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CHARACTERISTICS OF MUNICIPAL WASTE WATER FROM MOSUL

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Abstract. The waste water from the storm sewers was collected and analysed. Its characteristics and the average composition have been determined and analysed.

Mosul is the second largest city in Iraq and is situated on the bank of the river Tigris. It does not have a complete sewerage system, but sewers have been laid below the main streets to carry storm water and discharge from open drains existing in the downtown. In certain areas waste water pipes of dwellings are connected directly to sewers. Newly developing residental areas are provided with storm sewers. For domestic wastes septic tanks are constructed in every house in these localities.

The total length of sewers in the city is about 36 km. The maximum size of a sewer is 275/220 cm and the minimum size is 40 cm, Storm sewers finally discharge the waste water in the river Tigris which has a very small discharge during summer.

Scope of the Work. The city entirely depends for its water supply on the river Tigris. The aim of this work was to find the characteristics of water flowing through the storm sewers, because it was felt that the existing sewers are not only carrying the storm water but also the illegally discharged domestic wastes from a reasonable size of the population. Sewerage facilities for the entire city has to be provided as the existing method of sewage disposal in a septic tank is not a satisfactory solution for a growing urban community. This study was taken up to find also a basis for the design of the waste water treatment facilities, as raw-waste water cannot be allowed to flow directly into the river. A sugar factory and a tannery are also discharging their wastes to the storm sewers. The effect of discharge of such wastes to the sewerage system has also been considered.

Location of Outfalls. Most of the waste water from the city is being discharged at different points on the west bank of the river (Fig. 1). This bank of the river presents an ugly sight for about six months because of poor dispersion of the waste in the river and improper location of the outfalls. The inhabitants near the bank of the river complain regarding the bad odour due to unplanned discharge of waste water in the river. Due to all these factors the river cannot be used fully for recreational purposes. During summer months the main stream flows nearer to the east bank, as a result of which the entire west bank looks like an open drain.

Analysis of Data. Composite samples of waste water were collected twice weekly from an outfall near the bridge located on the downstream side and the last outfall. The outfall near the bridge was (Fig. 1) selected for sampling because it is accessible and relatively large quantity of waste water discharges at this point. Samples were also collected at the last outfall because it is another point which is accessible and where a large quantity of waste water alongwith the waste water from a sugar factory and a tannery discharges.

Forty-eight samples were analysed the results of which have been put to statistical analysis and are given as their means and standard deviations in Table 1. The tests were conducted according to the prescribed procedure. 1

The colour of the waste water was most of the time grey. Foul odour was noticed in all the collected samples which indicates that the waste water was not fresh.

Generally a waste water varies in concentration which can be seen from the values plotted in Fig. 2. Various quantitative parameters like total, suspended and dissolved solids alongwith oxygen consumed (OC) and biochemical oxygen demand (BOD) have been analysed statistically. The probability of occurrence of any value of total solids and OC has been

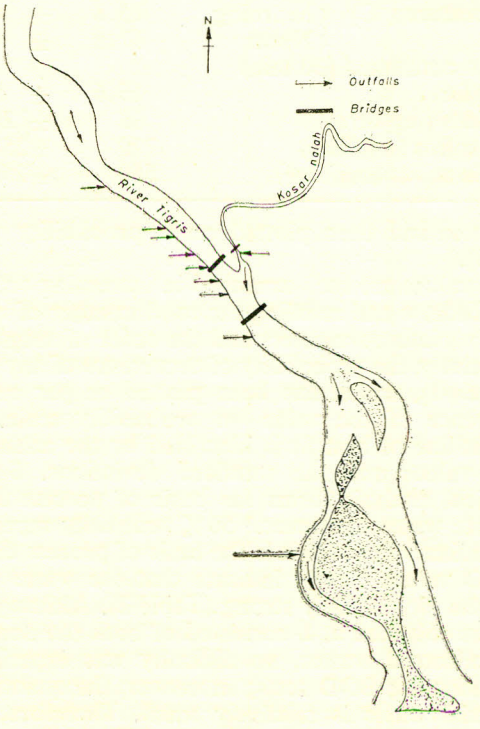

Fig. 1. Sketch of the river Tigris near Mosul showing the outfalls.

