General Oxygen Requirements for Wastewater Treatment

Aeration Systems

Bulletin Brief

Technical Presentation

Oxygen requirements for municipal wastewater treatment can be predicted closely with the standard laboratory analysis using the BOD test (special requirements exist for some industrial wastewaters. The BOD test is designed to measure Biological Oxygen Demand for the wastewater and provides an excellent basis for design assuming:

1. Wastewater is available to test, i.e., not a new project.
2. Wastewater is representative of full scale.

For wastewaters the field or actual oxygen demand is dependent on how far the treatment process is carried. In general the oxygen demand is broken into carbonaceous demands (oxygen required to stabilize carbon in the waste) and nitrogenous demand (oxygen required to stabilize nitrogen in the wastewater). Generally, Nitrogen in the waste appears as ammonia (NH 3 or 4).

Carbonaceous/BOD

For many treatment plants the carbonaceous demand must be considered as 2 components:

1. Oxygen to supply the active sludge to take soluble carbon (BOD) out of solution and grow more sludge. This conversion of carbon to cells is the synthesis reaction requiring about 0.5 to 0.6 lb O2/lbBOD (KgO2/Kg BOD).
2. If the process is continued, a second oxygen demand is exerted for oxidizing the cells or digesting (stabilizing) the cells. This second phase is endogenous respiration, and requires an additional 0.8 to 0.9 lb O2/lb BOD (Kg/Kg). Pounds (kg) total oxygen required for carbonaceous BOD removal can range from 0.7 lb/lb (kg/kg) BOD for high rate activated sludge with short detention of Biomass (low sludge age) up to 1.5 lb/lb (kg/kg) BOD for extended aeration with long detention of Biomass (MLSS, i.e., (long sludge age) in the bio system. Note: Nitrogen oxygen demand must be generally added for extended aeration as nitrification is expected in most long sludge age project at temperatures above 5-10°C.

Nitrogenous/BOD

For nitrogenous BOD the demand for oxygen is 4.6 lb O2/ lb BOD (4.6Kg/Kg) removed. To achieve nitrogenous conversion of ammonia to

nitrate requires longer aeration time with low food to microorganism ratio, i.e., much sludge MLSS (M) with low food supply (F). This condition results in a long sludge age, which promotes nitrification.

Biological Nutrient Removal (BNR for Nitrogen)

For advanced waste treatment systems de-nitrification may be required. To achieve denitrification both carbonaceous and nitrogenous removals must be successfully completed. Conversion of the nitrate (NO3) to nitrogen gas actually removes nitrogen from the system. A side result and benefit of de-nitrification is the recovery of oxygen and reduction of total oxygen requirements. Oxygen recovery is approximately 2.86 lb O2 per lb (kg/kg) of NO3 reduced and removed.

Total Oxygen Requirements

Field oxygen requirements for BOD removal can be computed as:

> Carbonaceous demand + Nitrogen demand Credit for oxygen recovered by de-nitrification

Each treatment process and each waste must be evaluated to determine field oxygen requirements. Refer to tech bulletins for details and examples for your process.

See EDI Technical Bulletins:

> 128 EDI Basic Design Calculations – Air volume Requirements and How to Calculate
>
> **134 Factors Influencing Air Requirements to Treat Wastewater**

For specific information on aeration system selection considerations, contact EDI at 573-474-9456.