4.1 Dry Cleaning

4.1.1 General[1,2]

Dry cleaning involves the cleaning of fabrics with nonaqueous organic solvents. The dry cleaning process requires 3 steps: (1) washing the fabric in solvent, (2) spinning to extract excess solvent, and (3) drying by tumbling in a hot air stream.

Two general types of cleaning fluids are used in the industry, petroleum solvents and synthetic solvents. Petroleum solvents, such as Stoddard or 140-F, are inexpensive combustible hydrocarbon mixtures similar to kerosene. Operations using petroleum solvents are known as petroleum plants. Synthetic solvents are nonflammable but more expensive halogenated hydrocarbons. Perchloroethylene and trichlorotrifluoroethane are the 2 synthetic dry cleaning solvents presently in use. Operations using these synthetic solvents are respectively called "perc" plants and fluorocarbon plants.

There are 2 basic types of dry cleaning machines, transfer and dry-to-dry. Transfer machines accomplish washing and drying in separate machines. Usually, the washer extracts excess solvent from the clothes before they are transferred to the dryer, but some older petroleum plants have separate extractors for this purpose. Dry-to-dry machines are single units that perform all of the washing, extraction, and drying operations. All petroleum solvent machines are the transfer type, but synthetic solvent plants can be either type.

The dry cleaning industry can be divided into 3 sectors: coin-operated facilities, commercial operations, and industrial cleaners. Coin-operated facilities are usually part of a laundry supplying "self-service" dry cleaning for consumers. Only synthetic solvents are used in coin operated dry cleaning machines. Such machines are small, with a capacity of 3.6 to 11.5 kg (8 to 25 lb) of clothing.

Commercial operations, such as small neighborhood or franchise dry cleaning shops, clean soiled apparel for the consumer. Generally, perchloroethylene and petroleum solvents are used in commercial operations. A typical "perc" plant operates a 14 to 27 kg (30 to 60 lb) capacity washer/extractor and an equivalent size reclaiming dryer.

Industrial cleaners are larger dry cleaning plants which supply rental service of uniforms, mats, mops, etc., to businesses or industries. Perchloroethylene is used by approximately 50 percent of the industrial dry cleaning establishments. A typical large industrial cleaner has a 230 kg (500 lb) capacity washer/extractor and 3 to 6 38-kg (100-lb) capacity dryers.

A typical perc plant is shown in Figure 4.1-1. Although 1 solvent tank may be used, the typical perc plant uses 2 tanks for washing. One tank contains pure solvent, and the other contains "charged" solvent (used solvent to which small amounts of detergent have been added to aid in cleaning). Generally, clothes are cleaned in charged solvent and rinsed in pure solvent. A water bath may also be used.

After the clothes have been washed, the used solvent is filtered, and part of the filtered solvent is returned to the charged solvent tank for washing the next load. The remaining solvent is then distilled to remove oils, fats, greases, etc., and is returned to the pure solvent tank. The

