〈特集〉

Public Sewage Treatment Plants in Malaysia

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Abstract

Sewerage systems in Malaysia had been managed by Local Sanitary Boards until the independence in 1957 and then by the municipalities and the Ministry of Health in urban and rural areas, respectively, until 1993. Enactment of the Sewerage Services Act 508 in 1993 resulted in sewerage services in peninsular Malaysia being privatized with the Department of Sewerage Services（JPP）as the regulatory body. Thus, the responsibility for the services came under the Federal Government. The local authorities surrendered their assets and staff to the newly formed consortium, Indah Water Konsortium（IWK）. In 2006, the Water Services Industry（WSIA）Act 655 was enacted where both water supply and sewerage services were placed under the Federal Government. Also in 2006, the National Water Services Commission（SPAN）was established. The function of SPAN has been to provide a holistic solution to supervision and regulation of both the water supply and sewerage services. IWK, which is in charge of 9000 treatment plants these days, has been placed under the Ministry of Finance Incorporated as a national sewerage company. Despite the WISA and the SPAN Acts, Malaysia has yet to cover the whole nation in ensuring balanced development and holistic management of water and wastewater from the point of regulation.

As for the sewerage treatment systems, large and centralized regional treatment plants with secondary treatment are in operation in heavily populated urban areas. Tertiary treatment is getting greater attention with the ongoing interest on reduction in loadings to the environment due to the effluent discharge. Sewerage pipe networks, which have been already laid out over 16000 km, will eventually replace the individual septic tanks in urban areas. However, the individual septic tanks will still continue in the rural areas. Effluents from domestic sewage treatment plant are now to meet the Environmental Quality（Sewage）Regulation 2009 standards. The new standards include ammoniacal and nitrate nitrogen, and phosphorus in addition to already regulated effluent qualities including BOD, COD, SS, heavy metals and other parameters.

Keyword：KeTTHA, IWK, SPAN, WSIA, Secondary treatment, Septic tank, Effluent standards
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Introduction

Malaysia Environmental Policy, which was introduced in 2002, integrates three elements of sustainable development : economic, social and cultural development and environmental conservation. IT aims at improving quality of life through environmentally sound and sustainable development. Conservation of the nation's nature vitality and diversity is one of the main principles of thrust. Accompanying development inevitably introduce undesirable waste. Thus as in the development of human settlements, there is a demand on potable supply and the need to manage the wastewater that ensue. Proper management of domestic sewage is essential as its impact on the public health and the environment can be very damaging if neglected or poorly managed. Despite the restriction on discharges of wastes imposed by the enactment of the Environmental Quality Act 1974 together with nearly 40 regulations supporting, the water environment continue to decline and as of date over 120 river basins in Malaysia are already critically polluted. Domestic sewage has been implicated as the main source of water pollution in Malaysian rivers, apart from the industrial effluents. Development of the sewerage services in Malaysia continues to lag behind as opposed to the development of potable water supply.

Regulatory Requirements

Local Sanitary Boards were mainly responsible for sewerage services in Malaysia（then known as Malaya）prior to its independence in 1957. There after, the Municipalities and the Ministry of Health were

managing the services in urban and rural areas, respectively. Nearing the year 1994, there were already 144 individual local authorities managing the sewerage services.

In 1993 the Sewerage Services Act 508 was enacted, which resulted in sewerage services being privatized with a concession contract, with the Department of Sewerage Services (JPP) overseeing as a regulatory body. The responsibility for the services thus came under the responsibility of the Federal Government (the Ministry of Housing and Local Authorities) and the local authorities surrendered their assets and staff to a newly formed consortium, Indah Water Konsortium (IWK). Thus, there began a new era of polluters pay principle, although the charges are rather minimal ; MYR8 for houses with sewer connection and MYR6 with septic tanks. The take over of these treatment plants and the responsibility to develop new ones were limited to Peninsula Malaysia with the exception of Kelantan and the City of Johor Bahru. The state of Sabah and Sarawak in the island of Borneo were also not affected by the privatization exercise.

