The Regulation and Measurement of Odor in Korea

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Abstract
Recently, the number of civil petitions on odor has soared, and a great deal of attention has been paid to odor in Korea. This paper reviews the status and management of odor in Korea and introduces the Direct Sensory Method, Air Dilution Sensory Method, and the Instrument Analysis Method as measurements applied in Korea. Secondly, this paper introduces regulation criteria on the two sensory methods and permission level of odor release of eight malodorous chemical compounds and lastly, odor prevention laws to be passed in the near future.

1. Odor status in Korea

In addition to noise through the human olfactory system, odor has been a major pollution element with many civil petitions filed as an environmental pollution index. Every year the number of civil petition cases related to odor in Korea increases (see Figure 1). It is reported that more than 2,760 civil petition cases among 1,626 manufacturing plants have been filed. The major cause of civil petition is that residential and manufacturing areas are in close vicinity, and consequently it has caused large manufacturing plants to restructure their policies(1).

The Ministry of Environment inspected approximately 45,805 order-emitting companies in 1999, prosecuted 790 companies, and imposed administrative measures such as facility renovation, suspension of businesses, and fines on law violation(2). The Ministry of Environment conducts inspection of odor-emitting companies annually, and 526 companies under stricter government-monitoring at least three times a year. The Environmental Protection Agency takes action and reduces odor through technical support for small and medium-sized companies and making a database of odor-emitting facilities, deodorization fuel, and odor-victimized areas.

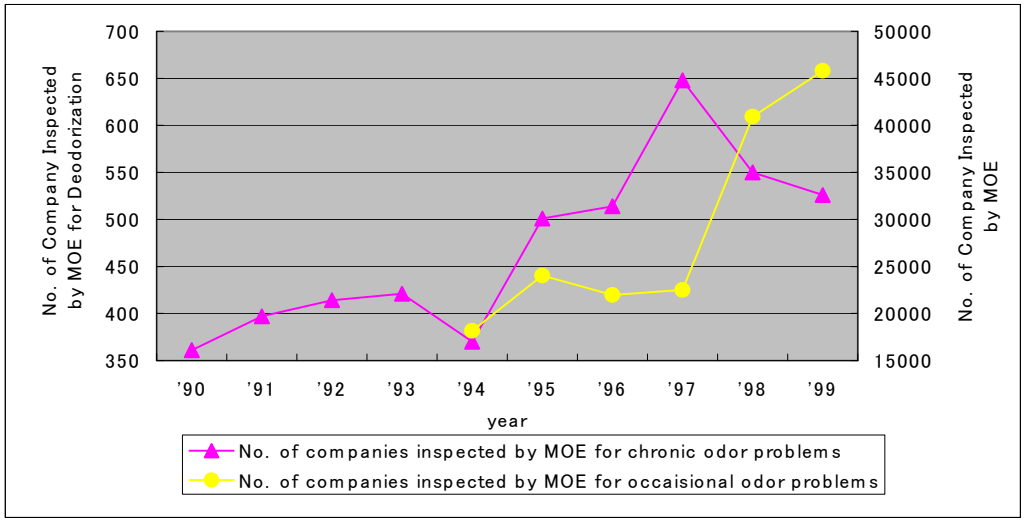

Figure 1. No. of odor emitting companies sighted by the MOE for odor prevention

2. Odor measurement in Korea

There are three major methods of odor analysis: direct sensory test, air dilution method, and chemical compound of analysis as shown in Tables 1 and 3. The actual spot odor analysis should use the direct sensory test or the air dilution method at the boundary of companies including the enclosures. It is regulated that the researcher could use chemical compound analysis using GC or UV as well as the two former tests, in case the eight odorous substances are contained among odor samples as defined in the atmospheric and environmental protection law(3).

The direct sensory test has been a major measurement. However, the sensory test using air dilution method has been welcomed recently by researchers as a measurement to identify the cause of odor more precisely. The direct sensory test was not effective in analyzing the cause of odor in wide-open spaces of industrial complexes and outlets, which cause highly-intensified odor.

