

Policies Regarding Industrial Wastewater Ocean Discharge in Korea

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Abstract

In August 2016, Korean press media released the news on the discharge of hazardous chemicals from power plant into surface waters of the sea in Ulsan area. The power plant used antifoaming agent which contains hazardous substance (Polydimethylsiloxane) to reduce the formation of foam for cooling system. Ministry of Maritime Affairs and Fisheries (MMAF) in Korea announced that the plant violated the law (Marine Environment Management) because Polydimethylsiloxane (PDMS) is a prohibited substance to discharge into the sea as a Noxious Liquid Substance by MARPOL 73/78. However, there is no standard to apply as a noxious liquid substance and no one knows the power plant is in the scope of Marine facilities of that law. ME (Ministry of Environment) and MOTIE (Ministry of Trade, Industry and Energy) argued it is uncertain how to discharge and there is no standards to apply. In this reason, MOTIE started feasibility study research of the regulations. This follow up study investigated how to treat and discharge wastewater containing hazardous chemicals from a facility, especially, power plants and companies in shore line. The primary objective is to find a reasonable method to make standards related to discharging industrial wastewater.

Keywords: Maritime laws; Industrial wastewater; Wastewater treatment; Water environment; Discharge standards

Introduction

Korea has been updating its Maritime laws to correspond with the developments of International Conventions. In 1977, the Korean marine environmental legal framework was launched with the "Prevention of Marine Pollution Act" which has led to the inclusion of the "International Convention for the Prevention of Pollution from Ships (MARPOL Convention, 1973)" and the "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention, 1972)" into the national legal system [1]. The laws related to the marine environment have considered the land-based pollution. "Prevention of Marine Pollution Act" has adjusted revision to MARPOL 73/78 and London Convention 1996 Protocol. It has adopted the articles related 'Noxious Liquid Substance' from MARPOL 73/78 and 'all dumping is prohibited at sea' from London 1996 Protocol. MMAF in Korea changed the name of this law to "Marine Environment Management Act" in 2009.

When the news released that the power plant discharged wastewater into the sea, MMAF claimed that the power plant discharged a 'noxious liquid substance' prohibited by "Marine Environment Management Act". ME, MOTIE and MMAF had meetings several times to discuss the matter because most of the industrial petrochemical complexes and power plants in Korea are located in shore line and if they are all applied as marine facilities, there is no way to avoid from the law. In other words, they all violate the law surely and if so, they have to establish different type of facilities to treat the substances in wastewater to comply the law. It costs them a fortune of course and double burden due to two different types of standards, ME's "Water Quality and Aquatic Ecosystem Conservation Law" and

"Marine Environment Management Act". MOTIE tried to find a way to solve for the companies may get same issue in Korea.

The aim of the study is to review the effectiveness of the Korean marine environmental laws by suggesting policies to the government comparing other countries' law which have pioneering marine environmental management systems. There has been a lot of controversy over applying "Marine Environment Management Act" against the companies located in shoreline as a scope 'Sea Area' or 'Marine Facility' and many researchers and specialists have studied on that matter. The Supreme Court already judged this case as suspension of prosecution since there is no standard to apply as a marine facility and the scope of application is unclear. However, some tasks we have to make clear are still remaining such as, how to manage and treat industrial wastewater containing hazardous chemicals, non-point source pollutant or to develop the agents without hazardous substances etc. Furthermore, it needs to have IMS (Integrated Management System) of ME, MOTIE, MMAF to solve the problems for the companies and water environment, so it includes the policy suggestion to control.

Methods and Approaches

Subjects in the study

In order to identify whether the power plants and companies in shoreline are under the 'Scope of Application' and to know their awareness of the "Marine Environment Management Act", MOTIE surveyed targeting petrochemical industry complexes located in Ulsan, Yeosu and Incheon area had meetings several times to collect their opinions and listen their difficulties. Also, they visited the companies to inspect wastewater discharge system. The companies are manufacturers, storage tank holder, importers/exporters of toxic chemicals mentioned in "Marine Environment Management Act".

Comparison and research

Each country has own policy to protect water environment and it has different rules and standards on the area, type of source etc. to estimate water pollution. Korea has also regulations for the water qualification, wastewater treatment, chemical substances management etc. This study started from 3 major questions to research.