In 2006 the Water Services Industry (WSIA) Act 655 was enacted where both water supply and sewerage services were placed under the Federal Government. However, the Act only covers the Peninsula Malaysia and the Federal Territories and had excluded the state of Sabah and Sarawak.

Simultaneously in 2006, the National Water Services Commission (SPAN) Act 654 was enacted, which saw the establishment of the SPAN, whose function is to supervise and regulate the water supply and sewerages services and conduct enforcement. This Act is to address the deficiencies in providing a holistic solution. Apart from allowing the integration between water supply and sewerage services, the Act also addressed the ownership and control of rivers and raw water sources.

Despite the WISA Act and the SPAN Act, Malaysia has yet to cover the whole nation in ensuring balance development and holistic management of water and wastewater from the point of regulation. IWK is still operating within its jurisdiction as it was developed since the Sewerage Services Act 1993.

Historical Development

In the early years, between the 60's and 70's, Malaysia has embarked on utilizing primary processes, such as, the communal septic tanks and Imhoff tanks including individual septic tanks for the treatment of domestic sewage. Prior to these, pit and bucket latrines have been widely used and together with overhung latrines along the waterways. The bucket latrines were still in existence until as late as 1990 in the urban areas. Primary processes could only produce partially treated effluent, which thus continue polluting the water environment and thus creating public health and environmental problems. The situation is aggravated when these tanks are poorly maintained or left undesludged.

In the 70's a national sewerage development programme was launched to modernize sewerage system in urban areas, which led to 19 sewerage master plans being developed. As funds at the local authorities limited, efforts were focused on decentralization of sewerage treatment. This effort was supported by the regulatory requirements that all new developments had to incorporate sewerage systems. Secondary processes, such as, stabilization or oxidation ponds were then introduced, which later were upgraded into aerated lagoons with the increasing sewage load. Package treatment units were then introduced in the 80s and later on the introduction of small and medium sized mechanized treatment plants. The trend was towards building mechanical plants such as Extended Aeration (EA), Oxidation Ditch (OD), Rotating Biological Contactors (RBC), Sequenced Batch Reactors (SBR) and Trickling Filters (TF). These were only giving the secondary stage of treatment.

In the Klang Valley alone there are more than 500 treatment plants, and these will be reduced to more than five folds and to function as centralized regional plants. Mechanical treatment process comprises 38% of the domestic sewage treatment plants in Malaysia. Some form of standardization on the types of plants was also made with time. **Table 1** shows the distribution of the different types of domestic treatment plants and the PE served in Malaysia.

Table 1 Public Sewage Treatment Plants in Malaysia

Types of Sewage Treatment Plant as at Oct 2014	Number	Population Equivalent
Imhoff Tank	679	507,648
Oxidation Ponds	403	1,681,176
Mechanical Plants	4,902	18,665,408
Network Pump Stations	982	4,852,844
TOTAL	6,966	25,707,076
Communal Septic Tank	3,625	405,432

Source : IWK (2016)

Presently large regional treatment plants are in operation in heavily populated urban areas but mostly at only at the secondary stage. Tertiary stage treatment is getting greater attention with the ongoing interest to reduce environmental issues still associated with the effluent discharged, despite these are meeting the discharge standard imposed by the Department of Environment, Malaysia.

To date the IWK, which started as a private entity, has been placed under the Federal Government as a national sewerage company under the Ministry of Finance Incorporated. IWK is responsible to develop and maintain a modern and efficient sewage treatment system in Malaysia. Its strategy is to reduce the large number of treatment plants through regionalization of treatment facilities. Sewerage pipe networks will eventually replace the individual septic tanks in urban areas to convey sewage to secondary treatment facilities. However, the individual septic tanks will still continue in the rural areas. Nearly 16000 km of sewer pipelines have been laid. IWK is responsible to maintain the sewer lines together with nearly 9000 treatment plants.

