PRTR Estimation Manual

15. Industrial Cleaning Industry

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Japan Industrial Conference on Cleaning

Contents

1. Outline of Industrial Cleaning

Degreasing and cleaning are the removing processes for the contamination on the work pieces in the processing and cleaned pieces are sent to next processing stage in various manufacturing industries.

It is very rare that the degreasing and cleaning process is identified as an independent business, because the process is widely utilized as a part of whole process in various industries even though it is based on the independent cleaning technologies.

When the national policy of quitting the utilization of CFC-113/1,1,1-trichloroethane in industrial cleaning was adopted in Japan for the action against the destruction of ozone layer, industries had to search the alternatives. The Japan Industrial Conference on Cleaning (JICC) was organized to support industries for such movements in 1994.

The JICC is not a group of companies performing cleaning operation itself as their own work, but a group organized by companies belonging to different types of industries such as manufacturing cleaning agents, cleaning equipment and related apparatus. The aim of the group is to work out solutions for the various environmental problems related to cleaning processes and to make a positive social contribution. The group supports technical and other aspects in the challenge of substituting CFC-113/1,1,1-trichloroethane in the cleaning processes that are part of the production processes used by the manufacturers of especially small and medium-sized companies in each industry.

In these years, it has been globally focused the environmental problems and especially taken up the global warming and the environmental releases of specific chemicals, these problems are closely related with industrial cleaning. The JICC is playing the active role not only in ozone layer problems, but also in newly emerged environmental problems of industrial cleaning fields.

The JICC composed of regular members of 82 companies, supporting members of 20 companies, organization member of 8 organizations and information member of 19 members, including 32 companies of cleaning agent supplier, 36 companies of cleaning apparatus suppliers and 14 companies of peripheral equipment suppliers. The board is organized by chairman, Mr. Hashimoto, president of SPC Electronics Corporation, 3 vice-chairmen and 17 directors. And the operation is managed by the activities of operational committee, division meeting and various committees.

2. Description of Cleaning Process

The appropriate cleaning systems are selected and used for the purpose of cleaning, because the objects of cleaning and contamination to be removed are broadly varied.

Cleaning system consists of cleaning agents, cleaning apparatus and auxiliary equipment. The cleaning agent is the most important element in the system, because the selection of the cleaning agent substantially determines the structure of the cleaning system and the framework of a cleaning process. And therefore the calculation method below is described by cleaning agent.

A number of alternative cleaning agents to CFC-113/1,1,1-trichloroethane have been developed, and systematic classification is as follows:

(1) Aqueous cleaning agents

(2) Semi-aqueous cleaning agents

(3) Non-aqueous cleaning agents

(a) Nonflammable solvents (chlorinated organic solvent, fluorinated organic solvent)

(b) Combustible solvents (hydrocarbon series)

2.1 Work Items in the Cleaning Process

The basic process for cleaning treatment is composed of three processes such as <cleaning>, <rinsing>, and <drying>, and the actual methods depend upon the cleaning agents. Consequently, the processes described here are according to the cleaning agents.

2.1.1 Aqueous Cleaning Agents

The cleaning systems are roughly divided into dipping cleaning and spray cleaning on a stage. Both systems use the cleaning solution repeatedly in a cleaning bath or tanks and the solution is changed to new solution after the cleaning power decreased. The spent cleaning solution is transferred to an industrial waste treatment business.

The remaining solution containing contaminant on the objects are washed away by water. Water washing method is same as cleaning process, dipping or spray, and uses fresh water while discharging spent water of rinsing. Spent water of rinsing usually contains cleaning agents and other components higher than the quality standard of discharge water, it has to be water treated in the facility before discharging to water bodies. The treated water still contains resolved chemicals even the concentration is below the standards. The chemicals removed by the water treatment process are mainly dissolved organic substances such as surfactant, and the treatment is based on biodegradation by microorganism. The resulting sludge is an industrial waste.

The cleaned objects after rinsing are dried up by heating.

2.1.2 Semi-Aqueous Cleaning Agents

Solvents of glycol ether series are mainly used as semi-aqueous cleaning agent, and this is often

used for the cleaning of residual soldering flu× on printed circuit boards. The objects are dipped in the cleaning solution in washing process, and are rinsed by water. The residual water on the objects is dried up by evaporation.

Spent cleaning solution used repeatedly and decreases its cleaning power by the accumulated contamination, which should be changed to fresh solution after certain level of accumulation. The spent solution is to be handled as industrial waste.

The objects taken out from cleaning bath are covered with cleaning solvents on its surface and are sent to first rinsing water bath for dipping instead of ordinary rinsing by water flow in order to avoid higher loading by rinsing water to the water treatment facility. Cleaning solvent accumulates in the first rinsing bath and bath water should be changed to fresh water when the concentration of cleaning solvents becomes higher.

Spent water from rinsing is transferred to industrial waste treatment business. The objects washed in the first rinsing bath are sent to fresh water bath for dipping, of which effluent is discharged to water bodies after treated in the waste water treatment facilities.

Today, the effluent from second rinsing is treated by activated carbon to absorb the resolved cleaning solvent, because its concentration in the effluent is low enough. Water from activated carbon vessel is recycled to rinsing bath. No effluent is discharged to water bodies.

Even though cleaning agents of glycol ether series are used by heating up to 60 ℃, it is not necessary to consider air emissions of solvents, because vaporization of solvents from the system is very low and drying of objects is done after rinsing.

2.1.3 Non-Aqueous Cleaning Agents

In the non-aqueous cleaning systems which are using organic solvents of flammable or non-flammable, the process is different from aqueous system. Cleaning is done by dipping in the cleaning bath same as aqueous or semi-aqueous system, but rinsing is done by using vapor cleaning with the vapor of solvents by boiling up the solvents. The objects are exposed to solvent vapor and are washed out by condensed vapor of solvents on the surface of objects. The temperature of objects rises by the contact and condensation of solvent vapor on its surface, condensation will be stopped at certain temperature of equilibrium, due to the temperature rise of objects by latent heat. Then the objects can be removed from the system and dried up by themselves.

Most of vapor generated in the vapor-washing bath are condensed and recovered at the cooling coils installed at the upper part of the cleaning system and recovered clean solvent is supplied to washing vessels. Spent solvent of washing bath is sent to vapor washing bath for regeneration. Thus washing can be continued by regenerating and recycling the solvents in the closed system.

After certain time period, oily contaminants removed from objects are accumulated in the vapor washing vessels. Then, fresh vapor for washing becomes difficult to obtain, and it causes the

deterioration of washing quality. Spent solvents should be removed from vapor washing to change with fresh solvents for keeping the washing quality. Spent solvents are distilled to recover solvents by separate distillation apparatus. In case that no distillation recovering equipment is installed in the system, spent solvents shall be sold to industrial waste business. And the bottom sludge from distillation recovering equipment is also transferred to industrial waste business.

In case of chlorinated or fluorinated solvents, large amount of solvent vapor leaks from the conventional cleaning system, because of its high vapor pressure and heating up the solvent to its boiling point. Generally, the vapor loss from such system is estimated to be 80 percent of total use of the solvent. In case of using hazardous solvents, the solvent recovery system is usually installed to the system, considering the occupational Health and Safety Law or Air Pollution Control Law and the economy of high cost solvents such as fluorinated solvents. In the recovery process, it is generally used activated carbon and its recovery rate is estimated to be 80 percent. As a result, 20 percent of solvent vapor is released to air. Adsorbed solvents to activated carbon is desorbed by contacting with water vapor and recovered by separating from water for the reuse. Small amount of solvents is dissolved into separated water, which should be degassed in case of hazardous solvents, or disposed as industrial waste. Spent activated carbon is handled as industrial waste because of its adsorption residue in the carbon. In case that activated carbon is used in the batch system, spent carbon after its life is sent to industrial waste business.

The flammable hydrocarbon solvent with high flash point tends to be used on the safety point of view. In this case, vapor phase rinsing cannot be used, but rinsing by dipping into clean solvent. Contaminated solvent in the rinsing bath is removed to send to vacuum distillation apparatus for regeneration. Recovered solvent is recycled to rinsing bath. The overflow from the rinsing bath is sent back to washing bath. Thus the solvents are used by recycling. Bottom residue is accumulated in the bottom of vacuum distillation equipment after certain time of operation and it is necessary to remove the bottom residue which is to be transferred to industrial waste business. And also it is necessary to make up fresh solvent to rinsing bath in order to compensate the solvent decrease.

Objects after rinsing are heated up to dry up wet surfaces by the evaporation of solvent. Solvent vapor from drying process and from washing, rinsing bath are released to the air. In order to decrease air emission of solvent, activated carbon adsorption apparatus can be installed to the exhaust line. In this case, 80 percent of solvent which could be released to air is recovered by the activated carbon and spent carbon is treated as industrial waste.

2.2 Outline of Usage and Releases and Transfers of Class I Designated Chemical Substances

Chlorinated solvents such as 1,1,1,-trichloroethane, dichloromethane (methylene chloride), trichloroethylene, tetrachloroethylene and fluorinated solvents such as CFC113, HFC225, HCFC141b are listed as Class I Designated Chemical Substances (PRTR chemicals) and it is necessary to notify the releases and transfers from the degreasing and cleaning process using these solvents.

HFE and HFC developed as CFCs alternatives are not in the list of the PRTR chemicals. However, in case of solvent mixture containing trans-1,2-dichloroethylene, it is necessary to calculate the amount and notify the releases and transfers of trans-1,2-dichloroethylene.

In the hydrocarbon type cleaning agents, 1,3,5-trimethylbenzene, which is a PRTR chemicals, is contained in aromatic hydrocarbon cleaning agent. In case aromatic hydrocarbon agents are used in the washing process, then it is necessary to calculate and notify its releases and transfers.

Following PRTR chemicals are often used as a component of surfactant in a aqueous and semi-aqueous cleaning agents: n-alkylbenzenesulfonic acid and its salts, poly(oxyethylene)alkyl ether(alkyl C=12-15), poly(oxyethylene)octylphenyl ether, poly(oxyethylene)nonylphenyl ether. And also following PRTR chemicals are sometimes used as a component of cleaning agents: (solvents) benzene, ethylene glycol, ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, 2-aminoethanol, (chelate) nitrilotriacetic acid, ethylenediaminetetraacetic acid, (others) boron and its compounds, hydrogen fluoride and its water soluble salts. It is necessary to confirm the detailed contents of the agents in use by obtaining MSDS from suppliers. If class I chemicals are identified in the cleaning agents, it must be necessary to calculate and notify its releases and transfers by each component.

It comes up spent cleaning liquor from each cleaning process, which can be assumed to be same as initial composition except dissolved contaminants. And therefore spent liquor containing class I chemicals are transferred as waste.

In case of aqueous cleaning, air emission can be ignored, and cleaning agents diluted in rinsing water are discharged to water bodies. When rinsing water discharge is treated by biodegradation, concentration of cleaning agents in the effluent decreased to 40 percent, and out of the removed 60 percent of object substance, about 40% turned to harmless material in the biodegradation. Then remaining 20 percent is transferred as waste sludge.

On the other hand for solvent cleaning, cleaning solvents are mostly released to air as vaporization loss except handled as spent cleaning agents. In case of activated carbon treatment of exhaust gas for the decrease of releases, it is possible to decrease the releases of object substances down to 20 percent. In the water vapor regeneration of activated carbon, it comes out the separated water from regeneration. If it contains object substances, it is transferred as waste. And spent

carbon is also transferred as waste containing object substances.

In the semi-aqueous cleaning, waste liquor from first rinsing bath and spent activated carbon used for the recycling of rinsing water are waste and there are no air emissions and releases to water bodies. It is not realistic that the releases to on-site land occur in the normal cleaning operation.

2.3 Water Treatment Facility: Its Process and Effects

In case of degreasing and cleaning with aqueous cleaning agents, it comes out the rinsing waste water containing cleaning agents with exceeding the water quality standard. And it should be treated by water treatment facility to enable discharging to water bodies. There are many types of water treatment systems such as plain sedimentation method, coagulation sedimentation method, biodegradation method, membrane filtering method and activated carbon adsorption method. It is generally used the biodegradation process or activated carbon adsorption process, because they are effective to remove surfactants which are the main component of cleaning agents. The rinsing water discharge is generally large amount, and biodegradation treatment method is adopted because it can be expanded easily to higher capacity. For rather smaller discharge amount, activated carbon adsorption method is used because of its rather smaller installation area compared with that of biodegradation method. The typical removal rate of dissolved organic substances for each system is estimated as follows: 60% for biodegradation and 80% for activated carbon.

On the other hand for organic solvent cleaning system, vapor loss is mainly released to air. In order to decrease air emission, cleaning systems are enclosed to send vapor to suction duct for the treatment by activated carbon. There are two types of activated carbon used in the solvent recovery system that are granular type and fiber type. The performance of the system depends on the type of activated carbon and also the charge amount of carbon depends on the exhaust gas volume and concentration of solvent vapor in the gas. In the ordinary equipment, removal rate of solvent vapor is estimated roughly about 80 percent. And it is the time for regeneration or change of activated carbon when it adsorbs solvent gas up to 10% of equilibrium adsorption.

2.4 Outline of Related Waste and its Treatment

In the solvent cleaning system, the bottom residue of vapor cleaning bath, of which content of solvent is high, is sent to waste treatment business to recover solvents. In case the bottom residue from solvent distillation equipment contains smaller amount of solvents, the residue is usually sent to incinerator.

In the semi-aqueous cleaning systems, the effluent contains organic solvents which are difficult to recover by distillation and is usually incinerated. The effluent from first rinsing bath contains water

by 95 percent and is treated together with the effluent from aqueous cleaning systems. In the solvent cleaning, separated water from the process of solvent vapor recovery by cooling and from the process of steam regeneration of activated carbon is processed by waste water treatment facilities.

Spent water in the aqueous cleaning system contains inorganic substances such as alkalis, inorganic builders, etc., and organic substances such as oil, surfactants, etc. This spent water is treated by coagulation sedimentation and biodegradation methods after neutralization. And the treated water is discharged to water bodies. The filtered sludge is sent to landfills.

Spent activated carbon used for the exhaust gas treatment and for the recycling water treatment is incinerated after repeated regeneration at the end of life.

3. Calculation Method and Examples of Releases and Transfers by Cleaning Agent

3.1 Calculation Method and Calculation Factors of Simplified Calculation for Releases and Transfers

The releases and transfers of PRTR chemical substances in degreasing and cleaning process usually calculated by using material balance method. And in case that emission factors are given such as for chlorinated solvent cleaning, releases and transfers can be calculated by using emission factor. In the industrial cleaning, it is difficult to measure releases directly and the releases are calculated by subtracting the amount of transfers from the handling amount. However, there are some cases that the amount of object substances cannot be calculated by the waste amount and the content of the substances. For example, the removed contaminant is mixed in the discharge of cleaning process and then the amount of discharge cannot be the amount of cleaning agents. In order to get the correct amount of cleaning agents, it is necessary to analyze the amount of contaminant and to subtract the results from the discharge amount. Thus, actual measurements sometimes become necessary to calculate the release amount of object substances. As for actual measurements, simplest method is shown in each section for cleaning agent.

Considering such calculation in the small and medium sized enterprise having the industrial cleaning systems, there might be very rare to keep the measurement equipment or person in charge. In order to enable to calculate the releases and transfers to be notified in such a case, JICC proposed a calculation method to use empirical values derived from the long industry experience instead of actual measurement. In the calculation equation for waste transfer, some unknown parameters necessary to complete calculation are given the empirical value, without actual measurement, defined as “calculation factor”.

The calculation factors are shown in the description of calculation method of releases and transfers for each cleaning agent and the list of these factors are attached in the reference 1. As a matter of fact, the accuracy of method using calculation factors is not high, but it might be very useful for companies, which could not measure actual value, to avoid calculating values without basis.

In the calculation of the content of object substances in the waste water from solvent cleaning process of chlorinated or fluorinated solvents, there are examples of using saturated water solubility of the object substance.

3.2 Calculation Method and its Examples of Releases and Transfers for Aqueous Cleaning

3.2.1 Premises

(1) Class I Designated Chemical Substances (PRTR Chemicals)

The object chemicals contained in the cleaning agents for aqueous and semi-aqueous cleaning system are not fully seized, but those were estimated by using the results of

questionnaire survey promoted by the PRTR committee in JICC and shown in Table 3.2.1.

Table 3.2.1. Class I Designated Chemical Substances Contained in Cleaning Agents for Aqueous and Semi-Aqueous Cleaning Systems

Cabinet	PRTR Chemicals	Remarks
16	2-amino ethanol	Rust preventives
24	N-alkyl benzene sulfonic acid and its salt (R = C10～14 and mixture)	Detergent major component
43	Ethylene glycol	Additive
44	Ethylene glycol mono ethyl ether	Additive
45	Ethylene glycol mono methryl ether	Additive
47	Ethylenediaminetetraacetic acid (EDTA)	Chelating agent
233	Nitrilotriacetic acid (NTA)	Chelating agent
283	Hydrogen fluoride and its water-soluble salt	Semiconductor, imaterials removal
299	Benzene	Additive
304	Boron and its compounds	Rust preventives
307	Poly (oxyethylene) = alkyl ether (R = C12～15 and its mixture)	Detergent major component
308	Poly (oxyethylene) =octyl phenyl ether	Detergent major component
309	Poly (oxyethylene) = nonyl phenyl ether	Detergent major component

(2) Method of Cleaning and Cleaning Process

In case of aqueous cleaning agents, method of cleaning varies widely such as dipping, swaying, bubbling, spraying and ultrasonic bath and also shape of work piece to be cleaned varies widely, and also it is difficult to prepare a manual because of wide variety of cleaning agents and cleaning conditions.

First, it is assumed the standard process flow of aqueous cleaning system as shown in Figure 3.2.1, considering the accuracy of the calculation of release and transfer amount for PRTR chemicals.

The discharges of the effluent from rinsing bath are generally disposed or sent to water treatment facility. It is necessary to calculate the transfer amount for disposal. And in case of water treatment, release and transfer amount should be calculated, considering the removal rate* of treatment process and dissolution of PRTR chemicals into effluent water. (*: PRTR Guideline: Japan Chemical Industry Association, revised version August, 1998. Attachment table 3)

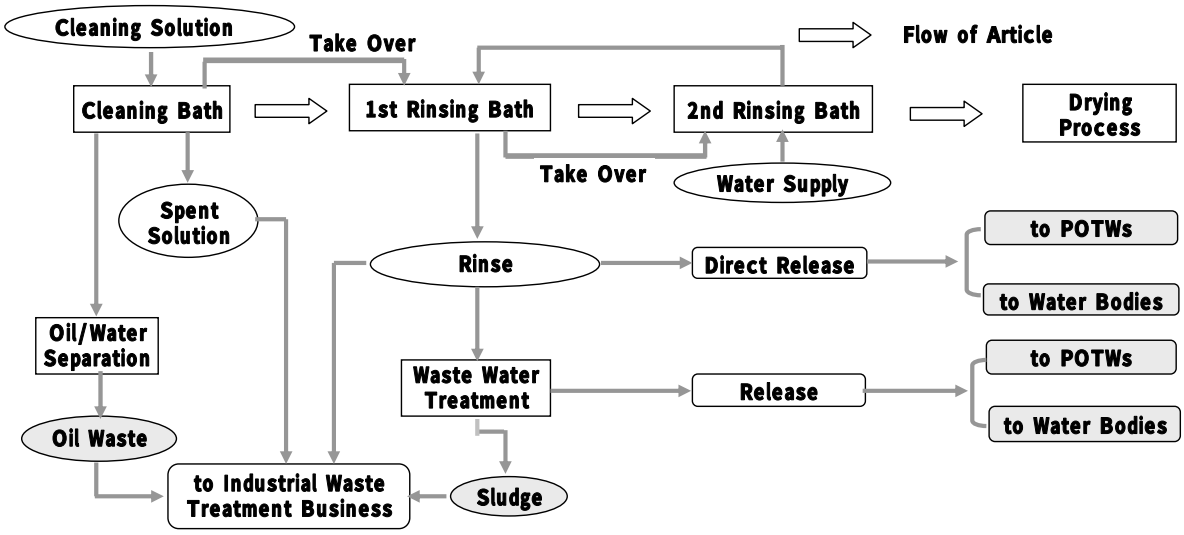


Fig. 3.2.1 Standard Process Flow Diagram of Aqueous Cleaning

(3) Releases and Transfers for Aqueous Cleaning Systems

The releases to the environment are divided into "water bodies", "air emission", "released to on-site land" and the transfers are divided into "waste" and "POTWs(Publicly Owned Treatment Works"

In case of aqueous cleaning agents, it is supposed that the air emissions and the releases to on-site land can be neglected, and it is limited to the releases to water bodies and the transfers as waste and to POTWs.

