# Problem of the Day
# 2014.Oct.15

## Discussion

The point was made in yesterday's Problem of the Day (2014.Oct.14) that the extended aeration mode of the activated sludge process is characterized by a low F/M ratio. This is the result of, more importantly, the fact that the extended aeration mode of the activated sludge process is characterized by a long hydraulic residence time (HRT) in the aeration basin and a long mean cell residence time (MCRT). The aeration basin HRT typical of extended aeration activated sludge plants ranges from 18 to 36 hours; the MCRT typical of extended aeration activated sludge plants ranges from 20 to 30 days.

As discussed in an earlier Problem of the Day, the return activated sludge (RAS) flow is **not** included in the aeration basin HRT calculation. **A lot of operators and engineers get this wrong**. Again: **the RAS flow is not included in the aeration basin HRT calculation**.

In the 2014.Sept.22 Problem of the Day, the following equation was presented:

$$\text{Time} = \frac{V}{Q}$$

where Time = either the time it takes to fill a tank, to empty a tank, or the detention in a tank with a volume V and and a flow rate Q either into a tank, out of a tank, or both. This is the equation that will always be used for every question asking about fill time, empty time or detention time. All that is needed to do the calculation is the volume, flow rate and the units required in the answer.

## Problem

In today's problem, we are asked to find the HRT in the aeration basin described in yesterday's Problem of the Day.

**Problem of the Day**: The operator at the Running Springs extended aeration activated sludge plant has found from experience that good sludge and effluent quality result when the F/M ratio is kept at 0.15. The influent flow to the plant is 0.9 MGD with a BOD concentration of 275 mg/L (no primary clarifiers). The MLSS are 74% volatile and the aeration basin volume is 1.2 MG. What is the aeration basin HRT in days?

## Solution

It is helpful to list the information given in the problem statement:

- Influent Q = 0.9 Mgal/d
- $BOD_{INF}$ = 275 mg BOD/L
- No primary clarifiers
- Target F/M = 0.15 lb BOD/d·lb MLVSS (these are the units on the F/M ratio)
- $V_a$ = 1.2 Mgal
- 74% MLVSS = 74 lb MLVSS/100 lb MLSS

Of all the information listed, **we only need the influent flow and aeration basin volume to calculate the aeration basin HRT**. Somewhat unique to this problem is that the **HRT is asked to be given in days**, so this unit is entered between heavy vertical lines followed by the equals sign and the blank railroad track. Also shown is the equation for calculating detention time that is used to populate the railroad track.

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$$\left| \; d \; \right| = \frac{V}{Q} = \frac{\qquad\qquad}{\qquad\qquad}$$

The aeration basin volume and influent flow are entered into the railroad track and units canceled that appear both in the numerator and denominator.

**Problem of the Day**: The operator at the Running Springs extended aeration activated sludge plant has found from experience that good sludge and effluent quality result when the F/M ratio is kept at 0.15. The influent flow to the plant is 0.9 MGD with a BOD concentration of 275 mg/L (no primary clarifiers). The MLSS are 74% volatile and the aeration basin volume is 1.2 MG. What is the aeration basin HRT in days?

$$\left| \; \mathbf{d} \; \right| = \frac{V}{Q} = \frac{1.2 \; \cancel{\text{Mgal}}}{0.9 \; \cancel{\text{Mgal}}} \; \frac{\mathbf{d}}{\;}$$

Already the railroad track only contains the units desired, so the math is complete. The arithmetic gives the answer:

1.2 ÷ 0.9 = **<u>1.3 d</u>**.

Because the detention time is equal to the time it would take to fill the empty aeration tank at the influent flow rate, it is often said that the aeration basin(s) in an extended aeration activated sludge plant will hold a day's flow, as just calculated. And this answer is consistent with range of detention times given for extended aeration plants discussed above, 18 to 36 hours, which is equal to 0.75 to 1.5 days.

Happy calculating!