Fluidized Coal Combustion IC Engine

Prof S A Shah[1], Prof. B. S. PATEL[2], Mr. Vimal Gohel[3], Mr. Ravi Javiya

[1,2]Asso. Prof., [3,4]Students,

B. V. M. Engineering College, V. V. Nagar (Gujarat)

[1] satishshah345@yahoo.com, [2]bharatvimlapatel@yahoo.com ,

[3]*ravi.javiya@gmail.com*, [4]*gohel.vimal@gmail.com*

Abstract

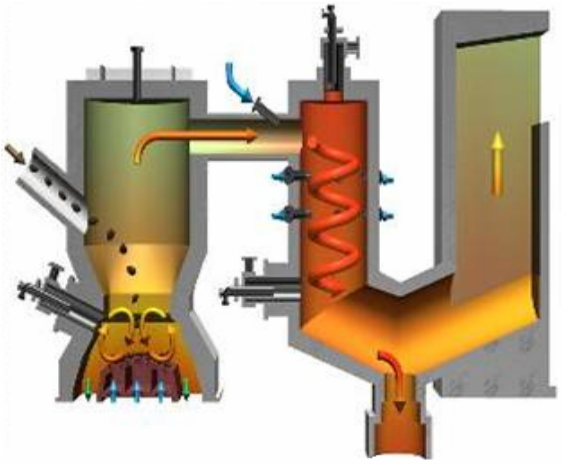
In today's world the oil prices are rising continuously. The reserves of crude oil are quite limited. There is monopoly of Middle East countries on crude oil. The coal is available cheaply and the reserves are more as compared to crude oil .The coal is available in three different categories like anthracite, bituminous, lignite. In country like India which is rich of coal and reserves of oil is quite limited as compared to that of coal and gas.

By using Fluidized Combustion of coal the coal can be used in conventional IC engines by little modification. The mixture of petrol and coal should be used as fuel. The petrol is to be used for igniting coal particles. High compressed air is passed through converging nozzle. So velocity of air is increased beyond fluidizing velocity. As a result coal behaves like a fluid and combustion can easily take place at a value of temperature around 800 to 900°C. So SO_2 and NO_x emissions are reduced to acceptable level.

When 4-stroke and 2-stoke are compared, the power to weight ratio of 2-stroke engine is more as compared with 4-stroke engine of same size and shape because there is one power stroke in every 2 crank revolution in case of 4-stroke engine and two power stroke in 2 crank revolution in case of 2-stroke engine.

By providing piston rod and having combustion on both sides of piston there is 2 power strokes in every two crank revolutions.

Introduction



Fluidized bed combustion in Power Plant

In this engine there is carburetor, fluidizing chamber, piston rod, air compressor and converging nozzle. The piston rod is rigidly connected to piston. The compressor is used to compressed air which is passed through converging nozzle

increasing velocity of air beyond fluidization velocity. Compressor is run by engine crank shaft or by exhaust gases.

Fluidized bed combustion (FBC) is a combustion technology used in power plants. Fluidized beds suspend solid fuels

Principle of operation of fluidized coal:

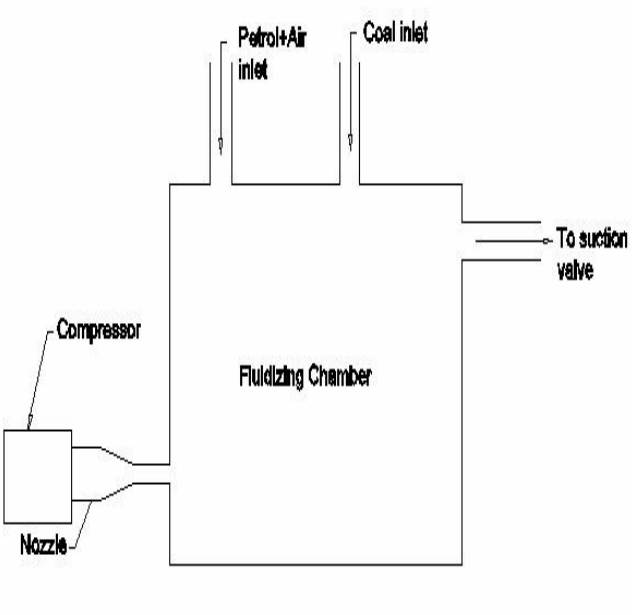
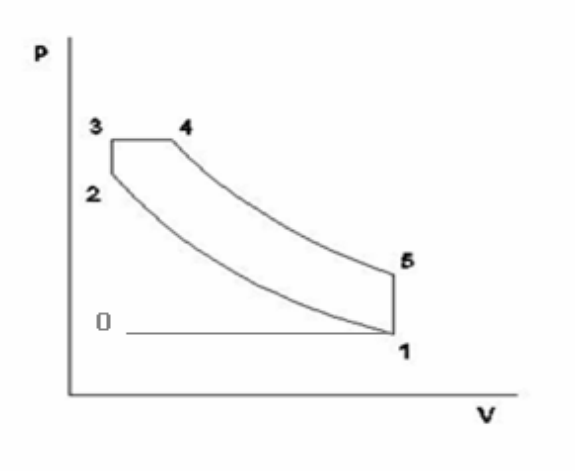


