Conversion of Furnace Oil Fired Boiler To Briquette Fired Boiler

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Abstract- *In the present era, with the prevailing competition, the cost of production plays a vital role. As the price of petroleum oils, especially diesel and furnace oil are growing at a steeper rate than solid fuel price, finding a substitute for furnace oil is one of the alternative available.*

Furnace oil is atomized with air in the burner and fired, which produces hot flue gases that pass into the boiler tubes to generate steam. The furnace oil fired boilers contribute to greenhouse gas emissions and secondary pollutants. Briquette as a fuel to address these problems is a better alternative. This work deals with the fuel system conversion of an existing fire tube boiler running with furnace oil to saw dust briquettes.

The efficiency of boiler when fired with briquettes is found lower than that when fired with furnace oil. A significant reduction in the operating cost of boiler is achieved by fuel conversion technology. The emissions of furnace oil boiler are compared with that of briquette boiler. The sulphur oxides (SOx), nitrogen oxides (NOx), carbon dioxide (CO2) emission levels are low while firing briquettes. Carbon monoxide (CO) emission level due to incomplete combustion of fuel is more when firing briquettes. This conversion of fuel system utilizing briquettes in boiler offers many economical, social and environmental benefits.

Keywords- Boiler (Fire tube), Furnace oil, Briquette, Emissions.

I. INTRODUCTION

The usage of fossil fuels has harmful effects on environment as well as on human. The emissions from the boilers include sulphur oxides, nitrogen oxides, carbon dioxide causing acid rains, global warming, respiratory problems, lung diseases, asthma etc. Fuel selection is one of the most important factors in minimizing the atmospheric emissions. Increasing energy demand, reduction in greenhouse emissions, and the need for reduced dependence on fossil based fuels has resulted in the need to use biomass for energy generation. Biomass is the name given to any organic matter which is derived from plants. Briquettes are one kind of biomass manufactured from agricultural and forest wastes. Briquetting is a way to convert loose biomass residues such as sawdust, straw or rice husk into high density solid blocks that can be used as a fuel. Sawdust, a milling residue is available in huge quantity which can be briquetted easily. These biomass briquettes replace fossil fuels for industrial processes. They are cleaner and easier to handle and cut greenhouse gas emissions. Furnace oil used in boiler can be totally substituted by briquettes with an equivalent ratio of 2.1:1 kg/l on the basis of calorific value.

Boiler

Definition: A boiler is a closed vessel in which water is heated until the water is converted into steam at required pressure. This can then be used to provide space heating and/or service water heating to a building. In most commercial building heating applications, the heating source in the boiler is a natural gas fired burner. Oil fired burners and electric resistance heaters can be used as well. Steam is preferred over hot water in some applications, including absorption cooling, kitchens, laundries, sterilizers, and steam driven equipment. Water is a useful and cheap medium for transferring heat to a process. When water is boiled into steam its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. This causes the boiler to be extremely dangerous equipment that must be treated with utmost care. The process of heating a liquid until it reaches its gaseous state is called evaporation. Heat is transferred from one body to another by means of Radiation, which is the transfer of heat from a hot body to a cold body without a conveying medium,

Convection, the transfer of heat by a conveying medium, such as air or water and Conduction, transfer of heat by actual physical contact, molecule to molecule.

Types of Boiler

Boiler systems are classified in a variety of ways. They can be classified according to the end use, such as foe heating, power generation or process requirements. Or they can be classified according to pressure, materials of

construction, size tube contents (for example, waterside or fireside), firing, heat source or circulation. Boilers are also distinguished by their method of fabrication.

Accordingly, a boiler can be pack aged or field erected. Sometimes boilers are classified by their heat source. For example, they are often referred to as oil-fired, gas-fired, coal-fired, or solid fuel –fired boilers.

