EVALUATION OF EFFLUENT WATER QUALITY SURROUNDING SRI GADING INDUSTRIAL ZONE

BATU PAHAT JOHOR

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Abstract

A study was conducted in the year 2001 and 2005 to determine the extent of pollution in the Sri Gading Industrial Area in Batu Pahat, Johor. It was found that some owners of the industrial premises had discharged effluent with BOD, COD and SS more than the allowable discharge standards stipulated in the Environmental Quality Act 1974. It was found that six monitoring stations out of ten had values of BOD exceeded 100 mg/L which were 172, 152, 120, 174, 168 and 174 mg/L at stations 1, 3, 4, 5, 7 and 10, respectively. The studies were repeated in 2005 by taking samples at the same stations. The BOD concentrations measured in 2005 for the same stations were 80, 71, 16, 86, 430 and 95 mg/L, respectively. Every station showed improvement except station 7. The allowable BOD discharge limits were 20 and 50 mg/L for class A and B, respectively. In 2005, the effluent quality of 8 stations had improved compared to the quality measured in 2001. Only two stations indicated worsen discharged effluent quality. As for SS, the studies showed that there were improvements in all stations monitored. Highest value of SS of 536 mg/L at station 7 recorded in 2001 had actually improved to 38 mg/L in 2005. The water quality index (WQI) in the drainage channels surrounding the industrial area was found be 42.5 which indicated the water in channels were still polluted.

Keywords: BOD, COD, SS, WQI

1.0 Introduction

Water is an element of life. Without it, life as we know, would not exist. Currently, about 1 billion people around the world routinely drink unhealthy water. Hardly surprising, since in the developing world, 90% of all wastewater still goes untreated into local rivers and streams. Some 50 countries, with roughly a third of the world's population, also suffer from medium or high water stress, and 17 of these extract more water annually than is recharged through their natural water cycles.

Most of the water used or affected by human activities can be classified as fresh water because the concentration of dissolved constituent is low. Water use is generally known as municipal water and divided into categories such as domestic, commercial and industrial, public service and unaccounted system losses and leakage.

Modern industrial, household and agricultural activities have produced a tremendous amount of wastes and by-products that are eventually discharged into such bodies of water such as rivers, lakes and streams (Eckenfelder, 2000). Wastes from manufacturing activities are commonly disposed of in the rivers, mainly because this method is usually the least costly waste management option. These had resulted in rivers being polluted to the extent that no life can exist in the water (Peavy et al., 1986). The water was fouled, smelly and murky. The Department of Environment, Malaysia has found that approximately 40% of the nation's surveyed lakes, rivers, and estuaries were too polluted for such basic uses as water supply, fishing and swimming. The pollutants include grit, asbestos, phosphates and nitrates, mercury, lead, caustic soda and other sodium compounds, sulfur and sulfuric acid, oils, and petrochemicals. In addition, numerous manufacturing plants discharged undiluted corrosives, poisons, and other noxious byproducts. The construction industry discharges slurries of gypsum, cement, abrasives, metals, and poisonous solvents (JAS, 1997; 2002). Something must be done to overcome this problem.

1.1 Characteristic of Water Quality

Water is a universal solvent because water normally dissolved a lot of solids. Most natural waters are clear. Tannins and other organic materials from decaying plants, brackish waters, and swamps often color them. Analysis used in the physical impurities in water and wastewaters are turbidity, suspended solids, colors, temperature and odours. Chemical measures of water quality include analysis for the presence of specific ions such as calcium, magnesium, and lead. The biological characteristics of water, related primarily to the resident aquatic population of microorganisms, impact directly on water quality.

1.2 Water Pollution

The level of municipal sewage treatment and the fraction of the population served by these facilities have risen sharply. Municipal sewage from raw sewage, industrial wastes, urban streets and runoff from agricultural lands has proven to be much difficult to regulate and control resulting in surface water quality. Pollutants reach water bodies from both point and non-point sources.

