PROBLEMS

10.1. The air supply to a fermenter was turned off for a short period of time and then restarted. A value for C^* of 7.3 mg/l has been determined for the operating conditions. Use the tabulated measurements of dissolved oxygen (DO) values to estimate the oxygen uptake rate and k_La in this system.

	Time (min)	DO (mg/l)
	−1	3.3
Air off	0	3.3
	1	2.4
	2	1.3
	3	0.3
	4	0.1
	5	0.0
Air on	6	0.0
	7	0.3
	8	1.0
	9	1.6
	10	2.0
	11	2.4
	12	2.7
	13	2.9
	14	3.0
	15	3.1
	16	3.2
	17	3.2

10.2. A value of $k_La = 30\ h^{-1}$ has been determined for a fermenter at its maximum practical agitator rotational speed and with air being sparged at 0.5 l gas/l reactor volume-min. *E. coli* with a q_{O_2} of 10 mmol O_2/g-dry wt-h are to be cultured. The critical dissolved oxygen concentration is 0.2 mg/l. The solubility of oxygen from air in the fermentation broth is 7.3 mg/l at 30°C.

a. What maximum concentration of *E. coli* can be sustained in this fermenter under aerobic conditions?

b. What concentration could be maintained if pure oxygen was used to sparge the reactor?

10.3. a. Estimate the required cooling-water flow rate for a 100,000-l fermenter with an 80,000-l working volume when the rate of oxygen consumption is 100 mmol O_2/1-h. The desired operating temperature is 35°C. A cooling coil is to be used. The minimum allowable temperature differential between the cooling water and the broth is 5°C. Cooling water is available at 15°C. The heat capacities of the broth and the cooling water are roughly equal.

b. Estimate the required length of cooling coil if the coil has a 2.5-cm diameter and the overall heat transfer coefficient is 1420 J/s-m^2-°C.

10.4. Consider Example 10.4. What would be the substrate concentrations in each compartment in the 10-l and 10,000-l tanks if the probe were placed in the bottom compartment?