Problem of the Day

2014.Sept.22

Discussion

While it seems very unintuitive, downright wrong, to many activated sludge wastewater treatment plant operators, it is a fact that the return activated sludge (RAS) flow is not used in calculating the **detention time** in the aeration basin. The Problem of the Day is not an aeration basin detention time calculation, but so many operators have this wrong it is worth repeating: **the RAS flow is not used in calculating the detention time in an aeration basin**.

Wastewater treatment plant operators often have to calculate how long it takes to fill a tank or a reservoir, how long it takes to empty a tank or a reservoir, or what the detention time is in a tank or a reservoir. Whenever a question arises asking about time and includes a volume (V) and flow rate (Q), the equation will be the same:

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

Again, this is the equation that will 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 and flow rate and the units required in the answer.

Problem of the Day: The Little Creek Resource Recovery Facility has two aeration basins and three secondary clarifiers. Primary effluent is mixed with RAS in the Aeration Basin Mix Box (ABMB). Primary effluent flow is 1.8 MGD and the total RAS flow to the ABMB is 840 gpm. One of the aeration basins has recently been out of service, but is being put back on line by opening a gate and splitting the flow from the ABMB to the two aeration basins. How long will it take (hr) to fill the empty aeration basin if it is 110 feet long and 25 feet wide with a water depth of 16 feet when full?

Solution

WWTT's Problem of the Day does not distinguish between math problems that may be on different grade certification tests. This problem is slightly complicated by the fact that the total flow to the ABMB must be calculated (primary effluent flow plus RAS flow). This total flow divided by two is the flow that is filling the empty aeration basin.

It seems rather silly to state the obvious, but this is something that will be important to operators under pressure when taking their certification exams: **two or more numbers cannot be added or subtracted unless they have the same units**. Therefore, in the current problem, 1.8 MGD cannot be added to 840 gpm; they have to be in the same units. It is easy to see that 1.8 Mgal/d is equal to 1,800,000 gal/d. A small railroad track is used to convert 840 gal/min to gal/d.

gal	=	840 **gal**	1,440 ~~min~~
d		~~min~~	**d**

= 1,209,600 gal/d.

Adding this RAS flow to the primary effluent flow and dividing by two [(1,209,600 gal/d + 1,800,000 gal/d)/2] gives 1,504,800 gal/d flowing to the emptying aeration basin. Now the volume of the tank and the flow into it are known so they can be entered into the railroad track (remember: time = V/Q).

Problem of the Day: The Little Creek Resource Recovery Facility has two aeration basins and three secondary clarifiers. Primary effluent is mixed with RAS in the Aeration Basin Mix Box (ABMB). Primary effluent flow is 1.8 MGD and the total RAS flow to the ABMB is 840 gpm. One of the aeration basins has recently been out of service, but is being put back on line by opening a gate and splitting the flow from the ABMB to the two aeration basins. How long will it take (hr) to fill the empty aeration basin if it is 110 feet long and 25 feet wide with a water depth of 16 feet when full?

hr	=	110 ft	25 ft	16 ft	d
					1,504,800 gal

All that is needed to complete the problem is two conversion factors, both well known to all operators, to cancel out unwanted units.

Problem of the Day: The Little Creek Resource Recovery Facility has two aeration basins and three secondary clarifiers. Primary effluent is mixed with RAS in the Aeration Basin Mix Box (ABMB). Primary effluent flow is 1.8 MGD and the total RAS flow to the ABMB is 840 gpm. One of the aeration basins has recently been out of service, but is being put back on line by opening a gate and splitting the flow from the ABMB to the two aeration basins. How long will it take (hr) to fill the empty aeration basin if it is 110 feet long and 25 feet wide with a water depth of 16 feet when full?

hr	=	110 ~~ft~~	25 ~~ft~~	16 ~~ft~~	~~d~~	7.48 ~~gal~~	24 **hr**
					1,504,800 ~~gal~~	~~ft³~~	~~d~~

The arithmetic gives the answer: 110 x 25 x 7.48 x 24 ÷ 1,504,800 = <u>5.2 hr</u>.

Of particular note is that the ft x ft x ft in the numerator cancel out with the ft^3 in the denominator. One of the amazing things about the railroad track (dimensional analysis) is that the units tell you whether you divide or multiply by each conversion factor.