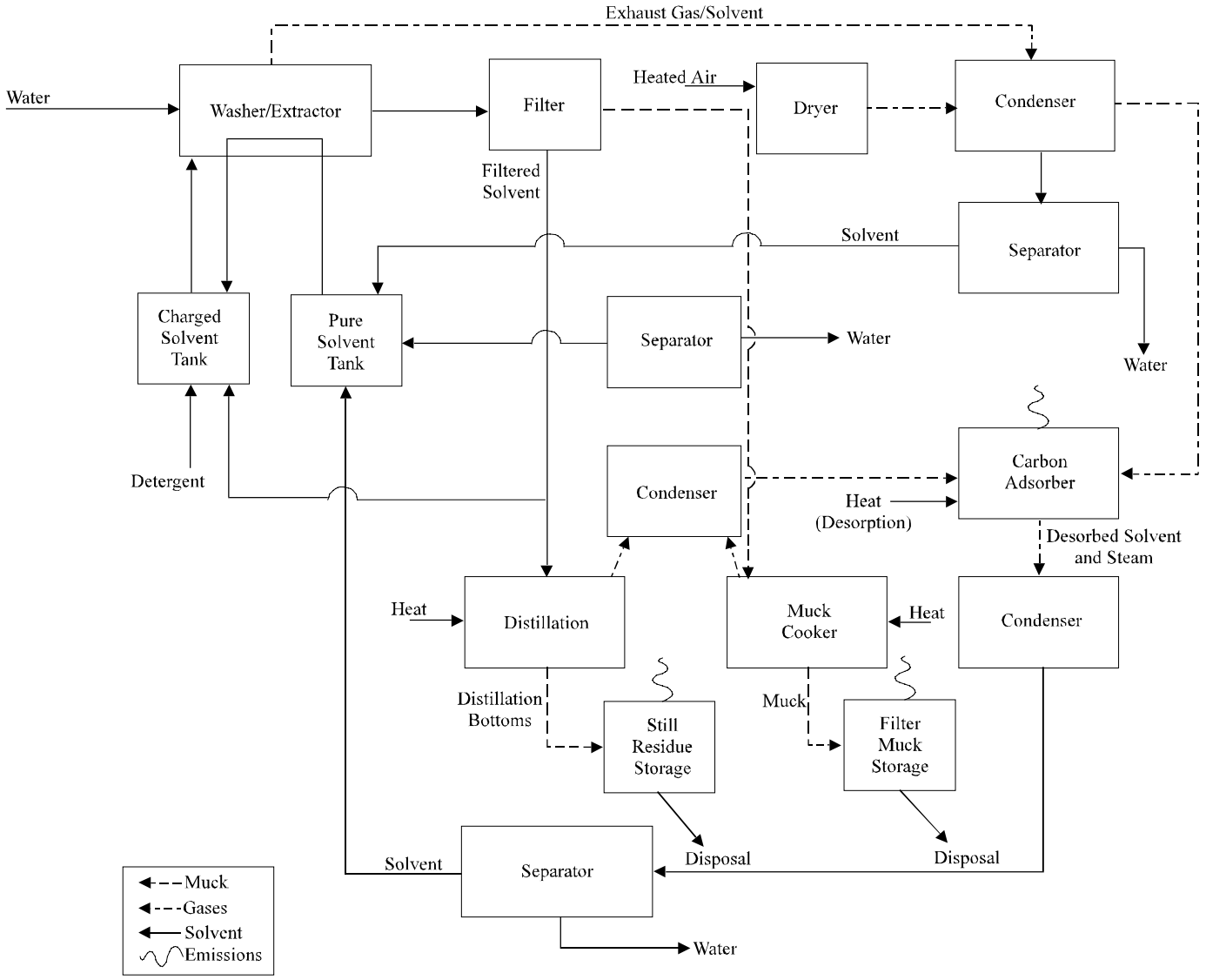

Figure 4.1-1. Perchloroethylene dry cleaning plant flow diagram.

collected solids (muck) are usually removed from the filter once a day. Before disposal, the muck may be "cooked" to recover additional solvent. Still and muck cooker vapors are vented to a condenser and separator, where more solvent is reclaimed. In many perc plants, the condenser offgases are vented to a carbon adsorption unit for additional solvent recovery.

After washing, the clothes are transferred to the dryer to be tumbled in a heated air stream. Exhaust gases from the dryer, along with a small amount of exhaust gases from the washer/extractor, are vented to a water-cooled condenser and water separator. Recovered solvent is returned to the pure solvent storage tank. In 30 to 50 percent of the perc plants, the condenser offgases are vented to a carbon adsorption unit for additional solvent recovery. To reclaim this solvent, the unit must be periodically desorbed with steam, usually at the end of each day. Desorbed solvent and water are condensed and separated, and recovered solvent is returned to the pure solvent tank.

A petroleum plant would differ from Figure 4.1-1 chiefly in that there would be no recovery of solvent from the washer and dryer and no muck cooker. A fluorocarbon plant would differ in that an unvented refrigeration system would be used in place of a carbon adsorption unit. Another difference is that a typical fluorocarbon plant could use a cartridge filter which is drained and disposed of after several hundred cycles.

4.1.2 Emissions And Controls[1-3]

The solvent itself is the primary emission from dry cleaning operations. Solvent is given off by washer, dryer, solvent still, muck cooker, still residue, and filter muck storage areas, as well as by leaky pipes, flanges, and pumps.

Petroleum plants have not generally employed solvent recovery, because of the low cost of petroleum solvents and the fire hazards associated with collecting vapors. Some emission control, however, can be obtained by maintaining all equipment (e. g., preventing lint accumulation, solvent leakage, etc.) and by using good operating practices (e. g., not overloading machinery). Both carbon adsorption and incineration appear to be technically feasible controls for petroleum plants, but costs are high.

Solvent recovery is necessary in perc plants due to the higher cost of perchloroethylene. As shown in Figure 4.1-1, recovery is effected on the washer, dryer, still, and muck cooker through the use of condensers, water/solvent separators and carbon adsorption units. Typically once a day, solvent in the carbon adsorption unit is desorbed with steam, condensed, separated from the condensed water, and returned to the pure solvent storage tank. Residual solvent emitted from treated distillation bottoms and muck is not recovered. As in petroleum plants, good emission control can be obtained by good housekeeping (maintaining all equipment and using good operating practices).

