Determining the Volume of a Closed Water System

fluorescent dye dilution method

Rhodamine WT (Water Tracing) is a bright red, brilliantly fluorescent synthetic dye. It was originally developed for water tracing applications and has subsequently been used in coloring automotive coolants (antifreezes) and inks. Rhodamine WT is also known as Acid Red #388 - CAS Number: 37299-86-8. State of the art fluorometers can detect 10 ppt (parts per trillion) dilution in ideal conditions and 100 ppt [0.1 ppb (parts per billion)] in polluted waters. It can also be detectable by the naked eye at 50 ppb.

When rhodamine dye is exposed to light of a specific wavelength, it fluoresces or "glows" with light of a different, specific wavelength. The intensity of the response is directly proportional to dye concentration and may be measured precisely with a precision fluorometer. Thus an accurately-weighed quantity of dye, when mixed in a unknown volume of water, yields a measureable concentration which is inversely proportional to the volume.

$$\frac{\text{amount of dye added to the system (micrograms)}}{\text{increase in dye concentration (micrograms / liter)}} = \text{system volume (liters)}$$

One bottle containing 400,000 micrograms of dye is supplied. This amount, diluted in 1000 gallons of water yields a concentration of about 100 micrograms / liter. For your convenience, a bottle containing 100 of dye, the TARGET concentration, is provided.

Instructions

1) Draw a representative water sample from the system into the BASELINE sample bottle.
2) Using the system's chemical pot feeder, carefully add all 400,000 micrograms of dye.
3) Rinse the bottle at least four times into the feeder with tap water.
4) With pumps running and all zones open, allow the dye to mix well with system water.
5) Sample repeatedly until dye concentration between samples appears the same.

If, at this point, the dye concentration is less than the TARGET concentration standard of 100 micrograms / liter, add another bottle of dye - repeating steps 2 through 5.

6) Draw a water sample from the system into the FINAL sample bottle.
7) Mail BASELINE and FINAL samples to the laboratory.

Sources of error

The BASELINE sample is not representative of system water.
All of the dye in the bottle does not enter the system.
Dye is not completely mixed with system water before FINAL sample is drawn.
Portions of the system are isolated from circulation.
Dye on hands contaminates FINAL sample.

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