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The development and regulation of occupational exposure limits in Korea

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Abstract

With the institution of the new chemical regulatory framework in 2003, chemicals at the workplace have been classified into five categories; banned substances, permission-required substances, regulated substances, occupational exposure limit set substances, and other generally controlled substances. Currently, there are 698 substances with OELs. As we have come to gain our own experiences in the study and control of chemical hazards at the workplace such as the 2-bromopropane poisoning, OEL setting process has been streamlined. The OELs in Korea, however, remain merely as a recommendation, which does not require all the substances with OELs to be measured at the workplace. Coordination of whole program for hazardous chemicals including workplace measurement, OEL setting process, and enforcement activities is still needed in Korea.

Keywords: Korea; OEL; Workplace environment measurement program; Industrial Safety and Health Act; 2-Bromopropane

1. Introduction

In Korea, the Industrial Safety and Health Act of 1981 has been the basis for the regulation of hazardous chemicals at the workplace. The Korean chemical regulatory policy adopted in the act had been, until the year 2003, exactly the same with that of Japan's; the same classification system was adopted with the same contents of the regulated chemical substances, regardless of their actual usage in Korea. This had resulted in regulation of substances not used in Korea, while not providing an administrative process for addressing the regulation of toxic substances that are 'new' to the Korean workplace.

In 1995, an outbreak of reproductive and hematopoietic disease in a group of workers was reported. Ensuing epidemiology studies had pinpointed 2-bromopropane as responsible for this incident (Kim et al., 1996). However, neither any toxicology information, nor OELs were available at that time. Later in 1998, Korea became the first country to set up an OEL for 2-bromopropane. In 2003, the chemical regulatory policy was finally revamped (Lee et al., 2004).

Korea has undergone rapid economic development since the 1960s. Its per capita income was less than a hundred dollars before 1960, but has soared more than a hundred folds since then. Not only in terms of national income but the whole country has changed in various aspects. The population has grown from 25 million in 1965 to more than 45 million. Over the same period, the labor participation rate has risen from 55 to 61%. A more dramatic increase was with the women's labor participation rate, from 36.5 to 55.1%. Also notable was the increased proportion of those over 50 years old among the total number of employed, which has risen from less than 16 to 25% (Paek and Hisanaga, 2002).

At present, the agriculture and fishery accounts for 10.9% of the workforce, manufacturing 20.2%, and social overhead capitals and other service sectors 68.9%. The proportion of manufacturing has reached the highest in the

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early 1990s with just under 30%, but has steadily decreased since then. However, it is still the largest economic sector with 4.3 million workers, and the petrochemical industry is quite a robust sector in Korea.

Currently, as many as 37,000 chemicals are known to be used at the workplace in Korea, and about 300 new chemicals are being imported or introduced each year. Based on the National Survey of Work Environment Status of 1999, 20,557(39.5%) out of 52,070 manufacturing companies employing more than five workers either manufacture or use chemicals. The figure is without counting the workers in manufacturing companies with less than five workers and non-manufacturing sectors such as construction and transportation industries. The number of workers diagnosed with occupational diseases from chemical exposures amounted to 322 in 2002 (Lee et al., 2004).

2. The procedure of OEL development

The Ministry of Labor can establish and notify OELs based on the Industrial Safety and Health Act. The first set of OELs was notified by the Ministry of Labor in 1986, which at that time was identical with the threshold limit values (TLVs) of American Conference of Governmental Industrial Hygienist (ACGIH). There was no statutory or centralized process for setting up TLVs at that time, and this was to provide the Korean translation of TLVs. Since then, only two ad hoc revisions were made by the Ministry until the episode of 2-bromopropane in 1995.

At the time 2-bromopropane was found to be responsible for the outbreak of reproductive and hematopoietic diseases, no ACGIH TLV, or any other OEL was available, and Korean Ministry of Labor had to set up its own OEL for 2-bromopropane without any reference from foreign sources. No observed effect level from animal experiment together with the safety margin of 1000 was the major rationale for the 1 ppm 8 h time-weighted average (TWA) OEL proposal for 2-bromopropane (Yu et al., 1997). Epidemiologic findings played a decisive role in hazard identification process, but later on mainly toxicology study results were used to quantify dose-response relationships. The Hazardous Substance Control Assessment Committee, which was founded under the Korea Industrial Safety Corporation (KISCO, later renamed Korea Occupational Safety and Health Agency), had reviewed the proposal, and the Ministry had set the OEL for 2-bromopropane based on the recommendation of the Committee review in 1998. Nineteen members in total belonged to the Hazardous Substance Control Assessment Committee, and 10 of them were internal members of the Ministry and KISCO while the remaining nine were from outside academic institutes and service agencies. No labor or management representatives were invited or consulted during the review process.