The releases of rinsing effluent to water bodies or the transfers to POTWs are to be in compliance with the Sewerage Law and the Water Pollution Control Law by the effluent management. As for the discharge of effluent, the effluent to water bodies must be reported as releases and to POTWs is to be reported as transfers, separately. For this purpose, it is very difficult to know the input amount of cleaning agents to rinsing bath. So, in this case, the release amount to water bodies is calculated by subtracting waste transfers from total handling amount.

(4) Calculation Method

There are 5 methods for the calculation of releases as follows:

material balance, emission factors, actual measurement, physico-chemical properties and the methods which are recognized as proper calculation method.

(5) Unit of Calculated Results

The releases and transfers are notified in the unit of kg/year with two significant digits. (expressing figures to one place of decimal)

3.2.2 Calculation of Handling Amount, Releases and Transfers

There are 3 cases for the transfer of cleaning and rinsing effluent and releases of effluent and these are summarized in the Table 3.2.2.a, 3.2.2.b and 3.2.2.c.

Table 3.2.2.a Case 1: Cleaning Waste Liquor and Rinsing Effluent are fully Transfered as Waste and No waste water treatment

No.	Calculation item	Calculation method
1	Amount handled(kg/y)	Annual amount handled (kg/year)= (annual amount purchased + stock amount at the beginning of the term−stock amount at the end of the term) x (content of PRTRvchemicals in detergent *1 ÷ 100)
2	Transfers as waste(kg/y)	Transfers as waste = Annual amount handled *:Cleaning agents are disposed as waste contained in waste liquor and rinsing effluent as shown in Fig. 3.2.1, then it is treated same with annual handling amount
3	Releases to water bodies	Releases to water bodies = 0 *: All rinsing effluent is transfered as waste, and nothing released to water bodies or POTWs.

*1: Referring the MSDS provided by the supplier, the content (%) of the PRTR chemicals is used

Table 3.2.2.b Case 2: Cleaning Waste Liquor is fully Transfered as Waste and and Rinsing Effluent is released to water bodies and to POTWs

No.	Calculation item	Calculation method
1	Amount handled (kg/y)	Annual amount handled (kg/year)= (annual amount purchased + stock amount at the beginning of the term−stock amount at the end of the term) x (content of PRTR chemicals in detergent *1 ÷ 100)
2	Transfers as waste (kg/y)	Transfers contained in waste (spent cleaning liquid) = [(amount of spent cleaning liquid) - (spent cleaning liquid amount x oil content % in spent cleaning liquid)*2 /100] x (concentration of cleaning agent used/100) x (concentration of PRTR chemicals in cleaning agent % *1/100) * : Amount of spent cleaning liquid = Annual transfers to industiral waste disposal business and industrial waste disposal with special management business. ** : concentration of cleaning agent used = supposing the concentration of cleaning agent purchased as 100%, the percentage in diluted liquid.
3	Releases to water bodies (kg/y)	Releases to water bodies = (Annual handling amount) - (Transfers contained in waste) *: All rinsing effluent is transfered as waste, and nothing released to water bodies or POTWs.
4	Transfers to POTWs (kg/y)	Transfers to POTWs = (Annual handling amount) - (Transfers contained in waste)

*1: Reffering the MSDS provided by the supplier, the content (%) of the PRTR chemicals is used

*2: The content of non-water solulbe oil component is supposed to be 0.7% and the content of water soluble oil content is supposed to be 4.8%.

Table 3.2.2.c Case 3: Cleaning Waste Liquor is fully Transfered as Waste and and Rinsing Effluent is fully Waste Water Treated

No.	Calculation item	Calculation method
1	Amount handled(kg/y)	Annual amount handled (kg/year)= (annual amount purchased + stock amount at the beginning of the term −stock amount at the end of the term) x (content of PRTR chemicals in detergent [*1] ÷ 100)
2	Transfers as waste(kg/y)	Transfers contained in waste (spent cleaning liquid) = (transfer amount in the spent cleaning liquid[*3]) + [(annual amount handled - transfer amount in the spent cleaning liquid*3) x (removal rate of the waste water treatment facility used - degradation rate of the treatment facility used[*4])] * : Amount of spent cleaning liquid = Annual transtfers to industiral waste disposal business and industiral waste disposal with special management business. ** : Chemical substances in aqueous cleaning agents are treated as water soluble organic chemicals as described in Table 2.4.7-2 (estimated values of the removable rate and decomposition rate for typical water treatment facilities) of Manual of PRTR Pilot Test 2000.
3	Releases to water bodies(kg/y)	Releases to water bodies = (Annual handling amount - Transfers contained in spent cleaning liquid) x (1 - removal rate of the facilitiy[*5])
4	Transfers to POTWs(kg/y)	Transfers to POTWs = (Annual handling amount - Transfers contained in spent cleaning liquid) x (1 - removal rate of the facilitiy[*5])

*1: Reffering the MSDS provided by the supplier, the content (%) of the PRTR chemicals is used

*2: The content of non-water solulbe oil component is supposed to be 0.7% and the content of water soluble oil content is supposed to be 4.8%.

*3: [(amount of spent cleaning liquid) - (amount of spent cleaning liquid x oil content % in spent cleaning liquid)[*2] /100] x (concentration of cleaning agent used %/100) x (concentration of PRTR chemicals in cleaning agent % [*1]/100)

*4: In a biodegradation system, it is supposed the removal rate to be 0.6 and the degradation rate to be 0.4. In case of activated carbon absorption system, it is supposed the removal rate to be 0.8 and decomposition rate to be 0. cf. Table 2.4.7-2

*5: The removal rates are supposed to be 0.6 for biodegradation system and 0.8 for activated carbon absorption system respectively. In the other systems, the removal rate is supposed to be 0. (ref. Manual of PRTR Pilot Test 2000, p463)

3.2.3 Examples

(3)-1: Data

1) Annual mount of cleaning agent purchased: 12,000 kg

2) Stock amount at the beginning of the term: 1,000 kg

3) Stock amount at the end of the term: 1,000 kg

4) Content of PRTR chemicals in cleaning agent: 15% (to be confirmed by MSDS)

5) Amount of waste liquid: 120,000 kg

[liquid volume in cleaning vessel (5,000 kg/time)

× exchange of cleaning liquid (2 times/M) × 12 months]

6) Concentration of cleaning agent in use: 10%

7) Species of contaminant oil component: oil soluble oil (concentration 0.7%)

8) Waste water treatment facility: Treated by biodegradation and released to water bodies.

(3)-2: Calculation of the Amount to be Reported

1) Annual amount handled (kg/y)

= (annual amount purchased + stock amount at the beginning of the term

— stock amount at the end of the term)

× (content of PRTR chemicals in cleaning agent ÷ 100)

= (12,000 + 1,000 — 1,000) × 15%/ 100

= 1,800 kg/y (no report is necessary as it is < 5 tons [now lowered to 1 ton since 2004])

2) Transfers contained in waste (spent cleaning liquid) (kg/y)

= [(amount of the spent cleaning liquid)

— (amount of the spent cleaning liquid × oil content ÷ 100)]

× (content of cleaning agent in use ÷ 100)

× (content of PRTR chemicals in detergent ÷ 100)

= [(120,000 — (120,000 × 0.7 ÷ 100)] × (10 ÷ 100) × (15 ÷ 100) = 1,787.4 kg/y

3) Amount of transfers in waste (kg/y)

= transfers contained in spent cleaning liquid

+ [(annual handling amount — transfers contained in spent cleaning liquid)

× (removal rate of the treatment system used — degradation rate of the system used)]

= 1,787.4 + [(1,800 — 1787.4) × (0.6 — 0.4)] = 1,789.9 kg/y

4) Release amount to water bodies (kg/y)

= annual handling amount — transfer amount in waste = 1,800 — 1,789.9= 10.1 kg/y

3.2.4 Useful Data for the Calculation (Aqueous Cleaning Agents)

(1) Estimation of Oil Content in Waste Cleaning Liquid

In the calculation of transfer amount in waste, it is necessary to subtract oil weight from the amount of waste cleaning liquid. (Oil is contaminant removed from cleaned articles) However, it is difficult to measure the concentration of oil, then it is convenient to use calculation factor derived from empirical data.

Though the survey of oil content in the waste cleaning liquid in the actual cleaning facility site, it was clarified that oil content of 0.1 — 2.0% for oil soluble oil and 0.8 — 10% for water soluble oil as shown in Table 3.2.4.

From these data, it can be supposed following content depending oil species by calculating the mean value of the data:

Oil contents of waste cleaning liquid in case of oil soluble oil: 0.7%

Oil contents of waste cleaning liquid in case of water soluble oil: 4.8%

Table 3.2.4 Measured Data of Oil Content % in Spent Cleaning Liquid

Cleaning Agent Supplier	Parts to be Cleaned	Cleaning Process	Concentration of Agents	Oil Species	Oil Content %
A	machining parts	spray		anti-rust	1.9
	pressed parts	spray		press oil	0.4
	transmission parts	spray		emulsion	3.6
	compressor parts	spray + US		soluble	0.8
B		spray	3	mineral oil	0.4
		spray	3	mineral oil	0.5
		spray	2	mineral oil	0.8
		spray	2	mineral oil	1.4
		spray	2	mineral oil	0.2
		spray	5.5	mineral oil	0.3
		spray	8	mineral oil	0.3
C	(alkaline agent)	US	10	machining oil	0.1
	(alkaline agent)	US	10	water dispersed machining oil	10
	(neutral detergent)	US	10	machining oil	0.5
	(neutral detergent)	US	10	kerosene	2.0

3.3 Calculation Method of Releases and Transfers for Semi-Aqueous Cleaning Agents

3.3.1 PRTR Chemicals in Semi-Aqueous Cleaning

The cleaning agents for semi-aqueous cleaning system contain mainly solvents consisting of glycol ethers with various additives including surfactant. The contents are not be fully clarified yet. The PRTR committee of JICC sent questionnaire to member companies asking the content of the cleaning agents, and results showed that the cleaning agents contain PRTR chemicals as shown in Table 3.2.1 for aqueous cleaning agents.

In case that the PRTR chemicals are contained in the cleaning agents purchased by the description of the MSDS attached, it is necessary to estimate the amount of releases and transfers of those PRTR chemicals and notify the results to the authorities under the Law concerning Reporting, etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management (herein after PRTR Law).

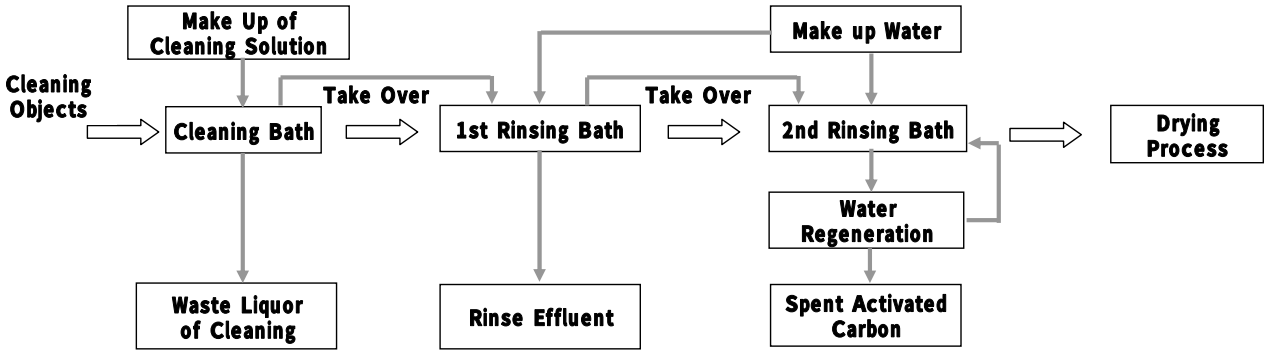
3.3.2 Cleaning Method and Process

In the semi-aqueous cleaning system, the objects to be cleaned are first washed by high boiling point solvents and then are rinsed with water. As a feature of the system, it can be pointed out that it is effective to remove both organic and ionic contaminant on the objects. The process therefore is suitable for the cleaning of the residual flu× of soldered print circuit boards, and the most of the usage is for print circuit board of electronic and electric industries.

The system flow diagram of standard semi-aqueous cleaning system is shown in Fig. 3.3.1. The

cleaning system consists of washing bath, first rinsing bath, second rinsing bath and dry up part, and objects are cleaned by moving through the process steps. Objects are dipped in the cleaning bath filled with cleaning agents and contamination on the objects is removed, and those objects are sent to first rinsing bath to be washed up most cleaning agents attached on the surface of objects. Then, objects are moved to second rinsing bath and cleaned up thoroughly by recycled clean water. Cleaning agents in the cleaning bath gradually contaminated and it should be changed to fresh agent before the cleaning power lowered below the limit. And the spent cleaning liquor is transferred to industrial waste treatment business as waste liquid. The water in the first rinsing bath also changed to fresh water after the concentration of the cleaning agents build up. The contaminated water with the cleaning agent from first rinsing bath is an industrial waste. The rinsing effluent from the second rinsing bath is sent to activated carbon absorption tower and the dissolved component is removed by activated carbon bed. And the treated water is recycled to second rinsing bath. Activated carbon of which adsorption power lowered below the limit is changed and spent carbon is an industrial waste.

Fig. 3.3.1 System Flow Diagram of Semi-Aqueous Cleanings



3.3.3 PRTR Chemicals from the System

PRTR chemicals contained in cleaning agent are wasted included in spent cleaning liquid, rinsing effluent and spent activated carbon. They are not released to air or water bodies.

3.3.4 Calculation Method

Table 3.3.1 shows the equations for the calculation of handling amount, releases and transfers for semi-aqueous cleaning systems. Finally, handling amount is identical to transfers. The transfers for each type of waste are also described. If one of the amounts of waste transfer is unknown, it can be derived by subtracting 2 remaining waste transfer from handling amount.

3.3.5 Unit of Calculated Figures

The calculated results of releases and transfers are described by the unit of kg/y, and should be notified to authorities.

3.3.6 Description of Calculation Method for Handling Amount, Releases and Transfers

[1] Calculation of Annual Handling Amount

annual handling amount
= (annual purchase amount of cleaning agents
+ stock amount at the beginning of the term — stock amount at the end of the term)
× (content of PRTR chemicals in cleaning agent ÷ 100)

(Remarks for the Calculation)

(1) In a cleaning agent for semi-aqueous cleaning system sometimes contains poly(oxyethylene)nonylphenyl ether, one of the PRTR chemicals. It is necessary to ask vendors whether the cleaning agents purchased contain the PRTR chemicals or not, and to get MSDS from the supplier for the check of the content, in case that PRTR chemicals are used in the agents. If the content of PRTR chemicals is higher than 1%, it should be notified to the authorities.

(2) In case of a number of PRTR chemicals are contained in the cleaning agent, it is necessary to notify the releases and transfers of each PRTR chemical substance.

[2] Calculation of Transfers as Waste

Transfers contained in waste (spent cleaning liquid)
= (annual transfer amount of spent cleaning liquid to industrial waste disposal business
— dissolved contaminant amount)
× (content of PRTR chemicals ÷ 100)
+ [(annual transfer amount of rinsing effluent to industrial waste disposal business
× (cleaning agent content in rinsing effluent ÷ 100)
× (PRTR chemicals content in cleaning agent ÷ 100)]
+ [amount of spent activated carbon from rinsing water recycle system(L)
× cleaning agent adsorption amount per litter of activated carbon
× (content of PRTR chemicals in cleaning agent ÷ 100)]

(Remarks for the Calculation)

(1) The following 3 types of wastes are discharged from the system: spent cleaning liquor discharged at the exchange of cleaning liquid, rinsing effluent from the first rinsing bath at its exchange, and spent activated carbon at its exchange, used in the second rinsing bath for the water recycling system.

(2) It is necessary to calculate net amount of cleaning agent in the spent cleaning liquid by subtracting the amount of accumulated contaminants removed from work pieces in the liquid. However, it is difficult to measure the concentration of cleaning agent in the spent liquid. On the other hand, the contamination of cleaning liquid proceeds by the repeated use, and the cleaning power decreased that causes the decrease of cleaning quality. So, it is usually fixed the limit of the accumulation of contaminants, and cleaning liquid is exchanged at this limit. The amount of dissolved contaminants is calculated by following equation by using the limit of accumulation:

amount of dissolved contaminants

= amount of spent cleaning liquid × (limit content of contamination ÷ 100)

It is recommended to manage the cleaning liquid by supposing the limit concentration of contaminants in the liquid and measuring its content. Usually, this limit of contaminant content is supposed to be 5 percent. In such a case, the content of cleaning agent can be calculated by following equation:

amount of spent cleaning liquid × ((100 − 5) ÷ 100)

(3) The stored water in the first rinsing bath is used for rinsing the work pieces cleaned in the cleaning bath to remove cleaning liquid attached on the work pieces. And it is exchanged with fresh water after the accumulation of removed contamination building up to certain level and discharged rinsing water is stored in a tank for the transfer to industrial waste treatment business. The concentration of removed contamination in the first rinsing bath can be measured by refractometer. However, the stored water in the first rinsing bath should be exchanged with fresh water when the concentration of contaminant, removed cleaning agent from the surface of work pieces, grow up to 5 percent, because it causes stains on work pieces by recontamination for the range of exceeding 5 percent. In such a case, the value of (content of cleaning agent in the discharge from first rinsing bath) can be supposed as 5 percent.

(4) The effluent from the second rinsing bath is sent to activated carbon adsorption equipment to remove dissolved cleaning agents and treated water is recycled back to the second rinsing bath. And therefore, no effluent is released to water bodies. When the adsorption of activated carbon becomes equilibrium limit after repeated desorption, activated carbon should be exchanged with fresh carbon. The spent carbon is transferred to industrial waste treatment business and the amount of cleaning agents attached to the spent carbon should be estimated and added to the amount of transfers. It is necessary to know the amount of adsorbed cleaning agents on the spent carbon for this estimation. The amount of adsorbed cleaning agents is supposed to be 0.0225 kg/L of activated carbon from the empirical data.

