Formulation

We write the energy equation in the form:

$$\frac{2}{3} n \left(\frac{\partial}{\partial t} + \mathbf{v}\cdot\nabla\right) T + P\, \nabla\cdot\mathbf{v} = -\nabla\cdot\mathbf{q} \qquad (1)$$

where the choice of $\mathbf{q}$ determines the closure. In the reactive model the closure is made at this stage in the fluid hierarchy. The choice for $\mathbf{q}$ is the Righi Le-Duc, diamagnetic heat flow:

$$\mathbf{q} = \mathbf{q}_{*} = \frac{5}{2}\frac{P}{m\Omega}(\mathbf{e}_{\|} \times \nabla T) \qquad (2)$$

Gyro fluid models add a complex Gyro-Fluid resonance, either at this level or at a higher level in the fluid hierarcy. In both cases the result can be reduced to the form:

$$\mathbf{q} = \mathbf{q}_{*} + i\, \mathbf{q}_{gl} \qquad (3)$$

The resulting energy equation is:

$$\frac{\delta T}{T} = \frac{\omega}{\omega - \frac{5}{3}\varpi_D}\left[\frac{2}{3}\frac{\delta n}{n} - \frac{\omega_{*e}}{\omega}\left(\frac{2}{3} - \eta\right)\frac{e\phi}{T_e}\right] \qquad (4)$$

Here ϖ_D equals ω_D for the reactive model and $\omega_D + i\,\omega_{gl}$ for a gyro Landau model where ω_{gl} is directly related to $\nabla\cdot\mathbf{q}_{gl}$ which was introduced in (3).
An important property of (14) is that it also includes the isothermal limit when $\varpi_D >> \omega$.

The linear threshold in the nonlocal strong ballooning limit is: (S.C. Guo and J. Weiland, Nuclear Fusion **37**, 1095 (1997))

$$\eta_{ith} = \frac{2}{3} + \frac{10}{9\tau}\varepsilon_n \qquad (5)$$

with real frequency given by:

$$\omega_r = \frac{5}{3}\mathrm{Re}(\hat{\omega}_{Di})$$