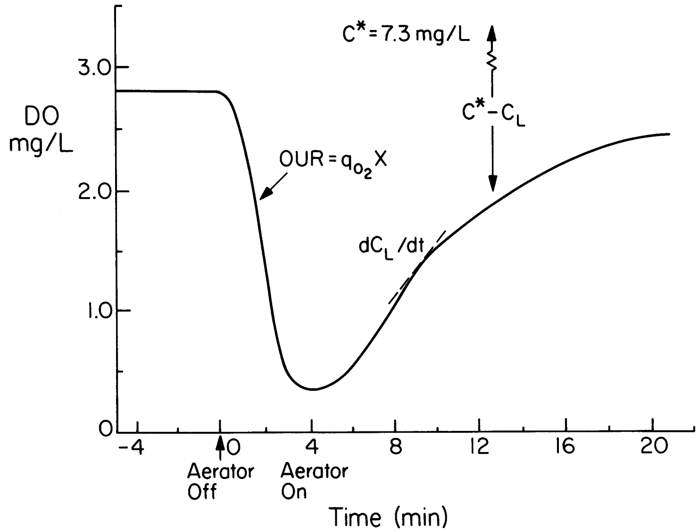

Figure 10.5. Example of response of DO in a fermenter when stopping and then restarting air flow. The dynamic method can be used to estimate OUR and k_La.

$$dC_L/dt = -q_{O_2}X \tag{10.10}$$

and the slope of the descending curve will give the OUR or $-q_{O_2}X$. The lowest value of C_L obtained in the experiment must be above the critical oxygen concentration (recall Chapter 6) so that q_{O_2} is independent of C_L. Further complications can arise due to the measurement lag in the DO probe (about 30 to 45 s) and the dissolution of oxygen from the headspace gas into the liquid (which may be significant primarily in small vessels, since the ratio of surface area for gas transfer is high compared to liquid volume). When air sparging is resumed, the ascending curve can be used to calculate k_La. Values of dC_L/dt can be estimated from the slope of the ascending curve calculated at various time points. A plot of $(dC_L/dt + \text{OUR})$ versus $(C^* - C_L)$ results in a line with a slope of k_La. The primary advantage of the dynamic method is that k_La can be estimated under actual fermentation conditions. Additionally, if q_{O_2} is known, the value of OUR can be used to estimate X.

Variations on these methods to determine k_La exist, but the general principles remain the same. However, once the OTR (oxygen transfer rate) can be estimated from either correlations or experimentally determined values k_La, it is possible to quickly estimate the rate of metabolic heat generation. Equation 6.29 provides such a relationship. Equations 6.27 to 6.29 apply in all cases and lead to an estimate of the rate of heat generation. The total amount of cooling surface (either jacket or coils) required can then be calculated, given the temperature of the cooling water, the maximum flow rates allowable, the desired temperature differential between the exiting coolant and the reactor, and the overall heat transfer coefficient. The latter presents the greatest problem, since it can vary greatly from fermentation to fermentation. Highly viscous fermentations, which decrease