Oxygen, Dissolved

For water, wastewater, and seawater

Azide Modification of Winkler Method and Luminescence Measurement (LDO) Method

Introduction

The dissolved oxygen test is one of the most important analyses in determining the quality of natural waters. The effect of oxidation of wastes on streams, the suitability of water for fish and other organisms, and the progress of self-purification can all be measured or estimated from the dissolved oxygen content. In aerobic sewage treatment units, the minimum objectionable odor potential, maximum treatment efficiency and stabilization of wastewater are dependent on maintenance of adequate dissolved oxygen. Frequent dissolved oxygen measurement is essential for adequate process control.

Dissolved oxygen is essential for the survival of aquatic plant and animal life. Generally, 4–5 mg/L of dissolved oxygen content is a borderline concentration for an extended time period. For adequate game fish population, the dissolved oxygen content should be in the 8–15 mg/L range.

Dissolved oxygen concentration varies with water depth, sludge deposits, temperature, clarity and flow rate. Thus a single water sample is rarely representative of the over-all condition of a body of water.

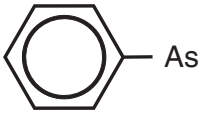
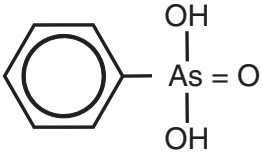
Chemical reactions

Azide modification of Winkler method

In the analysis, Mn^{2+} (manganous ion) reacts with the dissolved oxygen present in the alkaline solution to form a Mn^{4+} oxide hydroxide floc (1). Azide is added at this time to suppress interference from any nitrate present (which would react with the iodide). The solution is then acidified, and the manganese floc is reduced by iodide to produce Mn^{2+} and free iodine as I_3^-(I_2 + I^- in solution, see equation 2). The iodine gives the clear supernate a brown color. Phenylarsine oxide (PAO) or thiosulfate is then used to titrate the iodine to a colorless end point (3). (Starch indicator can be added to enhance the determination of the end point by producing a color change from dark blue to colorless.) The dissolved oxygen of the sample is then calculated from the quantity of titrant used.

(1) $2Mn^{2+} + O_2 + 4OH^- \longrightarrow 2MnO(OH)_2$

(2) $MnO(OH)_2 + 6I^- + 6H^+ \longrightarrow Mn^{2+} + 2I_3^- + 3H_2O$

(3) $2H_2O + I_3^-$  $\longrightarrow 2HI + I^-$ 

Luminescence measurement of dissolved oxygen (LDO)
The luminescence-based sensor procedure measures the light emission characteristics from a luminescence-based reaction at the sensor-water interface. A light emitting diode (LED) provides incident light required to excite the luminophore substrate. In the presence of dissolved oxygen the reaction is suppressed. The resulting dynamic lifetime of the excited luminophore is evaluated and equated to dissolved oxygen concentration.

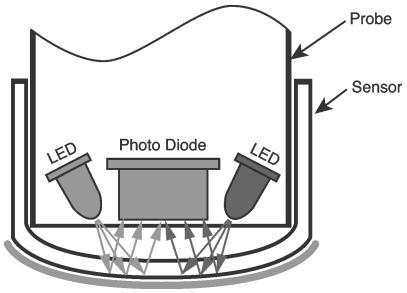


Figure 1 LDO probe

Dissolved oxygen
The *Dissolved oxygen saturation in water (mg/L)* table lists the mg/L dissolved oxygen in water at saturation for various temperatures and atmospheric pressures. The table was formulated in a laboratory using pure water. The values given are only approximations for estimating the oxygen content of a particular body of surface water

Table 1 Dissolved oxygen saturation in water (mg/L)

