

# 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  $\delta P_o$  for a 1D problem. Collect terms for  $\delta P_o$ .

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

### 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  $\delta P_o$  for a 1D problem. Collect terms for  $\delta P_o$ .

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

## 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  $\delta P_o$ ,  $\delta T$ ,  $\delta S_o$ , and  $\delta T_s$ .

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

## 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  $\delta P_o$ ,  $\delta T$ ,  $\delta S_o$ , and  $\delta S_g$ .

## 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  $\delta P_o$ ,  $\delta T$ ,  $\delta S_o$ , and  $\delta T_s$ .

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

## 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  $\delta P_o$ ,  $\delta T$ ,  $\delta S_o$ , and  $\delta S_g$ .