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HYDRAULICS RESEARCH DIVISION

Technical Note

DATE: May, 1975 REPORT NO: 75-1

TITLE: A Report on the Feasibility and Cost of Aeration on the Red River.

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REASON FOR REPORT:

This report is written in response to a request by the Ministry of Environment, Manitoba, relayed to the Hydraulics Research Division through Mr. J.P. Bruce and Dr. H.E. Eisenhauer.

CORRESPONDENCE FILE NO: 1373 & 1373-1

INTRODUCTION

Dissolved oxygen levels, monitored at Emerson, Manitoba, on the Red River recently showed a slug of water about 17.5 miles long which had only about 1 ppm of DO. The river was ice-covered at the time and atmospheric reaeration could not take place. Such a slug of 'dead' water would, of course, be harmful to fish and other aquatic life. The Hydraulics Research Division was, therefore, requested to give a quick preliminary report on the feasibility of using artificial aeration should such incidents reoccur and give a rough estimate of the costs involved.

AVAILABLE INFORMATION

Hourly DO readings indicated that the dissolved oxygen concentrations were about 7 or 8 ppm both before and after the slug, which took about 22 hours to pass. The cause of the slug is as yet undetermined.

The flow characteristics of the Red River at Emerson were as follows:

Discharge	2040 cfs
Mean speed	1.17 ft. per second
Width	217 ft.
Mean depth	8 ft.
Ice thickness	1.9 ft.

Assuming that the DO level has to be raised to 5 ppm from 1 ppm, the amount of oxygen, (M) which has to be transferred to the water is:

$$M = 2040 \times 24 \times 3600 \times 28.32 \times \frac{4}{1000} \times 2.20 \times 10^{-3} \text{ lb. } O_2/\text{day}$$

$$= 44{,}000 \text{ lb. } O_2/\text{day.}$$

This level of aeration would be acceptable if the BOD level in the slug is already quite low. If there is still considerable BOD in the slug, the DO level would have to be increased further or oxygenation repeated further downstream.

TYPES OF AERATORS

There are many types of artificial aeration devices. For use in rivers the most common types are mechanical surface aerators and diffuser aerators. The first type includes various devices which stir up the water at the surface or draw water up to the surface and cast it out by centrifugal force, creating a turbulent zone in which air is entrained into the water. Diffuser aerators consist of systems which bubble air or pure oxygen underneath the water, enabling oxygen to be absorbed by the water as the bubbles rise through the water. Other aeration devices such as U tube aerators are designed primarily for reservoir or ponds and are not commonly used in rivers.

In the present case, the aerator is to be operated when the river is ice covered. Mechanical surface aerators are obviously unsuitable and diffuser aerators become the logical choice. It remains now to choose between an air bubbling system or a system using pure oxygen bubbles.

For the air bubbling system, compressors are required to deliver the air under pressure to overcome the hydrostatic head as well as friction losses in the lines and the diffuser. The initial capital cost is therefore, quite high. However, operating costs are usually fairly low.

For the oxygen bubbles the capital cost is much lower because the oxygen is stored under pressure and no additional power is required to

push it through the diffuser. However, oxygen is expensive and operating costs can be high if lengthy operations of the aerator are required.

COST ESTIMATES

In preparing these estimates it is assumed that this aeration system is only to be used to remedy emergency situations such as the one just encountered. A total of 5 days' operations a year is assumed. Because this report is prepared with very short notice the figures given should be regarded as rough estimates only.

1. Air bubbler system:

From published data, the efficiency of transfer can be assumed to be about 2 lb. O_2 per horsepower hour. Therefore, to transfer 44,000 lb. O_2 per day would require about 12 units of 80 hp electric drive air blower.

Capital cost: 12 units 80 hp drive, diffusion system, shelter.....$550,000.00

Contingencies and engineering 20% of initial cost.....$110,000.00

Total initial cost.....$660,000.00

Based on a life time of 10 years for the equipment, and interest rate of 8%, the capital cost per year is 14% of initial cost.

Therefore, capital cost per year.....$ 92,400.00

Annual operating cost: Electric power, maintenance.....$ 10,000.00

Therefore: Total annual cost.....$102,400.00

2. Oxygen bubbling system:

For pure oxygen bubbles the efficiency of transfer is estimated from available data as 20% for the present case.

Capital cost:	storage tank, regulator, piping and diffuser, shelter	$ 30,000.00
	contingencies and engineering	$ 6,000.00
Total initial cost		$ 36,000.00
Based on 10 years life time and 8% interest rate, capital cost per year		$ 5,040.00
Operating cost:	Cost of oxygen @ $35/Ton for 5 days operation	$ 3,800.00
Maintenance		$ 1,000.00
Annual operating cost		$ 4,800.00
Therefore: Total annual cost		$ 9,840.00

SUMMARY

For emergency aeration of a slug of 'dead' water such as the one encountered, the only conventional aeration system which is feasible appears to be diffuser aerators.

Based on the type of operation required--large volumes of oxygen for short periods of time, the oxygen bubbling system is much less expensive than the air bubbling system. A rough estimate of the annual cost for the oxygen diffuser system is about ten thousand dollars. The actual costs however, clearly depend on the frequency of the occurrence and the mass of the oxygen deficit which is to be supplied.

There is sufficient information in the literature to proceed with engineering design of aeration systems. Further research is not required.

The cause of the slug of low DO water is not known and it may be of interest to elucidate and remove the cause rather than applying a palliative.

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SELECTED REFERENCES

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2. Whipple, W., Jr., Coughlan, F.P. and Yu, S.L. "Instream aerators for polluted rivers", J. of San. Eng. Div., ASCE, no. SA5, Oct, 70.

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