(5) In this cleaning system, annual handling amount of PRTR chemicals is equal to the transfers, because there are no releases to air and water bodies. Therefore, if the amounts of 2 types of

waste are known, then the amount of third waste can be calculated by using the material balance.

[3] References

The data of cleaning characteristics for Pine alpha ST-100S are shown in the table. The concentration of contaminant in the cleaning liquid is around 5 percent or less, reattachment of contamination onto work pieces is not observed in the first rinsing bath, even if the concentration of cleaning agent in the first rinsing bath is 5 percent. But the concentration of contamination in the cleaning bath built up to 10 percent, the reattachment should be cared, even if the first rinsing water is replaced fresh.

3.3.7 Calculation Example of Transfers as Waste for Semi-Aqueous Cleaning Agents

1) Annual mount of cleaning agent purchased: 9,000 kg
2) Stock amount at the beginning of the term: 1,500 kg
3) Stock amount at the end of the term: 1,800 kg
4) Content of PRTR chemicals in cleaning agent: 12.8%
5) Amount of waste cleaning liquid: 7,500 kg
6) Concentration of contamination in waste: 5%
7) Transfer amount in wastewater from first rinsing effluent: 29,250 kg
8) Content of cleaning agents in first rinsing effluent: 5%

Annual handling amount of cleaning agents = 9,000 + 1,500 — 18,000 = 8,700 kg

Annual handling amount of PRTR chemicals = 8,700 × 0.128 = 1,113.6 kg

Amount of cleaning agent in spent cleaning liquid = 7,500 × (1 — 0.05) = 7,125 kg

Amount of PRTR chemicals in spent cleaning liquid = 7,125 × 0.128 = 912 kg

Amount of PRTR chemicals in effluent from first rinsing bath = 29,250 × 0.05 × 0.128
= 187.2 kg

Amount of PRTR chemicals attached to spent activated carbon = 1,113.6 — 912 — 187.2
= 14.4 kg

Releases to air = 0

Releases to water bodies = 0

And therefore, annual transfers of PRTR chemicals are 1,113.6 kg which consist of:

with waste cleaning agent: 912 kg,
with rinsing effluent: 187.2 kg
with spent carbon: 14.4 kg

Case that transfer amount of PRTR chemicals in the effluent of first rinsing bath is unknown, and

the amount of waste carbon is known, the transfers can be calculated as follows:

If 200 cartridges (25L per cartridge) of activated carbon transferred to industrial waste treatment business,

Amount of PRTR chemicals adsorbed on the spent carbon

$= 200 \times 25 \times 0.0225 \times 0.128 = 14.4$ kg

Transfers of PRTR chemicals as first rinsing effluent = 1,113.6 — 912 — 14.4 = 187.2 kg

Table 3.3.1 Calculation Method of Handling Amount, Releases and Transfers for Semi-Aqueous Systems

No.	Items	Calculation Method
1	Handling Amount (kg/y)	Annual amount handled (kg/year) = (annual amount purchased + stock amount at the beginning of the term—stock amount at the end of the term) x (content of PRTR chemicals in detergent)/100
2	Transfers as Waste (kg/y)	Transfers contained in waste (spent cleaning liquid) = {(annual transfer amount of spent cleaning liquid to industrial waste disposal business) - (dissolved contaminant amount)} x (content of PRTR chemicals %)/100 + {(annual transfer amount of rinsing effluent to industrial waste disposal business) x (cleaning agent content % in rinsing effluent)/100 x (PRTR chemicals content in cleaning agent %)/100 + {(amount of spent activated carbon from rinsing water recycle system(L)) x (cleaning agent adsorption amount per litter of activated carbon) x (content of PRTR chemicals in cleaning agent %)/100}
3	Releases to Water Bodies	Effluent from first rinsing vessel is transfered to industrial waste treatment business. Effluent from second rinsing vessel is recyled and then discharge is zero.
4	Releases to Air	As the vapor pressure of cleaning agent is very low and vapor loss can be neglected, air emission is estimated to be zero.

3.4 Calculation Method of Releases and Transfers for Chlorinated Cleaning Agents

3.4.1 Premises

(1) PRTR Chemicals in Chlorinated Cleaning Agents

It is supposed that the cleaning agent made of chlorinated solvent used is not mixture, but single component (purity 100%). The PRTR chemicals in chlorinated solvents are dichloromethane (methylene chloride), tri-chloroethylene and tetrachloroethylene. The case of the mi× solvents of chlorinated and other organic solvents is out of scope in this manual.

The cabinet order numbers of PRTR chemicals are dichloromethane (No.145), trichloroethylene (No.211) and tetra-chloroethylene (No.200).

(2) Method of Degreasing and Cleaning and Its Process

The method of degreasing and cleaning for metal parts or other objects are categorized as

follows:

Hand wiping

Spray Washing

Showering

Dipping (at room temperature or heated temperature, simultaneous use of swing or ultrasonic)

Vapor Cleaning

1) 1 vessel type (vapor cleaning)

2) 2 vessels type (dipping — vapor cleaning)

3) 3 vessels type [dipping (warm bath, ultrasonic bath) — dipping (cold bath) — vapor cleaning]

(3) Releases and Transfers

The discharge of chlorinated solvents to environment is limited to releases to "water bodies", to "air" and to "on-site land" and to transfers as "waste" and to "POTWs". In short, for the degreasing and cleaning process using chlorinated solvents, the discharges from the system are vaporization or volatilization from degreasing and cleaning bath, vaporization of adhered solvents on work pieces and jig just coming out from cleaning bath, and the bottom residue of distillation equipment. Those are all industrial waste of special management.

Fig. 3.4.1 shows the typical 3 baths type cleaning apparatus with distillation and activated carbon adsorption equipment and also describes discharge sources and wastes.

(4) Calculation Method

There are 4 methods of calculating releases and transfers as described below, and out of four, the material balance method and the calculation factor method were adopted here as calculation examples. (It is desirable to use the former because of its accuracy, on the other hand, it is also recommended the latter as convenient method to save work load.)

[1] Material Balance Method

[2] Emission Factor Method

[3] Physical and Chemical Properties

[4] Actual Measurement

Fig. 3.4.2 shows the flow diagram of calculation method.

The releases to on-site land are estimated zero, as long as it is complied with the law inhibiting penetration of the chemical substances into underground. The releases to water bodies or transfers to POTWs are zero, because the only effluent coming out from the cleaning process shown in Fig.3.4.1 is that from water separator, of which is to be treated and transferred

as the industrial waste of special management. In the exhaust gas treatment by activated carbon adsorption, adsorbed chlorinated solvent gas is recovered by the regeneration of activated carbon by the steam. The recovered solvent is sent to condenser together with steam in which solvents and condensed water are separated. The dissolved chlorinated solvents in condensed water coming out from the condenser is aerated to release the solvents to air to decrease the concentration of solvents lower than the permissible level regulated by water pollution prevention law or sewage water law.

For the degreasing and cleaning process took up in this manual, transfers to POTWs is out of scope because there are no transfers to POTWs. (In case that there are transfers to POTWs, it is necessary to calculate the transfers and to notify the authorities. Calculation method is to be referred to (4) of 3.3.1 releases to water bodies.)

And as described previously, activated carbon adsorption processes for the waste gas treatment are classified into regeneration type and simple exchange type (non-regeneration type and separate regeneration). As shown in Fig.3.4.2, there are four ways of calculation method for the case of using activated carbon recovery process (Table 3.4.2 method, A, B and C method). For the ease of understanding, the Table 3.4.2 method is described here at first, and then A, B and C method are explained.

In case of no installation of activated carbon adsorption process, the most simple calculation method is that of emission factor method shown in Table 3.4.2 and the second is material balance method.

(5) Unit of Calculated Results

The releases and transfers are notified in the unit of kg/year with two significant digits. (expressing figures to one place of decimal)

Fig. 3.4.1 Typical 3 Vessel type Cleaning Plant and its Distillation Equipment

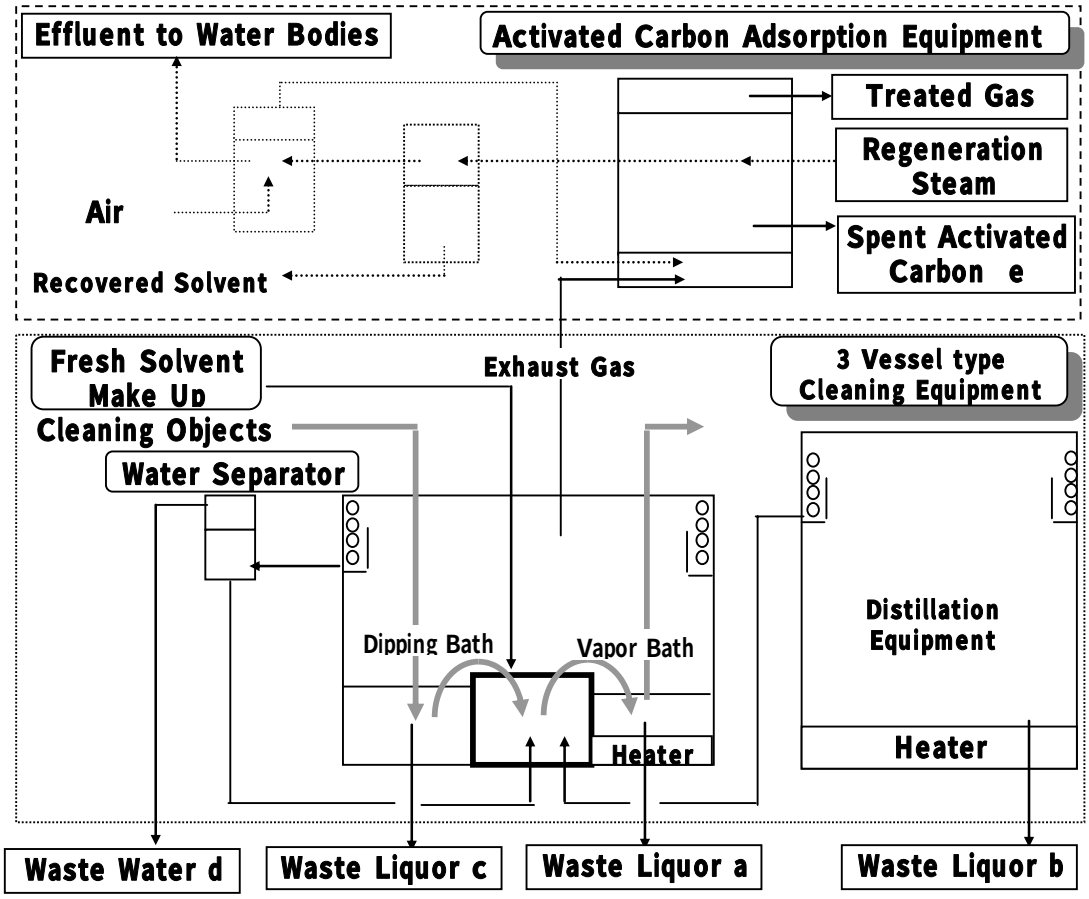
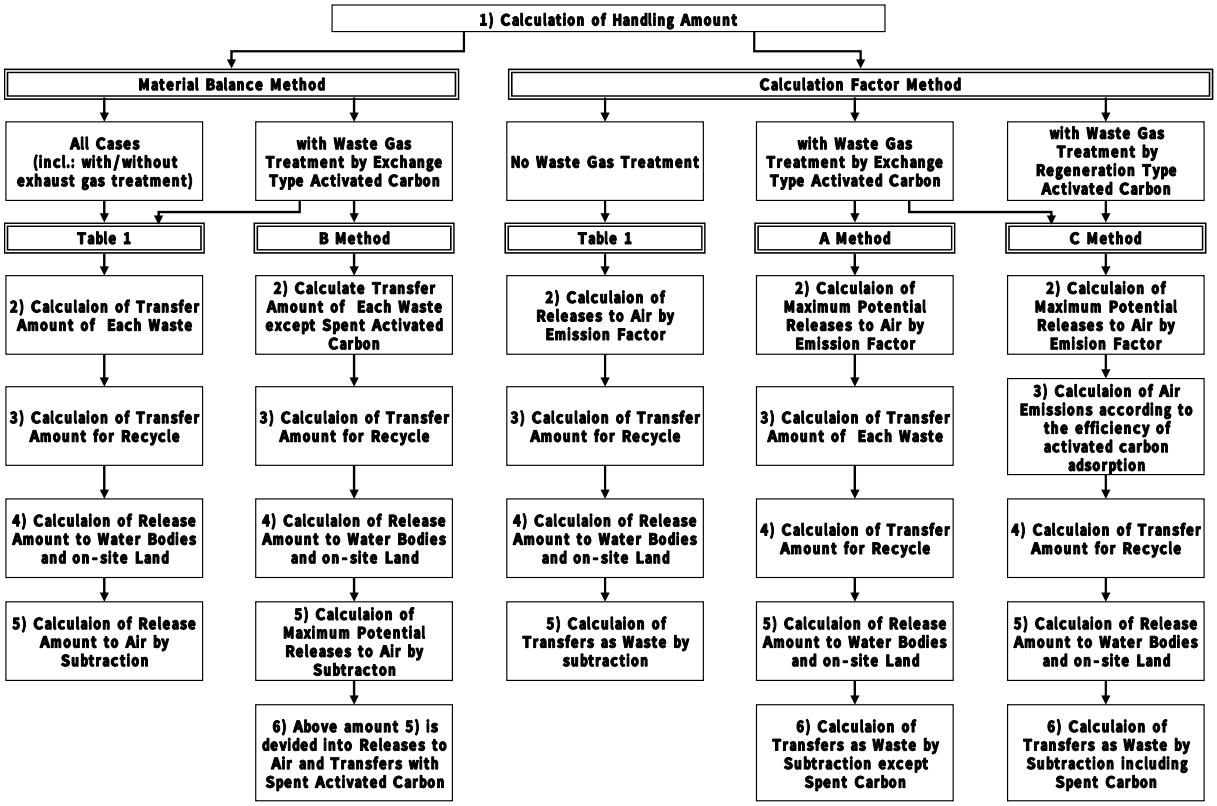


Fig. 3.4.2 Flow Diagram of Calculation Method



3.4.2 Description of Calculation Methods for Handling Amount, Releases and Transfers (Table 3.4.2)

Table 3.4.2 Calculation Method of Handling amount, Releases and Transfers

No	Item	Calculation Method
1	Handling Amount	(annual handling amount kg/y) = (annual amount purchased + stock amount at the beginning of the term - stock amount at the end of the term) x (content of PRTR chemicals in detergent)/100
2-1	Transfers as waste(Material Balance Method) : Waste is classified according to following categories a) to f)	Transfers contained in waste (kg/y) = (annual transfer amount of waste to industrial waste disposal business) x (content of PRTR chemicals in cleaning agent%)/100 (content of PRTR chemicals in cleaning agent%) are calculated by reffering to the references
	a) evaporator bottom liquid	a) To be estimated by the methods of ref. 1, 2 or other appropriate mathods
	b) distillator bottom liquid	b) To be estimated by the methods of ref. 1, 2 or other appropriate mathods
	c) waste and discharge from dipping vessels after the cleaning of washing apparatus and evaporator.	c) To be estimated by the methods of ref. 2 or other appropriate mathods
	d) water effluent discharged from water separator (waste water)	d) To be estimated by the methods of ref. 3 or other appropriate mathods
	e) waste attached to the spent activated carbon	e) To be estimated by the methods of ref. 2 or other appropriate mathods
	f) other waste	f) To be estimated by the methods of ref. 2 or other appropriate mathods
2-2	Transfers as waste(Emission Factor Method)	Transfers contained in waste (kg/y) = (No.1) - [(No.3) + (No.4) + (No.5) + (No.6-2)]
3	Transfers as Waste (valuable matter) to be sold for recycling	Transfers contained in waste liquid (kg/y) = (annual transfer amount of waste liquid to industrial waste disposal with special management business) x (content of PRTR chemicals in waste liquid%)/100 (content of PRTR chemicals in cleaning agent%) are calculated by reffering to ref.1, 2, 3 or other appropriate methods.
4	Releases to water bodies	1. In case no effluent discharge to water bodies from cleaning system, releases to water bodies is zero. 2. Waste water from the regeneration of activated carbon absorption system for waste gas treatment or waste water from the system in the accident are calculated by following equation: (Releases to water bodies kg/y) = (volume of effluent containing PRTR chemicals released to water bodies m^3/y) x (concentration of PRTR chemicals in the effluent released to water bodies mg/l) x (10^{-3}) If calculation results is less than 0.1 kg/y, the releases is counted zero, for the result of more than 0.1 kg/y, then it is necessary to report the results)
5	Releases to on-site land	1. Releases is counted zero for complying with the law of anti-penetration into underground. 2. It happened to release PRTR chemicals contained waste onto on-site land by an accident, then the spilled amount is to be calculated.
6-1	Releases to air (Material Balance Method)	Releases to air kg/y = (No.1) -[(No.2a) + (No.2b) + (No.2c) + (No.2d) + (No.2e) + (No.2f) + (No.3) + (No.4) + (No.5)]
6-2	Releases to air (Emission Factor Method), for the case of no installation of exhaust gas treatment facility	Releases to air kg/y = amount handled x emission factor Discharge coefficeints for Various Chlorinated Solvents[*3]: trichloroethylene : 0.838kg/kg of handling amount tetrachloroethylene: 0.790kg/kg of handling amount dichloromethane : 0.891kg/kg of handling amount

Remark 1: In the case that the regeneration type activated carbon adsorption equipment is installed to the system and also calculation is made based on the material balance method shown in the Table 3.4.2, the amount of recovered solvent by the adsorption system decreases the handling amount. It is not necessary to calculate the recovered amount separately, because those are substantially covered by the equation described in Table 3.4.2. (In the condensation of steam for regeneration, water from water separator contains chlorinated solvents with saturated concentration and it should not be released to water bodies. Then usually, it is treated by aerations or other process to decrease the concentration of chlorinated solvents. And exhaust air from aeration is sent to activated carbon equipment. So, this amount also is not necessary to calculate. By the way, the allowed limits of the concentration of chlorinated solvents by the waste water quality standard by law are:dichloromethane: 0.2 mg/l, trichloroethylene: 0.3 mg/l, tetrachloroethylene: 0.1 mg/l)

Remark 2: In the case that the exchange type activated carbon adsorption equipment is installed to the system and the exhaust gas is treated by activated carbon which is exchanged within its life, calculation can be made according to the method A, B and C described in Table 3.4.2 as shown in Fig. 3.4.2.

Remark 3: The Emission Factors used here are cited from "PRTR Pilot Project 2000, Calculation Manual of PRTR Releases and Transfers". Those figures used could be amended in future.

3.4.3 Description of estimation methods

(1) Annual Handling Amount

(Annual handling amount kg/y)

= [(annual amount purchased) + (stock amount at the beginning of the term)

— (stock amount at the end of the term)]

× (content of PRTR chemicals %) × 100

The content of PRTR chemicals in the cleaning agent is about 100%. Here, content of 100% is adopted.

(Remarks for Calculations)

1) The content of PRTR chemicals (%) is referred to Material Safety Data Sheet (MSDS) for the cleaning agent in use (The chlorinated cleaning agents here are usually of purity 100%. Then the content is 100%). As the chlorinated solvents used here are Class I Designated Chemical Substances of PRTR Law, the issue of MSDS is obligated to the supplier.

