Radioisotope and Radiation Applications
EXERCISES
Week 5a

Topic: Industrial Applications: Gauges

Problem 27:
Show why the maximum sensitivity of a level gauge is obtained for $\mu \cdot x = 1$.

Problem 28:
A smoke detector contains a ^{241}Am source with an activity of 30kBq. (This is the typical range.) What is the mass of the ^{241}Am?

Topic: Industrial Applications of tracer techniques to fluid dynamics

Assume in all of the following exercises that the transit time of the radiotracer through the system is very short in comparison to its half life, so that nuclear decays of the tracer in the system can be neglected.

Problem 29:
Show that the detector response at B (see figure on slide 6 of lecture week 5a/part2) is a direct measure of the RTD of tracer particles, provided that:

- the tracer is injected as an instantaneous pulse, and
- the flow rate Q through the system is constant.

Problem 30:
Show that (using the tracer dilution method) the flow rates Q for the total sample method and the total count method are given by $Q = qA_T/a$ and $Q = A_T F/N$, respectively. (A_T = activity of the tracer, q =sampling rate, a =tracer activity in the sample, F =calibration factor, N =total number of counts)

Problem 31:
Show that, after an instantaneous pulse at the inlet, the tracer concentration will decrease exponentially in a rapidly stirred tank. Assume a constant flow rate through the tank.

Problem 32:
Show that the MRT for tracer particles between injection and monitoring is given by (Q =flow rate, N_T =total number of tracer particles injected, $C(t)$ =tracer concentration at B at time t):

$$\text{MRT} \;=\; \frac{Q}{N_T}\int_0^\infty t\,C(t)\,dt$$