Temp		Pressure in millimeters and inches Hg							
		mm							
		775	760	750	725	700	675	650	625
		inches							
°F	°C	30.51	29.92	29.53	28.45	27.56	26.57	25.59	24.61
32.0	0	14.9	14.6	14.4	13.9	13.5	12.9	12.5	12.0
33.8	1	14.5	14.2	14.1	13.6	13.1	12.6	12.2	11.7
35.6	2	14.1	13.8	13.7	13.2	12.9	12.3	11.8	11.4
37.4	3	13.8	13.5	13.3	12.9	12.4	12.0	11.5	11.1
39.2	4	13.4	13.1	13.0	12.5	12.1	11.7	11.2	10.8
41.0	5	13.2	12.8	12.6	12.2	11.8	11.4	10.9	10.5
42.8	6	12.7	12.4	12.3	11.9	11.5	11.1	10.7	10.3
44.6	7	12.4	12.1	12.0	11.6	11.2	10.8	10.4	10.0
46.4	8	12.1	11.8	11.7	11.3	10.9	10.5	10.1	9.8
48.2	9	11.8	11.6	11.5	11.1	10.7	10.3	9.9	9.5
50.0	10	11.6	11.3	11.2	10.8	10.4	10.1	9.7	9.3
51.8	11	11.3	11.0	10.9	10.6	10.2	9.8	9.5	9.1
53.6	12	11.1	10.8	10.7	10.3	10.0	9.6	9.2	8.9
55.4	13	10.8	10.5	10.5	10.1	9.8	9.4	9.1	8.7
57.2	14	10.6	10.3	10.2	9.9	9.5	9.2	8.9	8.5

Table 1 Dissolved oxygen saturation in water (mg/L) (continued)

59.0	15	10.4	10.1	10.0	9.7	9.3	9.0	8.7	8.3
60.8	16	10.1	9.9	9.8	9.5	9.1	8.8	8.5	8.1
62.6	17	9.9	9.7	9.6	9.3	9.0	8.6	8.3	8.0
64.4	18	9.7	9.5	9.4	9.1	8.8	8.4	8.1	7.8
66.2	19	9.5	9.3	9.2	8.9	8.6	8.3	8.0	7.6
68.0	20	9.3	9.1	9.1	8.7	8.4	8.1	7.8	7.5
69.8	21	9.2	8.9	8.9	8.6	8.3	8.0	7.7	7.4
71.6	22	9.0	8.7	8.7	8.4	8.1	7.8	7.5	7.2
73.4	23	8.8	8.6	8.5	8.2	8.0	7.7	7.4	7.1
75.2	24	8.7	8.4	8.4	8.1	7.8	7.5	7.2	7.0
77.0	25	8.5	8.3	8.3	8.0	7.7	7.4	7.1	6.8
78.8	26	8.4	8.1	8.1	7.8	7.6	7.3	7.0	6.7
80.6	27	8.2	8.0	8.0	7.7	7.4	7.1	6.9	6.6
82.4	28	8.1	7.8	7.8	7.6	7.3	7.0	6.7	6.5
84.2	29	7.9	7.7	7.7	7.4	7.2	6.9	6.6	6.4
86.0	30	7.8	7.6	7.6	7.3	7.0	6.8	6.5	6.2
87.8	31	7.7	7.4	7.4	7.2	6.9	6.7	6.4	6.1
89.6	32	7.6	7.3	7.3	7.0	6.8	6.6	6.3	6.0
91.4	33	7.4	7.2	7.2	6.9	6.7	6.4	6.2	5.9
93.2	34	7.3	7.1	7.1	6.8	6.6	6.3	6.1	5.8
95.0	35	7.2	7.0	7.0	6.7	6.5	6.2	6.0	5.7
96.8	36	7.1	6.8	6.9	6.6	6.4	6.1	5.9	5.6
98.6	37	7.0	6.7	6.7	6.5	6.3	6.0	5.8	5.6
100.4	38	6.9	6.6	6.6	6.4	6.2	5.9	5.7	5.5
102.2	39	6.8	6.5	6.5	6.3	6.1	5.8	5.6	5.4
104.0	40	6.7	6.4	6.4	6.2	6.0	5.7	5.5	5.3
105.8	41	6.6	6.3	6.3	6.1	5.9	5.6	5.4	5.2
107.6	42	6.5	6.2	6.2	6.0	5.8	5.6	5.3	5.1
109.4	43	6.4	6.1	6.1	5.9	5.7	5.5	5.2	5.0
111.2	44	6.3	6.0	6.0	5.8	5.6	5.4	5.2	4.9
113.0	45	6.2	5.9	5.9	5.7	5.5	5.3	5.1	4.8
114.8	46	6.1	5.8	5.9	5.6	5.4	5.2	5.4	4.8
116.6	47	6.0	5.7	5.8	5.6	5.3	5.1	4.8	4.7
118.4	48	5.9	5.7	5.7	5.5	5.3	5.0	4.8	4.6
120.2	49	5.8	5.6	5.6	5.4	5.2	5.0	4.7	4.5
122.0	50	5.7	5.5	5.5	5.3	5.1	4.9	4.7	4.4