Improvement into regional centralized plants has being planned so that the future of Malaysia's public sewerage systems would continue to improve especially in the urban areas. Such regional plants are the Jelutong and the Pantai 2 sewage treatment plant (STP). The Jelutong STP is a biological nitrogen removal (BNR) with option for biological phosphate removal in the future. It is the Malaysia's largest STP, designed for 1.2 million PE, using the sequential batch reactor process and was completed in 2007. It can cater for a maximum daily flow of 600,000 m^3/d.

Pantai 2 is the lastest of the regional centralized facility that has been partially completed. Pantai catchment covers an area of over 6700 ha, and is the largest catchment in the city of Kuala Lumpur. The original centralized Pantai facility, comprising stabilization ponds covering an area of 17 ha, was completed in 1958 and to serve ultimately 527000 PE. This Pantai treatment plant was later upgraded to Aerated Lagoon in 1984, which saw increment of average dry weather flow from 23653 m^3/d to 72730 m^3/d, nearly three times the original flow. Mechanised Sewage Treatment Plants were then added to complement the Aerated Lagoons at this centralized facility giving a capacity of 877000 PE, but this centralized facility later having to serve 1.18 million PE, and thus hugely overloaded.

The Pantai 2 STP, with biological nitrogen and phosphorous removal capacity, is now in operation serving 700000 PE since early 2016 and expected to serve an ultimate capacity of 1,423 million PE upon full completion. The facility is to meet Standard A of the domestic sewage effluent discharge standard. The fully underground "eco-friendly" Pantai 2 facility is expected to have sports, recreation and community facilities above the ground level. Pantai 2 has been developed to embrace green technology, such as incorporating biogas generation for generating electricity, and for effluent reuse at industry. Mesophilic anaerobic digestion is used for the biogas generation. The 320000 m^3/d produced treated wastewater from Pantai 2 is also used for cooling.

The Langat STP with similar processes will be following suit after the Pantai 2 STP, and is expected to be completed in 2018.

Standards and Regulations

Effluents from domestic sewage treatment plant continue to be discharged into water bodies in Malaysia and having to meet the Environmental Quality (Sewage) Regulation 2009 (Anon, 2009b). **Table 2** shows the discharge standards based on the Regulation 2009. This Regulation 2009 replaces the Environmental Quality (Sewage and Industrial Effluents) Regulation 1979 (Anon, 1979). The 1979 Regulation had included many other parameters ; Mercury, Cadmium, Chromium (Hexavalent and Trivalent), Arsenic, Cyanide, Lead, Copper, Manganese, Nickel, Tin, Boron, Iron, Phenol, Free Chlorine and Sulphide. These parameters together with an expanded number of parameters were introduced in the Environmental Quality (Industrial Effluents) Regulation 2009 (Anon, 2009a). New parameters included in the 2009 Regulation on sewage dischare that were added are ammoniacal nitrogen, nitrate and phosphorous. The Regulation specifies discharges into inland waters within catchment areas listed in the Schedule 3 of the Regulation shall be of Standard A, while into other inland water bodies the Standard B applies. Discharges upstream of potable water intake shall meet Standard A.

Discharges from existing treatment systems that was approved prior to the implementation of the Guidelines for Developers : Sewerage Treatment Vol IV, as enforced by the Department of Sewerage Ser-

Table 2 Effluent discharged standards, A and B, for new sewage treatment system, as set by the Environmental Quality (Sewage) Regulation 2009 (Anon, 2009b), as provided by Environmental Quality Act 127 (Anon, 1974)