One more partial revision was made in 2002, and the ad hoc review committee was formed directly under the Ministry of Labor, instead of KISCO. Consultation from both labor and management sides was made at this time. In this 2002 revision, the OEL for asbestos was lowered from 2 to 0.1 fiber/cc, and from 10 to 1 ppm for benzene.

The OEL set up process was revamped in 2003 along with the streamlining of the regulatory framework of chemical hazards at the workplace. Under the new framework, Hazardous Agents Review Committee established under the Ministry of Labor by the Industrial Safety and Health Act is now in charge of examining the toxicity of the chemicals at issue and classifying them into the five categories of the revised chemical regulatory framework; banned substances, permission-required substances, regulatory-listed substances, OEL set substances, and other generally controlled substances (Fig. 1).

Manufacture, import, or the usage of 68 chemicals is currently banned in Korea based on their toxicity evaluation. Chemicals can be included into the banned substances category after the review of the Industrial Safety and Health Policy Deliberation Committee formed by the Industrial Safety and Health Act, if they fall under any of the three following criteria. First, it has to be a substance proven to cause occupational cancer and identified as particularly hazardous to the worker's health. Second, it has to be a substance likely to cause significant health risks to workers based on the results of hazard-risk evaluation process of Hazardous Agents Review Committee. Third, it can be any substance likely to cause significant health risks to workers as determined by the Presidential Decree. However, if such banned substances are to be imported, manufactured, or used for test or research purpose under the appropriate laboratory conditions, restricted import, and usage can be granted to the chemical industry after acquiring the Labor Minister's permission in advance.

Permission from the Labor Ministry is required in advance for 14 substances if anyone desires to manufacture, use, dismantle, or remove them. These permission-required substances hold the similar significant health hazard and risk as banned substances. However, in case an alternative material has not been developed, or banning them entirely

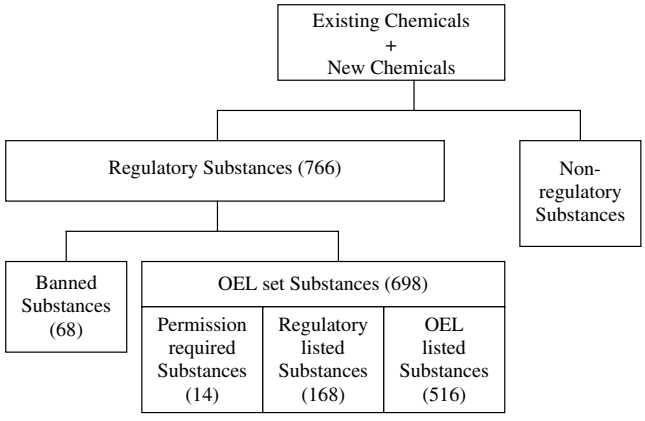

Fig. 1. Chemical classification under the 2003 regulatory framework. The OEL-set substances in Korea include three sub-categories, permission-required substances, regulatory-listed substances (in terms of measurement requirement), and OEL-listed substances without regulatory requirement.

will likely cause significant impact on the national economy and industry, permission will be granted after a demonstration of appropriate facilities and equipments for the control of chemical risks under the limits. The selection criteria and procedure for permission of required substances are the same as the banned chemicals.

Regulatory-listed substances are those chemicals for which detailed health and safety requirements such as appropriate facility standards, management methods, and provision of personal protective equipments are specified for employers because of their toxic potentials and volumes of usage in the industry. Formerly, the classification system for regulatory-listed substances, especially the category of specified substances was somewhat arbitrary, but now these regulatory-listed chemicals are classified into 113 organic compounds, 23 metals, 17 acids and alkali, and 15 gaseous agents, totaling 168 substances.

According to the new statutory framework, the OELs are established based on epidemiologic findings, toxicology data, and technical feasibilities. However, in practice, the current 698 OELs for chemicals have been set based mostly on the 1988 ACGIH TLVs. As these ACGIH TLV-based OELs have not been regularly updated, almost all of working environment monitoring service agents have been comparing their monitoring results not only with the Korean OELs but also with the updated ACGIH TLVs.

