Karunya
DEEMED UNIVERSITY
SOLVING HUMAN PROBLEMS
ARISE AND SHINE

CENTRE FOR RESEARCH IN RENEWABLE ENERGY

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Preface

Renewable energy is energy that comes from resources which are continually replenished such as sunlight, wind, rain, tides, waves and geothermal heat. Biomass (plant material) is a renewable energy source. Agricultural waste is a potentially huge source of biomass. Waste from agriculture includes: the portions of crop plants discarded (including forestry waste), whether damaged or surplus supplies, and animal dung. Industrial waste that contains biomass may be used to produce energy. For example the sludge left after alcohol is processed it can produce flammable gas. Other useful waste products include, waste from food processing and fluff from the cotton and textiles industry.

Biomass is any kind of organic waste, which can be transformed in different types of energy. Biomass is very abundant. It can be found on every square meter of the earth as seaweed, trees or dung. It is easy to convert to a high energy portable fuel such as alcohol or gas. It is cheap in contrast to the other energy sources. Biomass production can often mean the restoration of waste land (e.g. deforested areas). It may also use areas of unused agricultural land and provide jobs in rural communities. If it is produced on a renewable basis using biomass energy does not result in a net carbon dioxide increase as plants absorb it when they grow.

A wide range of energy-rich fuels can be produced by roasting dry woody matter like straw and woodchips. Pyrolysis process has been used for centuries to produce charcoal. The material is pulverised or shredded then fed into a reactor vessel and heated in the absence of air. Pyrolysis can also be carried out in the presence of a small quantity of oxygen ('gasification'), water ('steam gasification') or hydrogen ('hydrogenation'). One of the most useful products is methane, which is a suitable fuel for electricity generation using high-efficiency gas turbines.

Gasification process, usually using wood produces a flammable gas mixture of hydrogen, carbon monoxide, methane and other non flammable by products. This is done by partially burning and partially heating the biomass (using the heat from the limited burning) in the presence of charcoal (a natural by-product of burning biomass). The gas can be used instead of petrol and reduces the power output of the car by 40%. It is also possible that in the future this fuel could be a major source of energy for power stations.

Biogas is produced when wet sewage sludge, animal dung or green plants are allowed to decompose in a sealed tank under anaerobic (oxygen-free) conditions. Feedstock like wood shavings, straw and refuse may be used, but digestion takes much longer. Each kilogram of organic material (dry weight) can be expected to yield 450-500 litres of biogas. The residue left after digestion is a potentially valuable fertilizer or compost.

In our Renewable energy laboratory the equipments available are pyrolysis reactor, gasifier, biomethanisation plant, multifuel engine test rig, anaerobic digester, crusher, gas chromatography, ball mill, and sieve shaker.

Gasifier

Gasification is the process in which the biomass is subjected to heating and combustion with limited quantity of air so that partial combustion of the biomass occurs resulting in CO instead of CO_2.

The mixture of H_2 and N_2 is often called producer gas which can be used as source of thermal energy. The producer gas is combusted in an engine which is coupled to an alternator to generate electricity.

Features

Raw materials: wood chips, coconut shell

Quantity: 6-7 kg per batch

Duration of gas production: 1 - 1.30 hrs

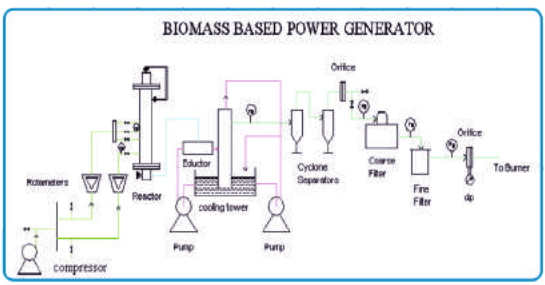
Starting time for gas evolution: approximately 10minutes