1.3 Types of Water Pollutants

The main types of water pollutants are physical pollutant such as suspended solids or solids wastes, nutrients in chemical such as nitrogen, phosphorus, carbon, sulfur, calcium, potassium, iron and cobalt that are essential to the growth of living things. Other water pollutants are micro-organisms such as pathogens in the form of bacteria, virus, and protozoa and chemical heavy metals such as mercury, arsenic, cadmium and lead which are very toxic to humans.

1.4 Impact of The Water Pollution

From the standpoint of usage, the quantity of water ingested by humans is very small compared with the quantity used in agriculture and industrial processes. If the water ingested by humans is not safe to consume, serious health problems and possibly death can result.

The impacts of polluting activities are widespread and they affect the public health, economy and especially the environment (Viessman et al., 1998). The direct impact of pollution to water is the decrease in oxygen content (DO), thus increase in BOD and other physical impacts such as turbidity and solids.

2.0 Problem Statements

Water pollution originated from industrial activities is not only causing negative impact to the water quality and aquatic life but also indirectly ruining the economical growth of the country. It is because water is a resource of all economic activities. Wastewater discharged by industries is often not treated properly and thus contribute to environmental pollution. Rivers and other water bodies are rendered useless by these unwanted discharges.

Therefore studies were carried out to determine the extent of environmental pollution originating from industrial activities. The Sri Gading Industrial Area (location as shown in Attachment 1) in Batu Pahat has been chosen as the study area. Field data and water samples were taken from pre-determined stations (location of stations as shown in Attachment 2) in the industrial area to monitor and establish the water quality index (WQI) of the drainage system within the industrial area.

3.0 Objectives of Study

Generally, the main objectives of this research are to determine the effluent quality discharged from various industries in Sri Gading Industrial zone as well as to establish the water pollution inventory in Sri Gading Industrial Zone and Water Quality Index (WQI).

4.0 Methodology

The study was conducted in 2001 and 2005 over 8 weeks period by measuring in-situ data as well as taking samples at pre-determined stations in the Sri Gading Industrial area. A total of 10 stations were chosen. Samples were taken from the stations during different weather conditions including wet and dry weather periods. All samples were kept in a box which was maintained at temperature of 4°C. This would help to slow the chemical reaction and decrease the microbial activities for a while (Hassan, 1988).

During sampling, 10 bottles had been prepared for the samples. Samples were taken on 22 July 2005, 28 July 2005, 5 August 2005, 12 August 2005, 19 August 2005, 9 September 2005, 15 September 2005 and 23 September 2005.

In-situ measurements were also made at selected stations using Water Quality Checker, Horiba model. Parameters measured were pH, temperature, DO, conductivity, salinity, total dissolved solids and turbidity.

Water samples were analyzed in the Environmental Engineering Laboratory, Faculty of Civil and Environmental Engineering, UTHM BOD, COD and SS. The BOD tests were carried out by means of the ordinary BOD bottles over 5 days incubated at 20°C. COD were measured by means of DR 4000 Spectrophotometer using low range COD vials preheated on a COD reactor for two hours. The suspended solids were determined by normal suspended solids apparatus which consists of vacuumed conical flask with appropriate filter fabric attached to the base of container fixed at the top of the conical flask. The filter fabric was pre-weighted before used. After filtration, the filter fabric was dried in an oven at 105°C and weighted again to determine the weight of the suspended solids (Sawyer, 2003).

5.0 Results and Data Analysis

The results from in-situ and laboratory tests for BOD, SS, COD, DO, and pH are shown in Figure 1 to Figure 5. The average values of the main parameters were shown.

