

KUECHENMEISTER & CHERMACK

CONSULTANTS

Mr. Robert L. Laing
Clean-Flo Laboratories, Inc.
Hopkins, MN 55343

April 25, 1984

Dear Mr. Laing:

A test of oxygen transfer for the Clean-Flo Continuous Laminar Flow Inversion System necessitates a different approach, as is explained below. Your system has been tested by others (1) and found to move 120,000 gallons of water per hour from the bottom to the surface for each diffuser. The method which we used does not require the need to know the amount of water being moved, as it only measures increase in oxygen content of the water.

Because your aerator uses oxygen transfer at the water surface to oxygenate a lake, it was decided to test the increase in oxygen of lake water in situ, f.e. in an actual lake situation. It is impossible to test oxygen transfer for your device using standard methods, because standard methods do not account for oxygen being transferred from the atmosphere to the bottom water as it is brought up to the surface and exposed to the atmosphere.

At noon on March 21, 1984, Mr. Chermack and myself tested the water at Super Valu Lake. While water touching the ice surface had 5.5 mg/l dissolved oxygen, all water immediately under the ice was 0.0 mg/l. Based on our tests, a high estimate of total average oxygen content is 1 mg/l. Testing was conducted using the Winkler Method.

Your system was observed to be two each one-half horsepower compressors mounted in a fiberglass cabinet, and connected by air hose to four air diffusers (two connected to each compressor), evenly spaced at the bottom of the lake. Super Valu Lake was measured by Minnesota Department of Natural Resources to be 23 surface acres. We measured the average depth to be 3 feet.

According to your design, the lake was completely turned over every 3.5 days. In eight days, dissolved oxygen content was 13.0 mg/l at the surface and 13 mg/l at the bottom. All ice was gone from the lake.

OXYGEN TRANSFER

To calculate oxygen transfer, the following method was used:

- 1) Weight of total volume of lake water:
 $23 \text{ acres} \times 3 \text{ ft} \times 43,560 \text{ ft}^2/\text{acre} \times 62.45 \text{ lb}/\text{ft}^3 = 187,551,930 \text{ lbs.}$
1 ppm of total lake water = 187.6 lbs.
- 1- Dr. Robert D. Goodwin, Walled Lake, Michigan (1975); and Environmental Quality Laboratory, Inc., Port Charlotte, Florida (1977). Clean-Flo Correspondence).

————— BIOLOGISTS, LIMNOLOGISTS, ENVIRONMENTAL PLANNERS —————

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$$2) \text{ Oxygen Transfer rate} = \frac{187.6 \text{ lbs} \times 13 \text{ ppm}}{1 \text{ hp} \times 8 \text{ days} \times 24 \text{ hours}} = 12.7 \text{ lbs O}_2/\text{hp-hr}$$

EFFICIENCY

$$3) \text{ Specific weight of air at } 34^\circ\text{F} = \frac{P}{RT}$$

where P= atmospheric pressure (abs) in lbs/ft²

R= universal gas constant = 53.3

T= absolute temperature, °F = 460+34=494

$$\text{SpWt} = \frac{14.7 \times 144}{53.3 \times 494} = 0.0804$$

$$4) \text{ Pounds of air pumped/hr} = \text{Sp.Wt.} \times \text{cfm} \times 60 \text{ min/hr}$$
$$\text{Lbs air} = 0.0804 \times 14.8 \times 60 = 71.4 \text{ lbs air/hr}$$

$$5) \text{ Oxygen} = 20\% \text{ by weight} = 14.3 \text{ lbs O}_2/\text{hr}$$

$$6) \text{ Efficiency} = \frac{\text{lbs O}_2 \text{ transferred to H}_2\text{O/hr}}{\text{lbs O}_2 \text{ pumped into lake/hr}}$$

$$\text{Eff.} = \frac{12.7}{14.3} = 88.8\%$$

I certify the above to be accurate to the best of my ability.

Sincerely,



David R. Kuechenmeister
Consultant

I certify that I indeed did sign
my name to this document.

David R. Kuechenmeister

Witnessed before me this 14th day of December, 1984

Lee Ann Ceeder