2) In case of using a number of chlorinated solvents, calculation should be made for each solvent, respectively.

(2) Calculation of Transfers

The transfers are generally divided into 1) transfers to off-site as waste, and 2) transfers to POTWs. In the case for the present process of chlorinated solvents, transfers to POTWs are not necessary to consider, because usually no effluent discharged to POTWs. (In case that there are transfers to POTWs, then it is necessary to calculate the amount and to notify it to authorities. The calculation method is to be referred to (3) i. calculation of releases to water bodies 4))

i) Calculation of the Amount of PRTR Chemicals Contained in Waste (Material Balance Method)

Transfers in Waste (kg/y)

= Annual transfer amount of waste to industrial waste treatment business with special management

× (content of PRTR chemicals in waste ÷ 100)

(Remarks for Calculation)

1) Wastes are divided into following species. [The names of waste listed a) to f) are corresponding to that of Fig.3.4.2]

a) evaporator bottom liquid

b) distillation bottom liquid

c) waste and discharge from dipping baths after the cleaning of washing apparatus and evaporator.

d) waste water discharged from water separator which is stocked in drum

e) waste attached to the spent activated carbon

f) other waste

2) The calculation for the waste of a) to f) are carried out by following methods:

1] Waste a): To be estimated by the methods of Ref.1, 2 or other appropriate methods

2] Waste b): To be estimated by the methods of Ref.1, 2 or other appropriate methods

3] Waste c): To be estimated by the methods of Ref.2 or other appropriate methods

4] Waste d): To be estimated by the methods of Ref.3 or other appropriate methods

5] Waste e): To be estimated by the methods of Ref.2 or other appropriate methods

6] Waste f): To be estimated by the methods of Ref.2 or other appropriate methods

ii) Transfers as Waste (Emission Factors Method)

Annual transfers in waste (kg/y)

= Annual handling amount － releases to air (releases calculated by using emission factor)

－ transfers as waste (valuable matter) sold for recycling － releases to water bodies

－ releases to on-site land

iii) Transfers as waste (valuable matter) sold for recycling

Transfers as waste (valuable matter) sold for recycling (kg/y)

= Annual transfer amount of waste liquid to industrial waste treatment business with special management

× content of PRTR chemicals in waste liquid

(Remarks for Calculation)

The amount of transfers of waste liquid of valuable matters for recycling is calculated by the method described in i. Calculation Method of Transfers of PRTR Chemicals in waste.

Note: It is not necessary to notify this amount under the Cabinet Order of the Law. However, it is necessary to calculate this amount to know the releases to the environment.

(3) Calculation of Releases

Releases are classified as 1) releases to air, 2) releases to water bodies, 3) releases to on-site land (exclude landfills) , and 4) releases to on-site landfills. In the present calculation for degreasing and cleaning process, on-site landfills are not the case. (In case the on-site landfills occur, it is necessary to estimate the amount and to notify the amount)

i) Calculation of Releases to Water Bodies

(Releases to water bodies (kg/y)

= Amount of waste water containing PRTR chemicals released to water bodies (m^3/y)

× Content of PRTR chemicals in waste water (mg/litter) × (10^{-3})

(Remarks for Calculation)

1) The releases to water bodies are zero, as long as no direct water flow from the cleaning apparatus is discharged to water bodies. The releases to water bodies come only from the water separator as shown in the flow diagram of Fig.3.4.1. And it is handled as industrial waste under special management, so there is no waste water released to water bodies. In such a case, the releases to water bodies are substantially estimated zero, as long as the waste effluent is not discharged to water bodies by an accident.
2) In the activated carbon adsorption of exhaust gas, solvents adsorbed by the activated carbon are recovered by desorption using steam. The mixture of steam and solvent vapor is sent to condenser for the separation of chlorinated solvents from water. The separated water containing dissolved solvents is aerated to remove solvents down to lower than the allowed level regulated by the water pollution control law for the release to water bodies. In this case, the amount of releases to water bodies is assumed substantially zero for the results of less than 0.1 kg/y. (Supposing the content of solvents in waste water released to water bodies is 0.3 mg/l and the amount of effluent is less than about 330 m^3/y, then the results of calculation is less than 0.1 kg/y.)

   The releases to water bodies are regulated by the water pollution control law and the wastewater standard (allowed limit) is established. It is necessary for the releases to meet the regulation.

   The wastewater standard for the chlorinated solvents is as follows:

   Dichloromethane: 0.2 mg/l (litter)

   Trichloroethylene: 0.3 mg/l

   Tetrachloroethylene: 0.1 mg/l
3) If the releases to water bodies occurred even if by an accident, it should be restored immediately to prevent the violation of law. The release amount to water bodies by accident is calculated by the methods described above.
4) It is supposed no discharge of waste water from the system to POTWs. If there the discharge to POTWs happens, the discharge amount should be notified. The amount should be handled as “transfers”. The waste water standard for POTWs is established as the same one with that of water bodies.

ii) Calculation of Releases to on-site Land

Releases to on-site land (kg/y) = 0

(Remarks for the Calculation)

1) The releases to on-site land to penetrate underground are prohibited by water pollution

control law. Then it is substantially zero in compliance to the law, except an accident.

2) In case of the accident, the amount released should be notified to the authorities.

iii) Releases to Air (Material Balance Method)

Releases to the air (kg/y)

= Annual handling amount － [transfers as waste of the sum of a), b), c), d), e) and f)]

－ transfers of valuable waste sold for recycling － releases to water bodies

－ releases to on-site land.

(Remarks for the Calculation)

1) In case of installing the waste gas recovery system, solvents are recovered as liquid and reused. The exhaust gas after the recovery in the activated carbon system is released to the air with lower concentration of chlorinated solvents. And for the case of desorption by steam, condensed water containing the chlorinated solvents is discharged and it should be treated to remove dissolved solvents by aeration so that the concentration of solvent becomes lower than the allowed limit of regulation. The exhausted gas from aeration containing solvent gas is sent back to activated carbon recovery system.

2) The incineration of exhaust gas can be used for the present purpose. But it is not common, because the incineration temperature should be high to avoid the generation of dioxins. And this method is not taken up here.

iv) Releases to Air (Emission Factor Method)

Releases to the air (kg/y) = Annual handling amount (kg/y) × Emission Factor

(Remarks for the Calculation)

The calculation method using Emission Factor is used for the system with no installation of waste gas treatment apparatus.

Dichloromethane:	0.891 kg/kg handling amount
Trichloroethylene:	0.838 kg/kg handling amount
Tetrachloroethylene:	0.790 kg/kg handling amount

3.4.4 Calculation Method for the System with Exchange Type Activated Carbon Adsorption System

It is supposed that activated carbon charged in the system is exchanged before its limit of adsorption.

The calculation methods are following A, B, C methods and Table 3.4.2 method.

1) Calculation Method Using Emission Factor (Method A)

By using annual handling amount, emission factor and treatment efficiency of activated carbon, the amount of releases to air and transfers with the spent carbon first calculated and then other

transfer amounts are calculated by subtraction.

2) Calculation Method Using Material Balance Method (Method B)

First, the annual handling amount and the transfer amounts except spent carbon are calculated, then the potential maximum releases to air is calculated by subtraction using material balance method. And the releases to air and the transfers accompanied with spent carbon are calculated by using treatment efficiency of activated carbon.

3) Calculation Method for Exchange Type (or Regeneration Type) Activated Carbon Adsorption System by Using Calculation Parameter (Method C)

(The same method can be applied for the system with regeneration type activated carbon adsorption system in case of using emission factors)

Annual handling amount and maximum potential releases to air are first calculated and then release amount to air is calculated by using the treatment efficiency of activated carbon and the maximum potential releases to air. Then the amount of transfers with waste including spent carbon is calculated by subtraction.

Methods A, B and C are described below:

(1) Method of Using Emission Factor (A Method)

i) Annual Handling Amount

The same method can be used as described in 3.1.

ii) Releases to the air (Calculation method using emission factors and treatment efficiency of activated carbon)

Releases to the air (kg/y)

= Annual handling amount (kg/y) × emission factors

× [1 — (treatment efficiency of activated carbon ÷ 100)]

(Remarks for the Calculation Method)

1) Emission Factor of Chlorinated Solvents

Dichloromethane: 0.891 kg/kg handling amount

Trichloroethylene: 0.838 kg/kg handling amount

Tetrachloroethylene: 0.790 kg/kg handling amount

2) The treatment efficiency of activated carbon is supposed to be 80%. (The value of actual measurement is used, if it is available.)

Remark: The value 80% of treatment efficiency of activated carbon is cited from "The PRTR Pilot Project 2000 - Manual of the Calculation of Releases".

It is the same for treatment efficiency of activated carbon described in this manual.

iii) Transfers Contained in the Spent Carbon

Transfers contained in the spent carbon (kg/y)

= annual handling amount × emission factors

× (treatment efficiency of activated carbon ÷ 100)

(Remarks for the Calculation)

1) Emission Factors of Chlorinated Solvents

Dichloromethane:	0.891 kg/kg handling amount
Trichloroethylene:	0.838 kg/kg handling amount
Tetrachloroethylene:	0.790 kg/kg handling amount

2) The treatment efficiency of activated carbon is supposed to be 80%. (The value of actual measurement is used, if it is available.)

iv) Calculation of Transfers of PRTR Chemicals as Valuable Waste Sold for Recycle

The same method described in (2) iii.

v) Transfer Amount of Waste other than Spent Carbon

Transfers of waste other than spent carbon (kg/y)

= annual handling amount — releases to the air — transfers contained in spent carbon — transfers of valuable waste sold for recycle — releases to water bodies — releases to on-site land

(2) Method of Material Balance (Method B)

i) Annual Handling Amount

The same method described in 3.4.3 (1)

ii) Calculation of Transfers of Waste other than Spent Carbon

The same method described in 3.4.3 (2) iii.

iii) Calculation of Transfers of Valuable Waste Sold for Recycle

The same method described in 3.4.3 (2) iii.

iv) Calculation of Maximum Potential Releases to the Air

Maximum potential releases to the air (kg/y)

= annual handling amount — transfers other than contained in spent carbon — transfers of valuable waste sold for recycle — releases to water bodies — releases to on-site land

v) Releases to the Air

Releases to the air (kg/y)

= Maximum potential releases to the air

× [1 — (treatment efficiency of activated carbon ÷ 100)]

(Remarks for the Calculation)

1) The treatment efficiency of activated carbon is supposed to be 80%. (The value of actual

measurement is used, if it is available.)

vi) Transfers Contained in Spent Carbon

Transfers contained in spent carbon (kg/y)

= maximum potential releases to the air × (treatment efficiency of activated carbon ÷ 100)

(Remarks for the Calculation)

1) The treatment efficiency of activated carbon is supposed to be 80%. (The value of actual measurement is used, if it is available.)

(3) Calculation Method for Exchange Type (or Regeneration Type) Activated Carbon Adsorption System by Using Emission Factor

The method described here can be applied to the calculation using the emission factors for the systems which install the exchange type (or regeneration type) activated carbon adsorption apparatus.

i) Annual Handling Amount

The same method described in 3.4.3 (1)

ii) Releases to the Air (Calculation Method of using the emission factors and Treatment Efficiency of Activated Carbon)

Releases to the Air (kg/y) = annual handling amount (kg/y) × emission factors

× [1 — (treatment efficiency of activated carbon ÷ 100)]

(Remarks for Calculation)

1) Emission Factor of Various Chlorinated Solvents

Dichloromethane: 0.891 kg/kg handling amount

Trichloroethylene: 0.838 kg/kg handling amount

Tetrachloroethylene: 0.790 kg/kg handling amount

2) The treatment efficiency of activated carbon is supposed to be 80%. (The value of actual measurement is used, if it is available.)

iii) Transfers of Valuable Waste Sold for Recycling

The same method described in 3.4.3 (1)

iv) Transfers of Waste (incl. Spent Carbon)

Transfers as Waste (kg/y)

= annual handling amount — transfers of valuable waste sold for recycling

— releases to water bodies — releases to on-site land

[Reference]

Calculation Method of the Content of Chlorinated Solvents

The calculation methods of the content of chlorinated solvent are:

a) Calculation method by using boiling point and specific gravity as shown in Ref.1

b) Calculation method by using weight as shown in Ref.2

c) Calculation method by using solubility to water as shown in Ref.3

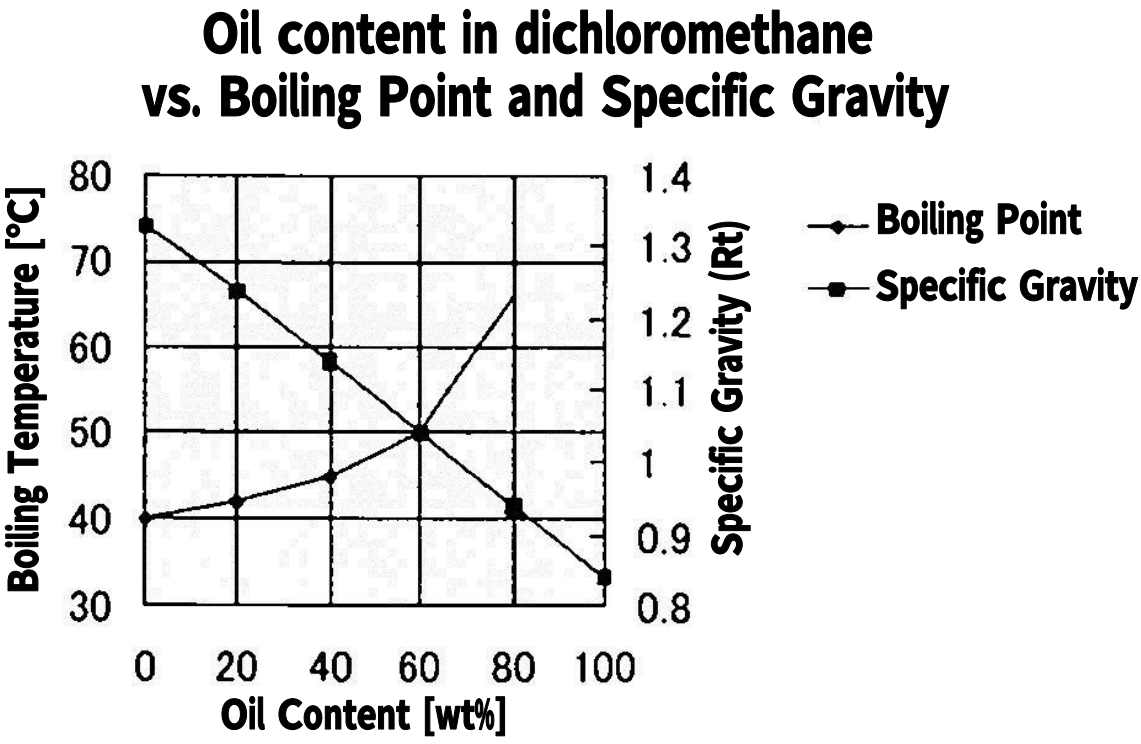
d) Direct measurement by appropriate method

Ref.1: Calculation Method of the Content by Using Boiling Point and Specific Gravity

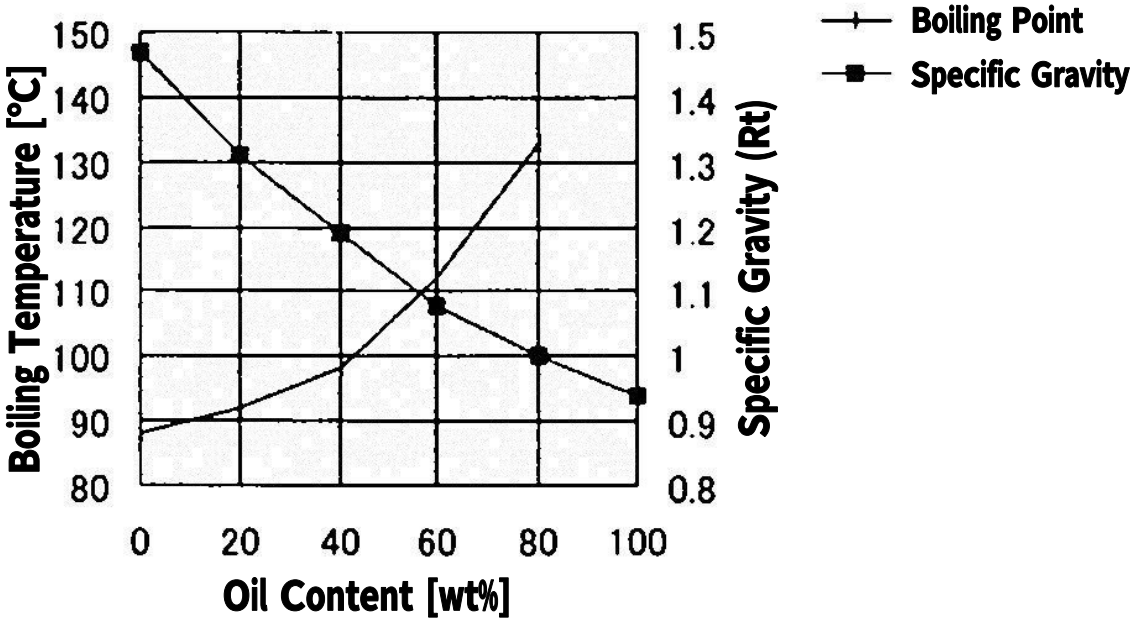
The boiling point or specific gravity of cleaning agents changes by building up contaminant such as oil into chlorinated solvent, major component of cleaning agent. It is possible to estimate the content by using these characteristics. The specific gravity can be measured hydrometer or gravity bottle and it should be measured at room temperature (15 ℃ to 30 ℃).

Usually in the process, the bottom liquor of distillation apparatus is discharged automatically or manually at the preset temperature and fresh liquid is made up of the same amount with the discharge. By this exchange of liquid, the boiling point is lowered and the operation continues. The content of oil contaminant is estimated by using the data chart of boiling point or specific gravity vs oil content in the chlorinated solvents as shown below. (The oil content in the preferable operation is about 20% for the vapor cleaning bath and 40-60% for distillation apparatus for solvent recovery.)

