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COMPARISON OF THE EFFICIENCY OF FOUR TYPES OF AGITATOR UNITS TO INTRODUCE OXYGEN INTO WATER

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In recent years an electrical device called an agitator has been developed to increase the dissolved oxygen content of water in tanks, such as storage vats or fish hauling trucks, where fish are being held.

The agitator consists of a flat blade, about 2 inches wide and 5 or 6 inches long, attached to the shaft of an electric motor. The motor is mounted on top of a screen cage and the shaft, with its attached agitator, is suspended vertically within the screen housing (Fig. 1). For various uses the motor may be wired for 6-, 12- or 110-volt current; the lower voltages permit use on trucks, and the higher one permits use with commercial current. The installation of the agitator on a fish hauling truck is quite simple. A hole (about 4 inches in diameter), which allows sufficient room for the lower assembly (shaft, impeller and basket) of the unit to be submerged in the water, is cut in the deck of the tank. A base plate, 5" x 5" and mounted immediately below the motor, provides a support. Direct wiring from the truck battery provides the necessary power.

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[1] Wolf Lake Fish Cultural Research Station.

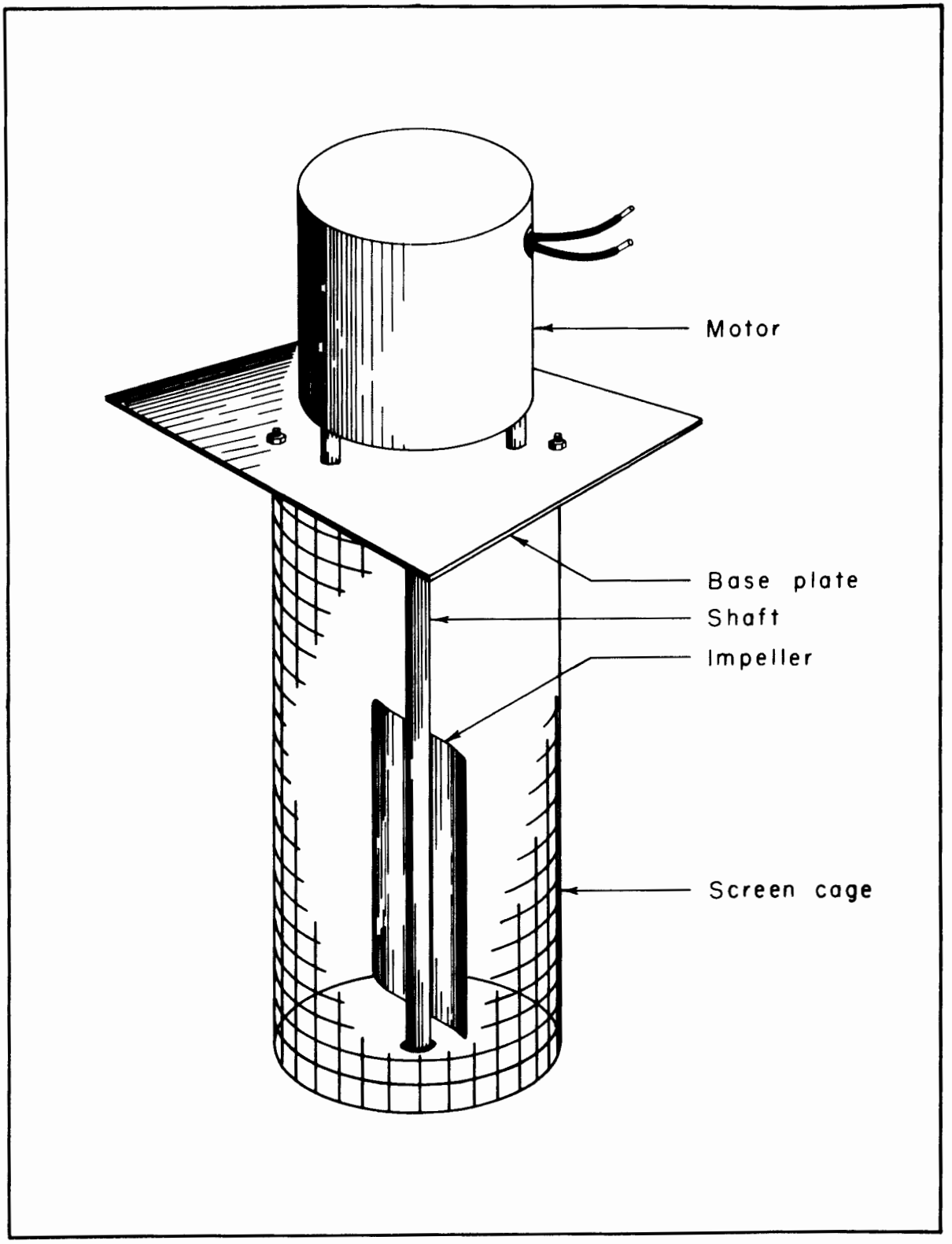

Figure 1. --Electric agitator

In operation the agitator creates a whirl of water around the central shaft violent enough to cause a vortex which sucks in air and directs it in a downward motion towards the bottom of the tank. As the trapped air tends to escape, the turbulent water disperses it in all directions.