Let us take a look at some typical types of boilers,

- Fire Tube Boiler
- Water Tube Boiler

Fire tube boilers

Fire tube boilers consist of a series of straight tubes that are housed inside a water-filled outer shell. The tubes are arranged so that hot combustion gases flow through the tubes. As the hot gases flow through the tubes, they heat the water surrounding the tubes. The water is confined by the outer shell of boiler. To avoid the need for a thick outer shell fire tube boilers are used for lower pressure applications. Generally, the heat input capacities for fire tube boilers are limited to 50 MMbtu per hour or less, but in recent years the size of fire tube boilers has increased. Fire tube boilers are subdivided into three groups. Horizontal return tubular (HRT) boilers typically have horizontal, selfcontained fire tubes with a separate combustion chamber. Scotch, Scotch marine, or shell boilers have the fire tubes and combustion chamber housed within the same shell. Firebox boilers have a water-jacketed firebox and employ at most three passes of combustion gases.Most modern fire tube boilers have cylindrical outer shells with a small round combustion chamber located inside the bottom of the shell. Depending on the construction details, these boilers have tubes configured in one, two, three, or four pass arrangements. Because the design of fire tube boilers is simple, they are easy to construct in a shop and can be shipped fully assembled as a package unit. These boilers contain long steel tubes through which the hot gases from the furnace pass and around which the hot gases from the furnace pass and around which the water circulates. Fire tube boilers typically have a lower initial cost, are more fuel efficient and are easier to operate, but they are limited generally to capacities of 25 tons per hour and low pressures about 17.5 kg per cm2.

As a guideline, fire tube boilers are competitive for steam rates up to 12,000 kg/hour. Fire tube boilers are available for operation with oil, gas or solid fuels. For economic reasons, most fire tube boilers are nowadays of "packaged" construction (i.e.manufacturers shop erected) for all fuels.

Advantages of Fire Tube Boiler

- The water is supplied in shell and outside tubes while hot gas is supplied inside tubes so the water volume cannot be shaken easily when the fire tube boiler is running.
- Fire tube boiler is so easy to use, operate, clean and maintain.
- Fire tube boiler can be used in small scale industries.
- Fire tube boiler is relatively cheaper than water tube boiler.

Disadvantages of Fire Tube Boiler

- From the furnace combustion side, required time to fill water is longer than to increase temperature and pressure.
- The efficiency of heat transfer (heat transfer efficiency) is bad enough because of the heat exchanger does not use thermal radiation.
- In case of bombers fire tube boiler would be very dangerous if a large amount of hot water and steam have been accumulated inside (leakage occur).
- The fire tube boiler cannot produce steam at a pressure higher than 250 pounds per square inch.
- Capacity of generated steam is limited.

Briquette

Briquette is a mixture of agro waste like buggasse, saw dust, groundnut shell, cotton husk etc.

The major use of biomass briquettes in India is industrial applications usually to produce steam. A lot of conversions of boilers from FO to biomass briquettes have happened over the past decade. A vast majority of those projects are registered under CDM under Kyoto protocol, which allows for users to get carbon credits the use of biomass briquettes is strongly encouraged by issuing carbon credits. One carbon credit is equal to one free ton of carbon dioxide to be emitted into the atmosphere. India has started to replace charcoal with biomass briquettes in regards to boiler fuel, especially in the southern parts of the country because the biomass briquettes can created domestically, depending on the availability of land. Therefore, constantly rising fuel prices will be less influential in an economy if sources of fuel can be easily produced domestically.

Lehar Fuel Tech Pvt. Ltd is approved by Indian renewable energy development agency (IREDA), is one of the largest briquetting machine manufactures in India.

Briquettes are made from the available waste materials at our localities. In general developing countries

have more agricultural wastes are available every year. In this paper we used Palm Branches as major ingredient along with Screw Pine powder, Indian Bdellium powder, saw dust, coconut coir as additives. Reasons for choosing the raw materials

- Palm Branches: they are rich fibre content and burn for a long time after burning and easily available from my locality
- Screw Pine and Indian Bdellium: they can catch fire quickly
- Coconut Coir: it is having high combustion calorific value
- Saw Dust: it gives more density to the briquettes

Raw Material Collection

The palm branches are collected from the palm plantation after removing the fruit bunch from the palm tree. Those branches are dried for 2-3 days, when the fibre appears lightly then by using paper machine chop the branches into powder. The additive material powders are also dried and they are mixed in the ratio of 1:2:2:1 (saw dust: screw pine: Indian Bdellium: coconut coir). Then this mixture is again mixed with palm powder.

Binder Preparation

First boil the starch which comes after preparation of rice till it appears as glue. Then take Maida flour and made glue by pouring it in boiling water. After that both are mixed and stirred well by boiling to reduce the moisture content. Avoid the formation of lumps while mixing the both glues. Now mix the glue with powder.

Equipment Preparation

Different techniques are used for making briquettes but in this work we made my own equipment for compressing. For pressing a hydraulic jack of 100 ton is used. Stand is prepared by using iron channels. Two long iron channels of 50 inches each, other two channels of 20 inch, 26 inch are welded to form a structure like the alphabet "A". The mould used is of cylindrical in shape having both sides open. A supporting rod is used for compressing. Fill the mould with powder and compress it with hydraulic jack upto its maximum capacity of 100 ton and kept it for 20-24 hrs. Take out the briquette from the mould. Six different briquettes A, B, C, D, E, and F are prepared.

