Application Note:
Fluorescent Tracer Studies

How it works...

Rhodamine WT is a highly fluorescent material with the unique ability to absorb green light and emit red light. Very few compounds have this property, so interferences from other substances are very rare. This makes Rhodamine WT a highly specific tracer. The Turner Designs fluorometer is easily configured to shine green light on the sample and detect the red light emitted. The amount of red light emitted is directly proportional to the concentration of the dye, up to 100 parts per billion (100 µg/L). Relative fluorescence readings, dye concentrations, dilution factors, dye travel time, and other parameters provide valuable data used to draw conclusions regarding the water system being studied.

The Model 10-AU Field Fluorometer in use in a fluorescent tracer study.

An Overview

Tracers are compounds, usually dyes or salts, used for measuring, mapping, and monitoring water systems. Tracers are used for measuring water flows, studying and modeling surface and ground water systems, tracing contaminants in emergency response situations, detecting leaks, and measuring tank retention times.

Fluorescent tracers are chosen because they are cost-effective and easily and accurately measured on-site with a portable, field-ready fluorometer.

The ideal tracer is nontoxic, usable in small quantities, cost-effective, easy to measure at very low concentrations, and stable during the course of the study. Rhodamine WT, the fluorescent tracer of choice, meets all of these requirements and is approved for use by the Environmental Protection Agency[1].

An Excellent Tracer System... Selective, Portable, Durable, Cost-Effective, and Convenient

The Turner Designs 10-AU Fluorometer and Rhodamine WT combine to form a near perfect tracer system. The fluorometer can be configured to selectively measure Rhodamine WT with minimal interference from background materials. The instrument's portable, rugged, and waterproof design allows on-site measurement, even in the most remote locations. The 10-AU Fluorometer will directly measure discrete or continuous flow samples in the field, eliminating the need for expensive laboratory analysis. The - hermetically sealed sample cell, automatic range changing, dual beam design, and temperature compensation features make the 10-AU the instrument of choice for fluorescent tracer studies. In addition, the 10-AU can detect as low as 10 parts per trillion (0.01 µg/L) of Rhodamine WT in potable water, and 100 parts per trillion (0.1 µg/L) in industrial and sanitary sewage. This low detectability minimizes the dye required, making this tracer system both economical and convenient.

Flow Measurement

Flow measurement by dye dilution is chosen for its superior accuracy (+/- 2%). This flow measurement technique can accurately measure flows as low as 1 gallon per minute and as high as 1 billion gallons per day. It is the method of choice in cases of turbulent, large volume, and rapidly changing flows. It is also commonly used to measure difficult-to-access flows and flows in large diameter pipes. In these situations, other methods are significantly more expensive, highly inaccurate, or impractical to implement.

To measure water flow, inject the dye at a constant rate and use the fluorometer to determine how much the water stream dilutes it. Multiply the dye injection rate by the dilution ratio to get the flow rate. These highly accurate flow measurements are used to:

Calibrate Flowmeters: Flow metering devices typically have measurement errors of +/- 20% when installed in the field. Flow measurement by dye dilution is an excellent way to routinely check the accuracy of these devices.

Verify Flow Capacity: Wastewater treatment plants use flow measurement by dye dilution to determine if they are operating at their hydraulic limit. Discovering an additional 25% capacity through accurate flow measurement has prevented treatment plants from spending millions of dollars to increase capacity.

Settle Billing Disputes: Municipalities often use flow measurement by dye dilution to settle billing disputes by verifying wastewater flows into treatment facilities. Resolution of a 3% billing error can result in significant savings for the wronged party.

Localize Infiltration: Flow measurement from manhole to manhole is used to determine groundwater infiltration or surface water inflow into a sanitary sewer. Differing flow rates between two points may indicate a leak in the sewer line. Using a dye tracer study to localize infiltration reduces field study time and eliminates the expense of personnel or camera equipment to monitor a sewer line.

Determine Discharge Rates: Flow measurement by dye dilution is used to accurately determine the discharge rate of chemically treated or heated water into natural systems. Accurate flow measurements are required in order to grant discharge permits or to confirm that facilities are in compliance with their discharge permits.

Measure Pump Performance: Power plants and wastewater treatment facilities use dye tracer systems to accurately measure flow in and out of pumps, turbines, condensers, and other flow system equipment; and to troubleshoot, check the performance of, and measure the efficiency of such equipment.

Time of Travel and Dispersion Studies

Time-of-travel and dispersion studies are used to better understand the behavior of a surface or ground water system. In these studies the travel time and distribution of the tracer is of interest. A fluorescent dye tracer system provides the accuracy and ease of on-site measurement critical to successful dispersion and time-of-travel determinations. One example is the use of time-of-travel studies for glacier mapping. Time-of-travel and dispersion studies are often used to map out zones and dilution patterns near sewage and wastewater discharge. This type of zoning is critical when establishing fish harvesting regions and -recreational areas.

Mixing Zone Studies

Engineering consulting firms use fluorescent tracers to determine how quickly a wastewater stream mixes with another body of water. The tracer mimics the behavior of the discharged wastewater. Mixing zone studies are conducted when new plants are built and discharge permits are granted.

Emergency Response

Fluorescent tracers are used to track contaminant spills. Emergency response crews inject Rhodamine WT at the spill site and use the Turner Designs fluorometer to trace the path of the contaminant. Rhodamine WT's physical and chemical properties make it an ideal tracer for pesticide tracking.

Leak Detection

Fluorescent tracers are used to detect leaks in sewers, discharge lines, underground tunnel and cooling systems, and landfills. Leaks as small as 1 gallon per minute can be detected using the 10-AU fluorometer and Rhodamine WT dye.

Tank Retention Time

Tracers are used to measure the time that a given volume of water is retained in a tank. This study is conducted by wastewater treatment plants in order to determine the efficiency of settling tanks and chlorine contact chambers.