Fig. Fluidizing Chamber

Fig. shows fluidizing chamber having four ports one for inlet of mixture of petrol and air from carburetor, one for inlet of finely divided particles of coal, one for inlet of high velocity air from nozzle, other port is to the suction valve.
As the finely divided coal is made to inlet in fluidizing chamber, it will mix with petrol + air from carburetor. This mixture will be blown away by high velocity air from nozzle.
This will lead to fluidization of coal mixture, which will behave like a fluid, which is easy to ignite.
Fluidized-bed combustion evolved from efforts to find a combustion process able

to control pollutant emissions without external emission controls (such as scrubbers-flue gas desulfurization). The technology burns fuel at temperatures of 1,400 to 1,700 °F (750-900°C), well below the threshold where nitrogen oxides form (at approximately 2,500 °F / 1400 °C, the nitrogen and oxygen atoms in the combustion air combine to form nitrogen oxide pollutants; it also avoids the ash melting problems related to high combustion temperature. The mixing action of the fluidized bed brings the flue gases into contact with a sulfur-absorbing chemical, such as limestone or dolomite. The problem of ash and unburnt carbon particles removal can be solved by using oil cleaning
The heat release is first used in keeping up the temperature of the inner material. It is essential to choose the inert material judiciously as it remains with the fuel in continuous motion and at high temperature(800º). The inert material should be resistance to heat and have similar density as that of coal. Sintered ash, fused alumina, sand, mullite and zirconia are few inert material for fluidized system.

on upward-blowing jets of air during the combustion process. The result is a turbulent mixing of gas and solids. The tumbling action, much like a bubbling fluid, provides more effective chemical reactions and heat transfer.



p-V diagram(Dual cycle)

The proportion of petrol and coal should be 3:10 by weight. As petrol will burn instantaneously the pressure inside cylinder will suddenly rise while volume almost remains constant. After that coal starts to ignite. As the delay period for coal is large so during combustion of coal the pressure almost remains constant. So the engine will work on dual cycle. As the delay period of coal is large the engine must run at moderately low speed.

Properties of Coal

1. Density: 2000 kg/m^3 for carbon
2. Calorific value : 33800 kJ/kg
3. Self ignition temperature : 700°C

Air Fuel Ratio

Approximate analysis for gasoline and coal,

$C_8H_{18} + 12.5\ O_2 \rightarrow 8CO_2 + 9H_2O$;

