RESEARCH REPORT

Operational problems of wastewater treatment plants in Thailand and case study: wastewater pollution problems in Songkhla Lake Basin

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Abstract

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By surveying 63 central municipal wastewater treatment plants throughout Thailand, it was found that about 80 percent of them did not function as expected (Pollution Control Department, 2004). Most of the problems were inadequate performance and operational problems. Concerning the Songkhla Lake Basin, there are 2 central municipal wastewater treatment plants serving only 7 percent of the basin population. These two plants were not designed for nutrient removal which is similar to most industrial wastewater treatment plants in southern Thailand. The untreated nutrients have caused eutrophication problems in Songkhla Lake. In addition, the existing activated sludge processes which treat industrial wastewaters are facing problems of bulking and rising sludge resulting in inadequate treatment. The major reason for the bulking sludge problem was most likely an insufficient oxygen concentration. Aeration control system is urgently required.

Key words : operational problems, Songkhla Lake Basin, wastewater treatment

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บทคัดย่อ

พนาลี ชีวกิดาการ

ปัญหาในทางปฏิบัติของระบบบำบัดน้ำเสียในประเทศไทย และกรณีศึกษา - ปัญหามลพิษทางน้ำเสียในลุ่มน้ำทะเลสาบสงขลา

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จากการสำรวจโรงบำบัดน้ำเสีย 63 แห่งทั่วประเทศไทย พบว่า ประมาณ 80% ของโรงบำบัดทั้งหมดไม่สามารถที่จะทำหน้าที่ได้อย่างที่กำหนดไว้ ปัญหาส่วนใหญ่เกิดจากประสิทธิภาพของระบบบำบัดที่ไม่เหมาะสม และปัญหาในทางปฏิบัติ จากการพิจารณาพื้นที่ลุ่มน้ำทะเลสาบสงขลา พบว่า มีโรงบำบัดน้ำเสียชุมชนเพียง 2 แห่ง และรองรับเพียง 7% ของประชากรทั้งลุ่มน้ำ อีกทั้งโรงบำบัดทั้งสองยังไม่ได้ถูกออกแบบให้บำบัดธาตุอาหาร เช่นเดียวกับโรงบำบัดน้ำเสียอุตสาหกรรมส่วนใหญ่ในภาคใต้ของประเทศไทย ธาตุอาหารที่ไม่ได้ถูกบำบัดนี้ ก่อให้เกิดปัญหาสภาวะอาหารมากเกิน (eutrophication) ในทะเลสาบสงขลา นอกจากนั้น ระบบบำบัดแบบตะกอนเร่งสำหรับโรงงานอุตสาหกรรมที่มีอยู่กำลังประสบปัญหาตะกอนลอยและตะกอนยกตัว ซึ่งทำให้เกิดปัญหาในการบำบัด เหตุผลหลักเกิดจากการความเข้มข้นของออกซิเจนที่ไม่เหมาะสม ระบบควบคุมการเติมอากาศจึงจำเป็นสำหรับระบบดังกล่าว

คณะการจัดการสิ่งแวดล้อม มหาวิทยาลัยสงขลานครินทร์ อำเภอหาดใหญ่ จังหวัดสงขลา 90112

Domestic wastewater treatment technology - Pollution Control Department (2004) reported that there are 68 constructed municipal wastewater treatment plants and collection systems and 16 plants are under construction in Thailand. They are distributed throughout the country. Several technologies are applied at these treatment plants from stabilization to an activated sludge process. Figure 1 shows the percentage of each technology used. The different systems used in Thailand are selected depending on land requirements, construction, and operation and maintenance costs.

However, by surveying 63 of the 68 completed central municipal wastewater treatment plants and collection systems throughout Thailand, it was found that only 13 plants were in good and satisfactory condition. Thirty-nine plants were in fair condition and 11 were in poor condition. These need refurbishment of the equipment and a major overhaul.

Main problems in wastewater facilities in Thailand

Unfortunately, about 80 % of the municipal wastewater treatment plants in Thailand do not function as expected. Despite the many billions of baht invested, the intended capacity of municipal wastewater treatment for the country was not achieved.