Question 1: “Do most of the laws and regulations in the world have similarity on the discharge standard and scope of area?”

Question 2: “Was there similar case which discharged wastewater into the sea in other countries too?”

Question 3: “Do the other countries have the law adopted MARPOL 73/78 and London 96 together in the same law?”

The study procedure is as follows:

- Research the international policies effected to Korean laws,
- Compare to laws, policies related in industrial wastewater management and treatment in other countries (USA, EU, Japan),
- Research on scope and standards to apply in the law,
- Research on management system in other countries (USA, EU, Japan) and
- Case study of other countries had similar problem.

Background

The western, eastern and southern coastlines of the country are covered by many industrial complexes, especially petrochemical industry complexes caused of geographical characteristics called peninsula (Figures 1 and 2).

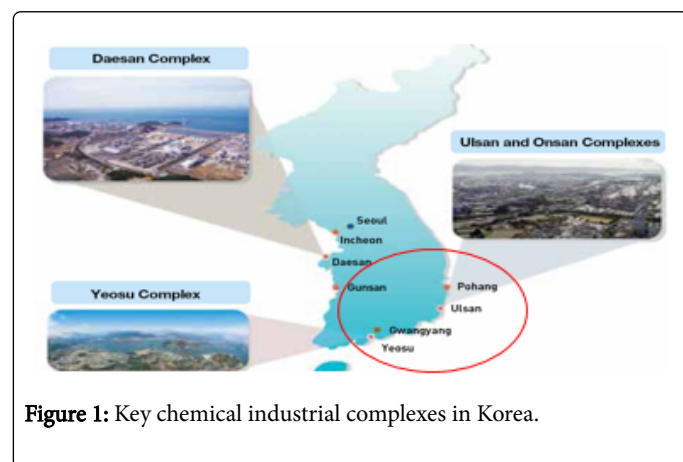


Figure 1: Key chemical industrial complexes in Korea.

Also, South Korea is a major world nuclear energy country and 4 power plants managed by MOTIE are located in east coastline. In other words, it is highly dangerous area which possible to occur chemical accident. In this reason, it is major target of environmental organizations and citizens to keep watch.

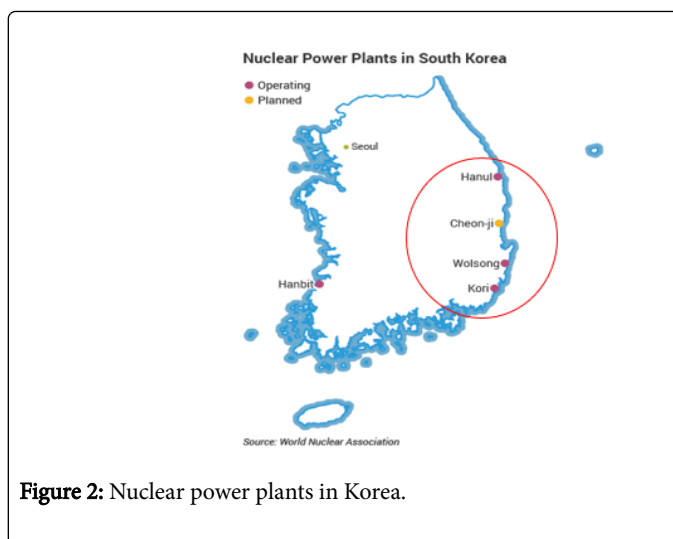


Figure 2: Nuclear power plants in Korea.



Figure 3: Power plants in Ulsan.

The power plant discharged wastewater through the hose from the cooling system into the sea directly and the citizens saw smelly burbles. They reported it to the Korea Maritime Police. PDMS was detected as a result of the analysis the collected water sample near power plant. MMAF claimed the power plant violated “Marine Environment Management Act” because PDMS is Y category substance of Noxious Liquid substances which is banned dumping into the sea in any cases by MARPOL 73/78 (Figures 3 and 4).

