Class 16

Particle Reactions

Table 2.6: Convective and Conductive Heat Transfer for Particle Model

Type	Equation
Particle enthalpy	$h_j = \frac{\alpha_{wj} h_{wj} + \alpha_{cj} h_{cj} + \alpha_{hj} h_{hj} + \alpha_{aj} h_a}{\alpha_j}$ (2.125)
Particle-gas heat transfer	$Q_i = Nu_{jg} \pi \left(\frac{B_j}{\exp B_j - 1} \right) k_g \left(T_j - T_g \right) d_j$ (2.126)
Nusselt No.	$Nu_{jg} = 2.0 + 0.65 \mathrm{Re}_{jg}^{0.5} \mathrm{Pr}_g^{0.333}$ (2.127)
Transpiration parameter	$B_j = \frac{r_j C_{pg}}{2 \pi d_j k_g}$ (2.128)
Reynolds No.	$\mathrm{Re}_{jg} = \frac{d_j \left\| \vec{v}_g - \vec{v}_j \right\| \rho g}{\mu_g}$ (2.129)
Prandtl No.	$\mathrm{Pr}_g = \frac{C_{pg} \mu_g}{k_g}$ (2.130)
Liquid enthalpy	$h_{wj} = h_{fwj}^0 + \int_{298}^{T_j} C_{pwj} dT_j$ (2.131)
Raw coal enthalpy	$h_{cj} = h_{fcj}^0 + \int_{298}^{T_j} C_{pcj} dT_j$ (2.132)
Char enthalpy	$h_{hj} = h_{fhj}^0 + \int_{298}^{T_j} C_{phj} dT_j$ (2.133)
Ash enthalpy	$h_{aj} = h_{faj}^0 + \int_{298}^{T_j} C_{paj} dT_j$ (2.134)
Volatiles enthalpy	$h_{vjm} = \frac{h_{cj} - h_{hj} \left(1 - Y_{jm} \right)}{Y_{jm}}$ (2.135)
Total particle product gas enthalpy	$h_{jg} = \frac{1}{r} \Big[\sum_m r_{vjm} h_{vjm} + h_{hj} \sum_l r_{hjl} + r_{wj} h_{wj} + \zeta \Big(\sum_m r_{vjm} \Delta h_{jm}^r + \sum_l r_{hjl} \Delta h_{jl}^r + r_{wj} \Delta h_w^v \Big) \Big]$ (2.136)
Particle heat of formation	$h_{fj}^O = \frac{\alpha_{wj} h_{fwj}^O + \alpha_{hj} h_{fhj}^O + \alpha_{cj} h_{fcj}^O + \alpha_{aj} h_{fa}^O}{\alpha_j}$ (2.137)

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Table 2.7: Particle Reactions for Particle Model

Type	Equation
Liquid vaporization rate (non-boiling)	$r_{wj} = \dfrac{S_f A_j k_{jw} \rho_g (X_{wjs} - X_{wb}) + X_{wjs} \sum_m S_f r_{vjm}}{1 - X_{wjs}}$ (2.139)
Liquid vaporization rate (boiling)	$r_{wj} = \dfrac{-Q_j + Q_{rj} + r_{cj}(h_{jg} - h_{cj})\zeta + r_{hj}\zeta(h_{jg} - h_{hj})}{\zeta(h_{jg} - h_{wj})}$ (2.140)
Particle reaction rate to gas phase	$r_j = \sum_l r_{hjl} + \sum_m r_{vjm} + r_{wj}$ (2.141)
Net char reaction rate	$r_{hj} = \sum_m r_{hjm} - \sum_l r_{hjl}$ (2.142)
Oxidizer-char reaction rate	$r_{hjl} = \dfrac{A_j^2 M_{hj} M_g \phi_l k_{cji} k_{jl} \zeta_j C_{o\lg} C_g}{M_g A_j C_g (\zeta_j k_{jl} {}_{-} k_{cjl}) + r_j}$ (2.143)
Kinetic char reaction rate coefficient	$k_{jl} = A_{jl} T_j^n \exp\left(\dfrac{-E_{jl}}{RT_j}\right)$ (2.144)
Transpiration parameter for mass transfer	$B_{jl} = \dfrac{r_j}{2\pi D_{im} \rho_g d_j}$ (2.145)
Mass transfer coefficient	$k_{cji} = \dfrac{Sh_{jg} D_{im} B_{ji}}{d_j (\exp B_{ji} - 1)}$ (2.146)
Total coal reaction rate	$r_{cj} + \sum_m - r_{cjm} = -\sum_m (r_{hjm} + r_{vjm})$ (2.417)
Volatile production rate	$r_{vjm} = k_{mj} Y_{mj} \alpha_{cj}$ (2.418)
Char production rate	$r_{hjm} = \dfrac{r_{vjm}(1 - Y_{mj})}{Y_{mj}}$ (2.419)
Coal kinetic rate coefficient	$k_{mj} = A_{mj} \exp\left(\dfrac{-E_{mj}}{RT_j}\right)$ (2.150)