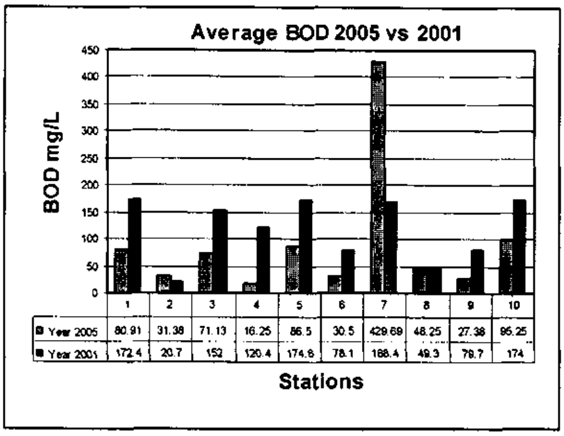

Figure 1: Average BOD for 10 Stations

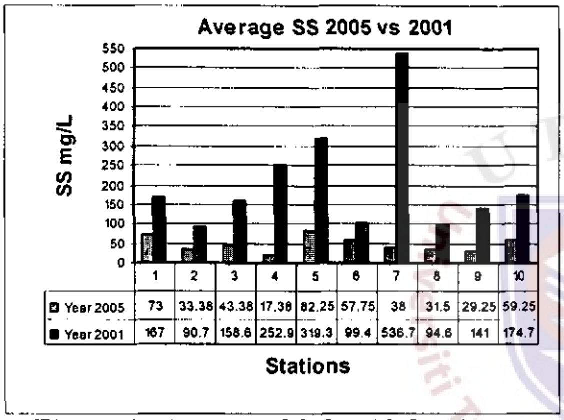

Figure 2: Average SS for 10 Stations

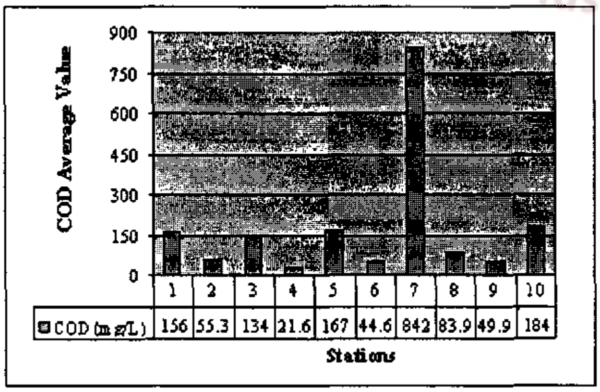

Figure 3: Average COD for 10 Stations in 2005

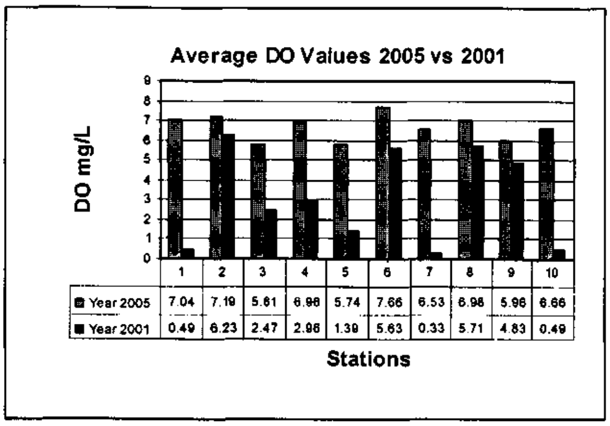

Figure 4: Average DO For 10 Stations

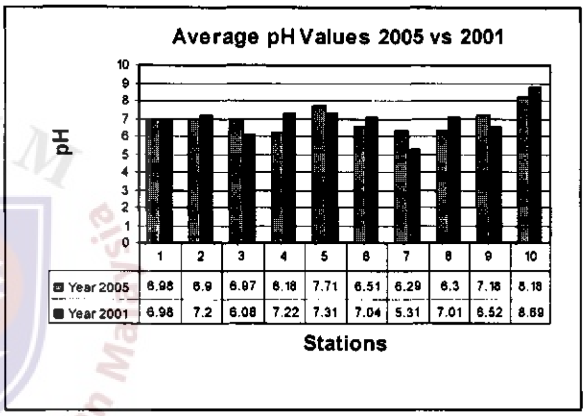

Figure 5: pH Average Values For 10 Stations

It was found from the results that there were improvements with regard to the effluent quality discharged. Figure 1 showed some decrease in BOD values between 2005 and 2001 except for station 7. Suspended solids values have also declined compared to 2001 as shown in Figure 2. Figure 3 shows the COD values which were not monitored in 2001. However it was observed that most of the values exceeded the allowable discharge level of 50 mg/L for Standard A discharge limit. As for dissolve oxygen, the level had increased in 2005 compared to 2001. This phenomenon supported the improvement in BOD and SS values mentioned earlier. The improvement can be attributed to the improved processes within the industrial premises with regard to their wastewater treatment facilities. This was due to the implementation of ISO 14000 in some of the industries themselves. ISO 14000 is a series of international standards on environmental management. It provides a framework for the development of an environmental management system and the supporting audit program (Letterman, 2000). The main thrust for the development of ISO 14000 came as a result of the Rio Summit on the Environment held in 1992.