After consideration, the four current issues of domestic wastewater management in Thailand can be summarized as follows:

In-appropriate performance: The existing treatment plants are often oversized and unnecessarily advanced compared to the inflow because of the over design from engineering aspects and an incomplete collection system. Consequently, the actual inflows to central treatment plants are lower than were estimated.

Furthermore, most treatment plants are principally concerned with carbon and solids removal (in terms of BOD_5 and suspended solids), following The Notification from the Ministry of Science, Technology and the Environment issued under the Enhancement and Conservation of the National Environmental Quality Act, B.E.2535 (Royal Government Gazette, 1992). Only total Kjedahl nitrogen (TKN) is controlled. There is no Thai standard for total nitrogen or for nitrate-nitrogen. Most treatment plants are operated as biological treatment process for carbon and suspended solids removal. A treatment plant is

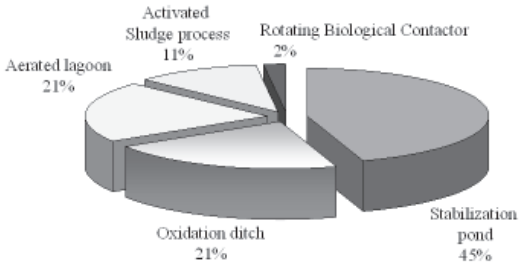

Figure 1. Municipal wastewater treatment plants in Thailand and types of existing technology (Pollution Control Department, 2004)

very rarely equipped with a nitrogen removal unit. For these reasons, the nitrogen concentrations from the wastewater treatment plants have not been regularly measured, nor considered a matter of concern to engineers and operators. Nitrate-nitrogen in effluent discharged to natural water resources is the main cause of eutrophication problems in the environment.

Low BOD_5 influence: Two main reasons lead to this phenomenon. Originally, domestic wastewater from each household was separated into grey and black wastewater. Black wastewater (from a toilet) flowed to septic tanks and the overflow to a sewer or seeped into the soil, as controlled by the municipal law. Grey wastewater was discharged to sewers without treatment. High retention time in a septic tank (onsite treatment) makes BOD_5 concentration discharged to the sewage system lower than expected.

Furthermore, most of the sewage systems in Thailand use the open channel system which was presented before a central treatment system was installed. Therefore, it is a combination sewage system (between rain water and wastewater). For this reason, the influent BOD_5 level is lower than the level considered in design BOD_5 (200 mg/L). The surveys show that influent BOD_5 concentrations are usually lower than 100 mg/L.

Lack of skilled operator: After construction, central municipal wastewater treatment plants are operated by local administrative organizations. However, these are not always able to operate and maintain technical services. Few local technicians are skilled in operating the plants. They cannot cope well with the engineering and scientific problems. Therefore, the municipality or local administrative offices need to make additional contracts with consulting companies. A weak point is that the prominent consulting companies, which always get the contracts, are located in Bangkok. They often send their engineers once a month to take care of plants, just to meet the criteria of the contracts.

Lack of budget for operation and maintenance: Financial and technical difficulties in operation and maintenance of mechanical installations in pumping stations and treatment plants are important problems. In Thailand, budgets for constructions are funded from government agencies, but the budget for O&M has to be financed from the municipality's budget, and not from the central government. The local municipalities need to provide their own funds for O&M, which include personnel salaries, energy, chemical, and annual maintenance costs.

The Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992) promulgated that the local authority of the government agency responsible for the operation of the public wastewater treatment plant shall have the power and duty to collect service fees, penalties, and claim for damages. The service fees shall be used as expenditures for operation and maintenance of the central wastewater treatment plant. However, at present, there are many obstacles to

user charges enforcement. Lack of understanding for the need of the levy by the user is the major obstacle. In addition, the local politicians are afraid to lose votes by making unpopular decisions. Even the fees charged for treating are very low, for example: 2-3 baht/m^3 for domestic wastewater.

