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Development of a Priority Substances List for Integrated Environmental Management

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Abstract−The Ministry of the Environment in Korea supports investigation of various substances that are potential contaminants of the environment and could cause adverse effects on the environment and/or human health and to list Priority Substances (PSL). The present study for PSL is aimed at estimating the new PSL for industrial areas or assessing the risk of refining processes for selecting priority substances in order to obtain better criteria of quality data. The present study lists 81 major priority substances among 106 candidate substances and scores with weight factors to CHEMS-1 based on amounts of materials in circulation and emissions levels. Of the 81 chemicals, 80% are classified as carcinogens, potentially causing acute oral toxicity among those within the 1st grade of data quality criteria for materials. For data quality criteria of items, BOD or hydrolysis half-life is the lowest 40% and acute oral toxicity is the highest 90%.

Key words: Priority Substances List (PSL), Emission Inventory, Industrial Area, EURAM, CHEM-1

INTRODUCTION

An initiative of the international harmonization on chemical safety for integrated environmental management requires the establishment of a priority substances program. A variety of substances that may contaminate the environment and cause adverse effects on the environment and/or human health have been recommended for placement on the priority substance list (PSL) in the European Union (EU) [Bodar et al., 2003; Kappes and Rasmussen, 2003; Lerche et al., 2002], in Canada [Hughes et al., 2001; Meek, 1996, 1999; Meek and Hughes, 1995], and in the United States of America (U.S.A.) [Tully et al., 2000]. Since 1990 in Korea, consequence analysis and risk assessment have been required for chemical process industries because of the potential risk of hazardous materials [Kim et al., 2003; Khan et al., 1998]. For chemical safety assessment and environment risk assessment, a PSL was also developed but there was difficulty in completing the list because of the lack of data [NIER, 1991, 1996]. In order to assess the risk and the toxicity of the environmental pollutants, the Ministry of Environment supported the G-7 project, starting in 1994. The G-7 project completed a database (DB) for 1500 chemicals and prepared the basis of the PSL. The PSL in the G-7 project was obtained by applying the DB for 1500 chemicals into the Dutch Risk Assessment system for New Chemicals (DRANC). Based on the results of the G-7 project, the PSL relative to chemical safety included 3600 chemicals from the 512 national distribution systems. However, the previous studies on the PSL in Korea had been finalized using insufficient data from the distribution systems, and the effect of emission, which would play a key role in selecting the priority substances that cause adverse effects on the environment and human health, was neglected.

In a preliminary study (2001-2002) of the integrated environment management (IEM) project supported by the Ministry of Environment in Korea and ECO-Technopia-21 (Core Environment Technology Development Project for Next Generation), emission inventories (EIs) were prepared that provide specific information on emission sources, the amounts of emissions, and the transfer of pollutants among the environmental multimedia [Yi, 2002; Chah et al., 2003]. A methodology was proposed for determining priority substances emitted or released from target areas, a metropolis (Seoul) and an industrial area (Ansan) [Chah et al., 2003]. The results of the preliminary study emphasized that the selection of chemicals for the area is one of the most important factors in further studies.

Goals of the present study are to estimate the PSL or to assess the risk of the refining procedure for selecting the PS for data quality criteria and to expand the priority substances list (PSL) by adding more substances from four industrial complex areas, Kumi, Yeocheon, and Ulsan as well as Ansan, which was used in the preliminary study. For this purpose, EIs were obtained from the data on various compounds for the material, regional, and industrial distribution systems for the selected industrial regions (1998-2001' data) [Yi, 2003]. When emission data is available a hypothetical matrix method was designed by EURAM (European Union Risk Ranking method), depending on information available on the distribution systems and the specific utility. EURAM of the European Union (EU) and CHEMS-1 (Chemical Hazard Evaluation for Management Strategies) of the USEPA were adopted for developing the priority substances list. The information required in CHEMS-1 is collected for the PSL and its database and characteristics of each data source are analyzed, so as to establish quality standards for the collected data, while EURAM, a simple priority setting model, is based on exposure and the effect on humans and the environment to determine a standard value for human and environmental potential risk.

