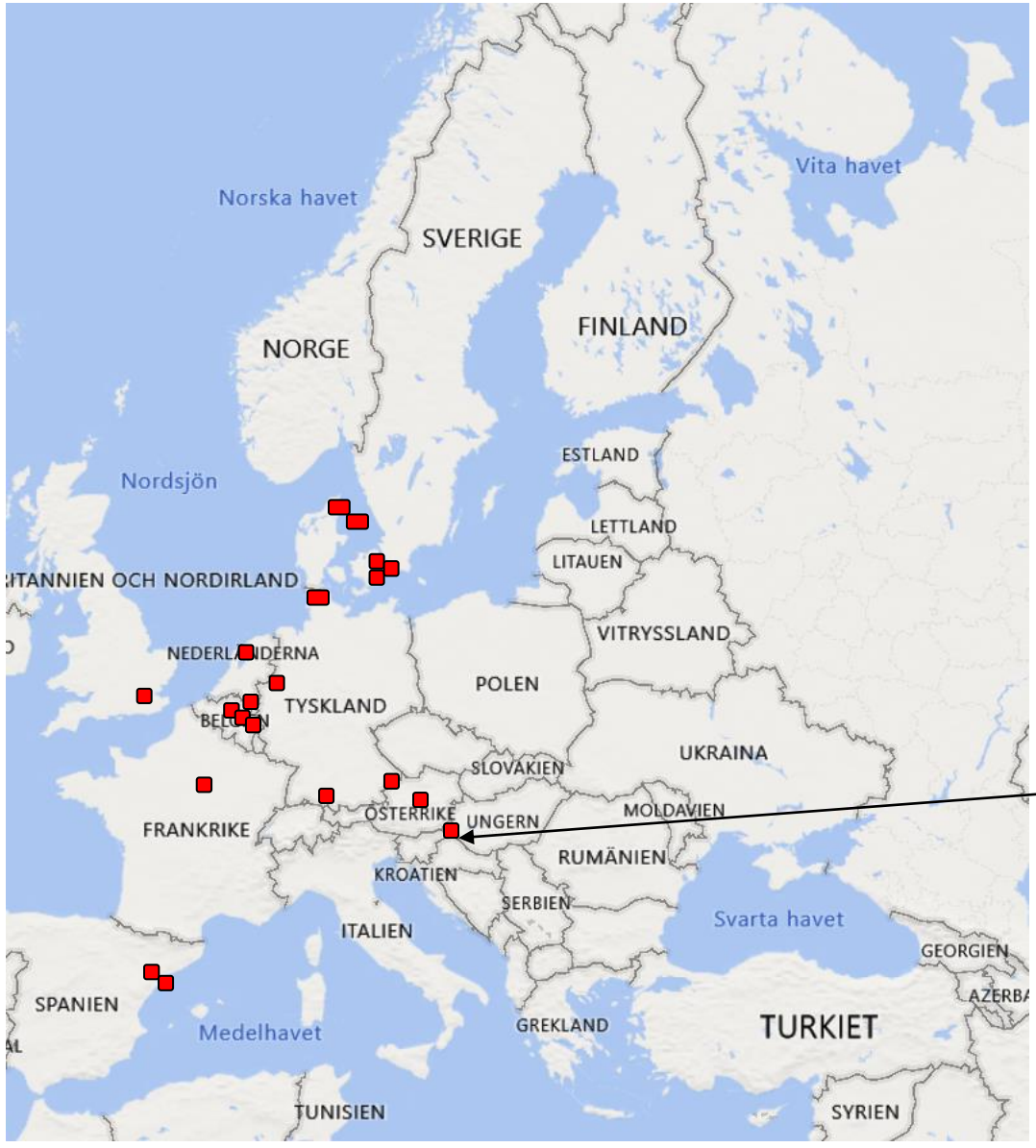


Source: Report from Life project Detective – an EU sponsored project

Benefits:

- No smell
- No hazardous solvent
- Very gentle cleaning
- Ability to clean items not suitable for other DC
- No risk for ground contamination from solvent
- 10 yr track excellent tech record DC with various prizes

Current CO_2 machines in Europe



Over 20 machines
in operation in Europe,
plus 3 in USA, AUS, NZ

Pioneer CO2DEX

Machine Features

- **The SiOx machine is delivered as a single unit**.

The only installation work needed:

Connect machine to:

- Power
- External vessel for CO_2
- Pressurized air
- Cooling water
- Venting pipe

Cleaning of Protective work wear

Removal of hazardous compounds on firemens gear

- Reduces level of PAHs, VOCs and oil on the garment more efficient than any other method
- Does not affect the protection ability of the garment (membrane)

Combination with water wash for two good reasons: polar contaminations, costs

CODEX Technologies d.o.o.

