PeGn624 Homework # 13

- Assigned: Monday, February 23, 2009
- Due: Monday, March 2, 2009

1 Question 1: Left-Hand-Side Expansion

The primary variables are P_o, S_o, T. When $T < T_s$, $S_g = 0$ and T_s is used as the fourth primary variable. When $T \geq T_s$, S_g is used as the fourth primary variable.

1.1 Part (a): Water Equation

Eq. 1.1 represents the left-hand-side of the water component equation. In homework #10, you expanded this in terms of P^{n+1}. Now complete this expansion in terms of δP_o for a 1D problem. Collect terms for δP_o.

$$\mathsf{LHSW} = \Delta\left(T_w^n \zeta_w^n X_{w1}^n (\Delta P_w^{n+1} - \gamma_w^n \Delta D\right) + \Delta\left(T_g^n \zeta_g^n Y_{w1}^n (\Delta P_g^{n+1} - \gamma_g^n \Delta D\right) + q_w \zeta_w X_{w1} + q_g \zeta_g Y_{w1} \tag{1.1}$$

1.2 Part (b): Oil Equation

Eq. 1.2 represents the left-hand-side of the oil component equation. In homework #10, you expanded this in terms of P^{n+1}. Now complete this expansion in terms of δP_o for a 1D problem. Collect terms for δP_o.

$$\mathsf{LHSO} = \Delta\left(T_o^n \zeta_o^n X_{w1}^n (\Delta P_o^{n+1} - \gamma_o^n \Delta D\right) + q_o \zeta_o X_{o2} \tag{1.2}$$

2 Question 2: Energy Equation Expansion

For the energy equation expansions, note that $H(T)$ is a function of T only. U is a function of $H(T)$, P, and $\zeta(P, T)$.

2.1 Part (a): Left-Hand-Side for $T < T_s$

Eq. 2.1 represents the left-hand-side of the energy equation. Complete this expansion in terms of the primary variables for a 1D problem. Collect terms for δP_o, δT, δS_o, and δT_s.

$$\mathsf{LHSE} = \Delta\left(T_w^n \zeta_w^n X_{w1}^n H_w^n (\Delta P_w^{n+1} - \gamma_w^n \Delta D\right) + \Delta\left(T_g^n \zeta_g^n Y_{w1}^n H_g^n (\Delta P_g^{n+1} - \gamma_g^n \Delta D\right) +$$
$$\Delta\left(T_o^n \zeta_o^n X_{w1}^n H_o^n (\Delta P_o^{n+1} - \gamma_o^n \Delta D\right) + \Delta\left(T_e^n \Delta T\right) + q_w \zeta_w X_{w1} H_w + q_g \zeta_g Y_{w1} H_g + q_o \zeta_o X_{o2} H_o \quad (2.1)$$

2.2 Part (b): Left-Hand-Side for $T \geq T_s$

Eq. 2.1 represents the left-hand-side of the energy equation. Complete this expansion in terms of the primary variables for a 1D problem. Collect terms for δP_o, δT, δS_o, and δS_g.

2.3 Part (c): Right-Hand-Side for $T < T_s$

Eq. 2.2 represents the right-hand-side of the energy equation. Complete this expansion in terms of the primary variables for a 1D problem. Collect terms for δP_o, δT, δS_o, and δT_s.

$$\mathsf{RHSE} = \frac{\mathsf{VR}}{\Delta t} \Delta_t \left(\phi (S_w \xi_w X_{w1} U_w + S_g \xi_g Y_{w1} U_g + S_o \xi_o X_{o2} U_o)\right) + \frac{\mathsf{VR}}{\Delta t} \Delta_t \left((1-\phi)(\rho_R C_R T)\right) \quad (2.2)$$

2.4 Part (d): Right-Hand-Side for $T \geq T_s$

Eq. 2.2 represents the right-hand-side of the energy equation. Complete this expansion in terms of the primary variables for a 1D problem. Collect terms for δP_o, δT, δS_o, and δS_g.