Parameter		Standards	
		A	B
Temperature	(℃)	40	40
pH Value	—	6.0–9.0	5.5–9.0
BOD5 at 20℃	(mg/l)	20	50
COD	(mg/l)	120	200
Suspended Solids	(mg/l)	50	100
Oil and Grease	(mg/l)	5.0	5.0
Ammoniacal Nitrogen	(enclosed water body)	5.0	5.0
Ammoniacal Nitrogen	(river)	10.0	20.0
Nitrate — Nitrogen	(river)	20.0	50.0
Nitrate — Nitrogen	(enclosed water body)	10.0	10.0
Phosphorous	(enclosed water body)	5.0	10.0

vices of the Ministry of Housing and Local Government, in January 1999 are specified in **Table 3**. Those treatment plants that were built between 1999 and the enforcement of the 2009 Regulation are allowed to discharge effluent quality as in **Table 4**. The limits set under both standards, A and B are more generous. However, these plants will cease operation as regional centralization of sewage treatment system is adopted. The licensing fees for the discharging effluents are based on the pollutant total load, comprising ; BOD at 20℃, Oil and Grease, and Ammoniacal Nitrogen.

Table 4 Sewage treatment plants (built between 1999 and 2009) effluent discharge standards, A and B

Parameter	Unit	Standard	
		A	B
BOD at 20℃	mg/l	20	50
COD	mg/l	120	200
Suspended Solids	mg/l	50	100
Oil and Grease	mg/l	20	20
Ammoniacal Nitrogen	mg/l	50	50

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Table 3 Standards A and B for facilities before the enforcement of the Guidelines for Developers : Sewerage Treatment Vol IV (DSS, 1999)

Parameter	Type of Sewage Treatment Systems										
		Communal Septic Tank		Imhoff Tank		Aerated Lagoon		Oxidation Pond		Mechanical System	
	Unit	A	B	A	B	A	B	A	B	A	B
BOD at 20℃	mg/l	200	200	175	175	100	100	120	120	60	60
COD	mg/l	—	—	—	—	300	300	360	360	180	240
Suspended Solids	mg/l	180	180	150	150	120	120	150	150	100	120
Oil and Grease	mg/l	—	—	—	—	—	—	—	—	20	20
Ammoniacal Nitrogen	mg/l	—	—	100	100	80	80	70	70	60	60

マレーシアの公共下水処理施設

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独立以前のマレーシアにおける下水道事業の管理は地域衛生会議の管轄であったが，1957 年の独立後は，都市部は自治体，地方部は保健省（Minstry of Health）の管轄となり，この体制は 1993 年まで続いた。しかし，1993 年に下水道サービス法が施行され，半島マレーシアの下水道は民営化され，下水道事業局の管下に置かれた。したがって，この年をもってマレーシアの下水道事業は連邦政府の管理下に置かれたことになる。地方の各当局はそれぞれの資産や人員を，新たに設立された IWK（Indah Water Konsortium）に供出し，事業の移転を行った。その後，2006 年に水事業産業法（WISA）が施行され，水道事業と下水道事業の両者が連邦政府の管轄下に置かれた。同年には，水道事業と下水道事業の両者の統合的管理と規制を担当する全国水事業委員会（SPAN）も設立された。現在 9000ヶ所もの処理場を管理する IWK は，全国下水道会社（公立）として財務法人省（現，財務省）の管轄のもとに事業を運営している。しかし，WISA 法や SPAN が成立したにも係わらず，マレーシア全土を網羅する統合的な水道・下水道事業管理体制の構築はまだ途上である。

下水処理システムについては，人口が集中している大都市部においては大規模な広域集中型の二次処理施設が稼働している。また，下水処理場放流水の環境負荷軽減の観点から，三次処理への関心が高まっている。すでに総延長 16,000 km に及ぶ下水道網は，将来的には都市部の戸別浄化槽（Septic Tank）をすべて置き換える予定である。しかし，地方部においては戸別浄化槽の利用は継続される。下水処理場放流水は，2009 年に制定された環境水質基準（下水放流水質基準）を満たさなければならない。この新らしい放流水質基準では，BOD, COD, SS, 重金属その他の従来の水質項目に加え，アンモニア態チッ素ならびに硝酸態チッ素が規制の対象となっている。

キーワード：エネルギー・環境技術・水省（KeTTHA），美しい水共同事業体（IWK），全国水事業委員会（SPAN），水事業産業法（WISA），下水二次処理，戸別浄化槽，下水放流水質基準