Case study: wastewater pollution problems in Songkhla Lake Basin

Songkhla Lake Basin (SLB) lies within the 3 provinces of Phattalung, Songkhla, and Nakhon Si Thammarat. The basin covers approximately 8,754 sq.km consisting of approximately 7,712 sq.km. of land area and approximately 1,042 sq.km of the lake area. SLB is the only basin in Thailand which receives fresh water from precipitation, canals, and overland flow, draining into the lake. This water mixes with saline water from the sea, and makes Songkhla Lake a large lagoon system (Ratanachai, 2005).

Ratanachai (2005) concluded that the two major reasons for water quality problems in SLB are:

1. Insufficient wastewater treatment facilities:

There are only two central wastewater treatment plants in SLB: one in Hat Yai City Municipality and another in Songkhla City Municipality. The service area, however, does not cover the total land area of both municipalities. Only about 100,000 inhabitants, or 7% of the basin population, are currently being serviced by the existing facilities. Moreover, the wastewater treatment systems were designed to treat organic matters in terms of BOD and suspended solids. There is no nutrient treatment facility which is a crucial factor in eutrophication remedy.

2. Wastewater pollution problems: Major wastewater pollution sources comprise:

(i) domestic wastewater sources which discharges approximately 100,000 cubic meters per day, containing approximately 17,000 kg BOD_5 per day, most of which is generated from large communities, especially Hat Yai and Songkhla;

(ii) industrial wastewater sources most of which lie along main highways have a total BOD_5 of approximately 3,000 kg per day;

(iii) wastewater from swine farms which has total BOD_5 of approximately 1,200 kg per day; and

(iv) wastewater from shrimp farms which fluctuates widely, and has total BOD_5 (considering only the portion which is discharged into Songkhla Lake) in the range of 13,600-19,000 kg/day. Apart from simple organic waste (BOD_5), these wastewaters also discharge nutrients (nitrogen and phosphorus), which contribute to the eutrophication problem.

At present, there is no standard to control effluent from shrimp farms. Therefore, appropriate wastewater treatment plants are rarely found applied to shrimp farms. Reduction of discharge nutrients, from aquaculture activities into the lake, is urgently required.

Hat Yai municipal wastewater treatment plant (HMWTP) was designed as stabilization ponds in series with constructed wetland as post-treatment. Their capacity is 138,000 m^3/d and area requirement is 2,040 rai (1 rai = 1600 m^2). They were designed for using a natural treatment system without high technology and mechanics to save energy.

However, in 2003, the HMWTP was faced with a serious problem. The effluent from the treatment plant contained high suspended solids concentrations of up to 75 mg/L (Regional Environmental Office 16, 2003). There was an eutrophication problem in the natural waters where the effluent from HMWTP was discharged. Its appearance was greenish. The survival rate of some aquatic animals living in the nearby canal was reduced.

After investigation, it was found that the problem was mainly caused by the failure of the constructed wetland. The nitrogen concentrations in influent were not removed in the pond system, nor in the constructed wetland. The main reason for the malfunction in the wetland was that the operator did not uproot the dead plants.

Hat Yai city municipality promulgated the regulation in 2002 for forcing people to pay for

their wastewater treatment. Currently, the municipality is trying to find an appropriate means of implementing the user fees (Simachaya, 2004).

Songkhla central wastewater treatment plant (SCWTP) was constructed and operates for treating municipal wastewater collected from Songkhla city and other small nearby towns. The plant has a pond system. Influent is divided into 3 treatment lines (shown in Figure 2). Each line consists of an oxidation pond, aerated lagoon, and polishing pond, in that order. Their capacity was designed for treating 21,900 m^3/d domestic wastewater (for designed BOD_5 of 170 mg/L). However, due to the incomplete collection pipe system in Songkhla city, the amounts of wastewater collected are less than the estimated values. The influent fed to the plant is normally less than 5,000 m3/d. Therefore, only the middle line is operational.

Similar to other central wastewater treatment plants, BOD_5 concentration fed to the SCWTP is very low. Table 1 shows that BOD influent was about 40 mg/L, instead of the targeted 170 mg/L.

After consideration, it was found that the treatment plant could remove BOD_5 and SS with low efficiency. The removal capacities for BOD_5 and SS were 59 and 32 percent, respectively. In comparison, the average DO concentration for August 2003 in the operating aerated lagoon was at 4.9 mg/L, while a level of 9.9 mg/L was found in the polishing pond. This phenomenon could be due to algal bloom in the polishing pond.

