Derivation for time dependent gas mixture in a perfectly stirred reactor with an open system

My assumptions are: ignore surface reactions, heat loss

\* = in

= outlet mass flow rate

= inlet mass flow rate

= mass density

V = reactor volume

= gas temperature

= residence time

Mass conservation

Species equation

Substitute continuity

Expand terms

Cancel terms

Which simplifies to

Where

Energy Equation

This reactor is constant pressure, but even though there is a constant total volume there is not constant specific volume

Definition of enthalpy

because constant pressure, substitute equation into equation terms cancel

Therefore we can conserve enthalpy instead of energy, energy is still conserved but would need an additional equation from ideal gas law to calculate if we would want to conserve energy instead of enthalpy.

Substitute continuity

Expand terms

Cancel terms

Substitute species equation

Expand terms

Cancel terms

Substitute