5.1 Water Quality Index (WQI)

Based from the parameters measured, the values for WQI are calculated using this equation;

$$WQI\,(\%) = (0.22*SIDO) + (0.19*SIBOD) + (0.16*SICOD) + (0.15*SIAN) + (0.12*SIpH) + (0.16*SISS)$$

Where;

$$SIDO = -0.395 + 0.030x^2 - 0.000198x^3$$
$$SIBOD = 108*e^{-0.055x} - 0.1x$$
$$SICOD = (103*e^{-0.0157x}) - 0.04x$$
$$SIpH = -181 + 82.4x - 6.05x^2$$
$$SISS = 97.5*e^{-0.00676x} + 0.05x$$

x = *average value of parameters considered*

(Source : Binnie, Hooi dan Syed Muhammad, 1990)

Table 1: Sample Results at Station 1

Date	Parameter				
	DO	BOD	COD	pH	SS
22/7/05	7.0	72.3	148	8.42	52
28/7/05	6.8	110.0	240	6.14	128
5/8/05	7.8	73.0	136	6.99	93
12/8/05	7.8	76.0	127	6.57	22
19/8/05	6.4	94.0	180	6.88	88
9/9/05	7.4	71.0	144	6.94	82
15/9/05	6.9	72.0	141	6.89	62
23/9/05	6.2	79.0	134	7.04	57

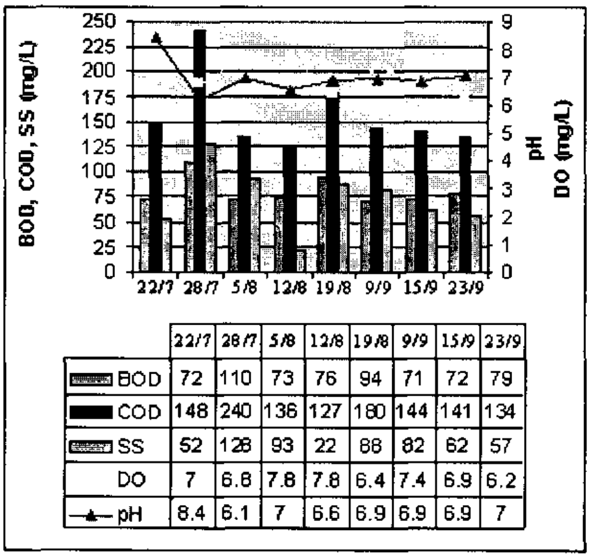

Figure 6: Graph on the Result at Station 1 during sampling days

From the sub-index (SI) calculations for every sampling day, Table 2 shows the average for the WQI value at Station 1.

Table 2: WQI Average Values at Station 1

Date	WQI (%)	
	Value	Class
22/7/05	42.56	IV
28/7/05	37.04	IV
5/8/05	43.05	IV
12/8/05	47.83	III
19/8/05	39.48	IV
9/9/05	43.42	IV
15/9/05	43.84	IV
23/9/05	42.40	IV
Average WQI	42.46	IV

From the data in Table 2, station 1 was categorized as class IV (42.46%) and considered as polluted. Figure 7 shows the WQI average at station 1 during the sampling days.