METHODOLOGY

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This section describes the methodology for estimating the PSL based on EIs, which are classified into three parts: selection of target areas, selection of chemicals, and emission estimation. The target areas are characterized by populations, societal concerns, geological significance, and the data on substances obtained from industrial circulation (or distribution) systems. The selection of a chemical priority repeats the refining processes based on the industrial distribution systems, the EIs, and available monitoring data [Chah et al., 2003; Yi, 2002; ME, 1999-2001; NIER, 1999]. However, emission data and the possible candidate chemicals for the EIs are often extremely limited. Thus, a hypothetical matrix method was designed as suggested by the EURAM which considers the industrial distribution systems, the use, and others [Yi, 2003].

A procedure for determining the chemical priority follows the screening of chemicals (such as agricultural chemicals and synthetic detergents) on the basis of amounts being circulated and emissions levels: (1) to delete general gases, natural resources, common chemicals, (2) to check the classification and specification and delete low hazard chemicals using EURAM, (3) to acquire information on selected chemicals and scoring by the CHEMS-1 method, and apply weighting factors to CHEMS-1 on the basis of amounts of materials in circulation and emissions levels, (4) to group and audit, (5) to check monitoring data and environmental regulations, and (6) to determine chemical priority.

The EURAM distinguishes the priority for environmental impact and the priority with respect to human health effects. The priority with respect to human health effects can be characterized by HEX (human health exposure value) and HEF (human health effect). The human health exposure, HEX=a[log(HEXV)−b], ranges from 1 to 10 and is dependent on the emission amounts and the distribution ratios (DistHH) of the physical and chemical properties. Human Health Exposure Value, HEXV, is determined by HEXV=Emission× DistHH where, Emission=$T_1\times0.01+T_2\times0.1+T_3\times0.2+T_4$ (T_1~T_4 are related to the utilities) and DistHH=Max (bp_S, vp_S)+LogK_{OW}_S, in which bp_S is the boiling point (°C) and vp_S is the vapor pressure (hPa). Based on the Risk Phrase of the EU Directive 67/548/EEC, the HEF (human health effect) simultaneously considers the exposure values and the effect values for the human health, and is in the range 0-100 for HS (human health score). Thus, the total calculated score depends on the values of HEX and the HEF: Total Score=HEX×HEF.

CHEMS-1 is a method for ranking and scoring chemicals based on their effect on human health and the environmental impacts of USEPA/600/R-94/177 in 1994. The factors for estimating CHEMS-1 include acute oral toxicity, carcinogenicity, acute fish-toxicity, NOEL, chronic fish toxicity, BOD half-life, hydrolysis factor, and bio-concentration factor. On the basis of the scoring items and scoring standards of CHEMS-1, the total hazards (HV) are dependent on the human health effect (HHE), the environmental effect (EE), and the extent of exposure (EF); HV=(HHE+EE)×EF. The human health effect is the sum of the oral toxicity, inhalation toxicity, the carcinogenicity, and others, while the environmental effect is calculated by adding the acute toxicity, fish toxicity, and the NOEL. In addition, the exposures constitute the addition of the BOD dissolution, hydrolysis, and bio-concentration.

The data sources were obtained from the EU, Canada, the USA, and other countries. The EU and Canada performed the risk assessments based on the selection of priority substances (PS), data collection over long periods, and analysis of PS data. The USEPA uses an Integrated Risk Information System (IRIS) to provide the information on risk assessment, the current response assessment, and/or arriving at a decision for risk. The present study considers all the data sources described previously, and the Quantitative Structure-Activity Relationship (QSAR) utility and offers data grades for quality (refer to Table 1). The criteria for quality involve estimates of the PSL or an assessment of the risk of the refining phases for selecting the PS. The first grade for the data quality criteria includes data controlled by government organizations and the EHC (Environmental Health and Criteria) of the IPCS (International Program on Chemical Safety). The second grade includes data that are widely used, generally, and commercially and the case includes the criteria for the unclear data quality. In the final grade, a part of the data is predicted acceptably.