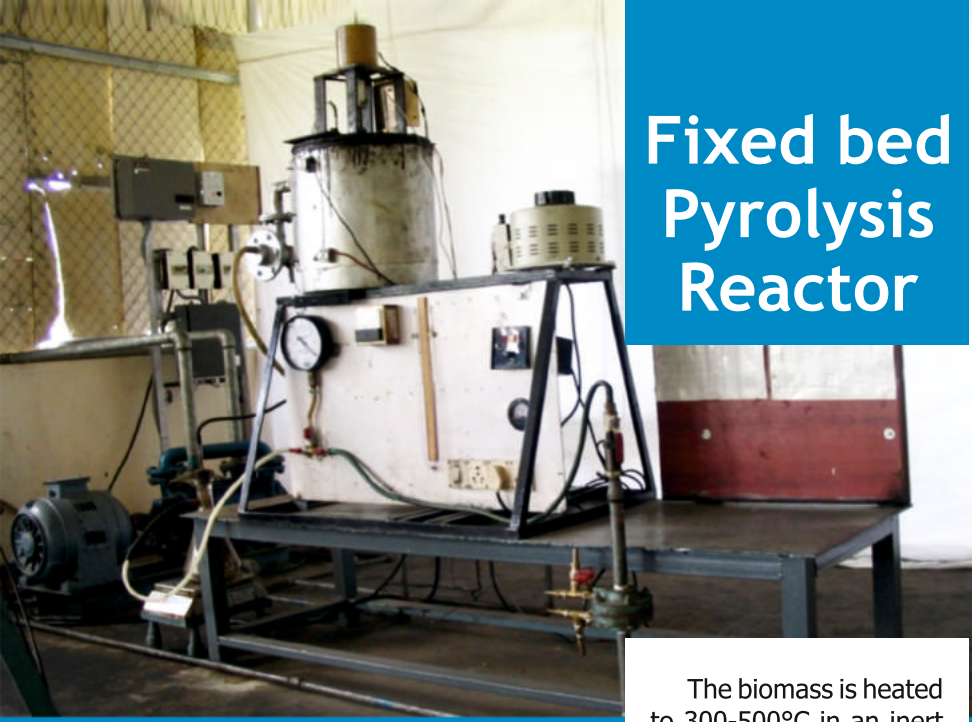
Lower heating value of producer gas: 5.7 MJ/kg
Composition of gas - CO, H_2, CO_2, N_2

Gasification Temperature: 650-900^{0}C

Application

Wood gas produced in a gasifier can be used to power cars with ordinary internal combustion engines.





Fixed bed Pyrolysis Reactor

The biomass is heated to 300-500°C in an inert atmosphere results in the breaking up of large organic molecules into smaller products including hydrocarbons and other organic products is called pyrolysis

Features

Raw materials: waste tires, rice husk, saw dust, edible and non edible oil cakes

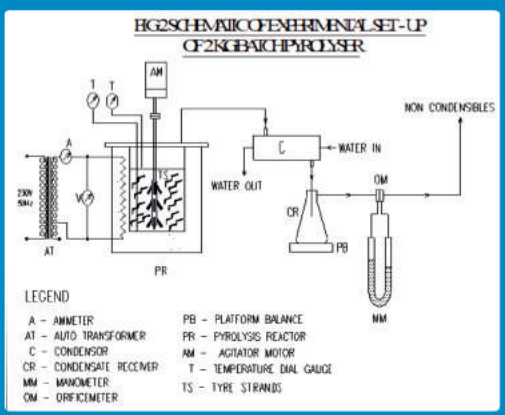
Particle size: 1 to 5 mm

Reactor: batch type, electrically heated

Capacity: 2 kg

Heating power: 1 to 3 KW, single phase, 230 volt AC, regulation by autotransformer

Pyrolysis condition: ambient pressure/vacuum



Application

- The pyrolysis oil can be used as fuel in furnace.
- By transesterification process the highly viscous
- Pyrolysis oil can be converted into biodiesel.
- The biodiesel can be used as a diesel substitute in CI engines.

High Pressure Gasification

The gasification process is carried out at high pressure. It generates synthesis gas which can be used as fuel in a gas turbine.

It can be coupled to an alternator to generate electricity.