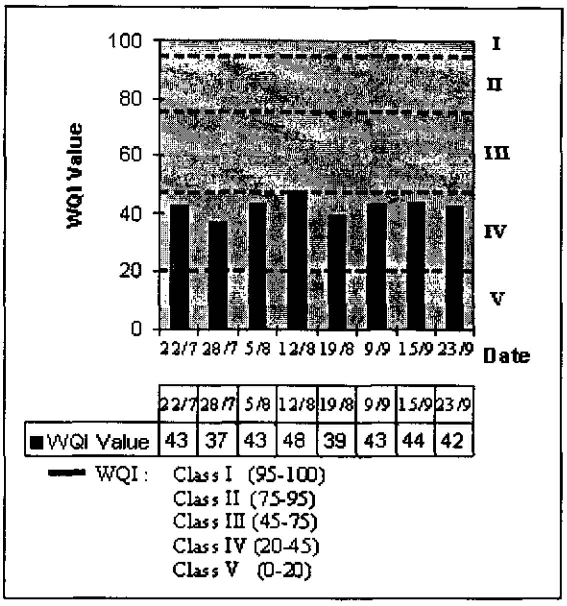

Figure 7: Average WQI Values at Station 1

The same calculations were repeated for every station using the same equation to determine the WQI values.

From this study, the results of water quality from the Sri Gading Industrial Zone are summarized in Table 3 and Figure 8.

Table 3: WQI for the 10 Stations

Date	WQI (%)	
	Value	Class
Station 1	42.46	IV
Station 2	57.45	III
Station 3	45.02	III
Station 4	65.96	III
Station 5	33.06	IV
Station 6	57.47	III
Station 7	29.96	IV
Station 8	53.22	III
Station 9	54.80	III
Station 10	38.35	IV
Average WQI	47.78	III

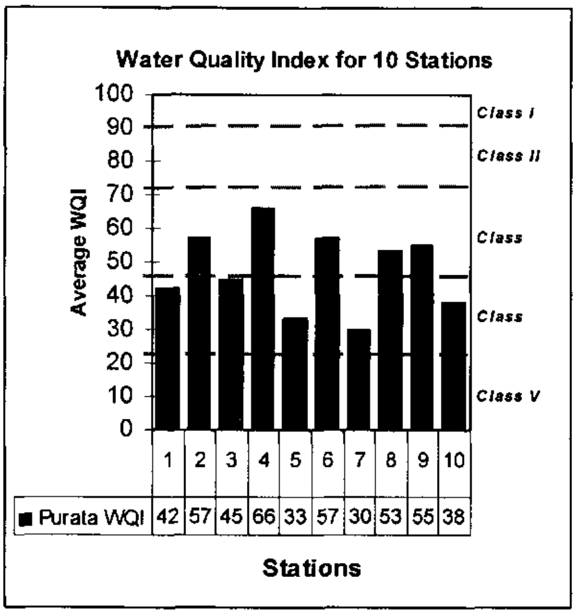

Figure 8: Average of WQI for 10 Stations

It is clear from the results that stations 1, 5, 7 and 10 were in class IV (polluted) while station 2, 3, 4, 6, 8, 9 were in class III (slightly polluted). The analysis showed that station 7 was the most polluted especially in terms of BOD and COD. This station is located near to a fruit factory and the wastewater from this factory was directly discharged into the drainage system

The reason for worsening water pollution in this industrial area was probably due the lack of awareness by the factory owners towards the management of their wastewater. It is a duty of the authorities to instill this awareness amongst the factory owners. This can be done by educating them through campaign, road shows, banners and of course the strict enforcement of the laws.