In 2005, the Ministry of Labor is in the process of revising these outdated OELs. Research funds have been allocated to solicit proposals from toxicology laboratories and academic institutions to gather and review evidences for the revision of OELs for 84 chemicals. For 77 chemicals, the current ACGIH TLVs are stricter than the current Korean OELs, and for the other seven chemicals with OELs, there are no US OSHA Permissible Exposure Limits. The Hazardous Agents Review Committee established under the Ministry of Labor by the Industrial Safety and Health Act, whose members have not been named yet, will review these research results later at the end of 2005.

3. The enforcement and communication of OEL

Detailed health and safety requirements are specified for regulated substances in the Ministry of Labor Ordinance on Industrial Health, along with separate chapters for banned substances and permission-required substances. Employers are required to monitor and evaluate work environment once every 6 months if workers are exposed to any one of permission-required substances (14), regulatory-listed substances (168), dust-causing materials (6), metal-working fluid, noise, or heat.

There are about 110 technical service agencies in Korea providing measurement services to employers, and the monitoring results are reported directly to the Ministry as well as to the employers. If any one of the monitoring results exceeds the OEL by 2 times (1 time for carcinogens), the monitoring period has to be shortened to every 3 month for the entire workplace. On the other hand, if two consecutive monitoring results for the entire workplace show no excess exposure over any OEL, the monitoring period can be extended to once every 12 months except for carcinogens. If the monitoring results are above the OELs, technical service agencies submit, on behalf of employers, written plans for the improvement of working environments. Noise level above 90 dB has been the most frequent violation. Personal protective equipments (PPEs) have been included in the improvement plans, and PPEs are often adopted as the only control measures in practice. Repeated violations are not infrequent.

OEL in Korea is a recommendation rather than a legally binding limit in the sense that not all the substances with OELs are required to be measured at the workplace. For 516 out of 698 chemicals, for which OELs have been currently established, the aforementioned mandatory measurement requirements do not apply. As there are no reporting requirements, these OEL-listed substances but outside the legal requirement category are not measured by the technical service agencies, and they are left up to the voluntary compliance efforts of employers.

At present, the workplace environment measurement program is focused on monitoring of production line maintenance rather than assessment of potential risks. Repeated one-day-per-every-6-months measurements of limited but the same problems, rather than progressive investigation of full-scale but the different problems, have been implemented. Under this strategy, obvious changes or malfunctioning in a regular production line or process can be easily detected and reported, but investigation of rare events or irregular tasks could be a problem. Also, determination of the exact exposure level is limited since daily variations cannot be encountered.

Currently, questions about the accuracy and effectiveness of this mandatory workplace environment measurement program have been raised. Especially the variations in exposure contents and levels are not well characterized and peak exposure levels or rarely used but highly toxic materials are often ignored during the measurements. Another problem is that measurement results are not linked directly with the other health and safety management programs of the workplace, such as mandatory improvement of work environment or exemption of medical monitoring program of workers. A special committee has been set up this year to examine and revise the work environment monitoring program of Korea.

4. Examples of OEL development

A special ad hoc committee including industry and labor representatives was formed in 2002 to discuss the OELs of benzene and asbestos. The OEL for benzene was lowered from 10 to 1 ppm, and the asbestos exposure level also from 2 to 0.1 fiber/cc in 2002.

The first case of occupational cancer due to asbestos exposure was recognized in 1993 in Korea. About 10 more cases due to occupational asbestos exposure have

been reported thereafter, and along with these case reports, concerns about environmental exposures has become a social issue in Korea. The first case of occupational cancer due to benzene exposure at the steel refinery was compensated in 1995, and soon after that, cases have been reported in the petrochemical industry. These reports of occupational cancers in late 1990s, together with the need to harmonize OELs with other countries, had prompted the 2002 revision of OELs for asbestos and benzene.