II. OBJECTIVE

To convert FO fired boiler to Briquette boiler as the oil prices is increasing and the company is considering alternative fuels as an option to expensive furnace oils used in boilers.

At the same time, it is considering to bring down the environmental pollution, which is caused by fuel oil burning. Current boiler efficiency (80%) is lower than that it should be (90%). With the increasing trend of oil prices, the energy cost component contributes a major part for the production cost. Hence an efficient conversion for the boiler assists in cutting down the increasing production cost.

III. METHODOLOGY

- Analyzing the consumption of steam for production and diying of fabrics.
- Studying the characteristics of FO fired boiler and its efficiency.
- Calculation of savings, investment and payback period for the conversion.
- Conversion process is initiated for converting FO fired boiler to Briquette fired boiler.
- Modeling activities are done by using software SolidWorks.
- Opting from the two methods available for conversion process:
  (i) Internal Furnace Method.
  (ii) External Furnace Method.
- As per the required quantity of steam per day External Furnace Method is opted.

External Furnace Method

First, a technical and environmental feasibility study was carried out to see the viability of the project. Then, a survey was conducted to find out the average daily steam demand, required steam quality and fuel oil consumption of the existing furnace oil fired boilers. Moreover, all technical information of the furnace, shell, blowers, other accessories of

the boiler, battery limit, water consumption, electricity consumption was studied. Flue gas analysis was carried out for exhaust at the chimney in a typical working day. (Note that the boiler was not running at full capacity). This is used to find the efficiency of the boiler and the GHG emission from the boiler. The space availability, continuous availability, quality (moisture content) and quantity of Gliricidia and availability other alternative fuel such as (sawdust, paddy husk, etc) were found. Based on the average steam demand and considering the future steam demand, the design of the boiler conversion was done.Other accessories were sized to suit the demand. (ID Fan, Chimney placement, etc.). Cyclone system (MDC) and water scrubber were designed. Finally, Carbon trading under clean development mechanism (CDM) is proposed.

The following procedure was followed.

- Removed the burner of the existing boiler.
- Designed a fuel feeding door.
- Designed an ash removal and primary air intake door.
- Laying fire bars.
- Constructed a fire brick wall.
- Refractory laying for the front door.
- Sizing and installation of the Induced draft fan.
- Fabrication and installation of necessary ducting for the flue gas path.
- Installation of a damper control system and temperature controller and indicator in the flue path.
- Re-wiring the electrical control system of the boiler unit.
- Repairing the fittings, and safety system of the boiler.
- Commissioning the boiler.
- Study of the financial savings.
    - Studying the characteristics of Briquette fired boiler and its efficiency.
    - Analyzing the difference between FO fired and Briquette fired boiler.

The advantage of using this modification is the retaining over 75 % of the existing capacity of the boiler. An external furnace is erected with sufficient grate area. Hot combustion chamber of the external furnace, multi-window air supply enables a firing and cleaning to be carried out simultaneously.

This helps to maintain the steam generation at a constant level. Here we can expect a clean combustion and reversal to oil firing is possible in 6-8 hours. The only disadvantage of this method is need of an extra space.

IV. CONCLUSION

It has been found that utilizing briquettes in boilers offers many economical, social and environmental benefits such as financial net saving, conservation of fossil fuel resources and emissions reduction thereby reducing the air pollution. The project has evident contribution to sustainable development, which are as follows:

- The retrofit technology used to convert the fuel system of boiler from furnace oil to briquettes is safe and environmentally sustainable.
- Reduction in efficiency due to retrofitting is observed. But the reduction of boiler efficiency has no effect on the steam production rate of the plant after retrofitting.
- Significant reduction in the operating cost of boiler.
- Conserving the fossil fuel reserves i.e., reducing petroleum oil requirement by use of renewable source of energy can be achieved.
- Reduction in the amount of green house gas emissions i.e. CO2 emission reduction is obtained.
- Higher CO emissions are observed during briquette combustion. However the emissions due to incomplete combustion from grate-fired boilers can be effectively controlled by an optimized combustion process, i.e., enhanced mixing, sufficient residence time at high temperatures, as well as by the appropriate choice of grate assembly. Combustion of solid saw dust briquettes on fluidized bed combustion chambers is an approach to minimize incomplete combustion.
- Reduction of secondary pollutants i.e., SOx and NOx is achieved.

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