6.0 Conclusion

It was found from the study that the WQI for all stations were categorized as Class III (slightly polluted) and IV (polluted) pollution did occur at an unwanted level.

The average WQI value was 42.5 which indicate that the water in channels are still polluted.

It is an urgent need for the local authorities to take action on this issue. One such action is to meet the industries and to tell them to improve their wastewater treatment facilities so that any effluent discharged from any of the premises inside the industrial zone are of an acceptable quality and does not violate the effluent quality discharge standards stipulated in the EQA 1974. The study has to be continued in order to monitor the pattern of pollution in the area continuously. The WQI should be improved to Class I or at least Class II.

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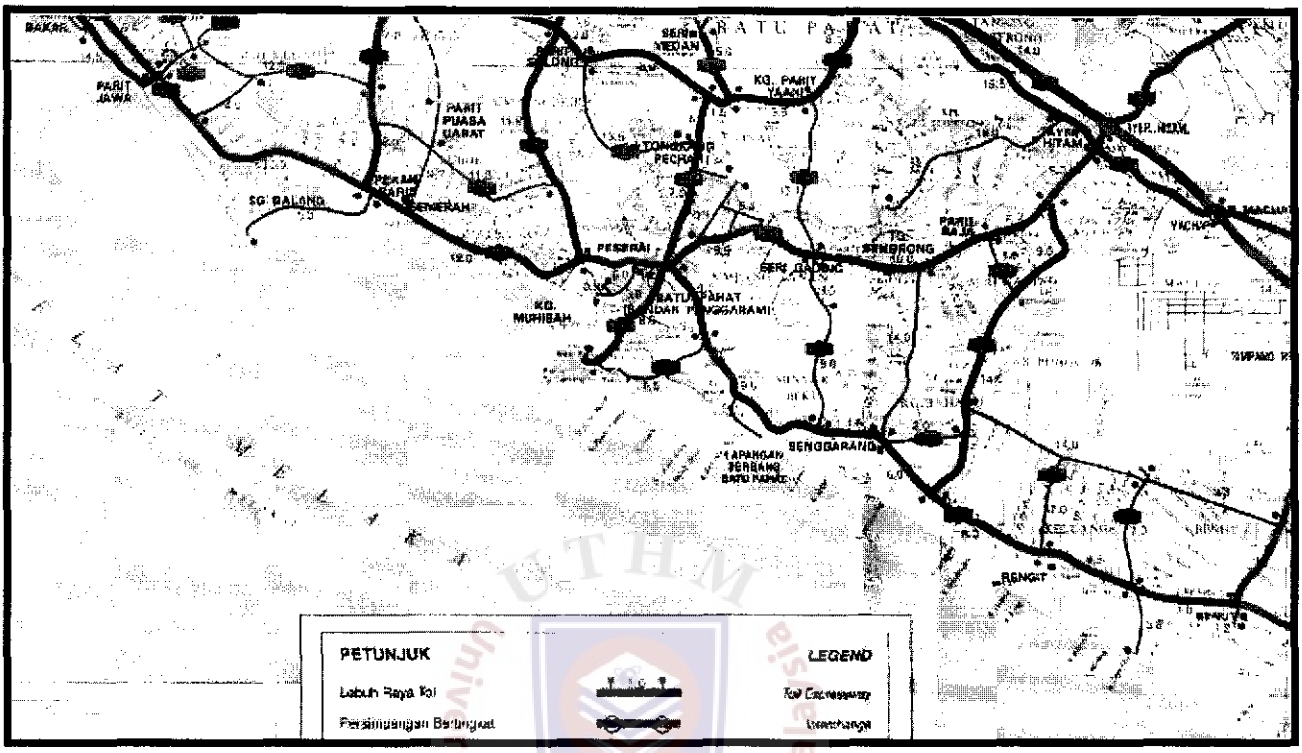
Attachment 1

Location of Sri Gading Industrial Area



Attachment 2

Sri Gading Industrial Zone Batu Pahat : Location of Stations