CHAPTER 11

SUMMARY AND CONCLUSIONS

Biomass has been identified as the main alternate energy source. Combustion, gasification and bio-methanation are the routes for the extraction of energy from the biomass. Combustion of biomass to produce power through steam cycle is economical only on a large scale. If the biomass contains more than 60% moisture, the bio-methanation is recommended. Since gasification of biomass is economical at all capacities, power generation through gasification gains importance day by day. Many stand alone power generation units are being installed. The main disadvantage in gasification is the producer gas is diluted by nitrogen thus lowering the specific calorific value.

A close look at the carbon, hydrogen and oxygen contents of different biomasses reveals that every biomass has enough oxygen (bio-oxygen) to convert carbon into carbon monoxide. Moreover ash has been observed to catalyze the gasification thus lowering the temperature. It has been shown that auto-gasification of biomass by bio-oxygen and by catalytic ash is feasible. However achieving uniform temperature throughout the biomass is essential. Bio-residues generated in agricultural processing are powdery and highly porous in nature. When they are heated in the absence of oxygen, complete gasification to ash is achieved due to uniform temperature.

Thermo gravimetric analysis (TGA) was carried out at a heating rate of 5°C/minute with static air or nitrogen resulted in complete gasification
of coir pith dust, thus proving auto-gasification. The kinetic parameters such as Arrhenius frequency factor and activation energy for various stages of gasification have been evaluated and verified satisfactorily.

Transportation cost and gasifier size can be reduced by palletizing the coir pith. When heating the coir pith pellet the temperature is not uniform throughout. Non-uniformity in temperature causes the drying, devolatilization and gasification occurring simultaneously at the appropriate temperature. Heat transfer rate depends upon the properties such as thermal conductivity (k), specific heat (Cp), density (ρ) and porosity of coir pith pellet. Isothermal and non-isothermal heating processes are used. As the heating is in progress, these properties vary with thermal degradation. At any time, the weight loss due to thermal degradation is sum of weight losses due to drying, devolatilization and gasification. However these three stages are taking place at different temperature simultaneously. Therefore determination of average temperature is very important. The present investigation has proposed and verified a procedure for validating this.

Temperature at of the coir pith pellet was measured while heating under isothermal and non-isothermal conditions. The thermal properties such as thermal conductivity (k), specific heat (Cp), density (ρ) are grouped in to one parameter called thermal diffusivity (α). The thermal diffusivities (α) were evaluated using Fourier’s law of heat of conduction. Thermal diffusivity (α) was found to vary with time for a given method of heating since the composition of biomass varied with conversion. The effect of surface temperature (Ts) of coir pith pellet on thermal diffusivity (α) was correlated.

Weight losses of coir pith pellet with time under an isothermal heating at 200, 250, 300, 350, 400, 450 and 500°C were determined experimentally. The rate constant (k) for every minute has been determined
from weight losses. The average temperature ($\bar{T}$) at every minute has been determined using the thermal diffusivity ($\alpha$) correlation developed for isothermal heating. Rate constant and average temperature ($\bar{T}$) was related. A step-by-step procedure to calculate the weight of coir pith pellet yet to be converted with time has been proposed successfully.

Similarly weight losses of coir pith pellet under non-isothermal heating conditions have been determined experimentally. Using this data, rate constants were determined at every minute. Average temperature ($\bar{T}$) was evaluated under non-isothermal heating using the thermal diffusivity ($\alpha$) correlation. Rate constant and average temperature ($\bar{T}$) was correlated. A step-by-step procedure to evaluate the weight of coir pith pellet yet to be converted has been developed for non-isothermal heating and has been verified successfully.

The validity of the correlations has been tested successfully for auto-gasification of coir pith pellet under isothermal heating at 200, 250, 300, 350, 400, 450 and 500°C and non-isothermal heating up to 525°C.

The studies prove that the auto gasification of coir pith is feasible. The data generated in the experiments are used to study the kinetics of auto gasification of coir pith. Since any external medium is not required, the size of the gasifier will be reduced.