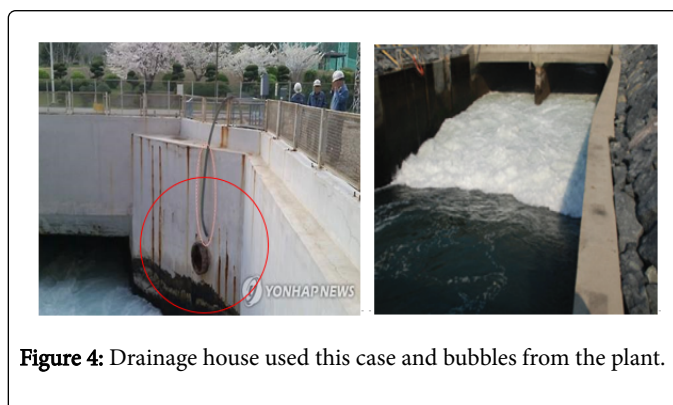


Figure 4: Drainage house used this case and bubbles from the plant.

Results and Discussion

Risk of PDMS

PDMS is a sort of polymeric organo-silicon compounds that are commonly referred to as silicones. It is the most widely used silicon-

based organic polymer and known for its unusual rheological properties. In general, it is considered to be inert, non-toxic and non-flammable. It is one of several types of silicone oil named polymerized siloxane. PDMSs are widely used in industrial, consumer, food and medicinal or pharmaceutical applications. Its range of applications is very wide from contact lenses and medical devices to elastomers, also, in shampoos, food, caulking, lubricating oils, and tiles. Almost of PDMS is expected to be removed during sewage treatment. It is immobile in soil and sediment, but will break down slowly to dimethylsilanediol, which is soluble in water and can biodegrade to carbon dioxide, water and inorganic silicate as demonstrated in the laboratory [2]. New environmental effect tests demonstrated that no adverse effects to aquatic and terrestrial organisms are anticipated from PDMS or its breakdown products, at concentrations many times higher than could possibly occur in the environment from typical applications. Laboratory and field measurements demonstrate that PDMS does not bio-accumulate [3].

Overall, there is no report to prove it is harmful for the humans or animals. According to the report published on 2012 by Special Chem “Polydimethylsiloxanes Pose No Environmental & Human Health

Risk”. PDMS has not reported a risk to the environment or to human health until now.

Review related laws and regulations

International policies:

MARPOL 73/78: MARPOL 73/78 is the most important international instrument in the prevention of pollution. The 1973 Convention addressed only the issue of operational pollution and required ballast to be carried only in clean or segregated ballast tanks. Since the lack of the number or parties, Protocol was revised in 1978 at the Conference on Tanker Safety and Pollution Prevention and it is called MARPOL 73/78 [4].

MARPOL is designed to deal with all type of intentional pollution from ships and it is made up of 6 Annexes that concern oil (Annex I), noxious liquid substances in bulk (Annex II), harmful substances carried by sea in packaged forms (Annex III), sewage (Annex IV), garbage (Annex V), and air pollution (Annex VI). For this study, it has to know the purpose of the regulations Annex II about noxious liquid substances and its categories are as shown in Table 1 [5].

Category	Noxious liquid substances
Category X	Noxious liquid substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a major hazard to either marine resources or human health. Prohibition of the discharge into the marine environment
Category Y	Noxious liquid substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a hazard to either marine resources or human health or cause harm to amenities or other legitimate uses of the sea. Limitation on the quality and quantity of the discharge into the marine environment
Category Z	Noxious liquid substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a minor hazard to either marine resources or human health. Less stringent restrictions on the quality and quantity of the discharge into the marine environment
Other substances	They are, at present, considered to present no harm to marine resources, human health, amenities or other legitimate uses of the sea when discharged into the sea from tank cleaning or deballasting operations. Not be subject to any requirements of the Annex

Table 1: Categorization and listing of noxious liquid substances and other substances. *Source: IMO, Guideline of MARPOL 73/78.

London Convention 96: The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention for short) has been in force since 1975 to protect the marine environment from human activities. The objective of this convention is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter [6]. In 1996, the "London Protocol" was agreed to further modernize the Convention and replace it. All dumping is prohibited under the protocol 1996 except for possibly acceptable wastes on the reverse list. It is reflected in "Marine Environment Management Act" in Korea and there is an article that all dumping into the ocean is prohibited. However, it is a different matter with noxious liquid substances like PDMS because of the scope of application and purpose of the law.