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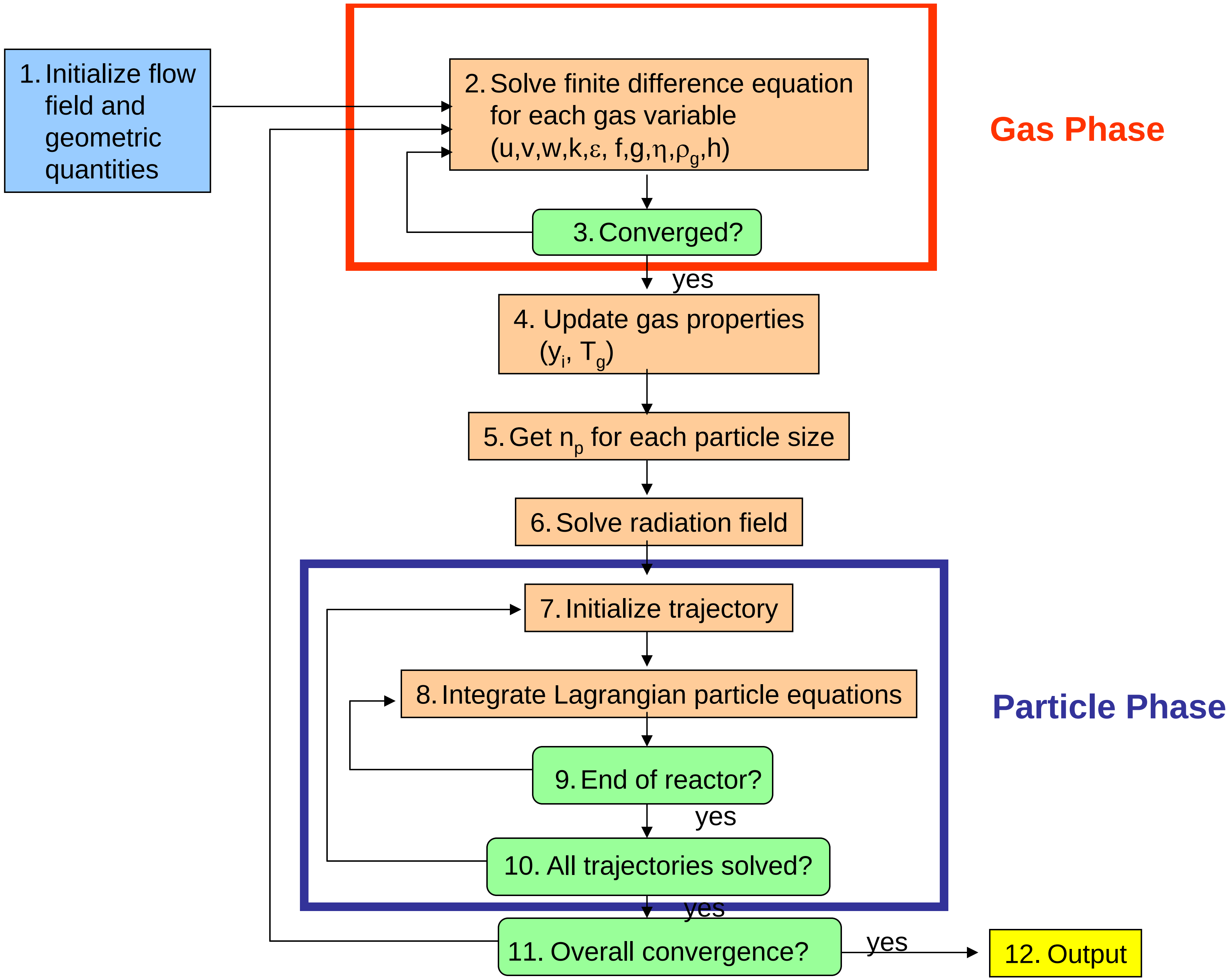

