7.34 Dry cleaning

7.34.1 Coverage

This sector covers dry cleaning of textiles, leather and furs. Dry cleaning relates to cleaning of fabrics with organic solvents.

7.34.2 Emission sources

In dry-cleaning, solvents such as perchloroethylene (PER) and light hydrocarbons (which are flammable) are mainly used today. Hydrocarbons with higher flash point are also used. In Germany where these solvents are used in dry cleaning, the requirements for use are as follows [6]: ebullition temperature between 180 and 210 °C, flash point larger than 55°C. They are less volatile than perchlorethylene. Consequently the drying cycle is longer. They have a lower Kb value than PER and are consequently less efficient than PER for some types of products to be removed (the Kauri butanol value (Kb**)** measures the cleaning power of the solvent, the higher the Kb, the more aggressive is the solvent).

Significant VOC emissions of solvents from dry-cleaning machines can be divided into two categories:

- Discharge of vapour, including venting of machines, air discharge from storage tanks during filling, leaks and solvent retained temporarily on cleaned clothes;
- Residues left outside.

Presently some other types of organic solvent emerge. One of them is the Siloxane D_5 CAS 541-02-6, a liquid silicone. Its vapour pressure at 20°C is 0.03 kPa. This product is attractive however it is not free of impact on human health according to studies carried in USA and Denmark [4] and [5]. The use of liquid is still marginal but is growing [8]. For any substitution of current solvents used in dry cleaning, special attention has to be paid to classification of solvents (see chapter 5.1).

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There are 4 types of dry cleaning machines presently in operation [1]:

Machine type I: this type of machine has only a water cooled unit at a temperature of 20-30°C to condense the solvent. After water cooling, the solvent laden air is exhausted without an activated carbon filter. The emissions to air are about 105 g solvent/kg textiles. The solvent consumption is about 110 g solvent/kg textiles.

Machine type II: this type of machine has a refrigeration cooling unit condensing perchorethylene at a temperature of -20°C. The exhaust air passes an activated carbon filter before being exhausted. The emissions to air are about 45 g solvent/kg textiles. The solvent consumption is about 50 g solvent/kg textiles.

Machine type III: this type of machine is a closed machine with a closed drying cycle where the drying air is recirculated through a refrigeration cooling unit. There is no exhaust air released. The assumed emissions to air are about 20 g solvent/kg textiles and the range of emissions 20 to 40 g solvent/kg textiles. The solvent consumption is about 25 g solvent/kg textiles.

Machine type IV: this type is totally closed with a closed drying cycle similar to type III. In this case, the air stream for drying cycles, circulates through the refrigeration cooling unit and the activated carbon, until the concentration of solvent in the turning cage is below 2 mg/m^3. The solvent from the adsorption phase of the activated carbon adsorber is returned into the machine. The assumed emissions to air are about 5 g solvent/kg textiles. The solvent consumption is about 10 g solvent/kg textiles.

7.34.3 Available Techniques, associated emission levels

Wet cleaning

A generally applicable primary measure with a high emission reduction potential consists in switching to wet cleaning processes with water

Wet cleaning use water to clean clothes that are typically dry cleaned. A special detergent and sizing formulated for wet cleaning applications is used. Both products are automatically dispensed to the machine at quantities set by the individual cycle programs. The detergent is a combination of active detergents, glycol ether, anti-shrinking agents, and alcohol dissolved in water. Occasionally, starch and other spot cleaners are used, some of which may contain hazardous chemicals. Wet cleaning is carried out in computer controlled washing and dry machines. The main cross media effect is water pollution. The quality can be lower than with solvent dry cleaning as fabrics can be deteriorated as colours. Restrictions with regard to leather and fabric have to be accounted for.

New generation dry cleaning machines

By introducing new generation closed-circuit machines (equipped with a condenser and an activated carbon filter), like type IV machines described above, VOC emissions can be reduced by 95% in comparison to open machines. Conventional closed-circuit machines with activated carbon filters can only reduce emissions by 80 %.

Table 1: Emission sources and selected available techniques with associated emission levels

Emission source	Combination of control measures	Available Technique Associated Emission Levels for VOCs
Open circuit machine and conventional closed machines (type I to type III machines) Solvent used : perchlorethylene (PER) or hydrocarbons	Switch to wet processes with water	0 g/kg textiles cleaned
	Switch to the newest generation type IV machine (closed machine with refrigeration cooling and activated carbon)	5 g/kg textiles cleaned

7.34.4 Emerging techniques

Liquid CO_2 cleaning

Liquid CO_2 cleaning machines already exist but are not yet widely spread. Like in a conventional process, liquid CO_2 cleaning machines have a cleaning chamber, a circulation loop, a filtration system, a lint trap, a distillation unit and storage. The equipment and chemistry is specially developed to house the pressure and interact with carbon dioxide. Garments have not to be dried after cleaning. Due to its low viscosity, liquid CO_2 enables to clean garments easily. Its performance is comparable to PER. A slight difference in cleaning performance is dirty motor oil and lipstick. However, these stains can be pre-spotted or post-spotted for complete stain removal [6].

Water less washing machines

The process is based on the use of plastic granules that are tumbled with the clothes to remove stains. The water consumption of 100 ml/kg garments is very low compared to traditional wet cleaning machines [8].

7.34.5 Cost data for emission reduction techniques

Costs are defined in the EGTEI background document concerning dry cleaning [3]. Investment cost of the last generation closed circuit machine is approximately 25 % higher than a conventional closed circuit machine.

7.34.6 References used for chapter 7.34

[1] Institute for health and consumer protection European Chemical Bureau. Risk assessment report for tetrachloroethylene. Final report 2005 – EUR 21680 EN

[2] Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations

[3] EGTEI background document: Dry cleaning – 2005

[4] Siloxanes in the Nordic Environment, TemaNord 2005 : 593 Nordic Council of Ministers, Copenhagen 2005 - ISBN 92-893-1268-8

[5] EPA study on siloxanes

[6] INERIS – rapport d'étude ERSA 05 9 – Note sur les produits de substitution du perchloroéthylène.

[7] Birgit Mahrwald UBA Comments on GD 7-36 dry cleaning version 1

[8] AEA energy and environment, OKOPOL and BIPRO: Guidance on VOC substitution and reduction for activities covered by the VOC solvent emissions directive – Guidance 11 - Dry cleaning – European commission 2008