Korean laws and policies: The major regulations related chemical substances managed by the government department in Korea are as follows:

- "Toxic Chemicals Control Act" (ME),
- "Act on Registration, Evaluation, etc. of Chemicals" (ME),

- "Occupational Safety and Health Act" (MOL),
- "Act on the Safety Control of Hazardous Substances" (MOTIE) and
- "Marine Environment Management Act" (MMAF).

Each law above has list of hazardous substances with different standard and scope of application.

However, PDMS is not on the list and there is no discharge standard or limit to control. "Marine Environment Management Act" cannot define clearly why and how it can be illegal matter. If the MMAF is able to prove the scope of the application includes the chemical industry or power plant or PDMS is a prohibited substances of ocean dumping by the law, it was acceptable as a crime. Furthermore the companies and power plants already managed by "Water Quality and Aquatic Ecosystem Conservation Act" (ME). "Marine Environment Management Act" reflected MARPOL 73/78 plus London 96 and the scope of application is more expanded. The scope of the law includes marine facility in shoreline and according to MMAF, the companies and power plants are marine facilities too. If so, MMAF has to have a standard to evaluate such as the discharge limit, measurement method, detecting method etc. The scope of application of MARPOL 73/78 is

only limited the facilities related in ships and vessels in land such as cleaning facility, storage of hazardous substances on the list near harbor. In London 96, there is no list of hazardous substances and is not mentioned about wastewater or industrial wastewater. In this reason, the Supreme Court already judged this case as a suspension of indictment since there is no standard to prove the violation of the law. Therefore, it could not be an issue to judge whether the power plant are guilty or not. This is the reason why changed the direction of study which is to find the way to make a standard and to develop policies to protect marine environment and companies.

Comparison of industrial wastewater discharge regulations-USA, EU, Japan:

USA-“Clean Water Act”: In USA, “The Clean Water Act” covers regulating discharges of pollutants into the waters and regulating quality standards for surface waters. EPA has implemented pollution control programs under this law such as setting wastewater standards for industry. Also, EPA has set water quality standards for all contaminants in surface waters. It needs a permit to discharge any pollutant from a point source into navigable waters. EPA's National Pollutant Discharge Elimination System (NPDES) is a permit program controls discharges. Industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters, however individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit [7].

NPDES's standards for direct dischargers are incorporated permits issued by States and EPA regional offices, and permits or other control mechanisms for indirect dischargers help indirect discharger. A facility that discharges pollutants to a publicly owned treatment works (municipal sewage treatment plant). The NPDES permitting program establishes discharge limits and conditions for industrial and commercial sources with specific limitations based on the type of facility and activity generating the discharge [7].

EPA has identified 65 pollutants as ‘toxic pollutants’, of which 126 specific substances have been designated priority toxic pollutants. All other pollutants are considered to be ‘nonconventional’ but PDMS is not on the list.

Regulations for industrial wastewater discharges set technology-based numeric limitations for specific pollutants at several levels of control (BPT, BAT, BCT, NSPS, PSNS or PSES). Each of these terms is defined below. Effluent limitations are based on performance of specific technologies, but do not require use of a specific control technology (Figure 5).

Type of Sites Regulated	BPT	BCT	BAT	NSPS	PSES	PSNS
Existing Direct Dischargers	•	•	•			
New Direct Dischargers				•		
Existing Indirect Dischargers					•	
New Indirect Dischargers						•

Pollutants Regulated	BPT	BCT	BAT	NSPS	PSES	PSNS
Priority Pollutants	•		•	•	•	•
Conventional Pollutants	•	•		•		
Nonconventional Pollutants	•		•	•	•	•

Figure 5: Technology-based numeric limitations.

EU: Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the marine environment of the Community (Figure 6).

Formal reference Framework Directive 76/464/EEC (OJ L129 18.5.76) Proposed 21.10.74 – COM(74)1706 2006/11/EC (OJ L64 04.03.2006)	Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community
Legal base	Articles 115 TFEU (originally Article 100 TEC) and 352 TFEU (originally Article 235 TEC)
Binding dates Notification date	5 May 1976
As no dates are set in the Directive the Commission suggested the following deadlines in a letter dated 3 November 1976: System of authorizations Pollution reduction programmes for List II substances Programmes to be implemented	15 September 1978 15 September 1981 15 September 1986

Figure 6: Dangerous substances in water.

