Heat loss in zone I:

The expression for heat loss is given as:

$$Q_{loss} = U_o A^{'} (T_{wall} - T_{\infty}) \tag{1}$$

The overall heat transfer coefficient U_o is determined using the following expression:

$$U_o = 1.9468(T_{wall} - T_o)^{1/4}(2.8633\upsilon_o + 1)^{1/2} + 5.75 \times 10^{-8} \varepsilon_{ins} \frac{T_w^4 - T_o^4}{T_w - T_o} \tag{2}$$

The temperature (T_o) can be determined using the energy balance equation as follows:

$$U_o(T_{wall} - T_o) = \frac{k_{ins}}{t_{ins}}(T - T_{wall}) \tag{3}$$

Performance criteria in Taguchi optimization:

i. Larger-the-better. (Calorific value, gasification efficiency).

$$S/N\,ratio = -10\log\left[\frac{1}{n}\sum\frac{1}{Y_i^2}\right] \tag{4}$$

ii. Smaller-the-better. (Pollutants and contaminants.)

$$S/N\,ratio = -10\log\left[\frac{1}{n}\sum Y_i^2\right] \tag{5}$$

iii. Nominal the better

$$S/N\,ratio = -10\log\left[s^2\right] \tag{6}$$

ANOVA

$$(SS) = n(\chi_1 - \overline{m})^2 + n(\chi_2 - \overline{m})^2 + n(\chi_3 - \overline{m})^2, \tag{7}$$

SS= sum of squares, n=number of trials

χ_1, χ_2, χ_3 = mean of all experimental trial for first, second and third level of variables respectively, $\overline{m}$ =mean of all SNR ratio at a time (e.g. mean of 27 experimental trial at a time)

$$SS_{Total} = \sum_{n=1}^{27}(\chi_i - \overline{m})^2 \tag{8}$$

$$SS_{error} = SS_{Total} - SS$$

$$Percentage\ contribution = \frac{SS\ of\ parameter}{SS_{Total}} \times 100 \qquad (9)$$

Table Orthogonal a

A	B	C	D	E
1	1	1	1	1
1	1	1	1	2
1	1	1	1	3
1	2	2	2	1
1	2	2	2	2
1	2	2	2	3
1	3	3	3	1
1	3	3	3	2
1	3	3	3	3
2	1	2	3	1
2	1	2	3	2
2	1	2	3	3
2	2	3	1	1
2	2	3	1	2
2	2	3	1	3
2	3	1	2	1
2	3	1	2	2
2	3	1	2	3
3	1	3	2	1
3	1	3	2	2
3	1	3	2	3
3	2	1	3	1
3	2	1	3	2
3	2	1	3	3
3	3	2	1	1
3	3	2	1	2
3	3	2	1	3