THE EFFECTS OF RAW WATER TURBIDITY IN WATER TREATMENT PROCESS AT SG KAMPAR TREATMENT PLANT

Ir Dr Mohd Nordin Adlan[1], Assoc. Prof. Dr Hamidi Abd Aziz[1], Rahmat Hasan[2].
[1]School of Civil Engineering,
Universiti Sains Malaysia,
Perak Branch Campus,
31750 Tronoh.

[redacted]

[3] Lembaga Air Perak, 31200 Ipoh.

ABSTRACT

Sungai Kampar, which is one of the tributaries of Sg Kinta in the State of Perak is currently used as a source of water supply for the town of Kampar and its surrounding areas. The catchment area of Sg Kampar is made up of ex-mining land, agricultural areas and forest reserved beside a number of aboriginal settlements and Malay reservations. A small town called Sg. Siput South is located within the catchment area. An intake works for potable water treatment is located at the bank of Sg Kampar, which is near Kuala Dipang. Water samplings at the intake works were carried out to determine the effects of its turbidity on the amount of chemical used for solid-liquid separation process. The results indicate that in order to maintain an appropriate sedimentation treated water quality the amount of alum used has to be increased with an increasing amount of raw water turbidity. It was also observed that the occurrence of high turbidity in the raw water quality has affecting the sedimentation treated water quality although higher retention time was adopted to lessen the load on the treatment works.

KEYWORDS
Raw water, turbidity, catchment area, sedimentation tank.

INTRODUCTION

Turbidity is usually caused by the presence of clay, silt, soil particles and other impurities such as algae and organic materials (Barnes *et al.*, 1981; Linsley *et al.*, 1992).). Turbidity is a measure of the ability of water to scatter light and absorbed by the suspended materials at right angles to a source of light. The turbidity of a water sample is depended on the number, size, shape and refractive index of the particles in suspension (Barnes *et al.*, 1981). The optical effect in turbidity measurement is affected by the fineness, colour and shape of the dispersed particles (Smethurst, 1983, 1988). In water treatment, the dosage of chemical for coagulation and flocculation is much depended on the jar test, which is carried out when there is a variation in the turbidity of raw water. In normal circumstances the variation in turbidity in most rivers is quite small unless there is a downpour in the catchment area. The variation in turbidity is not only a function of rainfall but also on the pollution from human activities within the catchment areas either in the forms of point or non-point sources. Logging, mining and agricultural activities can be considered belong to non-point source of pollution. Davis and Cornwell (1998) indicated that for point sources, the pollutants normally come from domestic and industrial wastes.

Treated water with high turbidity may cause some concerns amongst the consumers (Malaysian Water Association, 1994). It is a significant factor in disinfection because it can shield bacteria and virus from the effects disinfectant agent. According to Malaysian Water Association (1994), Malaysian river waters apparently have high turbidity consist of silts with 47% of them having more than 50 mg/L of suspended solids.

To date in Malaysia, measurement of turbidity is the main source of guidance towards chemical dos: the appropriate detention time in the sedimentation tank. If there is a rise in turbidity, the o| normally increase the chemical dosage and the detention time in the sedimentation tanks. The la: result in the decrease in the flow rate and consequently the output of the treatment plant.

STUDY AREA AND METHODS

Sungai Kampar is one of the tributaries of Sungai Kinta and currently is one of the main sources of water for the town of Kampar and its surrounding areas. According to population census, the popul: the town of Kampar in 1991 was approximately at 23,416 (Adlan *et al.*, 2000). The estimate of population can be made based on 1.8% annual growth rate for the state of Perak from 1991 to 202 catchment area of Sg Kampar intake is made up of an ex-mining land, agriculture areas, rural settle forest reserved and parts of Cameron Highlands. The later is well known for its agricultural activiti as growing of vegetables and tea plantations. North-South Expressway meets Sg Kampar at approx: 4 km to the south of Gopeng.

Treatment process involves screening, coagulation, flocculation, sedimentation, filtration, pH condit fluoridation and disinfection. Raw water quality in terms of turbidity is always changing depenc weather condition and upstream activities. During rainy period the turbidity may rise well above 30(The increase in turbidity is mainly due to rural erosion. However before the fallen of tin pri deteriorating in water quality is mainly due to mining activities.