The Directive sets a framework for the elimination or reduction of pollution of inland, coastal and territorial waters by particularly dangerous substances. Subsequent daughter Directives set standards for particular substances. The Directive is also intended to ensure consistency in implementing various international Conventions and to reduce distortion

An Annex has Lists I and II of families and groups of dangerous substances. List I-sometimes referred to as the ‘Black List’ includes substances selected on the basis of their toxicity, persistence and bio-accumulation, such as organohalogen and organophosphorus compounds, carcinogenic substances, and mercury and cadmium compounds. List II-sometimes called the ‘Grey List’ includes possibly less dangerous substances such as zinc, copper and lead compounds, cyanide and ammonia. Member States are to take appropriate steps to

eliminate pollution by List I substances and to reduce pollution by List II substances. 'Elimination' of pollution does not necessarily mean a zero-emission since pollution is defined not by reference to the presence of a substance but to its effects. Discharges of both List I and List II substances are to be subject to prior authorization by a competent authority, but these authorizations are arrived at in different ways.

The urban waste water treatment directive and the water framework directive of 2000: The European Union has now in place three main pillars addressing nutrients in aquatic ecosystems systems building on a tradition of water protection legislation since the 1970s. The Directives on urban waste water treatment and on nitrates pollution from agricultural sources 1 from 1991 and the 'flagship' of EU water policy and legislation, the Water Framework Directive of 2000. Whilst the first two are addressing key sources of nutrients pollution at the source, waste water from municipal and industrial sources, the Water Framework Directive has expanded EU water policy to all waters and addresses all sources of impacts.

The Directive presents a breakthrough in European Water Policy regards the scope of water protection and its implementation. It has been developed by the European Commission and come forward with its legislative proposals, with the following pillars;

- All waters to be protected, groundwater and surface water including coastal water,
- All waters to achieve good quality ('good status'), as a rule by 2015,
- 'Good status' comprehensively defined for surface waters by biological, physico-chemical and hydromorphological elements, for groundwater by balance between available recharge and abstractions, and chemical elements,
- Water management based on river basins; "combined approach" of emission limit values and quality standards, plus phasing out particularly hazardous substances and
- Economic instruments underpinning environmental objectives, in particular water pricing reflecting cost recovering; mandatory participation by citizens, stakeholders and NGOs, streamlining legislation, and ensuring one coherent managerial frame.

All waters in Europe will be protected under the Water Framework Directive, surface water and ground water. In the past only a limited number of water for specific human use, such as fish water, shellfish water, bathing water are protected under European legislation. Unlike previous water legislation, the Water Framework Directive covers surface water and groundwater together, as well as estuaries and marine water. Its purpose is threefold: to prevent further deterioration; to promote sustainable water consumption based on the long-term protection of available water resources; and to contribute to the provision of a supply of water in the qualities and quantities needed for its sustainable use.

European legislation is setting ambitious objectives for the protection of our water resources across Europe.

- Binding on environmental objectives,
- Flexible on tools to achieve these objective, as well as on organization and property ownership and financing, and thus open to innovation and technological progress and
- Providing a sound basis for long-term planning at a technical, financial and political level, involving the civil society, and thus providing a living example of Good European Governance.

Japan:

Water pollution control law: The Diet in 1970 concentrated on pollution problems and passed as many as 14 pollution control laws, including the amendment of the Basic Law of Environmental Pollution Control and enactment of the Water Pollution Control Law in Japan under the influence of Minamata disease well known worldwide as one of the most significant diseases resulting from environmental pollution. In that reason, it was known for "Environmental Pollution Diet" and also designed Environmental Quality Standards (EQS) by the national government. The Environment Agency was established in 1971 to control environmental pollution (Figure 7).

The Water Pollution Control Law obligates the governor of each prefecture to monitor the pollution of river, lakes, reservoirs and coastal water areas as public water areas. Water pollution monitoring system is including the establishment of annual measurement plans and publication of measurement result [8]. It is designated effluent standards for wastewater discharged from factories and business establishments all over Japan. Furthermore, the governor has the privilege to designate even more severe effluent standards depending upon the water pollution condition of the governing area, and to supervise the factories and establishments for pollution prevention on behave of the national government. The system allows identification of pollution source by examining the water quality data of effluent from factories and establishments, which can be a pollution source, and water quality data of public water area which accepts pollutants [9,10].