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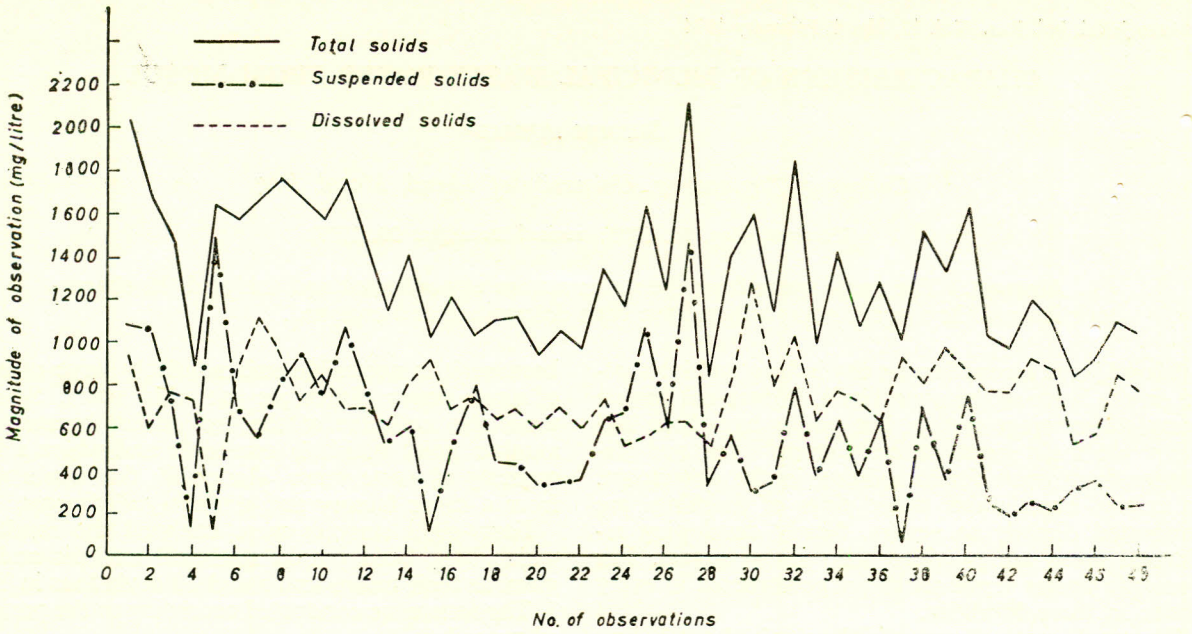

Fig. 2. Variation in the waste water characteristics.

TABLE 1. ANALYSIS OF WASTE WATER CHARACTERISTICS.

	Mean	Standard deviation
Biochemical oxygen demand (mg/litre)	395	± 48.5
Total solids (mg/litre)	1320	±321
Dissolved solids (mg/litre)	755	±185
Suspended solids (mg/litre)	565	±302
pH value	7.18	± 0.397
Temperature (°C) Morning	15.8	± 4.4
Temperature (°C) Noon	17.1	± 4.51
Oxygen consumed (30 min) (mg/litre)	45.6	± 9.9
Chlorides (mg/litre)	68	± 24.7
Fixed solids (mg/litre)	770	±257
Volatile solids (mg/litre)	550	±256

calculated and then plotted on a probability paper (Fig. 3).

The values are each arranged in increasing order of magnitude, n and m being the total number of values of the various parameters and the order of magnitude respectively, the probability of occurrence of any value is $m/(n+1)$, which has been plotted as per cent of occurrence of the value on probability scale. The straight-line of best fit is identified by the arithmatic mean values and the standard deviations. Such a statistical analysis forms the basis of process design of waste water treatment.[2] 50% probaility represents the median value which is the basis of process design.

BOD values clearly indicate that the waste water from the city is fairly strong (Table 2). Although the samples collected at B consisted of both the domestic and industrial wastes, no difficulty was experienced in conducting BOD tests; moreover, the quantity of industrial waste is relatively small. Therefore, it is expected that there will not be any difficulty in treating the domestic and industrial waste together.