CODEX Technologies d.o.o. is a company specialized in advanced solutions and services in its industry. We operate mainly in Slovenia with almost all PFB, many VFB and have also export activities in Germany, Austria, Hungary etc.

Our mission is to leverage innovative technologies and expert knowledge to provide our clients with solutions that drive efficiency, sustainability, and growth.

- Customer-Centric Focus
- Innovation and Excellence
- Sustainability and Responsibility
- Quality and Integrity
- Global Impact
- Technology and Expertise
- Collaboration and Growth
- Excellence in Service
- Innovation for Tomorrow

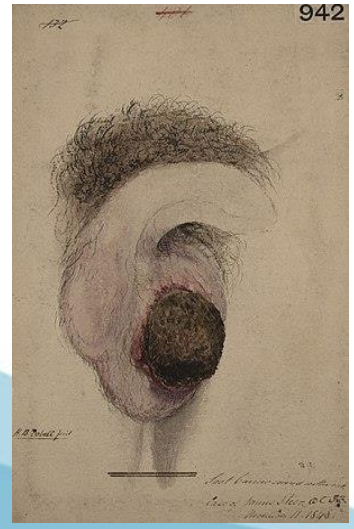
Collaboration

- End users - firefighters
- Responsible persons in the firefighting organization
- Manufacturers of cleaning equipment and technology
- Manufacturers of cleaning agents
- Manufacturers of protective equipment
- Manufacturers of component parts of protective equipment
- Institutions responsible for supervising the implementation of measures in the field of H&S for firefighters.

History

Sir Percivall Pott, chimney sweeps and cancer

- Over 200 years ago, doctor and writer Sir Percivall Pott (1714-1788) made the connection between **soot and scrotal cancer**, known then as the chimney sweep's cancer
- Chimney Sweep's Carcinoma, also known as soot wart, was the first occupational cancer to be described



Prevention of Exposure

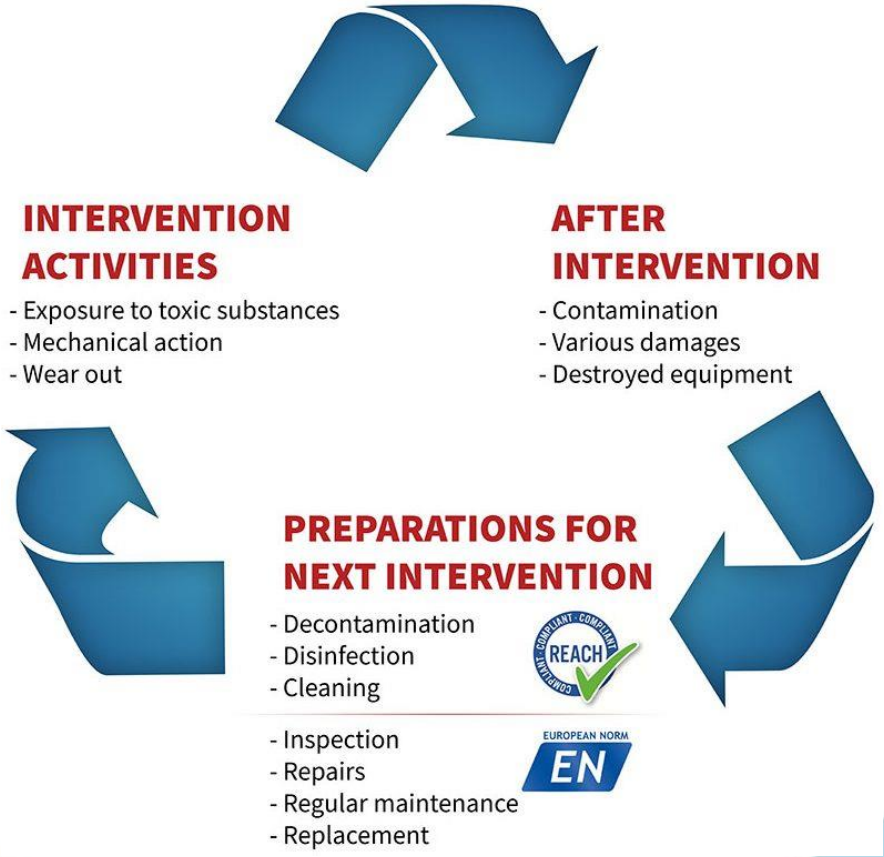
Reasons for PPE maintenance

- **LEGAL FRAMEWORK**
  - Directive 2004/37/EC – carcinogens or mutagens at work Article 10 Hygiene and individual protection
  - ISO 23616 Cleaning, inspection and repair of firefighters' personal protective equipment (PPE)
  - CEN/TR 14560:2018
  - Local legislation on Health&Safety (general and firefighting)

- **MANUFACTURER‘S INSTRUCTIONS**
  - Clean and inspect for any damage after every use.
  - Damaged PPE must be repaired before use.