$C + O_2 \rightarrow CO_2$

For the ratio of coal to petrol of 10:3,

$C + 3/95\ C_8H_{18} + 53/38\ O_2 \rightarrow 119/95\ CO_2 + 27/95\ H_2O$

So,15.6 kg of fuel will use 44.63 kg of O2

⇨1 kg of fuel will use 2.86 kg of O2

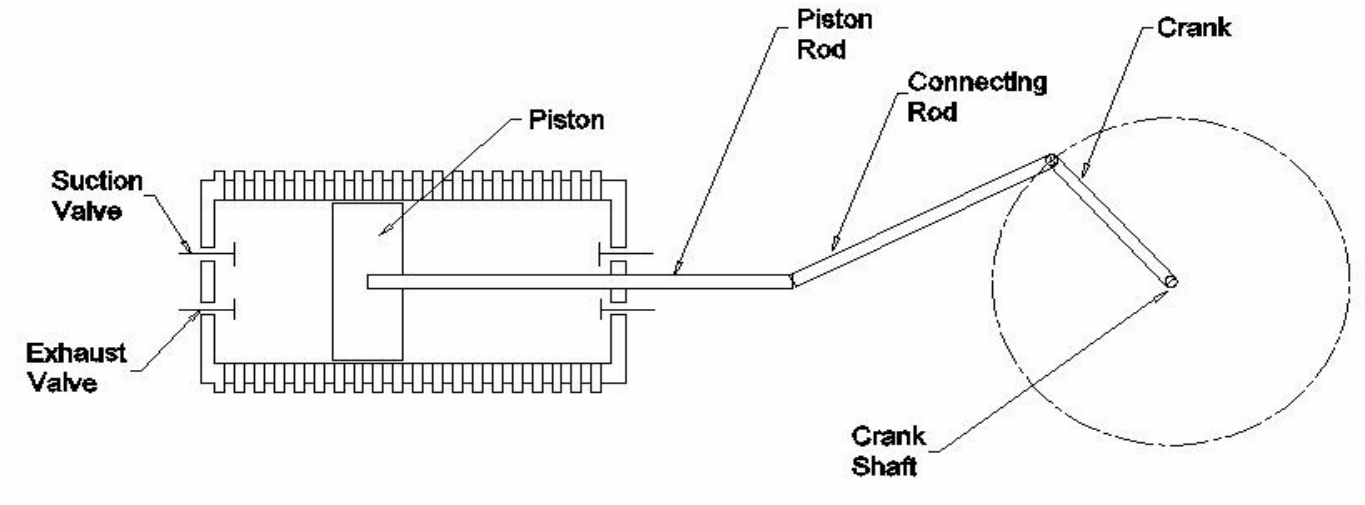
⇨Stochiometric Air Fuel ratio: 12.43

It is necessary to use lean mixture so that whole of coal is utilized.

So, A:F ratio should be 15 to 20.

WORKING

Movement of Piston	Left side of Piston	Right side of piston
I.D.C. to O.D.C.	Suction	Compression
O.D.C. to I.D.C.	Compression	Expansion
I.D.C. to O.D.C.	Expansion	Exhaust
O.D.C. to I.D.C.	Exhaust	Suction



As soon as we start the engine , suction valve opens and the mixture of air & fuel is about to enter in the cylinder from left side of the piston. The piston will proceed towards O.D.C. from I.D.C. So by the design or construction of the engine as shown in figure compression will take place at other side.

Now as piston proceed towards I.D.C. from O.D.C. compression will take place at left side of piston .At the same time there is an expansion of the fuels takes place at right side .This produces first power stroke of the engine. The Expansion of gases will help for compression at left side, so there is a little fluctuation superimposed on flywheel and hence small flywheel is required .At the end of the compression stroke at left side the spark is produced before piston reaches to I.D.C.

Due to the spark ,the petrol will ignite so temperature and pressure is increased to a higher value .It will help in combustion of the fluidized coal. It will push the piston towards O.D.C. and expansion takes place which result in second power stroke of the engine .There is a exhaust stroke at right side of piston at same time.

Now as piston moves towards I.D.C. from O.D.C. the exhaust takes place on the left side of piston, while suction takes place on the right side of piston

This process is repeated continuously.

Material of bushing

The temperature inside the cylinder is very high at the time of ignition. So the Copper alloys is used as a bushing material which can withstand high temperature and also provide high corrosion resistance property.

Advantages

- Comparatively smaller flywheel is required as there is less fluctuation of turning moment because of two power strokes in two revolutions of crank.
- Only one cylinder will produce twice as much power as that produced by conventional petrol engine approximately of same size and using same fuel.
- Space requirement is less as compared to conventional petrol engine using same fuel for production of same power.
- Cheaper fuel coal is used.
- Because of fluidized combustion, the coal particles can be easily ignited and amount of unburnt carbon particles can be reduced.
- The SO_2 and NO_x emissions are reduced because of low temperature combustion

Conclusions

Inspite of great scope to use coal as fuel in IC engines, There are many difficulties and demerits of using coal as fuel. Some of which are listed below:

- The ash and unburnt solid particles may erode piston and cylinder surfaces which requires complicated oil cleaning mechanism.
- The separate control of the valve at both side of the piston is quite complicated.
- High temperature resistant bushing material is required.
- The self ignition temperature of Carbon is 700°C

References

- Power Plant Engineering by ARORA & DOMKUNDWAR a DHANPAT RAI & CO. private limited.
- I.C. Engine by V.M.DOMKUNDWAR a DHANPAT RAI & CO. private limited.
- http://en.wikipedia.org
- http://energyproducts.com
- http://freepatentsonline.com
- http://sciencecentral.com
- http://minevaluation.com
- http://coalminer.com
- http://auroma.in