PPG-EM Seminars: season 2016
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RADIOTRACER TECHNIQUES FOR INDUSTRIAL AND ENVIRONMENTAL MEASURES

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June 2, 2016

Keywords: Tracers, flow systems, Radioactivity

Introduction

Tracers are materials that are added to the system of study in small quantities and are measured by special measures devices. The use of tracers in hydrology is very old, having been the most different types of tracers used sometimes artificially added directly into the system, and others, is used substances own system, from natural processes or accidental spills. The behavior of these tracers have hydrological parameters that characterize the system. Essential condition for this is that the tracer have similar to the system and to be analyzed behavior. Flow and dispersion measurements in rivers are daily practices, measures through various hydrological techniques, the most accurate and those using chemical tracers (fluorescent dyes) or radioactive (radioisotopes). There are many techniques for flow measurements, however, applied to each particular type of system. The dyes are good tracers, but their effectiveness decreases when the medium under study shows change in its pH, salinity, temperature, photo decay (fluorescence decreases with incident sunlight), the fluid viscosity and opacity. Regarding radioactive, the inconvenience is the acquisition of radiotracer that has restricted and controlled use. The choice of tracer is crucial in this study, therefore, a prior study is required for the system after choosing what the best tracer to be applied. The tracer must have physical/chemical characteristics similar to the studied system. There is a specific tracer technique for each type of systems that are found in industries or the environment, such systems have for example: industry mixers; complex systems, whose volumes are defined, such as ducts or partially filled volume variation; also confluent and divergent systems.

The aim of this paper is to present the practicality of tracer techniques, describing the stimulus and response technique applied in studies in systems in industries and the environment. As secondary objective will be described the methodology for flow calculation in transient ducts time.

Tracers

When studying the characteristics of a flow system is normally used to tracer technique consisting in adding a previously marked material, the system being studied it and observed moving in the middle. For the tracer behavior information (labeled population) in the middle represents the actual conditions of the main flow, it is necessary that the tracer must be the same features of the system. The main fluorescent tracers used are: Fluorescein, Rhodamine B. Since the radiotracer commonly used in liquid, Bromine-82, gaseous Iodine-123 and oils, Antimony-124 [1].

Technical Stimulus Response

The tracer technique known as stimulus-response, where the stimulus is the tracer and the answer are the results of properly set specific meters (input and output system) are applied and can be associated with mathematical operators, where: $X(t)$ the input function (tracer injection); $Y(t)$ the output function (system response to the input stimulus); and $F(t)$ is the transfer function (system action depends on the internal process), as shown in the flowchart of Figure 1 and equation 1.

$$Y(t) = X(t)F(t)$$

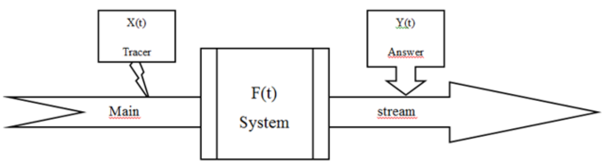

Figure 1: Scheme of the mathematical representation of the stimulus-response technique.

Changes caused by the distribution of the tracer in the medium, as it moves through unit are process characteristics, but the recorded response $Y(t)$ depends on both the system action, shown by $F(t)$, and the process injection of the tracer, given by $X(t)$. Thus we measured input and response by detectors, and solved the equation 1 for studying the system.

Time Transient Methodology

The flow of the fluid is measured from the difference between the tracer pulse signal measured at two different points. It consists of the injection of the tracer and after some distance, are positioned two detectors, which record the passage of the radioactive cloud. For the relationship between the two measurement points and the time difference of radioactive cloud passage between the two detectors is calculated from the displacement velocity of the fluid, and determines the flow rate by the product of fluid velocity and cross-sectional area straight pipe. Figure 2 represents schematically the experimental and equation 2 expresses the flow calculation [2].

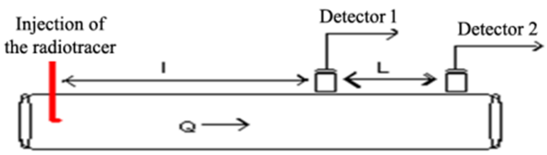

Figure 2: Schematic Arrangement of Transient Time methodology.

$$Q = \frac{\text{volume}}{\text{time transient}} = \frac{SL}{dt}$$

where S is the cross-sectional area of the duct, L is the distance between detectors and dt is the transient cloud passage time of the radiotracer by the two detectors.

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