Table 1. The data quality criteria grade in estimating the PSL

Grade	Reference	Chemicals
1^{st} Grade*	EU PECAR	App. 140
	Australia PECAR	App. 40
	Canada PSAPAR	App. 50
	USEPA IRIS data	App. 550
	RAIS	IARC**** substances
	IPCS EHC data	App. 300
	USA ATSDR data	App. 280
2^{nd} Grade	HSDB**	Commercial DB & internet data
3^{rd} Grade	QSAR***	EPA provides some programs

*See Table 3 for the references; **Hazardous Substances Data Bank; ***Commercial QSAR including EPWIN (Estimation Program Interface), ECOSAR (Ecological Structure Activity Relationship), etc.; ****International Agency on Cancer Research.
PSAPAR: Priority Substance Assessment Program Assessment Reports; IRIS: Integrated Risk Information System; PECAR: Priority Existing Chemicals Assessment Reports; EU PECAR: EU Priority Existing Chemicals Assessment Reports; RAIS: Risk Assessment Information System; ATSDR: Agency for Toxic Substances and Disease Registry; IPCS EHC: International Program on Chemical Safety Environment Health Criteria.

RESULTS

The four industrial areas selected in the present study were Kumi, Yeochon, and Ulsan including the industrial area (Ansan) which was considered in the preliminary study. The selection of industrial areas for the PSL was based on data on substances found in the industrial circulation (or distribution) systems for all regions in Korea. The industrial areas include a variety of industrial activities and the contamination is largely from point emission sources. Substance data obtained from the industrial circulation (or distribution) systems were used to select the industrial areas for inclusion in the PSL. The material circulation and the emissions of the priority substances are informed for the major industrial areas and for all regions over Korea. The four industrial areas account for about 80% of the industrial circulation and around 50% of the total emissions when all industries in Korea are taken into account. An averaged ratio of the

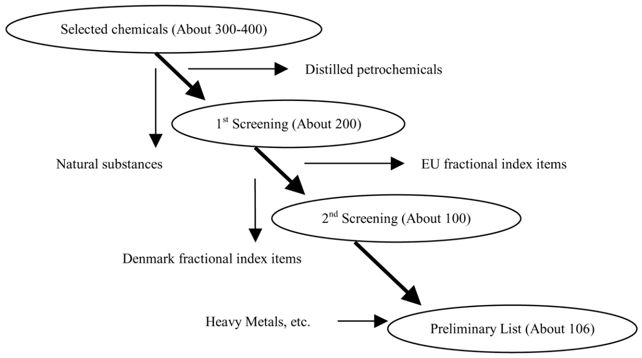

Fig. 1. Procedure for refining priority substances.

emission rate among all selected industrial regions is greater than 0.6 for Ulsan 0.75, Ansan 0.6, Kumi 0.78, and Yeocheon 0.8, respectively.

Fig. 1 shows the refining procedure used to select the priority substances for the PSL. The major 300-400 chemicals can be reduced to about 200 chemicals after the first screening, and about 100 chemicals remain after the second screening. Finally, the 106 candidate priority substances including additional heavy metals (Pb, Cd, and Hg), as well as tetrachloroethylene and arsenic, were selected from the second screening. In the case where no emission data is available, the emission of Acetone and 17 chemicals in two industrial areas (Kumi and Ansan) was estimated by a hypothetical matrix. Kumi has very low fraction for circulation and emission, and Ansan was the target industrial area in the preliminary study. The data, as estimated by the hypothetical matrix method, tend to contain much larger uncertainties than those determined by EUSES (European Union System for the Evaluation of Substances) or EURAM. To minimize these uncertainties, we used the Korean emission data of 1999 and 2000. In order to estimate the EIs for Ansan, 10 chemicals (benzene, styrene, phenol, tetrachloroethylene, methyl ethyl ketone (MEK) and heavy metals, Pb, Hg, Pb, and Cd, etc.) were sampled and analyzed for the PSL in the preliminary study. However, the five chemicals (tetrachloroethylene, phenol, Hg, Lead, and MEK) that had been analyzed more than four times were excluded

