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 \( Da = k\tau \ll 1 \), \([A]\) goes to \([A]_0\).

\[
F_B = rV = kV[A] = \frac{kV[A]_0}{1 + k\tau} = \frac{kV[A]_0}{1 + kV / q}
\]

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

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

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