Features

Raw material: wood chips

Starting time: 5 minutes

Amount of raw materials: 6 kg

Duration of gas production: 30 minutes

Calorific value of gas: 5.7 MJ/kg

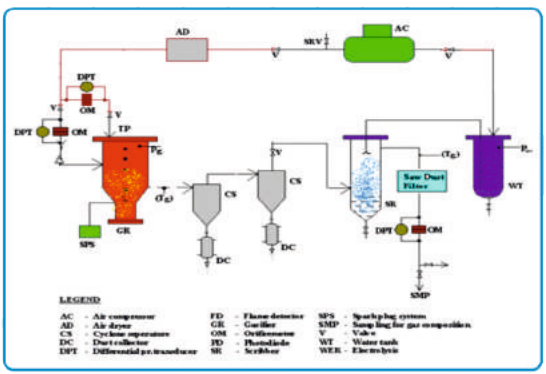
Gas composition: CO, H2, CO2, N2, H20

Application

Gasifier can be coupled with gas turbine for power production.

Wood gas produced in a gasifier can be used to power.

Cars with Ordinary Internal combustion engines.



Fluidized Bed Pyrolysis Reactor

(Electrically heated type)

This is a continuous process in which the biomass instead of being heated in a stationary bed is heated in a flowing stream of hot gas.

Care is taken to ensure that the residence time of the biomass has only 1-2 sec at temperature of 500-550°C. Under this condition, the biomass undergoes an endothermic reaction resulting in predominantly liquid fraction. The fluidizing gas is nitrogen.

Features

Raw materials: waste tires, rice husk, saw dust, edible and non edible oil cakes

Particle size: 0.5 to 2 mm

Reactor: electrically heated type

Pyrolysis condition: ambient pressure

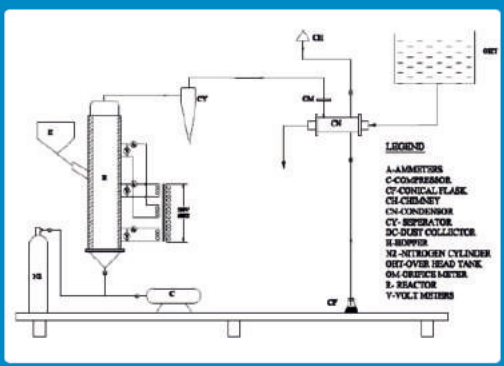
Reaction time: 45 minutes

Oil yield: 40 – 45%

Application

The pyrolysis oil can be used as fuel in furnace.

By transesterification process the highly viscous pyrolysis oil can be converted into biodiesel. The biodiesel can be used as a diesel substitute in CI engines.



Biomethanization Plant

Features

Tank Capacity: 1000 Liters

Stirrer speed: ½ to 10 rpm

Temperature of contents: 10^0C to 50^0C

Heating medium: hot water circulation

Cooling medium: cold water using a refrigeration unit

Water circulation: coils submerged in reactor

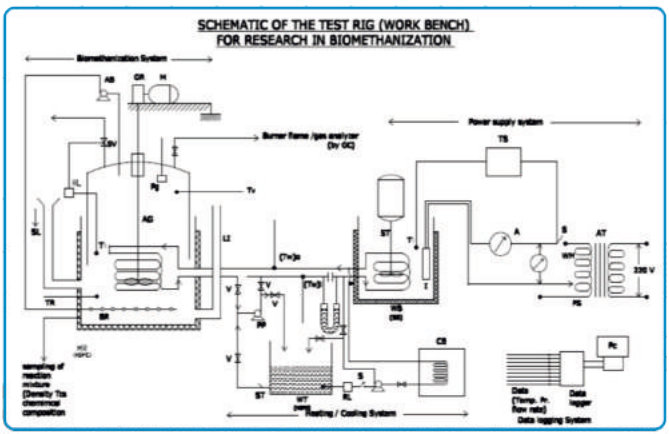
Gas collection: In 100 liters to 2000 liters rubber balloons

Product Obtained

Biogas is obtained from the biomethanization plant.