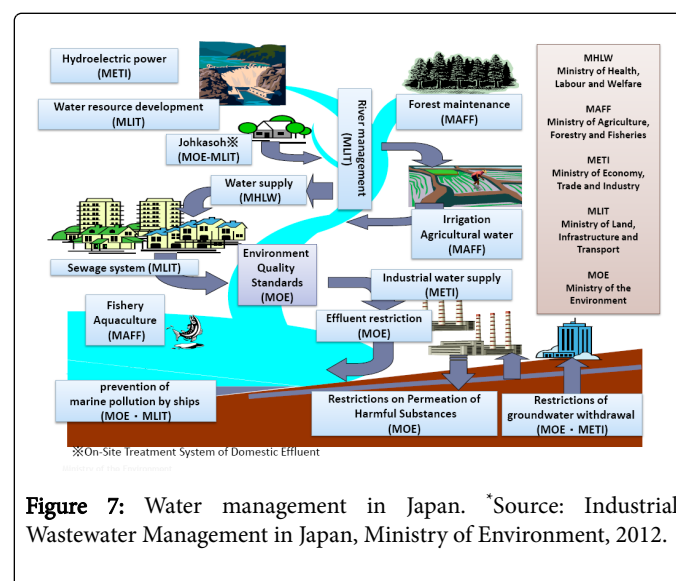


Figure 7: Water management in Japan. *Source: Industrial Wastewater Management in Japan, Ministry of Environment, 2012.

EQS and effluent standards for water: Environmental Quality Standards (EQS) is established to prevent health hazards and conserve the living environment" by the Environment Basic Law as part of the government's objectives. In order to satisfy EQS, Effluent Standards are applied on factories and establishments. An effluent standard value for a certain item is decided as 10 times as an environment quality standard for the same time in consideration of dilution effect by river water. Also, a provisional effluent standard is applied by specifying a time limit for some specific business categories that face difficulty to meet the uniform effluent standard for a specific item [11-13].

Unified National Effluent Standards (effluent standards) that applied across all industries for the specified establishments throughout the country is stipulated on that law (Water Pollution

Control Law). The control is carried out using direct penalty system by which penalties can be applied simply because of excess concentrations (Figure 8). Specifying time limit is applied for some specific business categories that face difficulty to meet the uniform effluent standard for a specific item when adding new regulation items or strengthen an effluent standard [14,15].

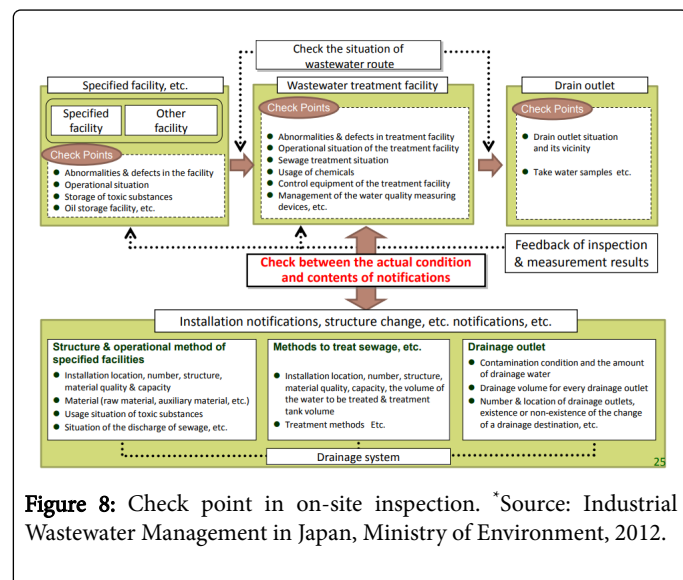


Figure 8: Check point in on-site inspection. *Source: Industrial Wastewater Management in Japan, Ministry of Environment, 2012.

Survey analysis: When the meeting was in Yeosu and Ulsan, almost of the participants did not know their facilities are in the scope of application of the law or even not to know the law. Most of the companies have own wastewater treatment system themselves as “Water Quality and Aquatic Ecosystem Conservation Act”. 4 companies are included in “Sea Area” and 6 companies are “Marine Facilities” in the scope of application. As seen the result below Table 2, there is no X category substances since they treated wastewater in their system so it can’t be in the wastewater. However, there are substances in category Y and Z. They claimed that the substances such as category Y and Z are from cleaning process by the agents and it is not possible to prevent (Figure 9).