- **PROTECTION**
  - Any damage reduces the protective effect of PPE.

- **HEALTH ASPECT**



Additional CARE challenge

- We deal exclusively with used equipment (new equipment is usually not cleaned, except during material testing)
- The complexity of individual pieces of equipment (many standards)
- Many different materials combined in one product

CLEANING METHODS

Decontamination with LCO_2

Wet washing (incl. disinfection and decontamination)

Reimpregnation

Decontamination in PPE washer

Decontamination efficiency

CODEX Technologies cleaning technology

Step 1:
Pre-washing with detergents and water at different 40/60 ^{0}C regime depending on manufacturers instructions and state of preservation of the PPE.

Step 2:
LCO_2 extraction technology, due to its properties, penetrates through all pores and layers.
Residue after 40/60 ^{0}C wet washing.

Decontamination efficiency

Proof of Decontamination efficiency

- Proving the decontamination efficiency with laboratory tests

Sample data:

Order code:	LCO2 Decontaminated membrane
Sample description:	LCO2 Decontaminated membrane
Time of sampling:	/
Delivery Details:	Sample meets acceptance criteria
Sample acquisition date:	28.01.2022
Report date:	21.02.2022

Laboratory identification number: Lab.No.: **2022 - 0132**

Analysis:

MESUREMENTS:

Parameter	unit	result		method	start / end analysis
PAH-polycyclic aromatic hydrocarbons; sum of 16 PAH	mg/kg d.m.	8,17	#	calculation	28.01.2022 21.02.2022
Benzo(a)pyrene	mg/kg d.m.	0,31		SIST EN 15527:2009	28.01.2022 21.02.2022
Benzo(b)fluoranthene	mg/kg d.m.	0,47		SIST EN 15527:2009	28.01.2022 21.02.2022
Benzo(g,h,i)perylene	mg/kg d.m.	0,41		SIST EN 15527:2009	28.01.2022 21.02.2022
Benzo(k)floranten	mg/kg d.m.	<0,35		SIST EN 15527:2009	28.01.2022 21.02.2022
Fluoranten	mg/kg d.m.	0,74		SIST EN 15527:2009	28.01.2022 21.02.2022
Indeo(1,2,3,c,d)piren	mg/kg d.m.	0,37		SIST EN 15527:2009	28.01.2022 21.02.2022
Naftalen	mg/kg d.m.	0,86		SIST EN 15527:2009	28.01.2022 21.02.2022
PAO- Dibenzo(a,h)antracen	mg/kg d.m.	<0,35		SIST EN 15527:2009	28.01.2022 21.02.2022
PAH-Fluorene	mg/kg d.m.	<0,35		SIST EN 15527:2009	28.01.2022 21.02.2022
PAH-Acennapthene	mg/kg d.m.	<0,35		SIST EN 15527:2009	28.01.2022 21.02.2022
PAH-Acenaphthyiene	mg/kg d.m.	1,22		SIST EN 15527:2009	28.01.2022 21.02.2022
PAH-Anthracene	mg/kg d.m.	0,48		SIST EN 15527:2009	28.01.2022 21.02.2022

RESULTS DES-infection CONTROLLER **KT4-6**

Testorganism : *Enterococcus faecium* Serialnumber : **195676**

Process information

Testdate : 14-09-2020

Machine : PPE

Formula : 03

RESULTS FOR EACH STARTVALUE [cfu/cm²]

