TRACER APPLICATIONS IN INDUSTRIAL PROCESSES CONTROL

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The Tracer Applications Group has as a main objective to apply tracers in several engineering and industry fields for example: flow rate determinations in rivers and channels, mean residence time in lakes and mercury mass determinations in sodium/clorine industry. During the 2002-2003 years we has the following activities:

Mean Residence Time Distribution in Wastewater Treatment Plant

The radiotracer, ^{82}Br or ^{131}I is instantaneously injected in the wastewater lake inflow section. After that its detection is made in the outflow section by using one spectrometer provided with one 2" NaI(Tl) scintillation probe. The tracer activity generally is between 2mCi and 60 mCi. The resulting graphic Counts(cpm) vs. Time(hours) allows us to obtain several informations concerning to the lake operation and the main data is the Mean Residence Time MRT used to characterize if the lake is having a good or bad operation. Another parameters are the existence or not of short-circuit between inflow and outflow sections; useful volume and wind influence on wastewater behavior in the lake or digester. We performed several Mean Residence Time determinations in digesters with 9,500m^3 up to 10,500 m^3 (FIG.1).

FIGURE 1 - Mean Residence Time Distribution in Wastewater Treatment Plant.

Liquid Flow Rate Determination by Using Continuous Injection Method.

The tracer, usually ^{82}Br, is injected at constant flow-rate q(cm^3/s) and concentration Co(m Ci/cm^3). In the downstream section the tracer is monitored with a spectrometer provided with one 2" NaI(Tl) probe and simultaneously liquid samples are taken in order to determine the concentration C(m Ci/cm^3) under the flow-rate Q(cm^3/s). Thus the channel flow-rate, Q, is given by: qCo = (Q+q)C. As q value is always lower than channel flow Q, it considers that for practical purposes, Q+q = Q.

Then, qCo = QC or Q = (qCo)/C.

We have made flow-rate determinations in channels from 0.002 m^3/s up to 4.0 m^3/s.

Mercury Mass Determination in Electrolytic Cells

The technique of dilution analysis allows to determine the mercury mass that is into each electrolytic cells of a soda/clorine production plant. The analysis is based on instantaneous injection of a tracer, in this case ^{203}Hg with well known values of mass and activity, into the cell that contains the unknown mass. Later, after one week in a mixing process (varying according to the cell volume) it is taken one sample of each cell in order to determine the dilution factor and consequently the total mass. Generally to analyze one 2,000 kg mercury cell it is necessary to use 30 mCi of tracer (15uCi / kg). Due to the low concentration of the tracer it is necessary to detect it in a very sensible pulse analysis system with a 3" x 3" NaI(Tl) well counter. The maximum calculation error is lower than 0,25% for each analyzed cell.. Additionally this technique allows to know the cell performance and in most cases to determine the amount of mass missed to the environment.

Liquid Flow Transit Time Determinations

The liquid flow transit time between two sections can be determined injecting the tracer instantaneously in the inflow section and detecting it in the outflow section. The uesed tracer is ^{82}Br or ^{131}I.

The detection equipment is a portable spectrometer with 2" NaI(Tl) probe. The tracer detection is plotted in a curve in terms of counts per minute vs. time. The transit time value can be assumed as the elapsed time between the injection and the curve peek. When this technique is applied in a natural channel (river) it can obtain another important information beyond the transit time for example the existence or not of retention zone caused by border vegetation or even some hydraulic construction.