Table 2. Weighting Factors to list Priority Substances for four industrial areas (Ulsan, Ansan, Kumi, and Yeocheon): 81 chemicals among 106 candidate priority substances

No.	Chemical	Weight factor (w)			
		Ulsan	Ansan	Kumi	Yeocheon
1	Formaldehyde	5.43	5.35	5.95	6.01
2	Aniline	2.05	2.79		5.63
3	Acetic acid	7.77	4.69	1.00	8.05
4	Methanol	9.04	9.50	9.05	8.13
5	2-Propanol	7.65	8.07	8.02	5.27
6	Acetone			2.26	
7	Chloroform	5.14	7.46		2.73
8	N,N-Dimethylformamide	6.25	7.30	8.78	6.31
9	Benzene	8.36			9.90
10	Vinyl chloride	9.19	4.00		10.00
11	Acetaldehyde	5.86	4.98		2.47
12	Methylene chloride	8.05	8.17		5.18
13	Carbon disulfide		2.49		1.88
14	Oxirane	5.72	1.80		8.07
15	Phosgene				2.71
16	Methyloxirane	7.03	2.67		
17	Dimethyl sulfate		2.41		
18	3,5,5-Trimethyl-2-cyclohexene-1-one		1.88	2.29	
19	2-Methyl-1-propanol	4.08	9.22	4.35	
20	Methyl ethyl ketone	7.16	9.80	7.03	1.00
21	Ethylene trichloride		9.01	7.66	6.55
22	2-Propenamide	5.26	1.00		2.27
23	2-Propenoic acid		3.27	1.00	
24	Chloroacetic acid		2.55		
25	4,4-(1-Methylethylidene)bis[2,6-dibromophenol]			1.00	
26	4,4-(1-Methylethylidene)bisphenol	6.97	7.55	6.91	10.00
27	Methyl methacrylate		5.52	1.81	
28	Dibutyl phthalate		4.69		
29	Phthalic anhydride		6.09		
30	4-Methyl-1,3-benzenediamine	4.09			7.00

Table 2. Continued

No.	Chemical	Weight factor (w)			
		Ulsan	Ansan	Kumi	Yeocheon
31	Ethyl methacrylate		1.00		
32	Isobutyl methacrylate		1.00		
33	Butyl methacrylate		1.50		
34	4-(1,1-Dimethylethyl)phenol		1.00		
35	(1-Methylethyl)benzene				9.71
36	Nitrobenzene	2.70			5.11
37	Terephthalic acid			6.63	
38	Ethylbenzene	7.01	2.80		8.56
39	Styrene	8.79	5.98	2.57	9.70
40	Hexamethylenetetramine			3.91	
41	3,3'-Diochloro-4,4'-diaminodiphenylmethane		2.51		
42	Diphenylmethane diisocyanate	2.67	5.05	4.81	4.37
43	4,4-Diaminodiphenyl-methane		2.66		4.97
44	2-Ethylhexylacrylate			1.00	
45	Carprolactam	10.00	3.03	10.00	
46	1-Chloro-2,3-epoxypropane	8.09	4.01		5.28
47	1,3-Butadiene	7.18			8.87
48	1,2-Dichloroethane	4.59	1.66		8.38
49	Acrylonitrile	8.30	1.00		8.22
50	Ethylene glycol			6.27	
51	Vinyl acetate	6.82	5.26		5.16
52	Methylisobutyl ketone	6.14	9.20	2.96	7.07
53	Maleic anhydride	9.46	10.00		
54	m-Cresol		3.23		
55	1,3,5-Triazine-2,4,6-triamine	2.98	4.15	5.16	6.88
56	Toluene	9.05	9.40	8.30	9.69
57	Cyclohexanone			1.00	
58	Phenol	1.00	5.46	4.35	6.48
59	Ethylene glycol monoethyl ether	2.72	6.26		
60	Ethylene glycol monoethyl ether acetate	4.31	5.56		
61	2-Butoxyethanol	4.59	9.40	3.18	
62	Bis(2-ethylhexyl)phthalate	5.16	7.56	3.36	
63	Di-n-octyl phthalate	4.93	4.46		
64	Dimethyl terephthalate	9.34		9.85	5.82
65	2,4-Dinitro- toluene				8.92
66	1,3-Benzenedicarboxylic acid	7.82	7.24	6.75	
67	Butyl acetate	8.81	9.14	5.55	
68	2,2-Dimethyl-1,3-propanediol	5.67	9.68	4.60	5.24
69	Tetrachloroethylene		2.30	10.00	
70	Ethyl acrylate	1.82	1.00		4.18
71	Ethyl acetate	6.05	10.00	9.78	5.18
72	Hydrazin				
73	Cresol		3.86	7.06	1.00
74	Xylene	10.00	7.62	7.52	9.33
75	Methyl tert-butyl ether	7.57			8.99
76	Lead	2.36	3.13	5.13	1.00
77	Mercury	1.00	1.00	1.00	1.00
78	Arsenic	1.00	1.00	1.00	1.00
79	Cadmium	1.00	1.00	1.00	1.00
80	Nonylphenol		6.16		
81	1,3-Diisocyanatomethylbenzene	4.72	6.15	2.94	7.64