10^3	10^4	10^5	10^6
☑	☑	☑	☑

DEGREE OF REDUCTION: 10^6

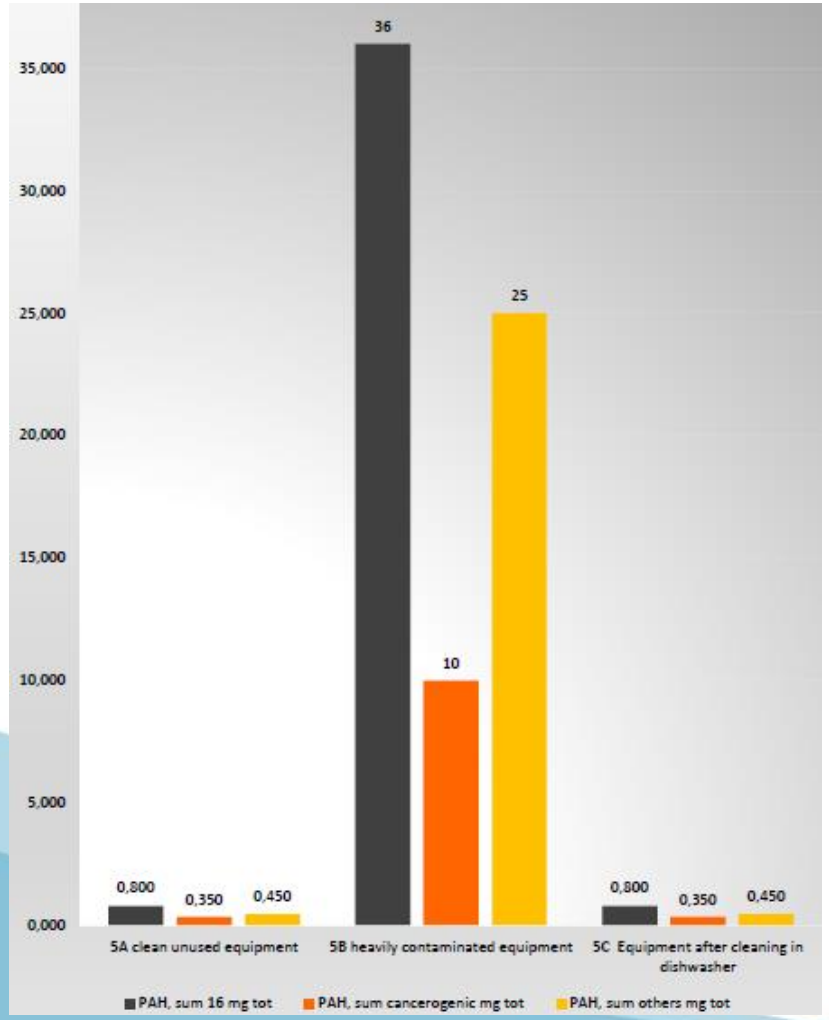
Remarks:

LCO_2 and wet washing

It is important to estimate when LCO_2 decontamination, wet washing and reimpregnation are required due to safety and health requirements.

PPE Washer

Decontamination of helmets and BA sets

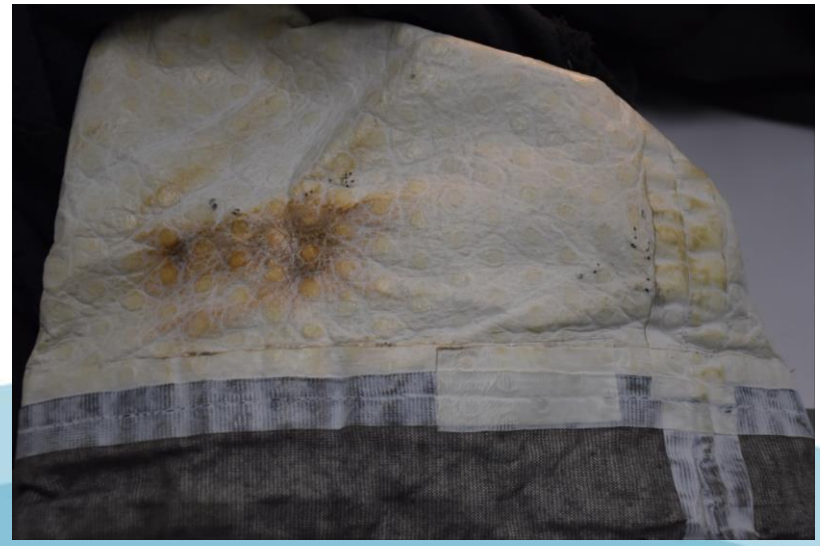


Report: Analysis of substances which are harmful to health and carcinogens (PAH) on sooty breathing apparatus before and after pre-treatment and washing in a PPE washer

REPORT ALS:
T 1822525. I.L 2.
Dat. 2018-10-03

Inspection of PPE

- Damaged PPE may endanger the safety of the user
- Physical injuries such as cuts, burns, etc.



Repairs

- Authorized repair service of several major producers of firefighting protective equipment
- Use of the original materials supplied by producers, as required by producers and EN standards




Thank you for your attention!

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Fraport Aviation Academy