Application

Cooking and lighting



Fluidized Bed Pyrolysis Reactor

(Gas heated Type)

Features

Raw materials: waste tires, rice husk, saw dust, edible and non edible oil cakes

Particle size: 0.5 to 2 mm

Reactor: gas heated type

Pyrolysis condition: ambient pressure

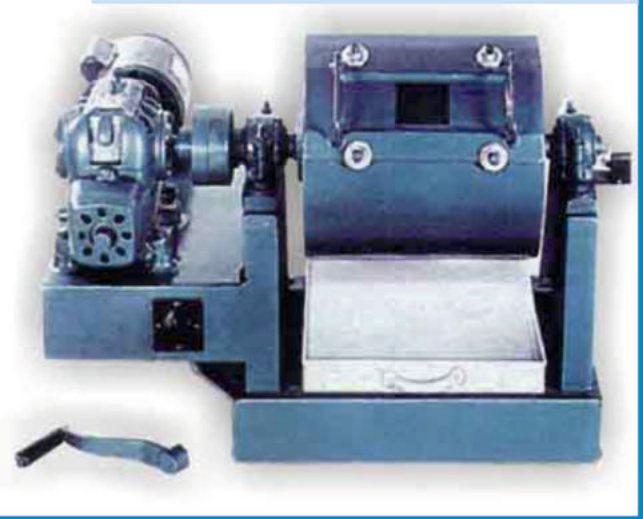
Reaction time: 45 minutes

Application

The pyrolysis oil can be used as fuel in furnace.

By transesterification process the highly viscous pyrolysis oil can be converted into biodiesel. The biodiesel can be used as a diesel substitute in CI engines.

Ball Mill



Features

Aball millis a type ofgrinderto grind, blend and sometimes for mixing of materials for use in mineral dressing processes, paints, pyrotechnics, ceramics andselective laser sintering.

It works on the principle of impact and attrition: size reduction is done by impact as the balls drop from near the top of the shell.

Application

The ball mill is used for grinding materials such as coal, pigments, and feldspar for pottery. Grinding can be carried out either wet or dry but the former is performed at low speed.

Multifuel Engine Test Rig

Features

Extensive range of Experiments

Compression ratio variable from 5:1 to 10:1 for petrol

Compression ratio variable from 14:1 to 20:1 for diesel

Runs on Both petrol and diesel fuels

Variable Spark Timing from 0 –70deg

Consists spark plug, ignition coil, diesel injector, Diesel pump and carburetor

Therefore very useful for testing alternative fuels

3-5 H.P; single cylinder; 1400-1500 rpm; forced lubrication type; water cooling;

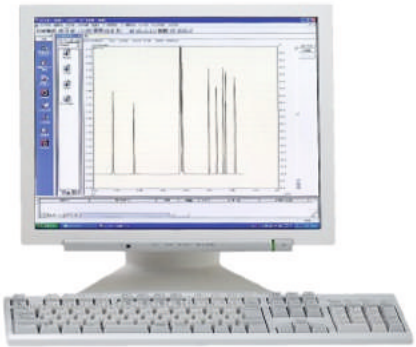
Eddy current dynamometer

Computerised Variable Compression Ratio Multifuel Engine Test Rig

This test rig is used to find the performance and combustion parameters of Variable Compression Ratio Multi-Fuel Engine. The compression ratio of the engine is variable from 5:1 to 20:1. A unique provision is been made to vary the spark timing of the engine. Wide range of combustion studies can be conducted with the help of this setup.

Engine Combustion and performance parameters like Actual volume of Air, Volumetric Efficiency, Specific fuel consumption (SFC), Brake Thermal Efficiency, Brake power, Heat Balance chart, mechanical efficiency, Frictional Power , indicated Power, PV and P-θ diagrams, Mass Fraction Burnt Angle, Estimated End of Combustion Angle (EEOC), Gross IMEP, Maximum Heat Release Rate, Maximum Heat Release

Gas Chromatography (GC)



Chromatography in which the sample mixture is vaporized and injected into a stream of carrier gas (such as nitrogen or helium) moving through a column containing a stationary phase composed of a liquid or particulate solid and is separated into its component compounds according to their affinity for the stationary phase.

Application

- Analyze the contents of chemical products.
- Volatile mixtures are separated
- Quality assessment of alcoholic beverages
- Analysis of food
- Analysis of Biomolecules (EG, Melanins)

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