All fluorocarbon machines are of the dry-to-dry variety to conserve solvent vapor, and all are closed systems with built in solvent recovery. High emissions can occur, however, as a result of poor maintenance and operation of equipment. Refrigeration systems are installed on newer machines to recover solvent from the washer/dryer exhaust gases.

Emission factors for dry cleaning operations are presented in Table 4.1-1.

Typical coin-operated and commercial plants emit less than 10^6 grams (1 ton) per year. Some applications of emission estimates are too broad to identify every small facility. For estimates over large areas, the factors in Table 4.1-2 may be applied for coin-operated and commercial dry cleaning emissions.

Table 4.1-1 (Metric And English Units). SOLVENT LOSS EMISSION FACTORS FOR DRY CLEANING OPERATIONS

EMISSION FACTOR RATING: B

Solvent Type (Process Used)	Source	Emission Rate[a]	
		Typical System, kg/100 kg (lb/100 lb)	Well-Controlled System, kg/100 kg (lb/100 lb)
Petroleum	Washer/dryer[b]	18	2[c]
(transfer process)	Filter disposal		
	Uncooked (drained)	8	
	Centrifuged		0.5 - 1
	Still residue disposal	1	0.5 - 1
	Miscellaneous[d]	1	1
Perchloroethylene	Washer/dryer/still/muck cooker	8[e]	0.3[c]
(transfer process)	Filter disposal		
	Uncooked muck	14	
	Cooked muck	1.3	0.5 - 1.3
	Cartridge filter	1.1	0.5 - 1.1
	Still residue disposal	1.6	0.5 - 1.6
	Miscellaneous[d]	1.5	1
Trichlorotrifluoroethane	Washer/dryer/still[f]	0	0
(dry-to-dry process)	Cartridge filter disposal	1	1
	Still residue disposal	0.5	0.5
	Miscellaneous[d]	1 - 3	1 - 3

Table 4.1-1 (cont.).

[a] References 1-4. Units are in terms of weight solvent per weight of clothes cleaned (capacity x loads). Emissions also may be estimated by determining the amount of solvent consumed. Assuming that all solvent input is eventually evaporated to the atmosphere, an emission factor of 1000 kg/Mg (2000 lb/ton) of solvent consumed can be applied.

[b] Different materials in wash retain a different amount of solvent (synthetics, 10 kg/100 kg [10 lb/100 lb]; cotton, 20 kg/100 kg [20 lb/100 lb]; leather, 40 kg/100 kg [40 lb/100 lb]).

[c] Emissions from washer, dryer, still, and muck cooker are passed collectively through a carbon adsorber.

[d] Miscellaneous sources include fugitives from flanges, pumps, pipes, and storage tanks, and fixed losses such as opening and closing dryers, etc.

[e] Uncontrolled emissions from washer, dryer, still, and muck cooker average about 8 kg/100 kg (8 lb/100 lb). About 15% of solvent emitted is from washer, 75% dryer, 5% each from still and muck cooker.

[f] Based on the typical refrigeration system installed in fluorocarbon plants.

Table 4.1-2 (Metric And English Units). PER CAPITA SOLVENT LOSS EMISSION FACTORS FOR DRY CLEANING PLANTS[a]

EMISSION FACTOR RATING: B

Operation	Emission Factors	
	kg/yr/capita (lb/year/cap)	g/day/capita[b] (lb/day/cap)
Commercial	0.6 (1.3)	1.9 (0.004)
Coin-operated	0.2 (0.4)	0.6 (0.001)

[a] References 2-4. All nonmethane VOC.
[b] Assumes a 6-day operating week (313 days/yr).

References For Section 4.1

1. *Study To Support New Source Performance Standards For The Dry Cleaning Industry*, EPA Contract No. 68-02-1412, TRW, Inc., Vienna, VA, May 1976.

2. *Perchloroethylene Dry Cleaners — Background Information For Proposed Standards*, EPA-450/3-79-029a, U. S. Environmental Protection Agency, Research Triangle Park, NC, August 1980.

3. *Control Of Volatile Organic Emissions From Perchloroethylene Dry Cleaning Systems*, EPA-450/2-78-050, U. S. Environmental Protection Agency, Research Triangle Park, NC, December 1978.

4. *Control Of Volatile Organic Emissions From Petroleum Dry Cleaners (Draft)*, Office Of Air Quality Planning And Standards, U. S. Environmental Protection Agency, Research Triangle Park, NC, February 1981.