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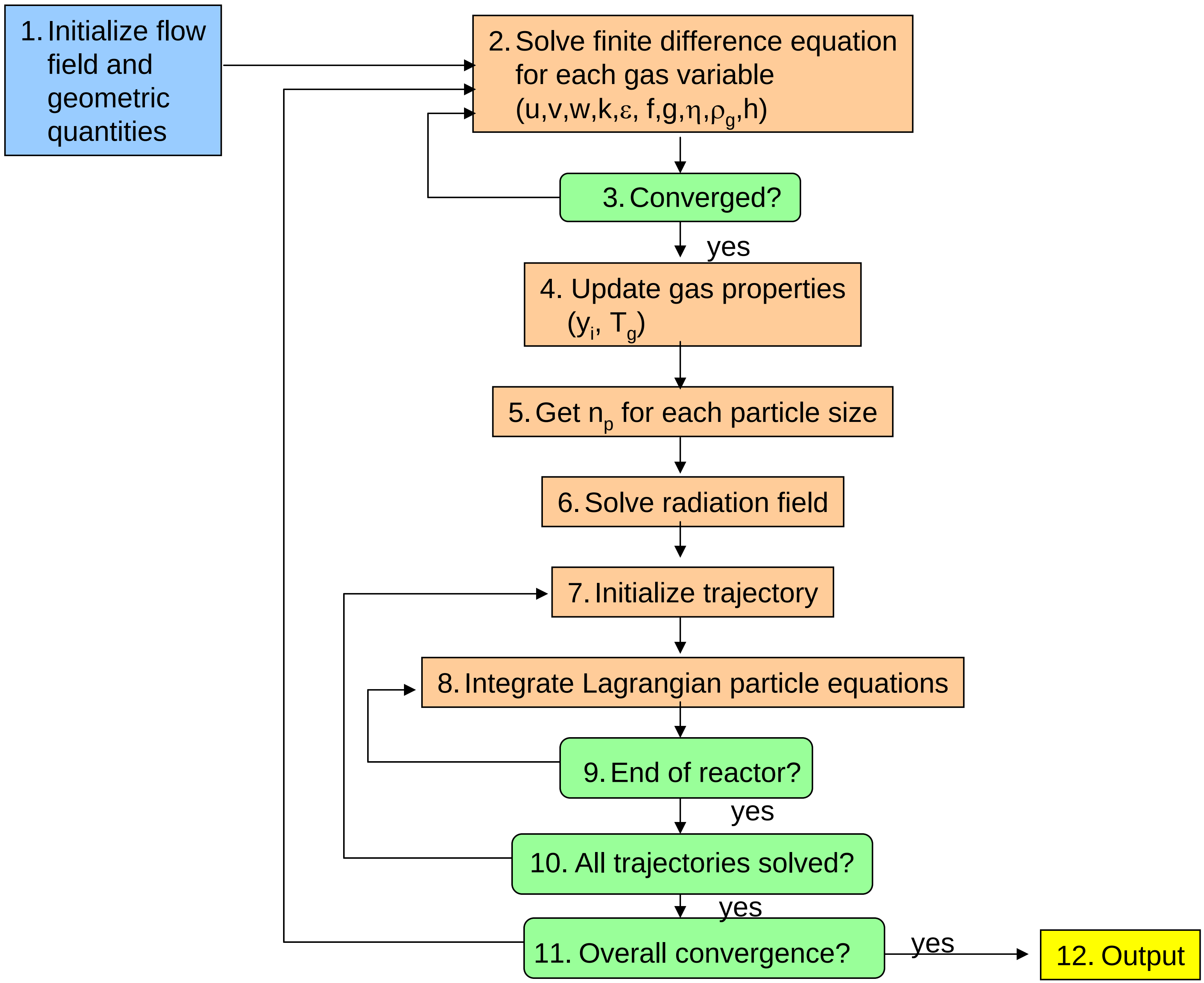

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