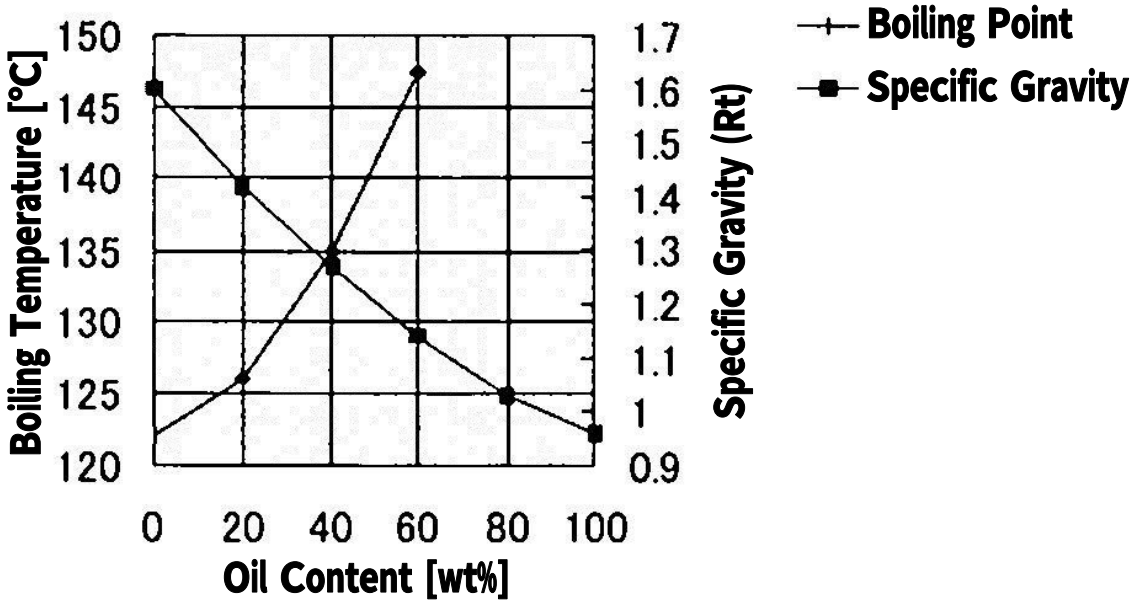
Content of chlorinated solvent in waste liquid (%) = 100 — oil content (%)



Oil content in trichloroethylene vs. Boiling Point and Specific Gravity



Oil content in tetrachloroethylene vs. Boiling Point and Specific Gravity



Ref.2: Calculation Method of Content by Weight Measurement

1) First, the weight of weighing bottle (it is possible to use glass beaker in place of weighing bottle) is measured by using the weight measurable down to 1 gram (W1), then, about 100g of sample is poured into the weighing bottle and weighed (W2). The sampling, for example sampling from drum, should be performed by sufficiently stirring the stored waste liquid to achieve uniform composition.
2) The sample in the weighing bottle is placed in the draft of which exhaust gas is discharged to the air preventing the harmful effect to human, and the chlorinated solvent contained in the bottle evaporated by heating at the temperature close to its boiling point. The weighing bottle with the sample is placed in the water bath enabling indirect heating. Or, it can be used the blower for hair drying, with which hot air is sent to the surface of sample in the weighing bottle. Such drying should be continued for more than 2 hours.
3) After finishing the evaporation of solvents, it is cooled down to room temperature.
4) After cooling down, the weight of the bottle is measured (W3).
5) By repeating the process of 2) to 4), the decreasing curve for W3 is obtained and the W3 measurement is finished when the weight difference with the previous measurement becomes less than 3g. The last measured value W3 is used for the calculation of the content.
6) Content of chlorinated solvent in waste liquid
   $= \{100 - [(W3 - W1)/(W2 - W1)] \times 100\}$

Ref.3: Calculation Method of Content by Solubility into Water

In the system for the vapor cleaning, the vapor of chlorinated solvents is sent to cooling coil and recovered by condensation. The condensed solvents are mixed with water and the mixture is sent to water separator to recover solvents only for recycling back to dipping baths. The separated water here contains chlorinated solvents with saturated level, which is exceeding the allowed concentration of wastewater regulation. It is usually stored in the drum for the treatment as waste. The concentration of chlorinated solvents in such stored wastewater (water solubility) is as follows: 2% for methylene chloride (dichloromethane), 0.11% for trichloroethylene and 0.015% for tetrachloroethylene.

* Calculation Example

The examples for trichloroethylene in the case of material balance method and Emission Factor method are shown below:

[Calculation Example-1]: Example by Using Material Balance Method

(Outline of the Process)

Process: Degreasing and Cleaning of Metal Parts

Equipment: 3 Baths Type Cleaning Equipment shown in Fig. 3.5.1 (without distillation and activated carbon process)

Exhaust Gas Treatment: non

Degreasing & Cleaning Agent: Cleaning solvent A (trichloroethylene (TCE) 100%)

Annual Purchasing Amount of Solvent: 5,000 kg/y

Inventory of Solvent (beginning-end of the term): 500 kg/y

Amount of Waste:

Water from water separator: 100 kg/y

Distillation apparatus bottom liquid: 800 kg/y

Waste liquid from equipment cleaning (sold for recycle): 200 kg/y

(1)Annual Handling Amount of trichloroethylene TCE (not necessary to notify)

The content of trichloroethylene in the cleaning solvents is 100 % according to the MSDS for the cleaning solvent A.

Annual handling amount = (5,000 + 500) × 100 ÷ 100 = 5,500 kg/y

(2) Transfers of Waste with Special Management (necessary to notify)

1) Transfers of the Water from Water Separator

TCE content in the separated water = 0.11 %

Transfers = 100 kg/y × 0.0011 = 0.11 kg/y

2) Transfers in Bottom Liquid

The bottom liquid of distillation system is discharged at the temperature of 98 ℃ and the content of removed oil is 40 wt% as descried in the reference.

Transfers = 800 kg/y × (100 — 40)/100 = 480 kg/y of TCE

3) Total Transfers of TCE in Waste

Total transfers kg/y = 0.11 + 480 = 480.11 kg/y

Figure to be notified is 480 kg/y by expressing with two significant digits. (rounded off to the first decimal place)

(3) Transfers of Waste Liquid from the Cleaning of Apparatus (sold for recycle):(not necessary to notify)

The content of the contaminant in the waste is estimated as 5 % from the reference.

200 kg/y × (100 — 5) ÷ 100 = 190 kg/y of TCE

(4) Releases to Water Bodies (necessary to notify)

There are no releases to water bodies.

Releases = zero

(5) Releases to On-site Land (necessary to notify)

There are no releases to on-site land.

Releases = zero

(6) Releases to the Air (necessary to notify)

Releases to the air = 5,500 kg/y － (0.11 + 480 + 190 + 0 + 0) = 4,829.89 kg/y

Figure to be notified is 4,800 kg/y by expressing with two significant digits. (rounded off to the first decimal place)

[Calculation Example-2]: Calculation Example of Using Emission Factors

(Outline of the System)

Process: Degreasing and Cleaning of Metal Parts

Equipment: 3 Baths Type Cleaning Equipment shown in Fig. 3.5.1 (without distillation and activated carbon process)

Exhaust Gas Treatment: non

Degreasing & Cleaning Agent: Cleaning Solvent A (trichloroethylene (TCE) 100%)

Annual Purchasing Amount of Solvent: 5,000 kg/y

Inventory of Solvent (beginning-end of the term): 500 kg/y

Amount of Waste:

Transfers of the waste with special management are water from water separator, waste of bottom liquid and waste liquid from the cleaning of the system and those are totaled 950 kg/y.

(1) Annual Handling Amount of trichloroethylene TCE (not necessary to notify)

The content of trichloroethylene in the cleaning solvents is 100 % according to the MSDS for the cleaning solvent A.

Annual handling amount = (5,000 + 500) × 100 ÷ 100 = 5,500 kg/y

(2) Releases to the Air (necessary to notify)

Use the emission factors of 0.838 kg/kg of handling amount

Releases to the air (kg/y) = 5,500 kg/y × 0.838 kg/kg = 4,609 kg/y of TCE

(3) Releases to Water Bodies (necessary to notify)

There are no releases to water bodies.

Releases = zero.

(4) Releases to On-site Land (necessary to notify)

There are no releases to on-site land.

Releases = zero

(5) Transfers in Waste (necessary to notify)

Water from the water separator, waste of bottom liquid and waste liquid from the cleaning of the system are transferred as waste with special management. Among those, the content of TCE for the bottom residue and waste liquid from the cleaning of the system are unknown.

Total transfers as waste = 5,500 − (4,609 + 0 + 0) = 891 kg/y

The figure to be notified is 891 kg/y.

3.5 Calculation Method of Releases and Transfers for Fluorinated Cleaning Agents

3.5.1 Case 1: HCFC-225

(1) Premises

i) PRTR Chemicals

The chemical substance of concern is the HCFC-225 of PRTR chemical of which cabinet order number and name are No.144 dichloropentafluoropropane. Here, the case study is limited to pure HCFC-225 (purity of about 100%). It is not taken up here the case for the mixture of fluorinated solvent with other organic solvents.

ii) Degreasing and Cleaning Method and Process

* Hand wiping
* Spray washing
* Showering
* Dipping (room temperature or heated up, swaying or together with ultrasonic)
* Vapor phase
  1) One Vessel Type (vapor phase cleaning)
  2) Two Vessels Type (cleaning by dipping in first vessel and then vapor phase cleaning in the second vessel)
  3) Three Vessels Type [dipping(warmed bath with ultrasonic) → dipping (cold bath) → vapor phase cleaning]

iii) Releases and Transfers

The fates of discharge for fluorinated solvents are limited to releases to “water bodies”, to “the air” and to “on-site land” and to transfers as “waste” and to “POTWs”. In short, for the degreasing and cleaning process using fluorinated solvents, the discharges from the system are vaporization or volatilization from degreasing and cleaning vessels, vaporization of adhered solvents on work pieces and jig just coming out from cleaning vessels, and the bottom residue of distillation equipment. Those are all industrial waste for special management.

Fig. 3.5.1 shows the typical 3 vessels type cleaning apparatus with distillation and activated carbon adsorption equipment and also describes discharge sources and wastes.

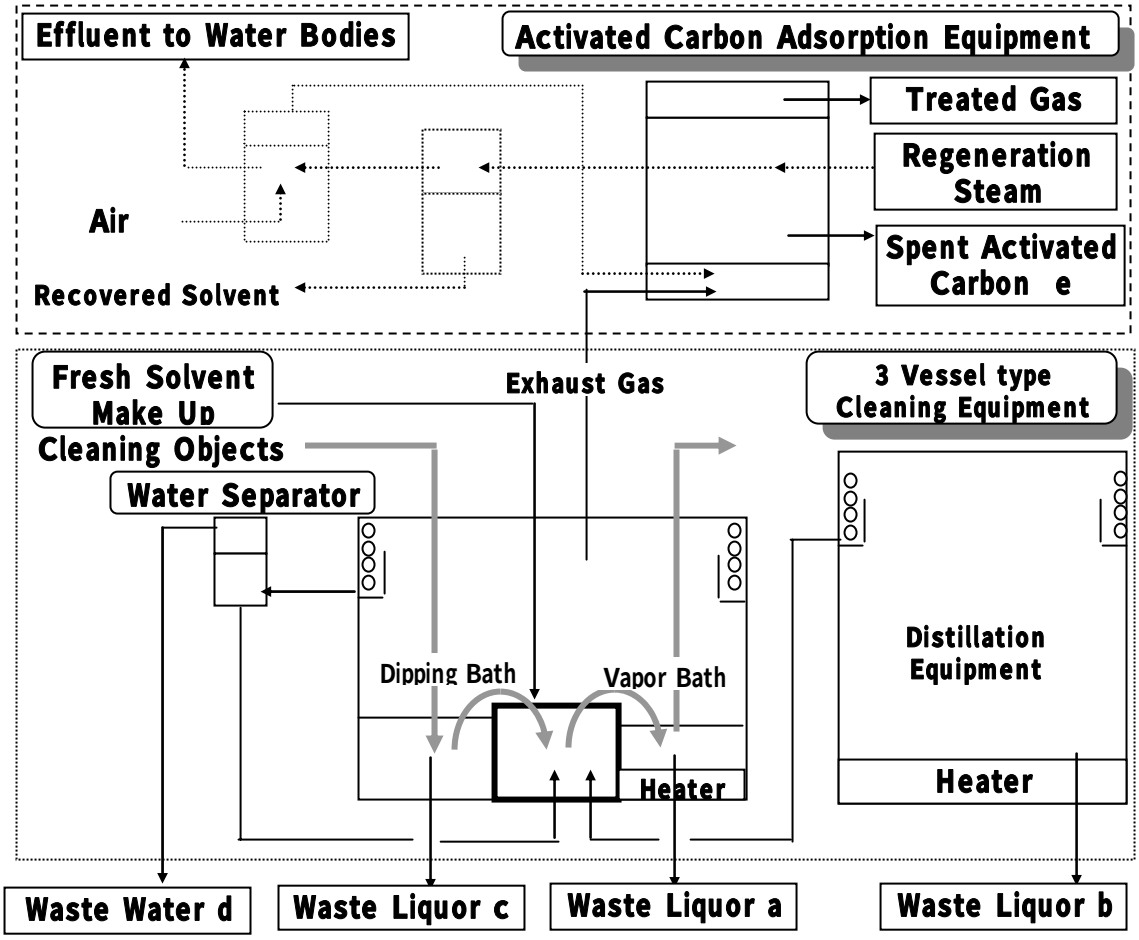
iv) Calculation Method

Material balance method

v) Unit of Calculated Results

The releases and transfers are notified in the unit of kg/year with two significant digits. (expressing figures to the first place of decimal)

Fig. 3.5.1 Typical 3 Vessel type Cleaning Plant and its Distillation Equipment



(2) Summary of Calculation Method for Annual Handling Amount, Releases and Transfers

Table 3.5.1 Calculation Method of Handling Amount, Releases and Transfers

No	Item	Calculation Method
1	Handling Amount	(annual handling amount kg/y) =[(annual amount purchased + stock amount at the beginning of the term−stock amount at the end of the term)] x (content of PRTR chemicals in cleaning agent *1 /100)
2	Transfers as waste(Material Balance Method) : Waste is classified according to following categories a) to f) a) evaporator bottom liquid b) distillator bottom liquid c) waste and discharge from dipping vessels after the cleaning of washing apparatus and evaporator. d) water effluent discharged from water separator (waste water) e) waste attached to the spent activated f) other waste	Transfers contained in waste (kg/y) = (annual transfer amount of waste to industrial waste disposal business) x (content of PRTR chemicals in spent liquid%)/100 (content of PRTR chemicals in cleaning agent%) are calculated by reffering to the references a) To be estimated by the methods of ref. 1, 2 or other appropriate mathods b) To be estimated by the methods of ref. 1, 2 or other appropriate mathods c) To be estimated by the methods of ref. 2 or other appropriate mathods d) To be estimated by the methods of ref. 3 or other appropriate mathods e) To be estimated by the methods of ref. 2 or other appropriate mathods f) To be estimated by the methods of ref. 2 or other appropriate mathods
3	Transfers as Waste (valuable matter) to be sold for recycling	Transfers contained in waste liquid (kg/y) = (annual transfer amount of waste liquid to industrial waste disposal with special management business) x (content of PRTR chemicals in waste liquid%)/100 (content of PRTR chemicals in cleaning agent%) are calculated by reffering to ref.1, 2, 3 or other appropriate methods.
4	Releases to water bodies	1. (Releases to water bodies kg/y) = (volume of effluent containing PRTR chemicals released to water bodies m^3/y) x (concentration of PRTR chemicals in the effluent released to water bodies mg/l) x (10^{-3}) *Release amount of HCFC-225 to water bodies disolved in discharge water is to be calculated by discharge amount multiply saturated solubility (330 mg/l) of HCFC-225 into water at 25degC. 2. In case that other organic substances are also mixed to the water contacted to HCFC-225, the concentration of HCFC-225 should be measured by the appropriate method and this concentration should be used for the calculation of transfers. 3. In case of no discharge effluent releases to water bodies, the releases is zero.
5	Transfers to POTWs	1. (transfers to POTWs kg/y) = (volume of effluent containing PRTR chemicals released to POTWs m^3/y) x (concentration of PRTR chemicals in the discharge mg/l) x (10^{-3}) *Release amount of HCFC-225 to water bodies disolved in discharge water is to be calculated by discharge amount multiply saturated solubility (330 mg/l) of HCFC-225 into water at 25degC. 2. In case that other organic substances are also mixed to the water contacted to HCFC-225, the concentration of HCFC-225 should be measured by the appropriate method and this concentration should be used for the calculation of transfers. In case of no discharge effluent releases to water bodies, the releases is zero.
6	Releases to on-site land	It happened to release PRTR chemicals contained waste onto on-site land by an accident, then the spilled amount is to be calculated.
7	Releases to air	Releases to air kg/y = (No.1) -[(No.2a) + (No.2b) + (No.2c) + (No.2d) + (No.2e) + (No.2f) + (No.3) + (No.4) + (No.5) + (No.6)]

Remark 1: In the case that the regeneration type activated carbon adsorption equipment is installed to the system, the amount of recovered solvent by the adsorption system decreases the handling amount. It is not necessary to calculate the recovered amount separately, because those are substantially covered by the equation described in the above Table 3.5.2-2. [In the condensation of steam for regeneration, water from water separator contains trans-1,2dichloroethylene with saturated concentration (0.63 wt%, 25C) and it is preferable to decrease its concentration by using aeration or other process, even it is not regulated. (There is no regulation of the releases, the concentration of this chemical in waste water would be controlled within the allowed limit of waste water quality standard for trichloroethylene, 0.3 mg/l) And exhaust air from aeration is sent to activated carbon equipment.

(3) Description of Calculation Methods for Handling Amount, Releases and Transfers

i) Annual Handling Amount

Annual handling amount (kg/y)

= (annual amount purchased + stock amount at the beginning of the term

— stock amount at the end of the term)

× (content of PRTR chemicals ÷ 100)

The content of PRTR chemicals % in the cleaning agent is supposed 100%.

(Remarks for Calculations)

1) The content of PRTR chemicals (%) is referred to Material Safety Data Sheet (MSDS) for the cleaning agent in use. (The chlorinated cleaning agents here are usually of purity 100%. Then the content is 100%.) As the fluorinated solvents used here are PRTR chemicals, the issue of MSDS is obligated to the supplier.

ii) Calculation of Transfers

The transfers are generally divided into 1) transfers to off-site as waste, and 2) transfers of waste water to POTWs.

ii-i) Calculation of the Transfer Amount of PRTR Chemicals Contained in Waste

Transfers as Waste (kg/y)

= Annual transfer amount of waste to industrial waste treatment business with special management

× (content of PRTR chemicals in waste ÷ 100)

(Remarks for Calculation)

1) Wastes are divided into following species.

a) evaporator bottom liquid

b) distillation bottom liquid

c) waste and discharge from dipping vessels after the cleaning of washing apparatus and evaporator.

d) waste water discharged from water separator which is stocked in drum

e) waste attached to the spent activated carbon

f) other waste

2) The calculation for the waste of a) to f) are carried out by following methods:

1) Waste a): To be estimated by the methods of Ref.1, 2 or other appropriate methods

2) Waste b): To be estimated by the methods of Ref.1, 2 or other appropriate methods

3) Waste c): To be estimated by the methods of Ref.2 or other appropriate methods

4) Waste d): To be estimated by the methods of Ref.3 or other appropriate methods

5) Waste e): To be estimated by the methods of Ref.2 or other appropriate methods

6) Waste f): To be estimated by the methods of Ref.2 or other appropriate methods

ii-ii) Calculation of Transfers to POTWs

Transfers to POTWs (kg/y)

= transfer amount of waste water containing PRTR chemicals to POTWs (m^3/y)

× concentration of PRTR chemicals in waste water mg/litter × (10^{-3}).

(Remarks for Calculation)

(1) The concentration of HCFC-225 in the discharge water transferred to POTWs is supposed to be the saturated concentration of 330 mg/litter at 25 ℃.

(2) In case that the other organic substances are mixed to HCFC-225 dissolved water, the saturated solubility of HCFC-225 changes from that of pure solution. The concentration of HCFC-225 should be measured in such a case.

(3) In case of no waste water discharge from the cleaning apparatus to POTWs, the transfers to POTWs is supposed to be zero.