Samples for turbidity measurements were taken at the inlet of the treatment works and at the outlet the sedimentation tank. At each point three samples were tested and the average readings were us representative turbidity. The treatment works is made up of two mixing channels, two sedimentatior four rapid sand filters and a clear water tank with a pumping station on the top. The overall dimen each sedimentation tank is 133 feet length, 43 feet wide and 11 feet depth of water. Water from the channel has to enter through an 18 square inches penstock in the horizontal direction and then dist vertically downwards through 22 numbers 12x6 inches openings into the first part of the sedime tank. A deflector was built at 15 feet from the edge of the tank at a height of 7 feet 3 inches prob: hinder the turbulent condition created by the penstock and the vertical openings. Figure 1 shows the diagram of the longitudinal section of the sedimentation tank. There are a total of 3 full size settlec collection weirs and 2 half-size settled water collection weirs in each sedimentation tank. Each fi weir has a total length of 19 feet 3 inches. This means the total length of all weirs in each tank is 77 1

All turbidity measurements were made using Hach turbidimeter, which was standardised witł suspension supplied by the manufacturer.

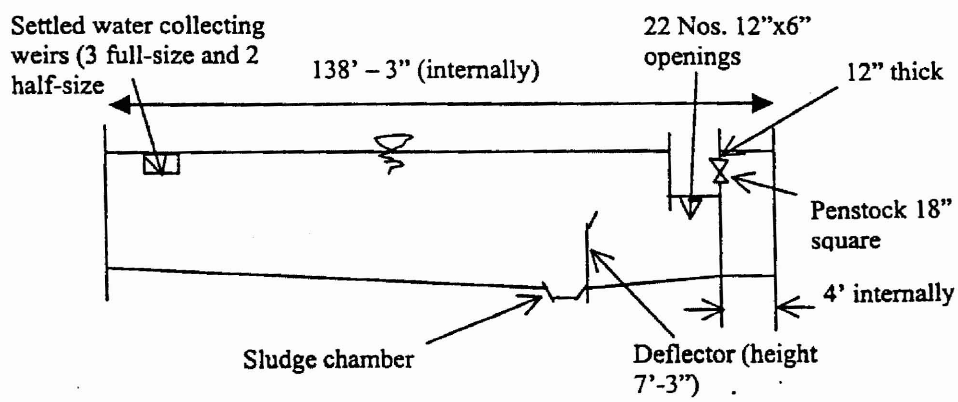

Figure 1 : A sketch diagram of the longitudinal section of sedimentation tank at Sg Kampar Treatn Works

RESULTS AND DISCUSSIONS

Figure 2 shows the results of the turbidity for raw water and sedimentation treated water. The x-axis represents the sequence of observation carried out during the study period. The values for sedimentation treated water turbidity were observed based on the same raw water, which had undergone coagulation, flocculation and sedimentation processes. The retention time in each process was used as a guideline for samplings of sedimentation treated water quality. Thus sedimentation treated water turbidity is a corresponding representation of the same raw water body. Figure 2 indicates that there are four significant spikes occurred during the study period of 14 days on the turbidity of raw water of which the highest is nearly 300 NTU. The corresponding sedimentation treated water turbidity in Figure 2 indicates that during the study period there was some irregularities in the treated water quality. For example in two incidents the sedimentation treated water turbidity were in the region of 50 NTU and more, whereas at other times the turbidities were quite low. The occurrence may be due to lack of alertness by the plant operator or presumably no jar test was carried out to determine the amount of alum required. The problem with higher turbidity in the sedimentation treated water may also be due to the shortfall in the design of sedimentation basin. Figure 1 in the previous section indicates that the entrance into the sedimentation basin consists of an eighteen square inches penstock and twenty-two number of 6"x12" openings. The penstock may create a bottleneck to the flow regime and will cause a turbulent condition. The latter may hinder the floc attachment process and subsequently delay the solid-liquid separation process in the sedimentation basin. As a result some flocs may enter the filters and finally induce blockages in the rapid sand filter.