During the revision process, the main issue was about technical feasibility rather a risk-free or safe exposure levels. This was particularly true in that past exposures, for which no measurement data was available, should have been analyzed, when safe level for occupational carcinogens had to be determined. The first asbestos-induced mesothelioma case had been found in a worker who had worked for 19 years in one workplace built in 1974 by a German company, Rex asbest, after Germany had tightened asbestos regulations in their home country. The index workplace had been regarded as the cleanest asbestos textile company in Korea even satisfying the previous German OEL of 2 fiber/cc, but the exposure level was apparently not low enough to prevent occupational cancer. Because of the lack of historical exposure data, the safe level was hard to define, and the major issue of discussion had shifted to the issue of technical feasibilities for the whole industry. By the time the new OEL was proposed according to the ACGIH TLV and OSHA PEL, however, those asbestos textile industries that had difficulties lowering their exposure levels had already been transferred to foreign lands, and almost all the remaining facilities could satisfy the revised standards.

The previous 10 ppm OEL for benzene was too high considering the fact that leukemia cases have been reported in petrochemical industries where no excessive exposures exceeding the OEL of 10 ppm were found in the work environment measurement results. The safe exposure level for benzene was also hard to define. The problem was compounded by the fact that OSHA PEL and ACGIH TLV for benzene were different from each other. Here technical feasibility also played a decisive role in setting the OEL for benzene, and as 1 ppm for 8 h TWA was already satisfied by most industries, 1 ppm 8 h TWA was adopted as the new OEL without any notation of short-term exposure limit.

Following the discussion of benzene OEL in 2002, however, short-term exposures have begun to be measured in some petrochemical industries. Short-term but high-risk tasks such as sampling, draining, and repairing are found to frequently be exceeded the 15 min short-term exposure limit of 2.5 ppm and many are exceeded 5 ppm. As the production process of petrochemical industries is run by a closed system, the significant exposures can occur only when the system is opened up or broken down. Currently, labor representatives are demanding short-term exposure limits be established for benzene.

Silica was classified as group one human carcinogen by the IARC in 1997. This had prompted the studying of lung cancer developments among miners in Korea, as the Ministry of Labor was trying to reevaluate the compensable categories of pneumoconiosis complications. Based on our own epidemiologic study results (Choi et al., 1999), which showed relative risk of 1.5–3.4 of lung cancer development among pneumoconiosis patients, the government began compensating coal miners with more than 1/0 profusion category of pneumoconiosis from 1999. This decision was based on the observation that the coal seam in Korea is so thin that the coal miners are usually exposed to crystalline silica. However, the OEL for silica has not been changed even with this decision, because only the weight of the respirable dust, not the contents, is analyzed in the monitoring program of mining environments.

5. Conclusion

OEL in Korea still remains as a guideline for the control and improvement of workplace environment by employers. Only part, not all, of those substances with OELs are required to be measured. Enforcement may still be incomplete and measurement results may not be directly linked with improvement requirements or other health and safety programs.

However, there have been significant advancements in the management of chemical health hazards at the Korean workplaces. Previously, ad hoc committees composed only of members from technical or academic institutions often ruled over the process of resolving issues of health and safety at the work environment. This was because, in adopting OELs from existing standards set by other developed countries, no need was raised to appreciate the contextual or social implications of OEL data. The copied data of OELs from other countries served only as personal information with limited context rather than as collective knowledge based on social reflections. Now management and labor representation are accepted as necessary in these statutory structures to resolve conflicts of social interests.

Previously, technical feasibility was the major basis for the OEL set up, but concerns beyond merely logical problems of standard settings, especially health effect itself, have been raised by the responsible social parties. Especially, the necessity of setting short-term exposure limit of benzene has been emphasized by labor unions in recent discussions of hematologic abnormalities that had occurred under the controlled environments within the limit of 8 h time weighted averages.

Again previously, references of toxicologic and epidemiologic health effects consisted of only foreign studies. Now research proposals are solicited from domestic institutions to substantiate the safe levels of chemicals to avoid adverse health effects.

Even though data, information, and knowledge may be used interchangeably, their meanings or connotations can be

differentiated based on values attached to them. In a more general sense, the mere data can only become information when it is purposefully collected, and the information can only become knowledge when its content is actively tested and reflected through experiences. In Korea, new regulatory framework has been in place since 2003. However, from the perspective of gaining knowledge, we still need to accumulate more experiences to make the framework actually work. This is especially true for coordinating workplace measurement program, OEL setting process, and enforcement activities. Hopefully, all these efforts should be directed to identifying and then solving health problems of toxic chemicals in our workplace, thereby these experiences can be transformed into social wisdoms in the near future.

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