The transfers to POTWs are zero, as long as no waste water flow from the cleaning apparatus is discharged to POTWs. The transfers to POTWs come only from the water separator as shown in the flow diagram of Fig.1. And it is handled as industrial waste under special management, so there is no waste water transfer to POTWs. In such a case, the transfers to POTWs are substantially estimated as zero, as long as the waste effluent is not discharged to water bodies by an accident.

ii-iii) Calculation of Transfers as Waste (valuable matter) Sold for Recycling

Transfers as waste sold for recycle (kg/y)

= annual transfer amount of waste liquid to industrial waste treatment business with special handling

× (content of PRTR chemicals ÷ 100)

(Remarks for Calculation)

The amount of transfers of waste liquid of valuable matters for recycling is calculated by the method described in 3.2.1 Calculation Method of Transfers of PRTR Chemicals in Waste.

(Remark) It is not necessary to notify this amount under the Cabinet Order of the Law. However, it is necessary to calculate this amount to know the releases to the environment.

iii) Calculation of Releases

Releases are classified as 1) releases to the air, 2) releases to water bodies, 3) releases to on-site land (exclude landfills), and 4) releases to on-site landfills. In the present calculation for degreasing and cleaning process, on-site landfills are not the case. (In case the on-site landfills occur, it is necessary to estimate the amount and to notify the amount)

iii-i) Calculation of Releases to Water Bodies

Releases to water bodies (kg/y)

= Amount of waste water containing PRTR chemicals released to water bodies (m^3/y)

× Content of PRTR chemicals in waste water (mg/litter) × (10^{-3})

(Remarks for the Calculation)

(1) The concentration of HCFC-225 in the discharge water released to water bodies is supposed to be the saturated concentration of 330 mg/litter at 25 ℃.

(2) In case that the other organic substances are mixed to HCFC-225 dissolved water, the saturated solubility of HCFC-225 changes from that of pure solution. The concentration of HCFC-225 should be measured in such a case.

(3) In case of no waste water discharge from the cleaning apparatus to water bodies, the releases to water bodies is supposed to be zero.

The releases to water bodies are zero, as long as no waste water flow from the cleaning apparatus is released to water bodies. The releases come only from the water separator as shown in the flow diagram of Fig.1. And it is handled as industrial waste under special management, so there is no waste water releases to water bodies. In such a case, the releases to water bodies are substantially regarded as zero, as long as the waste effluent is not discharged to water bodies by an accident.

iii-ii) Calculation of Releases to On-site Land

Releases to on-site land (kg/y) = 0

(Remarks for Calculation)

1) If the releases to on-site land happens, the amount of release should be estimated and notified to authority.

iii-iii) Releases to the Air

Releases to the air (kg/y)

= Annual handling amount ― [total of the transfer as waste a), b), c), d), e) and f)]

― transfer amount of valuable waste sold for recycling ― releases to water bodies

― transfers to POTWs ― releases to on-site land

(Remarks for Calculation)

1) In case of installing the waste gas recovery system, solvents are recovered as liquid and reused. The exhaust gas after the recovery in the activated carbon system is released to the air with lower concentration of fluorinated solvents. And for the case of desorption by steam, condensed water containing the fluorinated solvents at a saturated level is discharged water bodies and it should be counted as the releases to water bodies.

2) The incineration of exhaust gas can be used for the present purpose. But it is not common, because the incineration temperature should be high to avoid the generation of dioxins. And this method is not taken up here.

[Reference]

Calculation Method of the Content of Fluorinated Solvents

The calculation methods of the content of fluorinated solvent are:

a) Calculation method by using boiling point and specific gravity as shown in Ref.1

b) Calculation method by using weight as shown in Ref.2

c) Calculation method by using solubility to water as shown in Ref.3

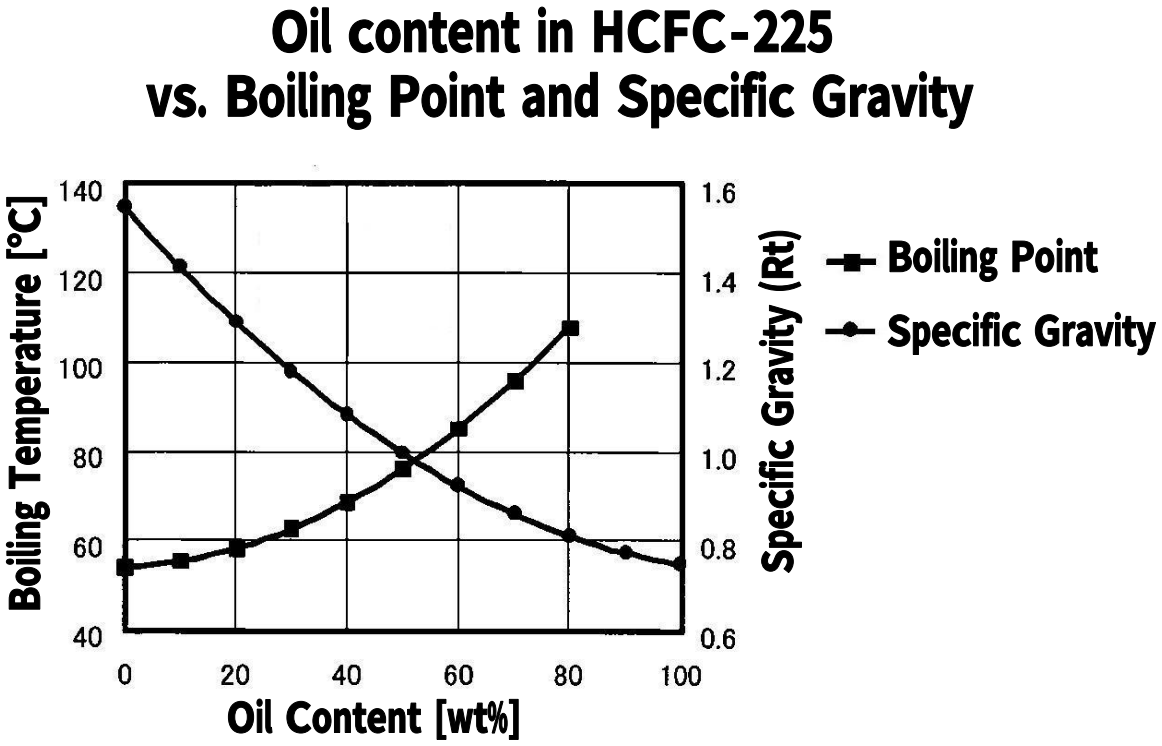
d) Direct measurement by appropriate method

Ref.1: Calculation Method of the Content by Using Boiling Point and Specific Gravity

The boiling point or specific gravity of cleaning agents changes by building up contaminant such as oil into fluorinated solvent, major component of cleaning agent. It is possible to estimate the content by using these characteristics. The specific gravity can be measured hydrometer or gravity bottle and it should be measured at room temperature (15 °C to 30 °C).

Usually in the process, the bottom liquor of distillation apparatus is discharged automatically or manually at the preset temperature and fresh liquid is made up of the same amount with the discharge. By this exchange of liquid, the boiling point is lowered and the operation continues. The content of oil contaminant is estimated by using the data chart of boiling point or specific gravity vs. oil content in the fluorinated solvents as shown below. (The oil content in the preferable operation is about 20% for the vapor cleaning vessel and 40-60% for distillation apparatus for solvent recovery.)

Content of fluorinated solvent in waste liquid (%) = 100 — oil content (%)



Ref.2 Calculation Method of Content by Weight Measurement

1) First, the weight of weighing bottle (it is possible to use glass beaker in place of weighing bottle) is measured by using the weightometer measurable down to 1 gram (W1), then, about 100g of sample is poured into the weighing bottle and weighed (W2). The sampling, for example sampling from drum, should be performed by sufficiently stirring the stored waste liquid to achieve uniform composition.
2) The sample in the weighing bottle is placed in the draft of which exhaust gas is discharged to the air preventing the harmful effect to human, and the chlorinated solvent contained in the bottle evaporated by heating at the temperature close to its boiling point. The weighing bottle with the sample is placed in the water bath enabling indirect heating. Or, it can be used the blower for hair drying, with which hot air is sent to the surface of sample in the weighing bottle. Such drying should be continued for more than 2 hours.
3) After finishing the evaporation of solvents, it is cooled down to room temperature.
4) After cooling down, the weight of the bottle is measured (W3).
5) By repeating the process of 2) to 4), the decreasing curve for W3 is obtained and the W3 measurement is finished when the weight difference with the previous measurement becomes less than 3g. The last measured value W3 is used for the calculation of the content.
6) Content of fluorinated solvent in waste liquid
$= 100 - [(W3 - W1)/(W2 - W1)] \times 100$

Ref.3: Calculation Method of Content by Solubility into Water

In the system for the vapor cleaning, the vapor of fluorinated solvents is sent to cooling coil and recovered by condensation. The condensed solvents are mixed with water and the mixture is sent to water separator to recover solvents only for recycling back to dipping vessels. The separated water here contains fluorinated solvents with saturated level.

It is usually stored in the drum for the treatment as waste. The concentration of HCFC-225 solvents in such stored wastewater (water solubility) is 330 mg/litter at 25 ℃.

* Calculation Example

The example for HCFC-225 in the case of material balance method is shown below.

[Calculation Example]: Example by Using Material Balance Method

(Outline of the Process)

Process: Degreasing and Cleaning of Metal Parts

Equipment: 3 Vessels Type Cleaning Equipment shown in Fig. 1 (without distillation and

activated carbon process)

Exhaust Gas Treatment: non

Degreasing & Cleaning Agent: Cleaning Solvent A (HCFC-225 100%)

Annual Purchasing Amount of Solvent: 3,000 kg/y

Inventory of Solvent (beginning — end of the term): 200 kg/y

Amount of Waste:

1) Water from water separator: 100 kg/y

2) Distillation apparatus bottom liquid: 800 kg/y

3) Waste liquid from equipment cleaning (sold for recycle): 200 kg/y

(1) Annual Handling Amount of HCFC-225 (not necessary to notify)

The content of HCFC-225 in the cleaning solvents is 100 % according to the MSDS for the cleaning solvent A.

Annual handling amount of HCFC-225 = (3,000 + 200) × 100/100 = 3,200 kg/y

(2) Transfers as Industrial Waste with Special Management (necessary to notify)

1) Transfers of the Water from Water Separator

HCFC-225 content in the separated water = 330 mg/litter (= 0.033%)

Transfers = 100 kg/y × 0.00033 = 0.033 kg/y

2) Total Transfers of HCFC-225 in Waste

Total transfers kg/y = 0.033 kg/y

Figure to be notified is zero, because the amount is less than 0.1 kg/y.

(3)Transfers of Waste Liquid from the Cleaning of Apparatus (sold for recycle): (not necessary to notify)

1) Transfers of Waste Liquid from Distillation Bottom

The bottom liquid of distillation system is discharged at the temperature of 60 ℃ and the content of removed oil is 25 wt% as described in the reference.

Transfers kg/y = 800 kg/y × (100 — 25)/100 = 600 kg/y

2) Transfers of Waste Liquid from the Clean Up of the System (sold for recycle)

The content of the contaminant in the waste is estimated as 5 % from the reference.

200 kg/y × (100 — 5)/100 = 190 kg/y of HCFC-225

3) Transfers of Waste Liquor Sold for Recycle

600 + 190 = 790 kg/y

(4) Releases to Water Bodies (necessary to notify)

There are no releases to water bodies.

Releases = zero

(5) Releases to On-site Land (necessary to notify)

There are no releases to on-site land.

Releases = zero

(6) Releases to the Air (necessary to notify)

Releases to the air = 3,200 kg/y － 790 = 2,410 kg/y

Figure to be notified is 2,400 kg/y by expressing with two significant digits. (rounded off to the first decimal place)

3.5.2 Case 2: HFE or HFC Cleaning Agents Containing trans-1,2-dichloroethylene

(1) Premises

i) PRTR Chemicals

The PRTR chemical of concern in this case is trans-1,2-dichloroethylene (trans-1,2-dichloroethylene is listed in the PRTR chemical Substances, and its cabinet order number is 119).

The study is limited to the cases using the solvents containing trans-1,2-dichloroethylene such as <HFE-71DE> and <HFE-71DA> provided by Sumitomo 3M, and <Vertrell SMT>, <Vertrell MCA>, <Vertrell MCA plus>, AND <Vertrell XMS plus> provided by Mitsui Dupont Florochemical.

Those cleaning agents are called hereinafter as "fluorinated solvents containing trans-1,2-dichloroethylene".

Table 3.5.2-1 shows the list of the concentration of trans-1,2-dichloroetylene in the "fluorinated solvents containing trans-1,2-dichloroethylene".

Table 3.5.2-1 Concentration of trans-1,2-dichloroethylene in Cleaning Agents

Name of Cleaning Agents	Concentration of trans-1,2-dichloroethylene
1) <HFE-71DE>	50%
2) <HFE-71DA>	44.6%
3) <Vertrel®SMT>	43%
4) <Vertrel®MCA>	38%
5) <Vertrel®MCA Plus>	45%
6) <Vertrel®XMS Plus>	43%

Vertrel® is trade name of Dupont product.

ii) Degreasing and Cleaning Method and its Process

* Hand wiping
* Spray washing
* Showering
* Dipping (room temperature or heated up, swaying or together with ultrasonic)
* Vapor phase

1) One Vessel Type (vapor phase cleaning)

2) Two Vessels Type (cleaning by dipping in first vessel and then vapor phase cleaning in the second vessel)

3) Three Vessels Type [dipping(warmed bath with ultrasonic) → dipping (cold bath) → vapor phase cleaning]

iii) Releases and Transfers

The fates of discharge for fluorinated solvents are limited to releases to "water bodies", to "the air" and to "on-site land" and to transfers as "waste" and to "POTWs". In short, for the degreasing and cleaning process using "fluorinated solvents containing trans-1,2-dichloroethylene", the discharges from the system are vaporization or volatilization from degreasing and cleaning vessels, vaporization of adhered solvents on work pieces and jig just coming out from cleaning vessels, and the bottom residue of distillation equipment. Those are all industrial waste for special management.

iv) Calculation Method

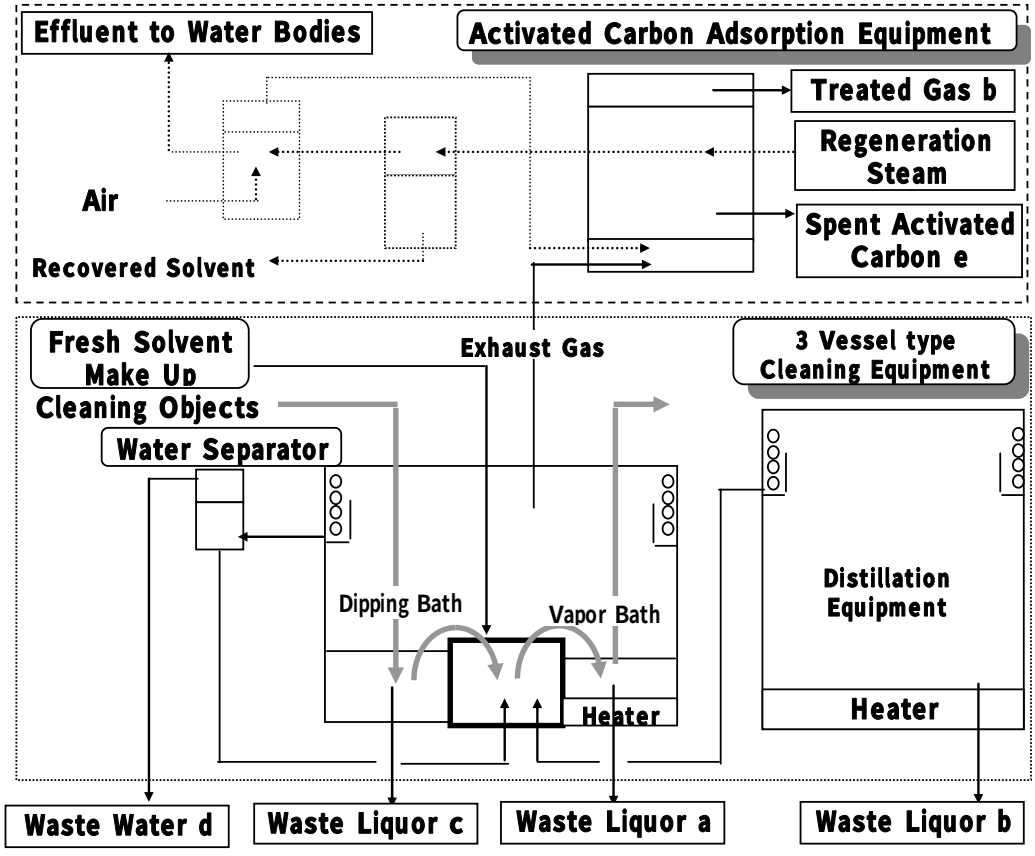
Material balance method

v) Unit of Calculated Results

The releases and transfers are notified in the unit of kg/year with two significant digits. (expressing figures to the first place of decimal)

Fig. 3.5.2 shows the typical 3 vessels type cleaning apparatus with distillation and activated carbon adsorption equipment and also describes discharge sources and wastes.

Fig. 3.5.2 Typical 3 Vessels type Cleaning Plant with Distillation Equipment



(2) Summary of Calculation Method for Annual Handling Amount, Releases and Transfers

Table 3.5.2-2 Calculation Method of Handling Amount, Releases and Transfers

No	Item	Calculation Method
1	Handling Amount	(annual handling amount kg/y) =[(annual amount purchased + stock amount at the beginning of the term −stock amount at the end of the term)] x (content of PRTR chemicals in cleaning agent *1 /100) For (content of PRTR chemicals in cleaning agent) , it should be used the value of solvent described in Table 3.5.2-1corresponding the solvent actually used. If it is 40%, then use the value of 40.
2	Transfers as waste(Material Balance Method) : Waste is classified according to following categories a) to f) a) evaporator bottom liquid b) distillator bottom liquid c) waste and discharge from dipping vessels after the cleaning of washing apparatus and evaporator. d) water effluent discharged from water separator (waste water) e) waste attached to the spent activated carbon f) other waste	Transfers contained in waste (kg/y) = (annual transfer amount of waste to industrial waste disposal business) x (content of PRTR chemicals in spent liquid%)/100 (content of PRTR chemicals in cleaning agent%) are calculated by reffering to the references a) To be estimated by the methods of ref. 1 or other appropriate mathods b) To be estimated by the methods of ref. 1 or other appropriate mathods c) To be estimated by the methods of ref. 1 or other appropriate mathods d) To be estimated by the methods of ref. 3 or other appropriate mathods e) To be estimated by the methods of ref. 2 or other appropriate mathods f) To be estimated by the methods of ref. 1, 2 or other appropriate mathods
3	Transfers as Waste (valuable matter) to be sold for recycling	Transfers contained in waste liquid (kg/y) = (annual transfer amount of waste liquid to industrial waste disposal with special management business) x (content of PRTR chemicals in waste liquid %)/100 (content of PRTR chemicals in cleaning agent%) are calculated by reffering to ref. 1, 2, 3 or other appropriate methods.
4	Releases to water bodies	1. (Releases to water bodies kg/y) = (volume of effluent containing PRTR chemicals released to water bodies m^3/y) x (concentration of PRTR chemicals in the effluent released to water bodies mg/l) x (10^{-3}) *It is the value of effluent water volume with which contacted the fluorinated solvent containing trans-1,2-dichloroethylene, multiplyed by saturated solubility of 6300mg/l (0.63 wt%) of this substance. 2. In case of no discharge effluent releases to water bodies, the releases are zero.
5	Transfers to POTWs	1. (transfers to POTWs kg/y) = (volume of effluent containing PRTR chemicals released to POTWs m^3/y) x (concentration of PRTR chemicals in the discharge mg/l) x (10^{-3}) *It is the value of effluent water volume with which contacted the fluorinated solvent containing trans-1,2-dichloroethylene, multiplyed by saturated solubility of 6300mg/l (0.63 wt%) of this substance. 2. In case of no discharge effluent transfers to POTWs, thetransfers are zero.
6	Releases to on-site land	1. It happened to release PRTR chemicals-contained-waste onto on-site land by an accident, then the spilled amount is to be calculated. 2. There are no regulation of anti-penetration into underground, but it is necessary to prepare to prevent such penetration. Releases is counted zero for the case of prepared to prevent such penetration and of substantially no dicharge.
7	Releases to air	Releases to air kg/y = (No.1) -[(No.2a) + (No.2b) + (No.2c) + (No.2d) + (No.2e) + (No.2f) + (No.3) + (No.4) + (No.5) + (No.6)]

Remark 1: In case that activated carbon adsorption recovery system is used, the amount of recovered solvent should be subtracted from handling amount. However, these factors, as well as that of releases though exhaust gas are already counted in the above equations.

