Are the Test Problems Well Posed with $C_H = C_M = 0$?

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Figure: Equal diffusion coefficient elemental mass balance at ablating surface for decomposing material.

\[
\rho_e u_e C_M (\tilde{\omega}_{k_w} - \tilde{\omega}_{k_e}) + (\rho v)_w \tilde{\omega}_{k_w} - \dot{m}_c \tilde{\omega}_{k_c} - \dot{m}_{pg} \tilde{\omega}_{k_{pg}} = 0 \tag{1}
\]

\[
\tilde{\omega}_{k_w} = \frac{\rho_e u_e C_M \tilde{\omega}_{k_e} + \dot{m}_c \tilde{\omega}_{k_c} + \dot{m}_{pg} \tilde{\omega}_{k_{pg}}}{\rho_e u_e C_M + \dot{m}'' + \dot{m}''_{pg}} \tag{2}
\]

\[
(\rho v)_w = \dot{m}_c + \dot{m}_{pg} \tag{3}
\]
Element Mass Balance (con’t)

If $\rho_e u_e C_M \neq 0$ then

$$\tilde{\omega}_k = \tilde{\omega}_k e + B'_c \tilde{\omega}_k c + B'_pg \tilde{\omega}_k pg \frac{1}{1 + B'_c + B'_pg}$$  \hspace{1cm} (4)

If $\rho_e u_e C_M = 0$, $B'_c$ and $B'_pg$ are undefined. For $\rho_e u_e C_M = 0$

$$\tilde{\omega}_k = \frac{m''_c \tilde{\omega}_k c + m''_pg \tilde{\omega}_k pg}{m''_c + m''_pg}, \quad \rho_e u_e C_M = 0 \quad \text{ (5)}$$

If $\rho_e u_e C_M = 0$ also corresponds to no ablation ($m''_c = 0$) then

$$\tilde{\omega}_k = \tilde{\omega}_k pg, \quad \rho_e u_e C_M = 0 \text{ and } m''_c = 0 \quad \text{ (6)}$$

Different from Eq. (4) with $B'_c = 0$

$$\tilde{\omega}_k = \frac{\tilde{\omega}_k e + B'_pg \tilde{\omega}_k pg}{1 + B'_pg}, \quad B'_c = 0 \quad \text{ (7)}$$
Replace $C_H = 0$ by $C_H = 0.003$

Scale time by factor of 12
Recommendations

- Replace $\rho_e u_e C_H = 0$ with a finite but non zero value
  - Eliminates each code developer selecting their own value
  - Eliminates ambiguity in what $B'_c$ and $B'_{pg}$ values are associated with $\rho_e u_e C_H = 0$
  - Eliminates potentially very large and non-physical values for $B'_c$ and $B'_{pg}$

- Reduced time scale reduces cpu time by a factor of 12
  - Important physics is not sacrificed
  - Debugging is significantly faster

- Eliminate blowing correction
  - Forces all code developers to implement the same blowing correction even though they may not want to use it for their problems