A study was undertaken to determine how efficient these units were in their ability to put oxygen into solution. Since it was suspected that a number of factors were involved in this process, the units used in these tests were modified in several ways. One test (A) involved the use of a unit (Fig. 2) as it came from the manufacturer. In another test (B) the same kind of unit was used except that the pitch of the impeller was changed (Fig. 3). In two instances (Figs. 4 and 5) the screen baskets surrounding the impellers were replaced by three stud bolts extending from the motor base plate to the lower bearing assembly. In these two cases the impellers were remodeled so that their motion would produce a spiral effect in the water. In one test (Fig. 4) the blade was one inch longer than in the other (Fig. 5).

Procedure

Tests were run intermittently for a period of two weeks, February 19 through March 3, in a plywood tank containing 116 gallons of well water. The dissolved oxygen content of the well water ranged from 2.7 to 3.2 ppm. The agitator was set on the deck of the test tank so that 3 inches of the lower assembly was always above the water level. Each test ran for 16 minutes. Oxygen analyses, using the standard Winkler procedure, were made at the beginning of each run and at 4-minute intervals thereafter. Each test was repeated 3 times under identical conditions in order to verify the results.

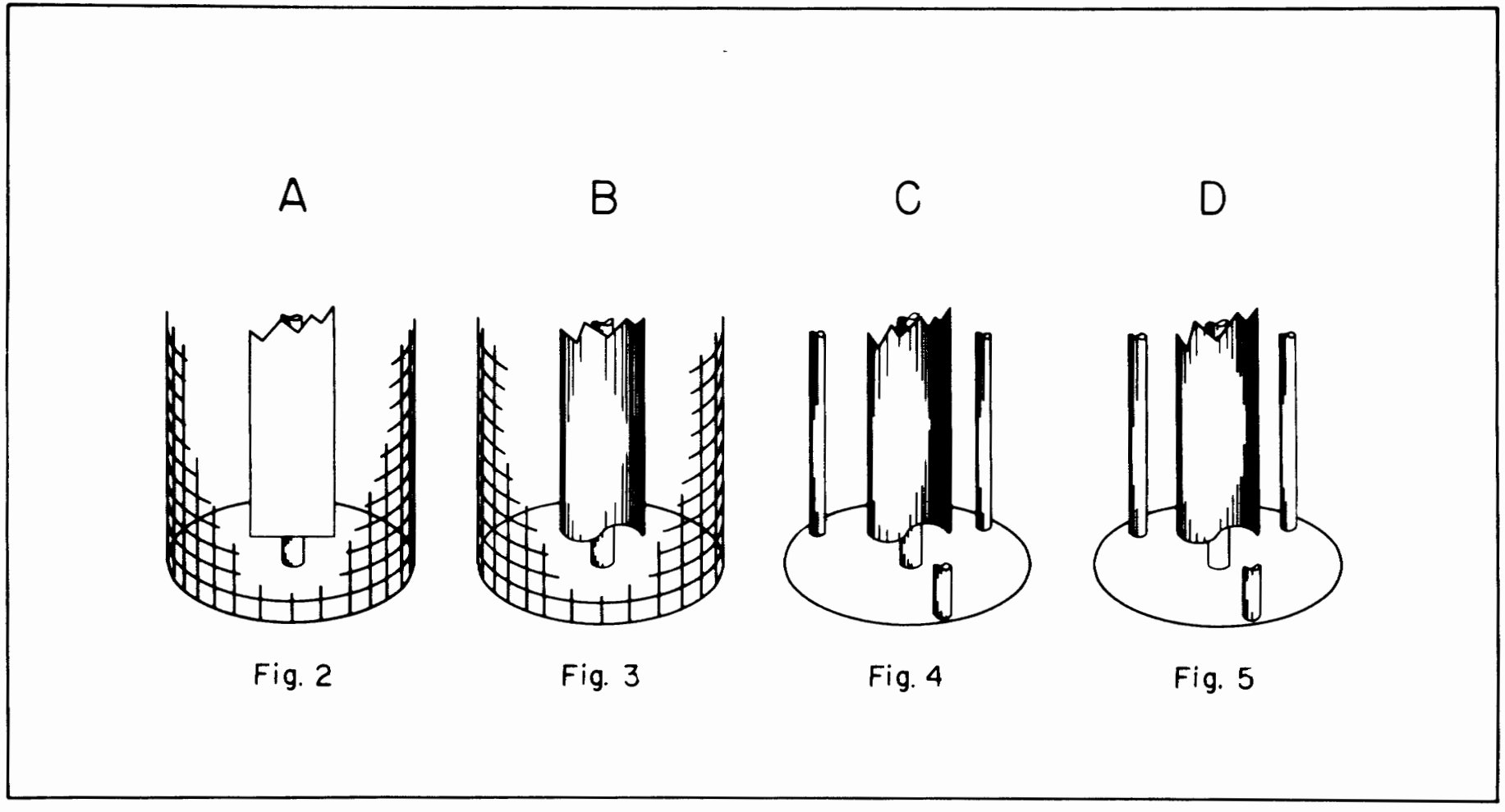

Fig. 2 Fig. 3 Fig. 4 Fig. 5

Figures 2-5. --Detail of lower portion of agitator, as modified for Tests A to D

Results

From the data obtained (Table 1), it is apparent that the efficiency of the agitator is influenced by the shape of the impeller and the presence or absence of the screen housing.

The screw-blade impeller was found to be more efficient than one equipped with a flat blade. On the average (3 tests), during 16 minutes of operation the former brought 2, 120 cc of oxygen into solution compared to an average of 1, 639 for the flat-blade impeller, a difference of 481 (Table 1, tests B and A, respectively). In both of these tests the impeller was enclosed in the screen, so the difference can be attributed to the curve and pitch of the impeller.

The efficiency of the agitator was increased by removal of the screen housing. The unit used in Test D (5-inch screw-blade, no screen) brought an average of 2, 346 cc of oxygen (3 tests) into solution compared to 2, 120 in Test B, a difference of 226.

From a single test it was learned that the length of the impeller blade may influence the efficiency of the unit. The 6-inch blade used in Test C brought an average of 2, 560 cc of oxygen into solution, compared with 2, 346 for the 5-inch blade used in Test D, a difference of 214.

