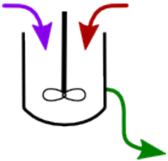
Introduction to Reactor Design

ChE 3K4



Kevin Dunn, 2013

(with credit to Dr. P. Mhaskar for many of the slides)

kevin.dunn@mcmaster.ca

http://learnche.mcmaster.ca/3K4

Overall revision number: 29 (April 2013)

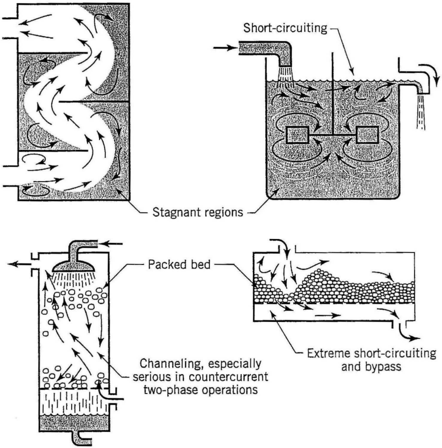
Residence time distribution (RTD)

RTD may be used to characterize nonideal flow behaviour in chemical reactors, and determine its effect on performance.

Examples of non-ideal behaviour:

- channeling
- bypassing
- dead volume

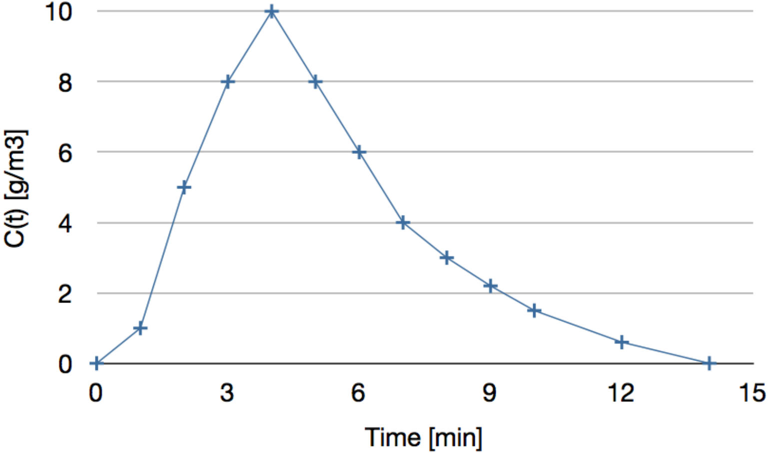
- Always reduces reactor performance



Derivation: pulse injection

- A total amount N_0 of tracer is injected [mol] **as a pulse** at the reactor entrance
- Concentration at the outlet is measured in periods of Δt duration
- Concentration is $C(t)\ \left[\text{mol.m}^{-3}\right]$ during this time, and is constant during Δt

Example: pulse injection made at $t = 0$



Time	0	1	2	3	4	5	6	7	8	9	10	12	14
Conc	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

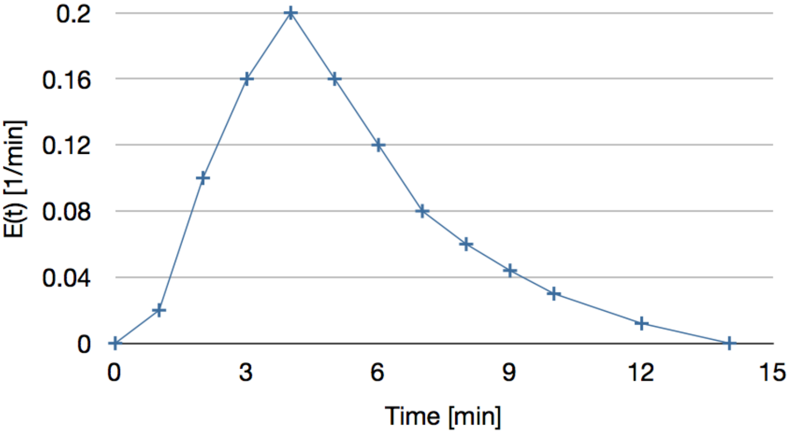
Interpretation

$$\int_{t1}^{t2} E(t)\, dt$$

- is the fractional amount of material leaving reactor that has spent between time t_1 and t_2 in the reactor.
- This implies

$$\int_0^{\infty} E(t)\, dt = 1$$

Example: pulse injection



Note it is just a rescaled version of $C(t)$ since q is constant.

CSTR's in series: tracer experiments