(A.2) Assume that the extraction factor, P, of a compound is given by the equation

$$P = 10*\theta*(1-2*P*X+ P^2*X^2)$$

where X is the concentration of the compound in the aqueous phase and θ is the flow rate ratio. An extraction battery with two extraction stages and one washing stage is used. The feed concentration, X_F, is 0.9. Neglect phase volume changes and calculate the flow ratios in the extraction and washing stages for 95% product yield at a wash flow rate which is 10% of the feed flow rate.

$X_F := 0.9$ $\quad M := 1$ $\quad N := 2$ $\quad E := 95\cdot\%$

$r := 0..10$

$\theta w_r := 90 + r$ $\quad \theta e_r := \frac{0.1}{1+0.1}\cdot \theta w_r$

$P = 10\cdot\theta\cdot\left(1 - 2\cdot P\cdot X + P^2\cdot X^2\right)$ Solving this eqn for P yields the following 2 results.

$$P(\theta, X) := \frac{1}{\left[20\cdot\left(\theta\cdot X^2\right)\right]}\cdot\left[(1 + 20\cdot\theta\cdot X) + \sqrt{1 + 40\cdot\theta\cdot X}\right]$$

$$P(\theta, X) := \frac{1}{\left[20\cdot\left(\theta\cdot X^2\right)\right]}\cdot\left[(1 + 20\cdot\theta\cdot X) - \sqrt{1 + 40\cdot\theta\cdot X}\right]$$

Use this solution which limits P at small values of $\theta*X$.

Trial and error graphical solution gives θ_{extr}=8.6 and θ_{wash}=94.6