Due to the high levels of DO values found in the second and third ponds, the consulting company decided to shut down the aerators in the aerated lagoon. The SCWTP presently operates as a natural treatment system (by personal surveying in January 2005). Shutting down of unnecessary aerators is good for energy saving. However, the operator left all aerators standing in the lagoon which would cause the aerators to later malfunction.

There are unwanted plants in the final polishing pond, as shown in Figure 3. The sediment from dead algae and unwanted plants cause siltation of the polishing pond. Low capacity utilization and the low level of maintenance are the main problems in this treatment plant.

Wastewater treatment plants in industrial sector: Industrial wastewater problem trends to be increasingly severe, especially in the areas around U-tapao canal (in Hat Yai city). Seventy-four medium and large-scale industries are in these area of which 26 of them discharge treated wastewater into the canals and 48 of them have no retention ponds for treatment prior to discharging raw sewage. Remedial efficiency and 26 factories is between 70-99%. About 500 kg BOD_5 loading is added per day into U-tapao canal. In addition, some factories shut down their treatment facilities in certain periods such as during night time (Ratanachai, 2005).

Rubber processing is the main industry in SLB. This wastewater contains huge quantities of organic carbon and sulfate that leads to bad odor when factories do not use an appropriate treatment, in the absence of oxygen. Most para rubber factories in Songkhla province have been forced to use activated sludge process or aerated lagoon to prevent the bad smell from the anaerobic condition. However, due to the peak energy demand charges,

Table 1. Wastewater characteristics in Songkhla central wastewater treatment plant (Average values in August 2003, for TKN - for only one sample)

Influent			Effluent(After Chlorination)		
BOD [mg/L]	SS [mg/L]	TKN [mg/L]	BOD [mg/L]	SS [mg/L]	TKN [mg/L]
39.2	41.5	14.2	16.1	28.2	7.7

Figure 2. Songkhla central wastewater treatment plant

Figure 3. Unwanted plants in the final polishing pond, non-operating

most of them avoid the use of aerators during peak time. For this reason, sulfate converts to hydrogen sulfide causing a foul smell to the factory neighborhoods.

Chevakidagarn and Ratanachai (2004) surveyed two para rubber treatment plants, which are single-stage activated sludge process in Songkhla province. They reported that the suspended solids removal capacities were low (from 78 to 87 percent). The treatment plants often had bulking and rising sludge problems. The major reason for this inadequate treatment was likely the insufficient oxygen concentrations. Normally, DO concentration fluctuates as a result of changing organic loads in the influent, and at times there is likely to be insufficient oxygen present to oxidize organic carbon and nutrients. This phenomenon was confirmed by the survey from Dendara *et al*. (2005). Seventeen wastewater treatments from para rubber and seafood industries in southern Thailand were investigated. The results showed that there were several kinds of filamentous bacteria found in those treatment plants with different rates of abundance.

From the findings of the mentioned researchers' survey, it is recommended that an appropriate oxygen control system be included in the existing conventional activated sludge waste treatment system for the para rubber industry to ensure sufficient oxygen is provided. This will assist in compliance with the effluent standards.

In 2004, Department of Industrial Works (DIW), Ministry of Industry announced a new law for factories generating more than 10,000 m^3/day wastewater. They were required to connect the online monitoring analyzer for BOD_5 or COD. This system is to be used as an early warning system for both government and public sectors.

Conclusion

At present, most municipal wastewater treatment plants in Thailand have low performances. The main reasons for plant failure are:

1. Inadequate influent loading fed to treatment plants
2. Inadequate budget for operation and maintenance.
3. Low capacity building.

The central wastewater treatment plants in Songkhla Lake Basin, as well as others, have low performance for the same reasons. Wastewater treatment plants in the industrial sector also lack the control system. The operating conditions are different from designed values.

The recommendation from this study is to increase the level of plant utilization and enforce laws for user charges for wastewater treatment. Each local municipality and industrial plant should prepare the plan for controlling their operational problems of wastewater treatment plant.

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