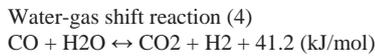Zainal et al. [14] and Higman and van der Burgt [15] stated that Eqs. (2) And (3) can be combined to give the water–gas shift reaction by subtracting equation (2) from equation (3): [13]

Water-gas shift reaction (4)
$CO + H_2O \leftrightarrow CO_2 + H_2 + 41.2$ (kJ/mol)

Another important reaction in the gasification process is the Methane formation reaction that can be expressed in the following form:

Methane reaction (5)
$C + 2H_2 \leftrightarrow CH_4 + 74.9$ (kJ/mol)
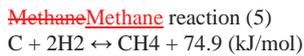
Due to the model's assumptions, in all gasification reactions, the thermodynamic equilibrium is established, and all gases are assumed ideal, and all reactions occur at one atmosphere pressure, and since the equilibrium constants are a function of temperature for the reaction of water-gas shift and Methane reactions, therefore the equilibrium constant is defined and the fourth and fifth equations can be obtained. The equilibrium constant for the reactions (4) and (5) is written as a function of molar ratio of components in equation (5) and (6).

$$(5)$$

$$(6)$$

Where p_i is partial pressure and x_i represents the number of moles of gas components. K_1 is equilibrium constant for water gas shift reaction, and K_2 is equilibrium constant for Methane reaction.

3-2-3 Energy Balance

To obtain equilibrium constants, we need to calculate the gasification temperature of T. For this purpose, the energy balance of the gasification area, which is generally assumed to be adiabatic conditions is used. [14] If the gasification zone temperature is considered to be T, and the input temperature 298 °K, the energy balance can be derived from Equation (7).

$$\sum_{i=react} H^o_{f,i} = \sum_{i=prod} ni(H^o_{f,i} + \Delta H^o_{T,i})$$ (7)

where $H^o_{f,i}$ is enthalpy of formation in kJ/kmol. $\Delta H^o_{T,i}$ is the enthalpy difference between in kJ/kmol that is estimated by equation (9).
By balancing the enthalpy inside the gasifier, the total enthalpy content in any chemical mechanism is equal to the total chemical enthalpy and the chemical enthalpy is expressed as equation (8).

$$(8)$$

We have the following relationship:

$$\Delta h^-_T = \int_{298}^{T} C^-_p (T) dT$$ (9)

Where C_p is Specific Heat Capacity in kJ/ kg·°K, and the value of C_p for the temperature range is calculated by equation (10) [5].

$$(10)$$

C_i is the specific heat capacity of gases. The apparent heat of any gas can be calculated by integration of the above equation from ambient temperature, to gasifier temperature. Table (2) shows the different specific heat capacities of gases.
The HHV relationship can be used to calculate the components of synthesis gas from biomass, and the LHV can be used to calculate the formation heat. Biomass formation heat (Fuel) is calculated according to the following equation: [15]

$$H^o_{f,bio} = LHV + \sum_{i=1}^{n} n_i p_i$$ (11)

LHV is Lower Heating Value in KJ/kg and is based on dried biomass and is calculated using the following equation: [15]