Comparing the least efficient agitator (Test A) with the most efficient one (Test C), there was a difference of 921 cc, or the agitator in Test C was 56 percent more efficient than in Test A at the end of a 16-minute period.

Table 1. --Comparison of dissolved oxygen input by four types of agitators used to re-oxygenate water

Test	Details of agitator	Time, minutes	Total O_2, ppm	Increase O_2, ppm	O_2 in cc's added to 116 gals.	
					Increase	Total
A	4-mesh wire basket	0	2.7	...	...	
	8-inch shaft	4	4.5	1.8	553	
	5-inch flat blade	8	6.0	1.5	461	
		12	7.1	1.1	338	
		16	7.9	0.8	246	1,598
		0	3.0	...	...	
		4	5.3	2.3	707	
		8	6.2	0.9	276	
		12	7.2	1.0	307	
		16	8.0	0.8	246	1,536
		0	2.9	...	...	
		4	4.7	1.8	553	
		8	6.4	1.7	522	
		12	7.8	1.4	430	
		16	8.7	0.9	277	1,782
B	4-mesh wire basket	0	2.9	...	...	
	8-inch shaft	4	5.4	2.5	768	
	5-inch screw blade	8	7.4	2.0	615	
		12	8.5	1.1	338	
		16	9.5	1.0	307	2,028
		0	3.2	...	...	
		4	6.2	3.0	922	
		8	8.3	2.1	645	
		12	9.4	1.1	338	
		16	10.3	0.9	277	2,182
		0	3.0	...	...	
		4	6.1	3.1	953	
		8	7.9	1.8	553	
		12	9.1	1.2	369	
		16	10.0	0.9	276	2,151
C	Open basket	0	2.9	...	...	
	10 1/2-inch shaft	4	7.2	4.3	1,321	
	6-inch screw blade	8	9.2	2.0	615	
		12	10.2	1.0	307	
		16	11.2	1.0	307	2,550
		0	3.2	...	...	
		4	6.8	3.6	1,106	
		8	9.8	3.0	922	
		12	10.9	1.1	338	
		16	11.5	0.6	184	2,550
		0	3.0	...	...	
		4	7.2	4.2	1,291	
		8	9.4	2.2	676	
		12	10.5	1.1	338	
		16	11.4	0.9	276	2,581
D	Open basket	0	3.3	...	...	
	10 1/2-inch shaft	4	7.8	4.5	1,383	
	5-inch screw blade	8	9.7	1.9	584	
		12	10.6	0.9	276	
		16	11.1	0.5	154	2,397
		0	3.1	...	...	
		4	7.2	4.1	1,260	
		8	8.6	1.4	430	
		12	9.7	1.1	338	
		16	10.6	0.9	277	2,305
		0	2.9	...	...	
		4	7.1	4.2	1,291	
		8	8.8	1.7	522	
		12	9.8	1.0	307	
		16	10.5	0.7	215	2,335

During the series of tests it was noted that all agitators were capable of introducing a significant amount of oxygen into the water during the first 8 minutes of operation (Fig. 6). The greatest increase occurred during the first 4 minutes and then there was a gradual decline for the next 4 minutes. As the dissolved oxygen content of the water approached the saturation point, the profile became very flat. It can be assumed that this condition would not exist in a transport unit where the oxygen above a 5-ppm* level was being consumed by fish. The 5-ppm level was attained in less than 2 minutes in Test D and at 2 minutes in Test C. In Test B it took about 2 1/2 minutes to reach this level and in A the total time required was nearly 5 minutes.