(3) Description of Calculation Methods for Handling Amount, Releases and Transfers

i) Annual Handling Amount

Annual handling amount (kg/y)

= (annual amount purchased + stock amount at the beginning of the term

— stock amount at the end of the term)

× (content of PRTR chemicals ÷ 100)

The content of PRTR chemicals % in the cleaning agent is used the figure listed in the Table 3.5.2-1. If it is 40%, then 40 is used as the content of PRTR chemicals.

(Remarks for Calculation)

(1) The content% of PRTR chemicals in the cleaning agent is adopted the figures described in the MSDS for the cleaning agent. Those figures are listed in Table 3.5.2-1. As trans-1,2-dichloroethylene contained in the cleaning agents is listed as Class I Designated Chemical Substance, of which suppliers are obliged to provide MSDS to users. Then, it is possible to obtain the MSDS on the request.

ii) Calculation of Transfers

Transfers to be calculated are: 1) transfer of waste to off-site, 2) transfer of waste water to POTWs.

ii-i) Calculation of Transfers of PRTR Chemicals in Waste

Transfers contained in waste (kg/y)

= Annual transfer amount of waste to industrial waste treatment business with special management

× (content of PRTR chemicals in waste ÷ 100)

(Remarks for Calculation)

1) Wastes are divided into following species.

a) evaporator bottom liquid

b) distillation bottom liquid

c) waste and discharge from dipping vessels after the cleaning of washing apparatus and evaporator.

d) waste water discharged from water separator which is stocked in drum

e) waste attached to the spent activated carbon

f) other waste

2) The calculation for the waste of a) to f) are carried out by following methods:

1) Waste a): To be estimated by the methods of Ref.1 or other appropriate methods

2) Waste b): To be estimated by the methods of Ref.1 or other appropriate methods

3) Waste c): To be estimated by the methods of Ref.1 or other appropriate methods

4) Waste d): To be estimated by the methods of Ref.3 or other appropriate methods

5) Waste e): To be estimated by the methods of Ref.2 or other appropriate methods

6) Waste f): To be estimated by the methods of ref.1, 2 or other appropriate methods

ii-ii) Calculation of Transfers to POTWs

Transfers to POTWs (kg/y)

= transfer amount of waste water containing PRTR chemicals to POTWs (m^3/y)

× concentration of PRTR chemicals in waste water (mg/litter) × (10^{-3}).

(Remarks for Calculation)

(1) The concentration of "fluorinated solvents containing trans-1,2-dichloroethylene" in the discharge water transferred to POTWs is supposed to be the saturated concentration of 6,300 mg/litter(0.63 wt%) at 25 ℃.

(2) In case of no waste water discharge from the cleaning apparatus to POTWs, the transfers to POTWs is supposed zero.

The transfers to POTWs are zero, as long as no waste water flow from the cleaning apparatus is discharged to POTWs. The transfers to POTWs come only from the water separator as shown in the flow diagram of Fig.1. And it is handled as industrial waste under special management, so there is no waste water transfer to POTWs. In such a case, the transfers to POTWs are substantially regarded as zero, as long as the waste effluent is not discharged to water bodies by an accident.

(3) Regarding the discharge to POTWs and water bodies, there is no regulation of discharge for trans-1,2-dichloroethylene. However in this process, considerable amount of waste water containing this substance is discharged from the desorption process of activated carbon treatment apparatus for the recovery of solvents, it is preferable to decrease the concentration of trans-1,2-dichloroethylene in waste water by using, for example, aeration. As there is no clear discharge water quality standard for trans-1,2-dichloroethylene, the permissible discharge level is supposed to be less than that of trichloroethylene (0.3 mg/litter). In case the result of calculation for the releases is less than 0.1 kg/y, then the figure for notification is regarded as zero. Otherwise, it should be notified. (When the concentration of the substance in the discharge to water bodies is 0.3 mg/litter and total release amount is less than 330 m^3/y, then the discharge amount is less than 0.1 kg/y.)

ii-iii) Calculation of Transfers as Waste (valuable matter) Sold for Recycling

Transfers as waste sold for recycle (kg/y)

= annual transfer amount of waste liquid to industrial waste treatment business with special handling

× (content of PRTR chemicals ÷ 100)

(Remarks for Calculation)

The amount of transfers of waste liquid of valuable matters for recycling is calculated by the method described in 3.2.1, Calculation Method of Transfers of PRTR Chemicals in Waste.

(Remark) It is not necessary to notify this amount under the Cabinet Order of the Law. However, it is necessary to calculate this amount to know the releases to the environment.

iii) Calculation of Releases

Releases are classified as 1) releases to the air, 2) releases to water bodies, 3) releases to on-site land (exclude landfills), and 4) releases to on-site landfills. In the present calculation for degreasing and cleaning process, on-site landfills are not the case. (In case the on-site landfills occur, it is necessary to estimate the amount and to notify the amount)

iii-i) Calculation of Releases to Water Bodies

Releases to water bodies (kg/y)

= Amount of waste water containing PRTR chemicals released to water bodies (m^3/y)

× Content of PRTR chemicals in waste water (mg/litter) × (10^{-3})

(Remarks for Calculation)

(1) The concentration of "fluorinated solvents containing trans-1,2-dichloroethylene" in the discharge water released to water bodies is supposed to be the saturated concentration of 6,300 mg/litter(0.63 wt%) at 25 ℃.

(2) In case of no waste water discharge from the cleaning apparatus to water bodies, the releases to water bodies is supposed zero.

The releases to water bodies are zero, as long as no waste water flow from the cleaning apparatus is discharged to water bodies. The releases to water bodies come only from the water separator as shown in the flow diagram of Fig.1. And it is handled as industrial waste under special management, so there is no waste water release to water bodies. In such a case, the releases to water bodies are substantially estimated zero, as long as the waste effluent is not discharged to water bodies by an accident.

(3) Regarding the discharge to water bodies, there is no regulation of discharge for trans-1,2-dichloroethylene. However in this process, considerable amount of waste water containing this substance is discharged from the desorption process of activated carbon treatment apparatus for the recovery of solvents, it is preferable to decrease the concentration of trans-1,2-dichloroethylene in waste water by using, for example, aeration. As there is no clear discharge water quality standard for trans-1,2-dichloroethylene, the permissible discharge level is supposed to be less than that of trichloroethylene (0.3 mg/litter). In case the result of calculation for the releases is less than 0.1 kg/y, then the figure for notification is regarded as zero. Otherwise, it should be notified. (When the concentration of the substance in the discharge to water bodies is 0.3 mg/litter and total release amount is less

than 330 m^3/y, then the discharge amount is less than 0.1 kg/y.)

iii-ii) Calculation of Releases to On-site Land

Releases to on-site land (kg/y) = 0

(Remarks for Calculation)

1) There is no clear regulation of releasing the chemical onto the on-site land, it is necessary to take preventive measure.
2) If the release to on-site land happens, the amount of release should be estimated and notified to authority.

The amount is estimated by the following equation:

Amount of PRTR chemicals released to on-site land (kg/y)

= release volume to on-site land (m^3/y)

× concentration of the chemicals in the releases (g/litter) × (10^{-3}).

iii-iii) Releases to the Air

Releases to the air (kg/y)

= Annual handling amount — [total of the transfer as waste a), b), c), d), e) and f)]

— transfer amount of valuable waste sold for recycling — releases to water bodies

— transfers to POTWs — releases to on-site land

(Remarks for Calculation)

1) In case of installing the waste gas recovery system, solvents are recovered as liquid and reused. The exhaust gas after the recovery in the activated carbon system is released to the air with lower concentration of the solvent. And for the case of desorption by steam, condensed water contains trans-1,2-dichloroethylene at a saturated level of 0.63% at 25 ℃, and it should be preferable to decrease the concentration of trans-1,2-dichloroethylene by using aeration. As there is no clear discharge water quality standard for trans-1,2-dichloroethylene, the permissible discharge level is supposed to be less than that of trichloroethylene (0.3 mg/litter).
2) The incineration of exhaust gas can be used for the present purpose. But it is not common, because the incineration temperature should be high to avoid the generation of dioxins. And this method is not taken up here.

[Reference]

Calculation Method of the Content of trans-1,2-dichloroethylene

The calculation methods of the content of trans-1,2-dichloroethylene are:

a) Calculation method (1) by using weight measurement as shown in Ref.1.
b) Calculation method (2) by using weight measurement as shown in Ref.2.
c) Calculation method by using the solubility to water as shown in Ref.3.

d) Direct measurement by appropriate method

Reference 1: Calculation method by Using Weight Measurement — 1

A) Case of Uniform Waste Liquid

1) First, the weight of beaker or crucible is measured by using the weight measurable down to 1 gram (W1).

2) Then, about 100g of cooled waste liquid sample is poured into the beaker or crucible and weighed (W2). The sample in the beaker or crucible is placed in the draft of which exhaust gas is discharged to the air and the trans-1,2-dichloroethylene contained in the bottle evaporated by heating at the temperature around 40 ℃. The beaker or crucible with the sample is placed in the water bath enabling indirect heating. Or, it can be used the blower for hair drying, with which hot air is sent to the surface of sample in the beaker. Such drying should be continued for more than 2 hours.

3) After finishing the evaporation of solvent, it is cooled down to room temperature for about 15 minutes. After cooling down, the weight of the bottle is measured (W3)

By repeating the process of 2) to 3), the decreasing curve for W3 is obtained and the W3 measurement is finished when the weight difference with the previous measurement becomes less than 3g. The last measured value W3 is used for the calculation of the content.

(Content of "fluorinated solvents containing trans-1,2-dichloroethylene" in waste liquid)

$= [1 - (W3 - W1)/(W2 - W1)] \times 100$

B) Case of Phase Separation of Waste Liquid occurred into Contaminants and Fluorinated Solvents Containing trans-1,2-dichloroethylene

All waste liquid is poured into drum can, previously weighed (its tare weight is W4), and measure the weight (W5). Then, the phase-separated-contaminants in the drum is removed by using, for example, kerosene pump. Then, the weight of the phase separated fluorinated solvents containing trans-1,2-dichloroethylene in the drum is measured again (W6). After the above measurement W4, W5 and W6, a 100 ml of waste liquid of W6 is sampled. The sample is measured by the procedure described in A) to derive the content of "fluorinated solvents containing trans-1,2-dichloroethylene".

The content of trans-1,2-dichloroethylene in the "fluorinated solvents containing trans-1,2-dichloroethylene(DCE)" is calculated by the following equation (W DCE).

Case B-1) Case of Uniform Waste Liquid: Content of trans-1,2-dichloroethylene in Waste Liquid

W DCE = [(Total waste liquid amount) — (amount of contaminants in waste liquid)]

× [content% of trans-1,2-dichloroethylene in “fluorinated solvents containing trans-1,2-dichloroethylene” tabulated in Table 3.5.2-1]/100

= (Total waste liquid amount) × [1 — (W3 — W1)/(W2 — W1)]

× [content% of trans-1,2-dichloroethylene in “fluorinated solvents containing trans-1,2-dichloroethylene” tabulated in Table 3.5.2-1]/100

Case B-2) Case of Occurring the Phase Separation between Contaminants and HFE: Content of trans-1,2-dichloroethylene in Waste Liquid

W DCE = [(Total waste liquid amount) — (amount of contaminants in waste liquid)]

× [content% of trans-1,2-dichloroethylene in “fluorinated solvents containing trans-1,2-dichloroethylene” tabulated in Table 3.5.2-1]/100

= [(Total waste liquid amount) — (amount of separated contaminants)]

× [content% of “fluorinated solvents containing trans-1,2-dichloroethylene” measured by A method]

× [content% of trans-1,2-dichloroethylene in “fluorinated solvents containing trans-1,2-dichloroethylene” tabulated in Table 3.5.2-1]/100

= [(W5 — W4) — (W5 — W6)] × [1 — (W3 — W1)/(W2 — W1)]

× [content% of trans-1,2-dichloroethylene in “fluorinated solvents containing trans-1,2-dichloroethylene” tabulated in Table 3.5.2-1]/100

= (W6 — W4) × [1 — (W3 — W1)/(W2 — W1)]

× [content% of trans-1,2-dichloroethylene in “fluorinated solvents containing trans-1,2-dichloroethylene” tabulated in Table 3.5.2-1]/100

In the above calculation, it is to be cared to use same unit of weight such as g, kg or ton.

Reference 2: Calculation method by Using Weight Measurement-2

In case of exchanging the activated carbon, dust filter or acid removal filer in the apparatus, it is necessary to calculate the amount of PRTR chemicals contained in those spent filters.

Case 1: Original Weight of those filters are Known:

1) The weight of activated carbon or other filters containing waste liquid are measured (W1).
2) The net weight of PRTR chemicals contained in the waste W = W2 — W1
3) Sampling the waste liquid contained in those waste, the content of trans-1,2-dichloroethylene in “fluorinated solvents containing trans-1,2-dichloroethylene” in the sample measured according to the procedure described in “Calculation method by Using Weight Measurement — 1”

The discharge amount of trans-1,2-dichloroethylene is calculated by the above calculation.

Case 2: Original Weight of those filters are Unknown:

1) The weight of activated carbon or other filters containing waste liquid are measured (W1).
2) Sampling the waste liquid contained in the spent activated carbon or filters, the content of trans-1,2-dichloroethylene in "fluorinated solvents containing trans-1,2-dichloroethylene" in the sample calculated according to the procedure described in "Calculation method by Using Weight Measurement — 1"
3) After the process above 2), the spent activated carbon or filters are placed in the draft of which exhaust gas is discharged to the air and the trans-1,2-dichloroethylene contained in the waste evaporated by heating at the temperature around 40 °C. Such drying should be continued for more than 2 hours.
4) After finishing the evaporation of solvent, it is cooled down to room temperature for about 15 minutes. After cooling down, the weight of the spent wastes are measured (W2).
   By repeating the process of 3) to 4), the decreasing curve for W2 is obtained and the W2 measurement is finished when the weight difference with the previous measurement becomes roughly equal. The last measured value W2 is used for the calculation of the content.
5) The content of waste liquid contained in the waste W = W1 — W2
6) The amount of trans-1,2-dichloroethylene in the waste is calculated by using the content % previously derived in the calculation 2).

Reference 3: Calculation Method of Content by Solubility into Water

In the system for the vapor cleaning, the vapor of trans-1,2-dichloroethylene in "fluorinated solvents containing trans-1,2-dichloroethylene" is sent to cooling coil and recovered by condensation. The condensed solvents are mixed with water and the mixture is sent to water separator to recover solvents only for recycling back to dipping vessels. The separated water here contains trans-1,2-dichloroethylene with saturated level, which is far above the allowed concentration of wastewater regulation. It is usually stored in the drum for the treatment as waste. The concentration of trans-1,2-dichloroethylene in such stored wastewater (water solubility) is 0.63 wt% (25 °C)

[Calculation Example]: Example by Using Material Balance Method

(Outline of the Process)

Process: Degreasing and Cleaning of Metal Parts

Equipment: 3 Vessels Type Cleaning Equipment shown in Fig. 1 (without distillation and activated carbon process)

Exhaust Gas Treatment: none

Degreasing & Cleaning Agent: "fluorinated solvents containing trans-1,2-dichloroethylene" (It took up VertrelMCA as an example here, of which concentration of trans-1,2-dichloroethylene in "fluorinated solvents containing trans-1,2-dichloro-ethylene" is about 38 %.

Annual Purchasing Amount of Solvent: 5,000 kg/y

Inventory of Solvent (beginning — end of the term): 200 kg/y

Amount of Waste:

1) Water from water separator: 100 kg/y

2) Distillation apparatus bottom liquid (sold for recycle): 800 kg/y

3) Waste liquid from equipment cleaning (sold for recycle): 200 kg/y

(1) Annual Handling Amount of trans-1,2-dichloroethylene (not necessary to notify)

The content of trans-1,2-dichloroethylene in Vertrel MCA is 38 % as described in MSDS.

Annual handling amount of trans-1,2-dichloroethylene

= (5,000 + 200) × 38/100 = 1,976 kg/y

(2) Transfers as Industrial Waste (Necessary to notify)

1) Transfers in Waste Water from Water Separator

Concentration of trans-1,2-dichloroethylene in separated water = 6,300 mg/l (0.63 %)

Transfers in waste water = 100 kg/y × 0.0063 = 0.63 kg/y

2) Total Transfers

Total transfers in waste = 0.63 kg/y

Figure for notification is 0.6 kg/y by expressing with two significant digits. (rounded off to the first decimal place)

(3) Transfers as Valuable Waste Sold for Recycle (not necessary to notify)

1) Distillation apparatus bottom liquid (sold for recycle)

It is supposed that the waste from the bottom is uniform and the content of Vertrel MCA in this waste, measured by weight measuring method is 85 %, then

800 kg/y × 0.85 × 0.38 = 258.4 kg/y

2) Waste liquid from equipment cleaning (sold for recycle)

It is supposed that the waste from the bottom is uniform and the content of Vertrel MCA in this waste, measured by weight measuring method is 95 %, then

200 kg/y × 0.95 × 0.38 = 72.2 kg/y

3) Total Transfers of Waste sold for Recycle

258.4 + 72.2 = 330.6 kg/y

Figure for notification is 0.6 kg/y by expressing with two significant digits. (rounded off to

the first decimal place)

(4) Releases to Water Bodies (necessary to notify)

There are no discharges to water bodies, and then the release to water bodies is zero.

(5) Releases to On-site Land (necessary to notify)

There are no discharges to on-site land, and then the release to water bodies is zero.

(6) Releases to the Air (necessary to notify)

Releases to the air = 1,976 kg/y — (0.63 + 258.4 + 72.2) = 1,644.77 kg/y

Figure for notification is 1,600 kg/y by expressing with two significant digits. (rounded off to the first decimal place)

3.6 Calculation Method of Releases and Transfers for Hydrocarbon Cleaning Agents

3.6.1 Premises

(1) PRTR Chemicals

The hydrocarbon solvents for cleaning agents are classified as paraffinic, naphthenic and aromatic solvents.