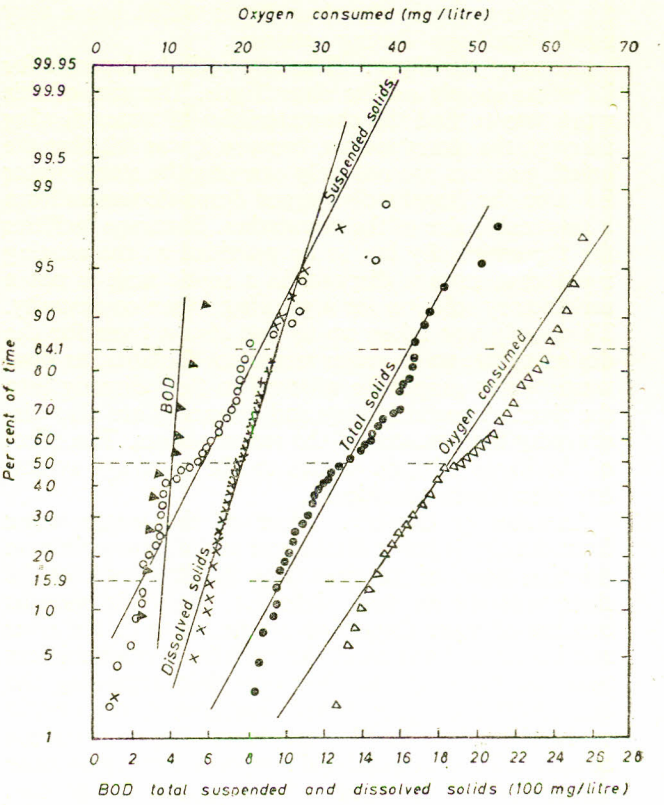

Fig. 3. Probability of occurrence of oxygen consumed BOD total suspended and dissolved solid in raw waste water.

Standard plate count(SPC) and most probable number(MPN) of organisms were determined at 35°C for a large number of samples. On an average SPC/ml was 3,000,000 and MPN/100 ml was 790,000 which indicates fecal contamination.[3]

TABLE 2. TYPES OF SEWAGE AND DILUTION RATIO REQUIRED BY RIVER WATER.

Types of sewage liquor	Dissolved oxygen taken up in 5 days by typical sewage liquor of various concentration (mg/litre)	*Dilution theoretically permissible to give a mixture not taking up more than 4 mg/litre dissolved oxygen in 5 days. With fairly clean river water taking up 3 mg/litre dissolved oxygen in 5 days
A strong precipitation liquor	200	196
A strong septic tank liquor	330	326
An average sewage liquor	350	346
A strong sewage	500	496

*Sample calculation for dilution. Let X be the quantity of waste water being discharged and Y be the quantity of water following in the river. Assuming an average sewage liquort $350X + 3Y = 4(X+Y)$ dilution $= Y/X = 346$

TABLE 3. AVERAGE COMPOSITION OF WASTE WATER (mg/litre).

	Matter		
	Mineral	Organic	Total
Suspended solids	290	275	565
(a) settleable	213	232	445
(b) non-settleable	77	43	120
Dissolved	480	275	755
Total	770	550	1320

The average composition of the waste water in Mosul is separately given in Table 3. These values are given here to give an idea about the settleable and non-settleable solids in waste water and the amount of mineral and organic matter present in it. The quantity of mineral matter is relatively large because of open drains discharging to sewers and the dry climate of the region. These factors encourage the entry of sand and dust particles in sewers.

Quantity of Waste Water and its Effect. The total quantity of waste water reaching the river during dry weather has been estimated to be 4500 m^3/hr (1.25 m^3/sec). Considering the worst condition the dilution ratio as per Table 2 for an average sewage liqour should be 346. Thus the minimum discharge required in the river for avoiding severe oxygen depletion is $346 \times 1.25 = 432$ m^3/sec. Usually the minimum flow in the river is less than the theoretically calculated discharge which is required for keeping the stream healthy. In 1930, which was the driest year, the flow in the river was as low as 91 m^3/sec.[4]

Conclusion

The analysis of various parameters indicate that the waste water from a city is fairly strong in character. The standard plate count and most probable number are high which is expected in domestic waste water.

No adverse effect of the waste water discharge from a sugar factory and a tannery on the treatability of waste is expected.

A complete sewerage system is essential for the collection and transportation of the waste water of the city. To improve the utility of the river both as a raw water source and as a recreational spot outfalls must be located on the downstream of the city.

Raw waste water should not be discharged into the river. The waste water in sewers is predominantly domestic and, therefore, there appears no difficulty in setting up a complete treatment plant having a biological process in the secondary stage.

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