from the list, due to their ranking as negligible in the PSL. Five chemicals (ethylene trichloride, methylene chloride, bis(2-ethylhexyl) phthalate, ethylacetate, and arsenic) were subsequently added to the list to be investigated. These chemicals are in the PSL database, especially in the 40 priority substances for Ansan. The Kumi, Yeocheon, and Ulsan industrial areas were also added to the priority substances. This program comprehensively assesses 40 chemicals (20 on the first priority substances list (PSL) and, relatively, 20 compounds on the second PSL) for the entire industrial regions in Korea.

The PSL in the present study lists 81 major priority substances among the 106 candidate priority substances basically given by CHEM-1 and scores as applying weighting factors to CHEMS-1 on the basis of amounts of materials in circulation and emissions levels as shown in Table 2. Table 3 indicates the scores of the PS with the weighting factors. Carcinogenic substances in Table 3 are classified as the 1st grade, the 2nd A-grade, and the 2nd B-grade depending upon the IARC (International Agency on Cancer Research). The maximum values or 60% of the maximum values for the worst case are given for the limited BOD half-life and the hydrolysis half-life. The BOD or hydrolysis half-life is the lowest 40% and acute oral toxicity is the highest 90%. The toxic assessments are divided between 'negative' and 'positive'. If it is positive or possible to be positive or unknown, it is positive.

To reduce the uncertainty indicated in the preliminary IEM study, the amounts of the emissions were determined separately and those values were used. Substances, for which the emissions are difficult to estimate, are valued using data obtained from distribution systems. The priority substances selected from all of Korea and for the industrial areas were standardized by the industrial areas. When 40 chemicals from each of the industrial areas were selected for the study, the priority substances were 73 (72 chemicals with methyl