In the Class I Designated Chemical Substances, many aromatic solvents are listed, such as benzene, toluene, xylene, ethylbenzene or 1,3,5-trimethylbenzene, whereas paraffinic or naphthenic cleaning solvents are not listed as the PRTR chemicals.

According to the results of questionnaire survey for the users by JICC, it was found that 1,3,5-trimethylbenzene among aromatic hydrocarbon solvents was used for industrial cleaning and is PRTR chemicals.

(2) Cleaning Method and Process

Aromatic solvents is widely used for the cleaning of wa× and flu× because of its superior solvent power. This manual is prepared on the basis of basic process shown in Fig. 3.6.1.

Recovered solvent is recycled together with fresh make up solvent to rinsing vessel. In the distillation process, part of solvent comes into bottom liquor to be wasted. And exhaust gases from cleaning, rinsing and drying process are sent to activated carbon adsorption equipment and treated gas is released to air. In some cases, those exhaust gases are released to air directly without treatment. (Fig.3.6.1)

(3) Releases and Transfers

The releases to the environment are to “water bodies”, to “the air” and to “on-site land”, and the transfers as waste. For the aromatic solvents, the discharges are limited to releases to the air and transfers as waste. It is assumed that there are no releases to water bodies and to on-site land.

(4) Calculation Method

Material balance method is used for the calculation as shown in Table 3.6.2-1,-2,-3.

The basic concept of the calculation is that the net weight of object chemicals in the waste liquid and spent activated carbon discharged, at first. And then the releases to the air are derived by subtracting the net weight from total annual handling amount.

The following three cases are taken up here for examples such as:

[1] Cleaning Apparatus with Thin Film Evaporator (Table 3.6.2-1)

[2] Cleaning Apparatus with Vacuum Distillation Recycling (Table 3.6.2-2)

[3] Cleaning Apparatus without Distillation Recycling (Table 3.6.2-2)

(5) Unit of Calculated Figures

The calculated results of releases and transfers are described by the unit of kg/y, and should be notified to authorities.

Fig. 3.6.1 Standard Model of Cleaning Process

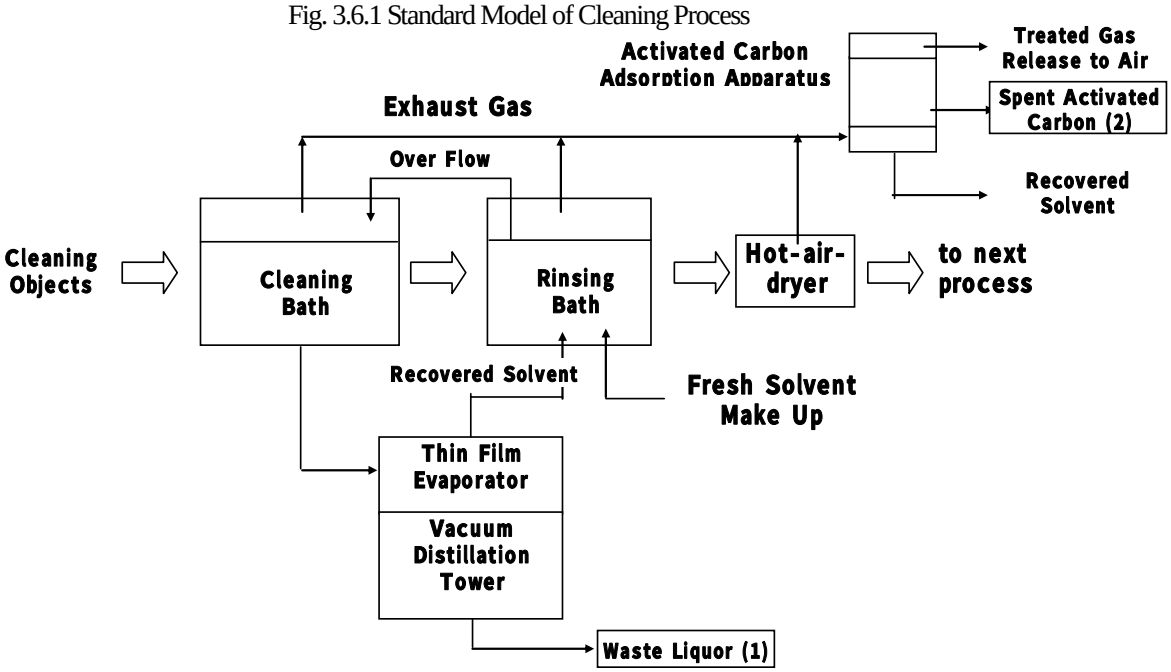


Table 3.6.2-1 Summary of Calculation Method of Releases and Transfers for Hydrocarbon Cleaning Agents

[1] Case 1: Cleaning Apparatus wih Thin Film Evaporator

No.	Iems	Calculation Method
1	Annual Handling Amount (kg/y)	(annual handling amount kg/y) =[(annual amount purchased + stock amount at the beginning of the term－stock amount at the end of the term)] x (content of PRTR chemicals in cleaning agent *1 /100) *1: It should be used the value of solvent described in MSDS supplied by the producer.
2	Transfers as Waste (kg/y)	a) Transfer amount of solvents in waste liquor (1) Transfer amount contained in waste liquor = 0 Content of solvent in the waste liquor(1) is supposed to be 0%. b) Transfers of solvents contained in spent activated carbon (2) Transfers with spent activated carbon = (handling amount of spent activated caobon (2)) x (content % of cleaning solution in spent activated carbon *4 /100) x (content % of PRTR chemicals in cleaning solution*5/100) *4: In case the amount of cleaning solution adsorped to activated carobon is measured, then this amount is used in the calculation. If it is not known, the designed figure is used in the above calculation. *5: In case the content of PRTR chemicals in the cleaning solution is known, then this figure is used in the calculation. If it is unknown, then the content described in MSDS is used in the calculation. c) Total transfers as waste Total amount of transfers contained in waste = (transfer amount contained in waste liquor (1)) + (transfer amount contained in spent activated carbon (2))
3	Releases to Air (kg/y)	Release amount to air = (annual handling amount) - (transfers contained in waste)

Remark: In the case that the regeneration type activated carbon adsorption equipment is installed to the system, the amount of recovered solvent by the adsorption system decreases the handling amount. It is not necessary to calculate separately the amount in the exhaust gas from activated carbon treatment, because those are substantially covered by the equation of “released to air” described in the above Table 3.6.2-1.

Table 3.6.2-2 Summary of Calculation Method of Releases and Transfers for Hydrocarbon Cleaning Agents

[2] Case 2: Cleaning Apparatus wih Vacuum Distillation Apparatus

No.	Iems	Calculation Method
1	Annual Handling Amount (kg/y)	(annual handling amount kg/y) =[(annual amount purchased + stock amount at the beginning of the term－stock amount at the end of the term)] x (content of PRTR chemicals in cleaning agent *1 /100) *1: It should be used the value of solvent described in MSDS supplied by the producer.
2	Transfers as Waste (kg/y)	a) Transfer amount of solvents in waste liquor (1) Transfer amount contained in waste liquor(1) = (annual handling amount of waste liquor (1)) x (content % of cleaning solution in waste liquor (1)*2 /100) x (content % of PRTR chemicals in cleaning solution*3/100) *2: The value of content % of cleaning solution in waste liquor for the cleaning plant with vacuum distillation regeneration is adopted the calculation factor of 75% which is the typical value in the actual plant. (If the actual measured value is available, this value should be used for calculation, because the content of cleaning agent is dependent on the product. *3: If the content of PRTR chemicals of the remaining solvent is known, then this value is to be used. If it is unknown, the calculation factor of 50% can be used. b) Transfers of solvents contained in spent activated carbon (2) Transfers with spent activated carbon = (handling amount of spent activated caobon (2)) x (content % of cleaning solution in spent activated carbon *4 /100) x (content % of PRTR chemicals in cleaning solution*5/100) *4: In case the amount of cleaning solution adsorped to activated carobon is measured, then this amount is used in the calculation. If it is not known, the designed figure is used in the above calculation. *5: In case the content of PRTR chemicals in the cleaning solution is known, then this figure is used in the calculation. If it is unknown, then the content described in MSDS is used in the calculation. c) Total transfers as waste Total amount of transfers contained in waste = (transfer amount contained in waste liquor (1)) + (transfer amount contained in spent activated carbon (2))
3	Releases to Air (kg/y)	Release amount to air = (annual handling amount) - (transfers contained in waste)

Remark: In the case that the regeneration type activated carbon adsorption equipment is installed to the system, the amount of recovered solvent by the adsorption system decreases the handling amount. It is not necessary to calculate separately the amount in the exhaust gas from activated carbon treatment, because those are substantially covered by the equation of “released to air” described in the above Table 3.6.2-2.

Table 3.6.2-3 Summary of Calculation Method of Releases and Transfers for Hydrocarbon Cleaning Agents

[3] Case 3: Cleaning Apparatus wihout Distillation Regenertion

No.	Iems	Calculation Method
1	Annual Handling Amount (kg/y)	(annual handling amount kg/y) =[(annual amount purchased + stock amount at the beginning of the term－stock amount at the end of the term)] x (content of PRTR chemicals in cleaning agent *1 /100) *1: It should be used the value of solvent described in MSDS supplied by the producer.
2	Transfers as Waste (kg/y)	a) Transfer amount of solvents in waste liquor (1) Transfer amount contained in waste liquor(1) = (annual handling amount of waste liquor (1)) x (content % of cleaning solution in waste liquor (1)*2 /100) x (content % of PRTR chemicals in cleaning solution*3/100) *2: For thecase of the system without distillation regeneration, the calculation factor 95% can be used for the calculation *3: If the content of PRTR chemicals of the remaining solvent is known, then this value is to be used. If it is unknown, the value should be reffered to MSDS*1. b) Transfers of solvents contained in spent activated carbon (2) Transfers with spent activated carbon(2) = (handling amount of spent activated caobon (2)) x (content % of cleaning solution in spent activated carbon *4 /100) x (content % of PRTR chemicals in cleaning solution*5/100) *4: In case the amount of cleaning solution adsorped to activated carobon is measured, then this amount is used in the calculation. If it is not known, the designed figure is used in the above calculation. *5: In case the content of PRTR chemicals in the cleaning solution is known, then this figure is used in the calculation. If it is unknown, then the content described in MSDS is used in the calculation. c) Total transfers as waste Total amount of transfers contained in waste = (transfer amount contained in waste liquor (1)) + (transfer amount contained in spent activated carbon (2))
3	Releases to Air (kg/y)	Release amount to air = (annual handling amount) - (transfers contained in waste)

Remark: In the case that the regeneration type activated carbon adsorption equipment is installed to the system, the amount of recovered solvent by the adsorption system decreases the handling amount. It is not necessary to calculate separately in the exhaust gas from activated carbon treatment, because those are substantially covered by the equation of “released to air” described in the above Table 3.6.2-3.

[Calculation Example]: Example by Using Material Balance Method (Case of Cleaning Apparatus with Vacuum Distillation Recycling System)

(Outline of the Plant)

Process: Cleaning of Photo Resist remaining on Ceramics Board and Adhesive Wax

Equipment: 4 Vessels Type Cleaning Equipment shown in Fig. 3.6.1 (consisting of 2 cleaning vessels, 1 rinsing vessel and hot air dryer)

Exhaust Gas Treatment: none

Cleaning Agent: Aromatic hydrocarbon cleaning agent (PRTR chemical: 1.3.5-trimethylbenzene)

Annual Purchasing Amount of Solvent: 12,000 kg/y

Inventory of Solvent (beginning-end of the term): 400 kg/y

Amount of Waste: waste liquid (a) = 2,500 kg/y

(1) Annual Handling Amount of 1,3,5-trimethylbenzene (not necessary to notify)

The content of 1,3,5-trimethylbenzene is 9 % as described in MSDS.

Annual handling amount of 1,3,5-trimethylbenzene = (12,000 + 400) × 9/100 = 1,116 kg/y.

(2) Transfers as Waste (necessary to notify)

1) Transfers in Waste Liquid (a)

The content of solvent in the waste (a) is unknown, then the content of 75% described in the list of calculation factors is used. (Reference 1: List of Calculation Factors). And the net content of 1,3,5-trimethylbenzene in the solvent is also unknown, the figure of 50% in the list of Reference 1 is adopted.

Transfers in the waste (a) = 2,500 × (75/100) × (9/100) × (50/100) = 84 kg/y

2) Transfers in Spent Activated Carbon

There is no installation of activated carbon adsorption system, then transfers are zero.

3) Total Transfers as Waste

Total transfers as waste = 84 + 0 = 84 kg/y

(3) Releases to Water Bodies (necessary to notify)

No waste water discharged to water bodies, then the releases to water bodies are zero.

(4) Releases to On-site Land (necessary to notify)

No releases of waste discharged to on-site land, and then the releases to on-site land is zero.

(5) Releases to the Air (necessary to notify)

Releases to the air = 1,116 — 84 = 1,032 kg/y

4. Further Development

The Japan Industrial Conference on Cleaning (JICC) intends to edit the calculation manual of the releases and transfers of PRTR chemicals for the industrial cleaning based on this report, and to publicize it for the convenience of medium, small sized industries.

The manual would be revised in future by the results of investigation of the applicability of this manual in the industrial cleaning field.

"The Calculation Factors" (Reference 1) proposed here for use by medium and small sized companies will be continuously reviewed and improved its accuracy by collecting actual data.

Reference 1: List of Calculation Factors

Table: The List of Calculation Factors used in the Calculation of the Amount of Transfers as Waste in Degreasing and Cleaning

Cleaning Process	Equation	Calculation Parameter
Aqueous Cleaning	(transfer amount) x [1 - (oil content%)/100] x (concentration of PRTR chemicals%/100)	oil content: 0.7% (oil solubuleoil) 4.8% (water solubuleoil)
Chlorinated Solvent	transfers of waste liquor from vapor bath = (transfer amount) x [1 - (dissolved oil content%)/100]	dissolved oil content in waste liquid from vapor bath: 20%
	transfers of waste liquor from distillation botom = (transfer amount) x [1 - (dissolved oil content%)/100]	dissolved oil content in waste liquid from distilation bottom: 50%
	transfers in waste water from oil/water separator = (transfer amount) x (saturated water solubility of PRTR chemicals)	saturated water solubility of dichloromethane: 2% saturated water solubility of trichloroethylene: 0.11% saturated water solubility of tetrachloroethylene: 0.015%
	Air emission from activated carbon treatment = (maximum potential release amount to air) x [1 - (efficiency of activated carbon treatment/100)]	efficiency of activated carbon treatment: 80%
	Transfers with spent activated carbon = (transfer amount of spent carbon) x (adsorption rate of chlorinated solvent/100)	adsorption rate of chlorinated solvent in spent carbon = (saturated adsorption rate) x 0.1
Fluorinated Solvent		
HCFC-225	transfers of waste liquor from vapor bath = (transfer amount) x [1 - (dissolved oil content%)/100]	dissolved oil content in waste liquid from vapor bath: 20%
	transfers of waste liquor from distillation botom = (transfer amount) x [1 - (dissolved oil content%)/100]	dissolved oil content in waste liquid from distilation bottom: 50%
	transfers in waste water as waste from oil/water separator = (transfer amount) x [(saturated water solubility of HCFC-225) x 10^6	saturated water solubility of HCFC-225= 330 mg/kg
	releases of waste water from oil/water separator to water bodies = (transfer amount) x [(saturated water solubility of HCFC-225) x 10^6	saturated water solubility of HCFC-225= 330 mg/kg
	Air emission from activated carbon treatment = (maximum potential release amount to air) x [1 - (efficiency of activated carbon treatment/100)]	efficiency of activated carbon treatment: 80%
	Transfers with spent activated carbon = (transfer amount of spent carbon) x (adsorption rate of HCFC-225/100)	adsorption rate of HCFC-225 in spent carbon = (saturated adsorption rate) x 0.1

Table: The List of Calculation Factors used in the Calculation of the Amount of Transfers as Waste in Degreasing and Cleaning (cont'd)

Cleaning Process	Equation	Calculation Parameter
HFE, HFC	Transfers in separated water from oil/water separator = (transfer amount) x [(saturated water solubility of DCE) x 100]	saturated water solubility of DCE = 0.63%
	transfers in waste liquor from vapor bath = (transfer amount - separated oil amount) x [1 - efficiency of activated carbon treatment)/100] x [DCE content %/100]	dissolved oil content in waste liquid from vapor bath: 20%
	transfers in waste liquor from distillation botom = (transfer amount - separated oil amount) x [1 - efficiency of activated carbon treatment)/100] x [DCE content %/100]	dissolved oil content in waste liquid from distilation bottom: 50%
	Air emission from activated carbon treatment = (maximum potential release amount to air) x [1 - (efficiency of activated carbon treatment/100)]	efficiency of activated carbon treatment: 80%
	Transfers with spent activated carbon = (transfer amount of spent carbon) x (adsorption rate for HFE, HFC /100) x (DCE content % of cleaning agent/100)	adsorption rate of HFE,HFC in spent carbon = (saturated adsorption rate) x 0.1
Hydrocarbon solvents	* Cleaning plant with vacuum distillation	
	Transfers in waste liquor = Transfer amount x (content of cleaning agent %/100) x (TMB content in cleaning agent %/100)	content of cleaning agent: 75%, TMB content in cleaning agent: 4.5%
	* Cleaning plant without vacuum distillation	
	Transfers in waste liquor = Transfer amount x (content of cleaning agent %/100) x (TMB content in cleaning agent %/100)	content of cleaning agent: 95%, TMB content in cleaning agent: 9.0%
	Transfers with spent activated carbon = (transfer amount of spent carbon) x (adsorption rate of hydrocarbon solvent/100)	adsorption rate of hydrocarbon solvent in spent carbon = (saturated adsorption rate) x 0.1
Semi-aqueous cleaning	Transfers in waste liquor = (transfer amount of waste liquor) x [1- (content of dissolved contamination/100)] x (content of PRTR chemicals/100)	content of dissolved contamination = 5%
	Transfers with spent activated carbon = (transfer amount of spent carbon(L)) x (adsorption rate of cleaning agentt/100) x (content of PRTR chemical/100)	adsorption rate of cleaning agent in spent carbon = 0.0225kg/L

Reference 2: Adsorption Characteristic Data of Activated Carbon

Table : Activated Carbon Adsorption of PRTR Chemicals used in Cleaning Agent

PRTR Chemicals	Equillibrium Concentratiuon of Adsorption (g/kg-carbon)				
	Concentration in Gaseous Phase (ppm)				
	10	50	100	500	1000
dichloromethane	25	-	66	-	159
trichloroethylene	199	-	332		494
tetrachloroethylen	392	-	547		694
trans-1,2-dichloroethylene	69	-	143		262
HCFC-141B	-	90	130	230	300
HFE	-	330	390	540	620
HFC	-	-	-	-	-

Remark 1: Above data are measured at the temperature of 20-25C.
Remark 2: There are no data for 1,3,5-trimethylbenzene, HCFC-225 and HFC.
Remark 3: Adsorption amount of activated carbon for simplified calculation is supposed to be 10% of the above figures depending on the equilibrium concentration for the system used.