GO WITH THE FLOW: Supplement, cylindrical pipe

Cover Sheet for Instructors/Students

Water and wastewater treatment plants process very large quantities of water, sometimes 20-35 million gallons per day or more, depending on the size of the cities they service. Water Treatment Operators have to know ***how long*** it will take for water to get from one place to another based on "flow rate", which is measured in millions of gallons per day (MGD). The time it takes for water to flow from one end of a pipe or tank to the other is called "detention time".

Water Treatment Operators introduce chemicals into the water supply to remove particles in the water and to disinfect it so it is safe to drink. Have you had the experience of being in water that has been treated? Well, if you've ever been in a pool then you have been in water treated with chlorine.

Wastewater treatment facilities must treat enormous quantities of water with very specific quantities and combinations of chemicals at very precise moments in time as the water flows from the beginning to the end of the treatment plant. Therefore the plant operators who are responsible for treating the water must be able to calculate the volume of water and the speed at which it moves from one place to another. ("detention time")

Here are some terms and mathematical concepts that must be understood before a student can make these flow rate calculations accurately:

Volume: In this context we will be talking about cylindrical pipes.

The volume of water in a cylinder is obtained by the following calculation:

$\pi r^2 l$ where 'r' is the radius of the pipe and 'l' is it's length (make sure units match)

Conversion: 7.48 gallons of water = 1 cubic ft.

Therefore 1 gallon of water occupies 0.133689 cubic feet.

If we calculate the volume of a pipe in cubic feet, we can easily convert that volume to gallons. In other words we can find out how many gallons would occupy a certain sized container/cylinder.

If you are given flow rate in terms of gallons per ***day***, can you convert that number to gallons per ***hour***? How? What about gallons per ***minute*** or gallons per ***second?***

Now imagine a fixed quantity of water flowing through a pipe…would the water flow more quickly or more slowly if the pipe had a smaller diameter? Are you sure? How can you test this hypothesis?