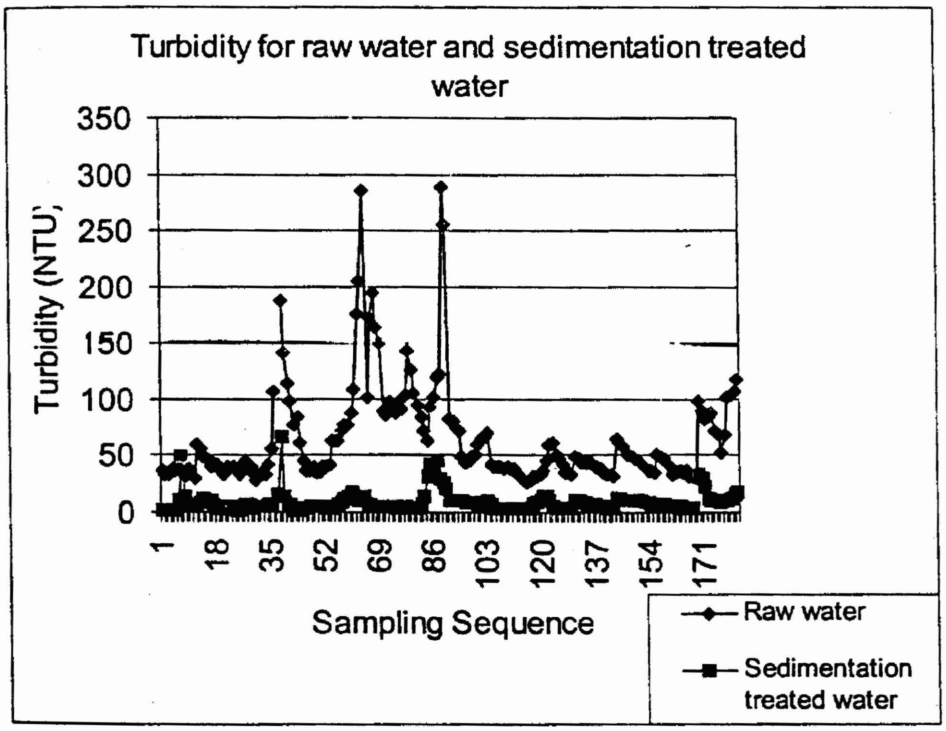

Figure 2 – Turbidity readings for raw and sedimentation treated waters during the study period

Figure 3 indicates the average daily raw water and sedimentation treated water turbidity, percentage turbidity removal and the dosage of alum during the study period. The graph (Figure 3) suggests that when the raw water turbidity was increased, the dosage of alum would also be increased. The lowest dosage of alum during the study period was 12 mg/L and the highest was 32 mg/L. This means there was a difference of 20 mg/L in the alum dosing to cater for the variation of raw water quality. For an average production of 10 MLD (million litres per day) of potable water, an extra amount of 200 kg of alum will be required. If more than 50% (based on higher dosage of alum in Figure 3) of the time in a month the daily average river water turbidity is higher, then at least an extra amount of 3,000 kg of alum will be required. In this case the amount of lime, which is used for pH correction is not yet taken into account. Normally the higher the amount of alum used, then end product will be acidic, which required more lime to be added.

amount of lime, which is used for pH correction is not yet taken into account. Normally the higher the amount of alum used, then end product will be acidic, which required more lime to be added.

There were also some uncertainties on the dosage of alum with respect to raw water turbidity (Figure 3) Two points (in Figure 3) indicate that for raw water turbidity of approximately 40 NTU, the dosage of alu was about 30 mg/L whereas 5 points at about 40 NTU the dosage were only 13 mg/L. This discrepanc occurred although the dosage of alum was based on the jar tests. The graph (Figure 3) also indicates th there is no direct relationship between raw water turbidity and the dosage of alum. Further research nee to be carried out on the adequacy of jar test to estimate the amount of alum required for the solid-liq separation process.

Figure 3 also indicates that there was an incident where the turbidity of sedimentation treated water w quite high, which was approximately at 20 NTU. This incident was in fact corresponding with the highe average daily raw water turbidity. The incident occurred on day 7 where the retention time in th coagulation, flocculation and sedimentation tanks was approximately 7.75 hours. The percentage fo turbidity removal was about 81% (Table 1). However on day 4 where the retention time was increased 10 hours for raw water quality of approximately 65 NTU, the percentage of turbidity reduction wa improved to 91%. The later was corresponded to a turbidity of 5 NTU for the sedimentation treated wate The observed results demonstrated that there is a need to increase the retention time in the solid-liqu separation process if the raw water quality is deteriorated. Unfortunately the later may cause delay in t production of treated water.