Table 3. Priority Substances Scores on a basis of weighting factors to CHEMS-1

No.	Chemical	Scores as a function of weight factors (wHV)§			
		Ulsan	Ansan	Kumi	Yeocheon
1	Formaldehyde	543.52	535.09	595.72	601.77
2	Aniline	119.35	162.50	0.00	327.40
3	Acetic acid	12.88	7.78	1.66	13.34
4	Methanol	110.25	115.95	110.35	99.20
5	2-Propanol	152.32	160.74	159.58	105.00
6	Acetone	0.00	0.00	22.17	0.00
7	Chloroform	403.55	586.20	0.00	214.33
8	N,N-Dimethylformamide	29.57	34.54	41.51	29.84
9	Benzene	640.02	0.00	0.00	758.54
10	Vinyl chloride	774.15	337.30	0.00	842.11
11	Acetaldehyde	288.91	245.36	0.00	121.62
12	Methylene chloride	275.89	280.08	0.00	177.74
13	Carbon disulfide	0.00	154.44	0.00	116.49
14	Oxirane	603.39	190.45	0.00	851.57
15	Phosgene	0.00	0.00	0.00	81.19
16	Methyloxirane	380.95	144.99	0.00	0.00
17	Dimethyl sulfate	0.00	173.56	0.00	0.00
18	3,5,5-Trimethyl-2-cyclohexene-1-one	0.00	32.64	39.82	0.00
19	2-Methyl-1-propanol	20.17	45.54	21.48	0.00
20	Methyl ethyl ketone	192.42	263.45	188.85	26.88
21	Ethylene trichloride	0.00	833.29	708.55	606.00
22	2-Propenamide	437.85	83.19	0.00	188.64
23	2-Propenoic acid	0.00	142.15	43.53	0.00
24	Chloroacetic acid	0.00	108.29	0.00	0.00
25	4,4-(1-Methylethylidene)bis[2,6-dibromophenol]	0.00	0.00	75.10	0.00
26	4,4-(1-Methylethylidene)bisphenol	257.67	279.19	255.48	369.91
27	Methyl methacrylate	0.00	122.78	40.23	0.00
28	Dibutyl phthalate	0.00	402.40	0.00	0.00
29	Phthalic anhydride	0.00	195.98	0.00	0.00
30	4-Methyl-1,3-benzenediamine	382.82	0.00	0.00	655.08
31	Ethyl methacrylate	0.00	24.16	0.00	0.00
32	Isobutyl methacrylate	0.00	20.27	0.00	0.00

§wHV=(wHHE+wEE) *EF; wHHE=Human Health Effect with weight factors (w); wEE=Environmental Effect with weight factors (w); EF=Exposure Factor.

Table 3. Continued

No.	Chemical	Scores as a function of weight factors (wHV)[§]			
		Ulsan	Ansan	Kumi	Yeocheon
33	Butyl methacrylate	0.00	46.96	0.00	0.00
34	4-(1,1-Dimethylethyl)phenol	0.00	52.10	0.00	0.00
35	(1-Methylethyl)benzene	0.00	0.00	0.00	536.46
36	Nitrobenzene	91.63	0.00	0.00	173.60
37	Terephthalic acid	0.00	0.00	79.60	0.00
38	Ethylbenzene	382.89	152.94	0.00	467.65
39	Styrene	276.54	188.04	80.73	304.94
40	Hexamethylenetetramine	0.00	0.00	96.72	0.00
41	3,3'-Diochloro-4,4'-diaminodiphenylmethane	0.00	186.16	0.00	0.00
42	Diphenylmethane diisocyanate	12.46	23.53	22.39	20.38
43	4,4-Diaminodiphenyl-methane	0.00	243.77	0.00	455.88
44	2-Ethylhexylacrylate	0.00	0.00	61.13	0.00
45	Carprolactam	241.46	73.24	241.40	0.00
46	1-Chloro-2,3-epoxypropane	757.03	374.85	0.00	494.07
47	1,3-Butadiene	543.63	0.00	0.00	671.23
48	1,2-Dichloroethane	308.47	111.35	0.00	562.79
49	Acrylonitrile	488.01	58.80	0.00	483.59
50	Ethylene glycol	0.00	0.00	50.13	0.00
51	Vinyl acetate	304.54	234.69	0.00	230.39
52	Methylisobutyl ketone	154.20	231.16	74.51	177.79
53	Maleic anhydride	386.85	409.01	0.00	0.00
54	m-Cresol	0.00	154.44	0.00	0.00
55	1,3,5-Triazine-2,4,6-triamine	78.16	108.87	135.44	180.66
56	Toluene	364.93	378.77	334.76	390.57
57	Cyclohexanone	0.00	0.00	23.89	0.00
58	Phenol	47.80	260.99	208.17	309.97
59	Ethylene glycol monoethyl ether	33.30	76.55	0.00	0.00
60	Ethylene glycol monoethyl ether acetate	219.38	282.63	0.00	0.00
61	2-Butoxyethanol	169.20	347.01	117.23	0.00
62	Bis(2-ethylhexyl)phthalate	398.76	583.75	259.57	0.00
63	Di-n-octyl phthalate	330.32	298.51	0.00	0.00
64	Dimethyl terephthalate	327.80	0.00	345.76	204.16
65	2,4-Dinitro-toluene	0.00	0.00	0.00	908.79
66	1,3-Benzenedicarboxylic acid	110.00	101.79	94.92	0.00
67	Butyl acetate	256.13	265.81	161.45	0.00
68	2,2-Dimethyl-1,3-propanediol	0.00	0.00	0.00	0.00
69	Tetrachloroethylene	0.00	210.17	913.71	0.00
70	Ethyl acrylate	134.90	74.25	0.00	310.29
71	Ethyl acetate	114.75	189.53	185.41	98.16
72	Hydrazin	0.00	0.00	0.00	0.00
73	Cresol	0.00	191.95	351.19	49.74
74	Xylene	570.03	434.46	428.47	531.77
75	Methyl tert-butyl ether	146.69	0.00	0.00	174.18
76	Lead	103.23	137.16	224.29	43.75
77	Mercury	53.36	53.36	53.36	53.36
78	Arsenic	63.60	63.60	63.60	63.60
79	Cadmium	149.24	149.24	149.24	149.24
80	Nonylphenol	0.00	566.28	0.00	0.00
81	1,3-Diisocyanatomethylbenzene	271.49	353.63	169.26	439.63