The measurement and regulation of odor in Korea has been conducted in two places: outlets including stack and boundaries of companies including enclosures. (1) It can be conducted within outlets including stack and boundaries of companies including enclosures if the stack height is over 5m. There are other causes of odor besides outlet including stack in the industrial area if the emitted odorous substances are ammonia, hydrogen sulfide, and trimethyl amine. (2) It can be conducted only in outlets including stack if there are no other causes of odor. (3) It can be conducted only in boundaries of companies including enclosures besides the two cases mentioned above.

Table 1. Direct sensory test method

Intensity (degree)	Status
0	None
1	Threshold
2	Moderate
3	Strong
4	Very strong
5	Excessively strong

Table 2. Procedure for air dilution sensory test method in Korea

▸ Sampling - 3 ~ 20Liter/ less than 5minutes, - use the teflon sampling bag
▸ Prepare odor free air
▸ Panelist screening test - test the olfactory sensibility using 4 standard odors - more than five persons - wait for the test for 10 minutes - stop the negative effective activity of the test
▸ Perform the sensory test - prepare diluted odor samples using odor free air (dilution ratio 3, 10, 30, 100, 300 times, etc …) by the method of descending series - prepare odor samples which consist of 2 bags filled with odor-free air and 1 odor-injected bag and keep the break period to maintain the olfactory sensibility after the first phase of the test.
▸ Calculation of odor using the sensory test results - calculate the odor concentration using the statistics equation, and disregard the extraneous data.

Table 3 Odor-containing compounds analysis using instruments

Compounds	Instruments
Ammonia	UV-Spectrophotometry
Hydrogen sulfides, Methyl mercaptan Dimethyl sulfide, Dimethyl disulfide	GC-FPD
Trimethyl amine	GC-FID
Acetaldehyde	GC-FID
Styrene	GC-FID

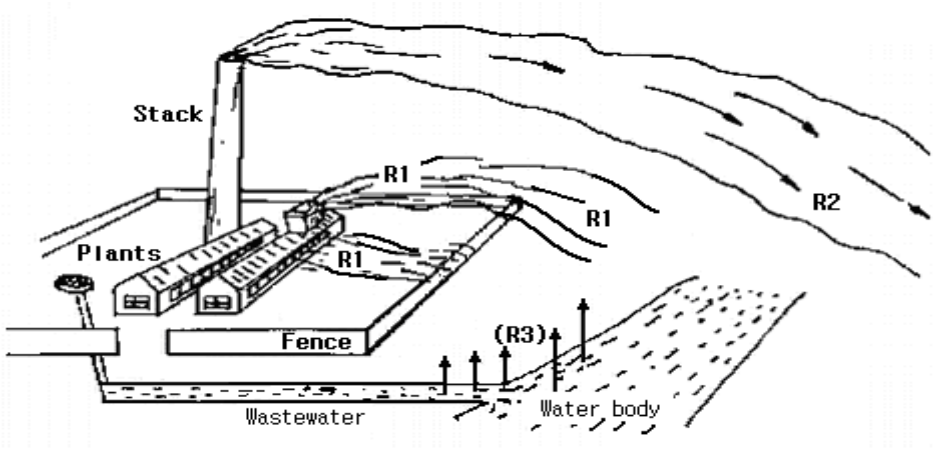

Figure 2. Schematic diagram of odor control strategy in Korea

3. Odor policy in Korea

3.1 Status of odor policy

As seen in Table 4, atmospheric and environmental protection laws (Chap. 3 Sec.30) classified eight odorous compound substances (e.g., hydrogen sulfide) in Korea according to the place of measurement.