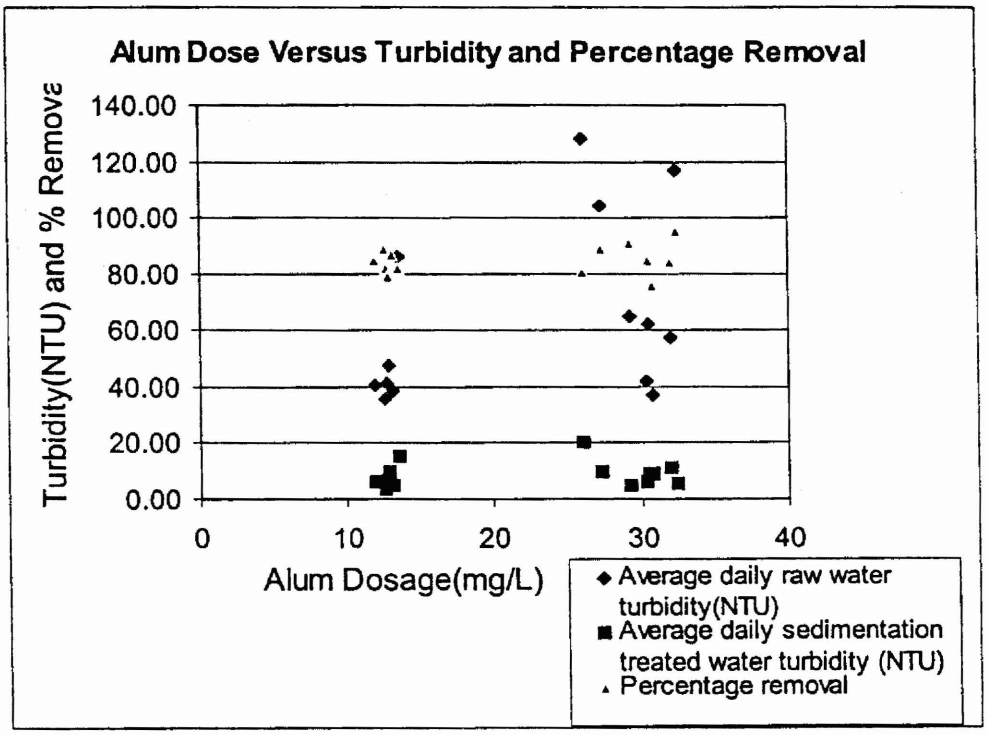

Figure 3 – Comparisons of turbidity for raw and sedimentation treated waters and percentage of turb removal with alum dosage.

Table 1 – Average daily water quality during the investigation

Raw water(NTU)	Sed.Water(NTU)	Aver.%removal	Day	Retention time
37.17	8.74	75.91	1	7
41.58	6.12	85.18	2	7.75
57.11	11.40	84.14	3	7.75
64.80	5.12	91.02	4	10
104.35	9.52	89.42	5	7.75
117.32	5.25	95.27	6	7.75
127.95	20.48	80.61	7	7.75
61.85	9.01	84.90	8	7.75
35.85	3.79	89.48	9	9
41.28	7.06	81.94	10	8
40.14	6.09	85.26	11	8.5
47.38	9.80	79.34	12	8.5
38.18	4.99	87.30	13	8.5
86.29	15.46	82.13	14	8.5

CONCLUSIONS

The following conclusions can be drawn out from this study:

Alertness to major changes in river water quality by plant operator is very important part in water treatment to avoid unnecessary deteriorating in potable water quality.

Inlet to the sedimentation tank has to be designed appropriately so that turbulent condition can be minimised or avoided. Construction of pilot plant may be an advantage prior to the construction of a full-scale plant.

The relevance of jar test and turbidity measurements for coagulation and flocculation processes need to be checked and reviewed as there is no appropriate relationship between alum dose and turbidity reduction (figure 3).

The increase in retention time in the sedimentation tanks due to deteriorating in river water quality is not an appropriate solution because it may affect the water demand.

There is a need for the community to understand and to identify the roles they can contribute toward maintaining a clean river quality.

REFERENCES

Adlan M.N.B., Hamir R., Aziz H.A. and Isa M.Y. M. (2000) "The effects of demography and rel domestic water consumption in Kinta, Malaysia", Al-Azhar University Engineering Journal (speci Proceedings of Al-Azhar Engineering Sixth International Conference AEIC 2000, Vol.4, p54-62, of Engineering, Al-Azhar University, Cairo.

Barnes D., Bliss P. J., Gould B. W. and Vallentine H. R. (1981) *Water and Wastewater Eng Systems,* Pitman Books Ltd., London.

Davis M.L. and Cornwell D.A. (1998) *Introduction to Environmental Engineering*, 3rd Ed. McGra

Linsley R.K., Franzini J.B., Freyberg D.L. and Tchobanoglous G. (1992) *Water-R Engineering*, McGraw-Hill, Inc., Singapore.

Malaysian Water Association (1994) *Design Guidelines for Water Supply Systems,* Malaysia Association, Kuala Lumpur.

Smethurst G. (1983) Water quality and treatment, In *Water Supply and Sanitation in De Countries,* (Edited by Bernard J. Dangerfield) Chapter 7, The Institution of Water Engineers and S London.

Smethurst G. (1983) *Basic Water Treatment for Application World-wide,* 2nd Edition, Thomas London.