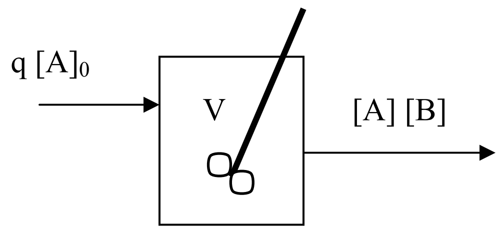
Consider the unconstrained optimization of a CSTR with volume V.

$$A \rightarrow B$$
$$r = k[A]$$



The goal is to maximize F_B with respect to changes in the volumetric flow rate, q.

$$F_B = q[B]$$

Steady state material balances on species A and B give:

$$0 = F_{A0} - F_A - rV = q([A]_0 - [A]) - kV[A]$$
$$0 = F_{B0} - F_B + rV = -q[B] + kV[A]$$

Hence,

$$[B] = k[A](V/q)$$

and

$$F_B = rV = k[A]V\ ;$$

thus production of B is maximized when [A] takes its maximum value, which is $[A]_0$.

Continuing with the material balances, we find:

$$[A] = \frac{[A]_0}{1 + (kV/q)} = \frac{[A]_0}{1 + k\tau}$$

When Da = kτ << 1, [A] goes to $[A]_0$.

$$F_B = rV = kV[A] = \frac{kV[A]_o}{1 + k\tau} = \frac{kV[A]_o}{1 + kV/q}$$

$$\lim_{q\to\infty} F_B = \lim_{q\to\infty}\left(\frac{kV[A]_o}{1 + kV/q}\right) = kV[A]_0$$

Unfortunately, in the limiting case of infinite flow rate, the concentration of B in the output solution is vanishingly small:

$$\lim_{q\to\infty}[B] = \lim_{q\to\infty}\left(k[A](V/q)\right) = \lim_{q\to\infty}\left(k\frac{[A]_0}{1 + (kV/q)}(V/q)\right) = 0\ .$$