Report approved by G. P. Cooper

Typed by M. S. McClure

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* Arbitrary minimum level satisfactory for fish life.

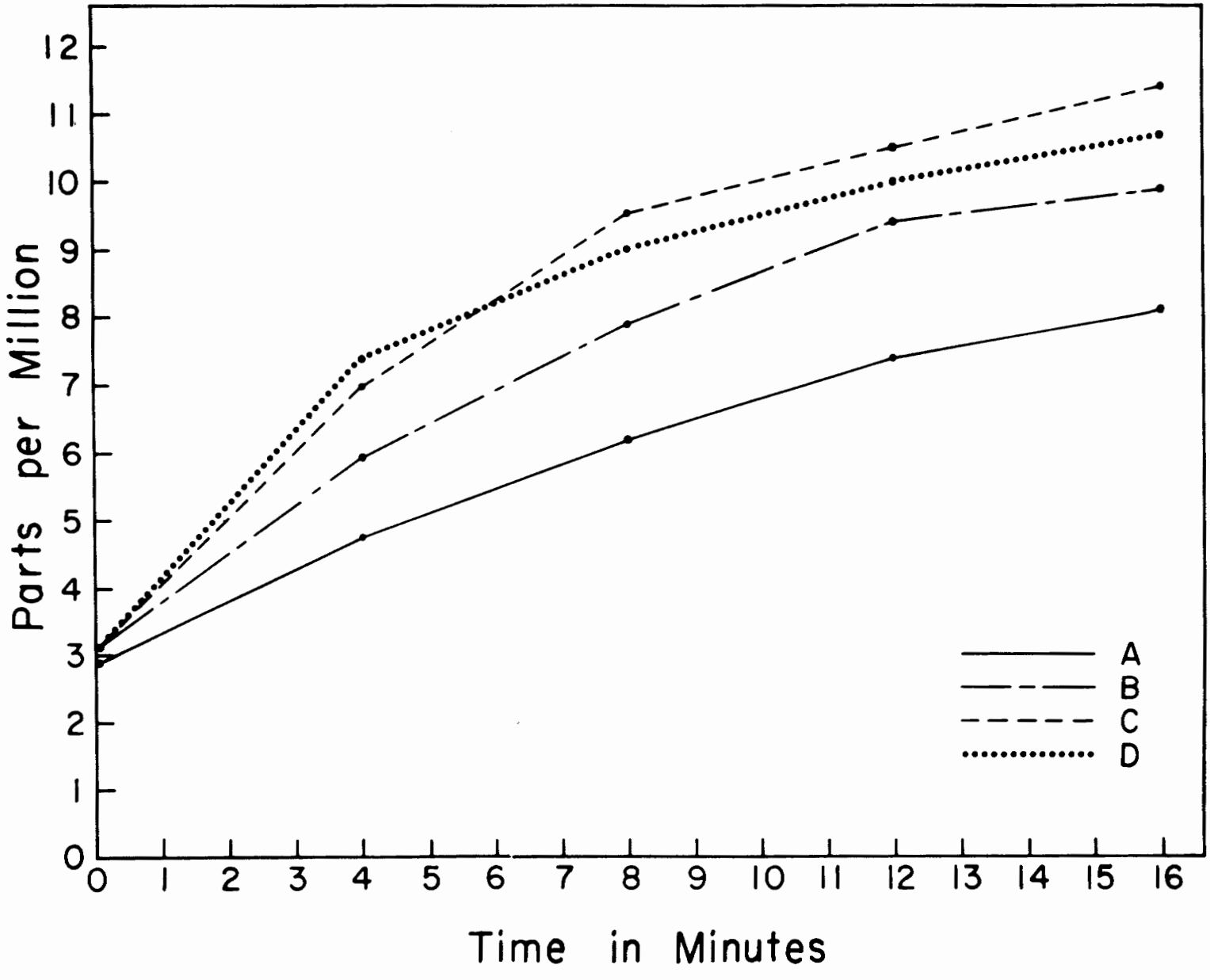

Figure 6.--Dissolved oxygen profiles during Tests A-D