1.061 / 1.61 Transport Processes in the Environment
Fall 2008

Residence Time Distribution and System Circulation

BEFORE COMING TO LAB:
Neatly draw the Residence Time Distribution for 1) a Plug Flow Reactor, 2) a Stirred Reactor, and 3) a system with Short-Circuiting. On each graph be sure to note the position of the mean hydraulic residence time, T_R, and the detention time, T_{det}. Clearly state the assumptions of each circulation model. **One copy of this will be handed in at the beginning of lab, and one copy should be included in your lab notebook.**

Objectives: Estimate detention time and nominal residence time in a model basin

Record Experimental Set-up
Make a detailed sketch of the experiment. Include sufficient detail that you could recreate the experiment from your sketch ten years hence. Record the length, *L*, width, *W*, and depth, *H*, of the model basin with uncertainty. Measure and record the flow rate, Q, with uncertainty. Estimate the nominal residence time, T_R, including uncertainty. Include units.

Case 1 – Open Basin
In this section you will observe the circulation and estimate the effective residence time for an open basin. Record the following observations.
- Sketch the circulation indicating dead-zones [regions of slow or no motion], recirculation zones and the main flow zone.
- Estimate the surface area of each zone with uncertainty.
- Estimate the residence time in the flow zone, t_{fz}. Include uncertainty.

- *Lagrangian Tracer Experiment*. Release a series of 50 beads at the inlet. Record the residence time of each bead. Plot the residence times in a histogram. Based on this Residence Time Distribution (RTD) is the circulation closest to plug flow, well-stirred or short-circuiting? Defend your answer with specific details from the RTD and your sketch of the circulation pattern.
- Calculate the average arrival time of the beads, t_{ave}.
- Which one of the time-scales, t_{ave}, T_R and t_{fz}, best represents the effective residence time in the model. Why? Describe what each time-scales represents.

Case 2 – Engineered Basin
Using the Plexiglass walls provided improve the residence time distribution by manipulating the flow pattern in your model basin. Your goal is to minimize the ratio σ_t/t_{ave}, and maximize the average residence time, *i.e.* t_{ave} approaching T_R. Repeat the *Lagrangian Tracer Experiment* to evaluate t_{ave} and σ_t

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