Result of Survey		
No. of Companies	Scope of Application	
4	Sea Area	
6	Marine Facility	
Type of Discharge Substances(Noxious Liquid Substances)		
Categories	No. of substances	Name of Substances
X	-	-
Y	10	Sodium, Hydeoxide, Benzene, BG, Toluene, MMA, Methyl alcohol, Sulfuric Acid, Xylene, Styrene
Z	5	Phosphoric Acid, Acetic Acid, Hydrochloric Acid, Butadien, MTBE

Table 2: Survey analysis.



Figure 9: Industrial wastewater treatment system in Korea.

Most of the companies in Ulsan and Yeosu complexes have well equipped system to treat wastewater since they are large sized company with sufficient capital. The companies are managed by lots of specialists to deal with problems and to comply laws. Though, how about SMEs? They have no manpower and capital to establish treatment facilities for each different law's standards. One more thing that has to clear is how to manage nonpoint source pollutant. There can be nonpoint source pollutant in process of discharge from the facility to the ocean [16-18].

Conclusions

How to treat and manage nonpoint source pollution?

The term 'nonpoint source' is defined to mean any source of water pollution that does not meet the legal definition of "point source". In general, nonpoint source pollution results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. NPS pollution comes from many diffuse sources unlike pollution from industrial and sewage treatment plants. It is difficult to control since it comes from the everyday activities of various people, such as fertilizing a lawn, using a pesticide, or constructing a road or building [7].

USA has "Section319 Nonpoint Source Management Program". The term "nonpoint source" is defined to mean any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the "Clean Water Act". A management system is made because of the large number of nonpoint sources and difficulties to regulate. USA operates national NPS Monitoring Program expanding the scope of management [19-22].

Moreover, there is more specific management program named "Section6217 Coastal Nonpoint Pollution Control Program" to develop Coastal Nonpoint Pollution Control Programs. In its program, a state or territory describes how it will implement nonpoint source pollution controls, known as management measures. This program is administered jointly with the National Oceanic and Atmospheric Administration (NOAA). They provide a guidance specifying management measures for sources of nonpoint pollution in coastal waters. The guidance provides management measures that provide other tools available to address many source categories of nonpoint pollution. The tools include the protection, restoration, and

construction of wetlands, riparian areas, and vegetated treatment systems [23-25].

In Korea, in accordance with the Comprehensive Plan on Nonpoint Source Management, the national and local governments were made responsible for NPS management, and the construction of NPS mitigation facilities is mandatorily required to the large land-development activities and wastewater-discharging facilities. NPS management provisions to 27 regulations and guidelines associated with environmental impact assessments, city master plans, and forestry legislation. In addition, seven regions where NPS pollution may significantly harm the water use, residents' health and property, or natural ecosystem were designated as NPS Control Areas and various projects have been implemented to reduce the NPS pollution. There is a mission to cover all industrial area to control but it is a first step to progress [26-30].

Policy suggestion

It is important to development in areas concerning the water environment and its related fields by establishing research committees composed of members from several industries, government agencies and academic institutions. To prevent water pollution, it needs to manage and monitor the quality of discharged water. It is sure the companies and facilities in shoreline have to make efforts to protect managing water pollution levels. In order to improve policies, reasonable and effluent discharge standards determined credibility by identifying the exact pollution level.

As a conclusion of this study, here are some improvement proposals to protect the water environment including marine water environment and the companies that could not have self-wastewater treatment system as follows:

- Establish the integrated management system between government department (ME, MOTIE, MMAF) to protect both water environment and the companies,
- Provide the guideline with unified standards for the companies,
- Unify the standards of wastewater treatment and of discharge hazardous substances,
- Develop technical system to control industrial wastewater treatment and
- Find a solution how to manage Nonpoint source pollutant and apply reasonable standard for the evaluation.

To actualize the suggestions above, EQS and Effluent standards for water in Japan could be a role model and example to set the integrated management system. Also, it needs to review the Coastal Nonpoint Pollution Control Programs and NPS Monitoring program of EPA [31-34].

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