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1. 7 variables

$P, \dot{m}$

T_2, T_3

$\dot{W}_t, \dot{W}_c, \dot{W}_s$

Inner loop would be Gaussian Elimination

Outer loop would be newton Raphson for ~~each variable~~.

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \end{bmatrix} = \begin{bmatrix} P \\ \dot{m} \\ T_2 \\ T_3 \\ \dot{W}_t \\ \dot{W}_c \\ \dot{W}_s \end{bmatrix}$$

Equation (2) is split into two equations. ($\dot{W}_c$ & $\dot{m}$)

Finding the Jacobian (7×7) :

$$\cancel{\begin{bmatrix} 1 & 45.6-2\dot{m} & 0 & 0 & 0 & 0 & 0 \\ 0.38 & & & & & & \end{bmatrix}}$$

$$\begin{array}{cccccccc}
x_1 & x_2 & x_3 & x_4 & x_5 & x_6 & x_7 & \\
\end{array}$$

$$\left[\begin{array}{ccccccc}
1 & 45.6-2\dot{m} & 0 & 0 & 0 & 0 & 0 \\
0.383-10.26\times10^{-3}P & c_p(T_2-25) & \dot{m}c_p & 0 & 0 & 0 & 0 \\
0.383-10.26\times10^{-3}P & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & c_p(T_2-T_3) & \dot{m}c_p & -\dot{m}c_p & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & -1 & -1 \\
\begin{array}{l}-2.33\times10^{-2} \\ -9.6\times10^{-2}P \\ +1.21\times10^{-4}T_3 \\ +5.4\times10^{-7}PT_3 \\ +1.137\times10^{-7}T_3^2 \\ -4.24\times10^{-10}\,2PT_3^2\end{array} & 1 & 0 & \begin{array}{l}2.6\times10^{-2} \\ -3.6\times10^{-5}T_3 \\ -1.21\times10^{-4}P \\ +5.4\times10^{-7}P^2 \\ +2.2\times10^{-7}\,2PT_3 \\ -4.2\times10^{-10}\,2P^2T_3\end{array} & 0 & 0 & 0 \\
\begin{array}{l}10.06 \\ -6.6\times10^{-2}P \\ -5\times10^{-2}T_3 \\ +17\times10^{-5}PT_3 \\ +2.536\times10^{-5}T_3^2 \\ -8.8\times10^{-8}\,2PT_3^2\end{array} & 0 & 0 & \begin{array}{l}7.47 \\ -7.8\times10^{-3}T_3 \\ -5.09\times10^{-2}P \\ +8.5\times10^{-5}P^2 \\ +4.6\times10^{-5}PT_3 \\ -8.8\times10^{-8}P^2T_3\end{array} & 1 & 0 & 0
\end{array}\right]
\begin{array}{c} f_1 \\ f_2 \\ f_3 \\ f_4 \\ f_5 \\ f_6 \\ f_7 \end{array}
= J$$

7×7

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Newton Raphson for Multiple Variables

$$x^{(k+1)} = x^{(k)} \div \left(J^{-1} f\right)^k = x^k + \Delta x$$

Using $x^{(k)}$, Jacobian is found at that x,

~~and then~~

$$\therefore \quad \Delta x^k = -\left(J^{-1} f\right)^k$$

$$\Rightarrow \quad J \, \Delta x^k = -f$$

we also know f by putting in values at x^k.

Then Δx^k can be found using Gaussian Elimination.

Then we move to $\underline{\underline{x^{k+1}}} = x^k + \Delta x$ and Repeat until convergence.

Pseudo Code:

do while (convergence) ← Newton Raphson Loop

$\quad x^k = x^{k+1}$

$\quad$ Find J ;

$\quad$ Find f ;

$\quad$ ~~$\Delta x =$~~ $J \Delta x = -f$; ← Apply Gauss Elimination

$\quad x^{k+1} = x^k + \Delta x$;

end