[§]wHV=(wHHE+wEE) *EF; wHHE=Human Health Effect with weight factors (w); wEE=Environmental Effect with weight factors (w); EF=Exposure Factor.

tert-butyl ether) in all of Korea. Thus, the 81 chemicals, including formaldehydes, among the 106 candidate priority substances are listed in the database (DB) as the major priority substances (PS). The 80% (73 chemicals) of the 81 substances are classified as the carcinogen, the acute oral toxicity, and so on and satisfy the 1st grade of the data quality criteria.

DISCUSSION AND CONCLUSION

A project for inventory development of integrated environmental management (IEM) was funded by the Ministry of Environment (ME) in Korea in order to investigate a variety of substances that may contaminate the environment and cause adverse effects to the environment and/or to human health. Based on the results of a preliminary study of the IEM project, the present IEM project study continues to develop a priority substance list (PSL), preparing data quality criteria, estimating the new PSL, and assessing the risk of the refining processes for selecting priority substances (PS). Emissions inventories are obtained from the data on various compounds for the material, regional, and industrial distribution systems for selected industrial regions (1998-2001' data). In the case where no emission data was available, a hypothetical matrix method, designed by EURAM (European Union Risk Ranking method) was used as the priority setting method, which is a simple model of the exposure and effect on humans and the environment to determine the standard for potential human and environmental risk. The information required in CHEMS-1 was collected for the PSL and its database and the characteristics of each data source were analyzed in order to establish quality standards for the collected data. To reduce the uncertainty indicated in the preliminary IEM study, the amounts of the emissions were determined separately and those values were used. Substances, for which of the emission are difficult to estimate, are valued using data obtained from distribution systems. The priority substances 73 (72 chemicals with methyl tert-butyl ether) selected from all of Korea and for the industrial areas were standardized by the industrial areas. The 80% (73 chemicals) of the 81 substances including formaldehydes, among the 106 priority substances are listed in the database from the present study are classified as the carcinogen, the acute oral toxicity, and so on, and satisfy the 1st grade of the data quality criteria for materials. The data quality criteria for the items is similar to those for the materials and the BOD or hydrolysis half-life is the lowest 40% and the acute oral toxicity is the highest 90%.

The investigated priority substances are significantly used and emitted or released into the environment even though their hazardous effects are known in public. Of course, the current PSL may have uncertainties of information and criticism of data trustworthiness. Therefore, for further studies, one may (1) effectively select representative priority substances for the industrial areas or for the metropolitan areas, (2) correctly use information built by other people, (3) check much more various materials in order to consider the representation of the selected materials, and (4) need to make a thorough analysis of the selected information in an aspect of the trust. In addition, it is required to examine the materials concerned internationally such as Persistent Organic Pollutants (POPs).

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