Facilities for regulations are classified as outlet facilities of atmospheric pollutants (Preservation Law of Air Environment Article 2) and as facilities for control of odor in residential areas (Preservation Law of Air Environment Article 30). Outlet facilities of atmospheric pollutants consist of rubber and plastic product manufacturing plants, leather product manufacturing plants, industrial waste incinerators, painting mills, and petrochemical refinery plants. Facilities for the control of odor in residential areas constitute agricultural product wholesale markets, joint markets, butchery treatment areas, excretion treatment facilities, livestock farming waste treatment facilities and cleaning facilities. It is designated to other facilities, excluding the facilities mentioned above. This law and act prevent the establishment of waste incinerators and outdoor waste incinerators able to burn rubber, leather and synthetic resin in order to reduce the amount of odor (Preservation Law of Air Environment Article 29).

Table 4. Analysis and permission level of odor in Korea

Methods of odor analysis	Criteria for permission level of odor release		
Direct sensory test	Odor Intensity : less than 2 degree		
Air dilution sensory test	A. Outlets including stack (a) Companies in industrial area: less than 1000 OC (b) Companies in other area : less than 500 OC B. Boundaries of companies including enclosures (a) companies in industrial areas : less than 20 OC (b) companies in other areas : less than 15 OC		
Chemical compound analysis using GC or UV	Compounds	in industrial areas	in other areas
	Ammonia	less than 2 ppm	less than 1 ppm
	Methane ethiol	less than 0.004 ppm	less than 0.002 ppm
	Hydrogen sulfide	less than 0.06 ppm	less than 0.02 ppm
	Dimethyl sulfide	less than 0.05 ppm	less than 0.01 ppm
	Dimethyl disulfide	less than 0.03 ppm	less than 0.009 ppm
	Trimethyl amine	less than 0.02 ppm	less than 0.005 ppm
	Acetaldehyde	less than 0.1 ppm	less than 0.05 ppm
	Stylene	less than 0.8 ppm	less than 0.4 ppm

3.2 Legislation of odor prevention law (Draft)

As mentioned above, odor is a part of atmospheric pollution. Although atmospheric pollutants occur widely and consistently, there is a big difference as compared to other pollutions because it occurs in small areas and disappears instantly. There are many instances where various types of odorous substances occur, caused by the outlet facilities of atmospheric pollutant including various manufacturing processes. As a result, current atmospheric and environmental protection laws are highly limited to control over regulation of odor emission. Accordingly, odor prevention was separated from atmospheric and environmental protection on July 1, 2002. Odor prevention bills will be enacted and are as follows(4):

(1) Local communities in charge of odor management on behalf of the government: Since the scope of odor influence is not nationwide but regional, local communities should take charge of odor management and consider the needs of each area.
(2) Designation and management of problematic areas: The law designates the scope of problematic facilities or areas and effectively regulates odor emission by gradually expanding the designated odor management areas to industrial complexes and facilities making frequent civil petitions.
(3) Establishment and management of the permission level of odor release according to the characteristics of areas: Intensifying the criteria by the rules of city and province in cases where odor problems do not settle down on the permission

standard of odor release is in accordance with the Ministry of Environment (MOE)

(4) Application of regulation standards of odor emitting facilities: Regulating odor emitted from the processing and storing of products as well as odor emission facilities, excluding small businesses.

(5) Utilization of preliminary prevention measures for odor emitting facilities: Reducing odor emission by making designated odor emission facilities report odor prevention plans. The designated odor emitting facilities are decided by the MOE or by the rules of the city and province.

(6) Establishment of odor inspection institutions for the reliability and objectivity of measurements: Setting up odor inspection institutions for the development of measurement techniques, the improvement of inspection accuracy, and ruling out the application of permission level of odor release.

(7) Management of odor by the inspection of odor status on a regular basis: Having governors of local communities periodically investigate odors occurring in concentrations of designated odor compounds, status of civil petitions filed against odor problems, and report to the minister of MOE. Contents of odor inspection are to be decided by the ordinance of MOE.

References

1) Ministry of Environment, Environmental White Paper, 2000
2) Ministry of Environment, Investigation study to improve the management system of odor emission sources, 2001, p138
3) Ministry of Environment, Preservation Law on Air Environment Article 12 Annexed Chart 8 , 1999
4) Ministry of Environment, Major Contents of Odor Prevention Law (Draft), 2003