ACCEPTED MODERN TECHNOLOGY

IN

WOOD-FIRED BOILERS FOR POWER STATIONS

FOR

SOUTHWOOD RESOURCES
FORESTRY TASMANIA

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Accepted Modern Technology for Wood-Fired Boilers for The Power Station

Introduction

Jott Engineering has prepared this report on behalf of the proponents for the Power Station, in order to comply with Condition GG2 of the Southwood Operating Permit.

Condition GG2 states that:- "***All wood-fired combustion sources on the land must utilise technology generally accepted as constituting AMT in relation to Greenhouse Gas Emissions. Within 60 days of issue of this permit, the proponent must provide the Director with a report which demonstrates that the chosen technology constitutes AMT in relation to greenhouse gas emissions***."

The Permit also specifies that AMT is defined as:- *"'AMT' or* '***accepted modern technology' means a technology which has a demonstrated capacity to achieve the desired emission concentration in a cost-effective manner, takes account of cost-effective engineering and scientific developments and pursues opportunities for waste minimisation***."

The use of wood by-products as fuel in boilers for steam generation is very well known. The range of boiler designs incorporating symbiotic mechanisms and technologies used for the combustion of such fuels is very wide. The key emission from combustion processes of carbonaceous materials that has greenhouse gas impact is Carbon Dioxide, with minor contributions due to Methane and Nitrous Oxide. Emissions of NOx, Carbon Monoxide and particulates from such installations are essentially related to ambient air quality rather than greenhouse issues. For greenhouse gas emissions the fuel choice (wood versus fossil fuel) and source of fuel (renewable versus non-renewable) is the significant issue rather than boiler technology.

State of Biomass Technology

In the process of obtaining commercial advantage in a very competitive environment, manufacturers of boiler equipment have introduced many variations in design with mixed levels of success.

Biomass fuels cover a range of compositions, impurities and moisture contents. Included in the range are fuels such as bagasse, wood, demolition waste, green waste from municipal refuse and mixed municipal refuse.

Over the last thirty years, energy prices and environmental issues have introduced market forces which have resulted in the introduction of increasingly sophisticated technologies that have only really matured over the last ten years or so:- for example, Bubble-Bed; Fluidized-Bed; and, Two-Stage (gasification + second-stage) combustion systems are but a few. In addition, a multitude of fuel preparations and mixes have also been introduced:- for example, one of the latest is pelletised and dried wood and/or biomass waste, which enables a large variety of wood-waste sources to be homogenized into a very tractable and easily combustible fuel.

Most of the above innovative approaches, however, have been necessitated by an increased need to combine the combustion of conventional fuels with the disposal of a range of biomass by-products right through to municipal-type waste, in a useful manner. This trend has been accepted in Europe for most of the above-mentioned period, and, has had some success in a number of "demonstration-type" plants in the North American Continent and even Australia:- one very successful plant was built in the NSW suburb of Waterloo and had been in operation until some four years ago; a more recent candidate was the proposed Carole Park Biomass Boiler plant in a Brisbane suburb, which could have used a fluidised bed with triple stage combustion and re-cycling of fluidising materials and combustion products; again, this technology could accept a very wide range of biomass fuels whilst meeting all the environmental requirements.

Combustion Systems for Wood Chips

In contrast with the above-mentioned more complex (and costlier) technologies, the combustion of clean wood-waste, in the form of wood chips, is a relatively tame affair, which has needed very little improvement, if any (depending on the manufacturer) for the last few decades.

The fundamentals of combustion of woodchips in an environmentally acceptable way simply involves:-

- Ensuring that even and controlled distribution of the fuel on a surface (grate) is achieved, and
- Correct air distribution, to ensure the correct air / fuel mixtures at the various zones of the furnace.

Standard grate configurations will ensure acceptable, reliable and economic combustion, whilst meeting the required environmental limits, provided that the boiler meets these fundamental combustion considerations.

The fuel to be used in the proposed boilers is generated either as residues from harvesting operations or from milling operations. Normally this wood is either open-air burnt, disposed through landfill or burnt in a tepee or olivine burner. Each of these processes sees the generation of greenhouse gases. Therefore, the extraction of energy for a beneficial use from the combustion of the wood in a boiler is a major waste-reduction contributor. The extracted energy negates the use of a fossil fuel (natural gas, petroleum or coal) otherwise needed to provide the heat required.

Emissions of Greenhouse Gases

The principal greenhouse gases that need to be considered comprise:-

- Carbon Dioxide,
- Carbon Monoxide,
- Oxides of Nitrogen, and
- Methane

Oxides of Carbon

None of the technologies available, when used in an efficient manner, will change the amount of carbon released in combustion of the wood. The carbon is converted principally to Carbon Dioxide and comprises about 99.4% of the total greenhouse gas emissions from the boilers; Carbon Monoxides will comprise about 0.3% of total greenhouse gas emissions.

Oxides of Nitrogen

The difference between the various boiler designs thus revolves around the minor emissions, representing about 0.3% of total greenhouse gas emissions. The major environmental effluent, which is controllable through the manipulation of the combustion process, is the formation of NOx.

This requires low combustion temperatures to avoid thermal NOx, and low Oxygen concentration in spaces where volatiles are combusting to minimize fixed fuel Nitrogen conversion to NOx. Therefore, as far as NOx is concerned, conventional grate technology, with judicious use and distribution of primary, secondary and sometimes tertiary air, can be considered to be Accepted Modern Technology (AMT) when applied to clean woodchips as fuel.

Grate Selection

The matter of the type of grate to be used is less important than the manner of feeding the fuel onto the grate.

The grate type is usually strongly driven by the ash content of the fuel:- a low-ash fuel, such as wood, will tend to overheat the grate so that, to compensate, it needs cooling if of metal or, alternatively, made of heat-resistant refractory materials. The fuel-feed mechanism is important in that mal-distribution of fuel on the grate causes uneven resistance of air-flow and, therefore, low combustion quality (high CO, NOx and excess air). In selecting the type of grate, consideration needs to be given to the load profile of the boiler. When part-load operation is frequent, good fuel distribution is even more important; however, the Southwood Power Station is expected to operate at full load most of the time.

For industrial-size plant, typical of the Southwood Power Station, where steady base-load operation is expected, three examples of grate types which might be considered are:- water-cooled "pinhole", travelling and "vibration" grates.

Where overfire feeders are employed, as in the firing of woodchips, one of the duties of these grates is to provide the desired distribution of primary air for the various parts of the grate surface. This distribution of primary air is then dependent on the distribution of the fuel by the fuel feeding mechanism for the desired combustion conditions to be achieved; the greater the moisture content the more important this becomes. The correct type, number and location of fuel feeders assures uniform distribution of fuel over the grate. In addition, the base-load characteristics of the Power Station minimize the difficulties associated with the tuning of the fuel distribution equipment with varying plant loads; this could be somewhat difficult for larger plant if the fuel is of changing characteristics but, again, for relatively uniform wood chips the difficulty is very much reduced .

The preference to grate type is basically related to the maintenance of the grate: a grate that requires relatively little maintenance will assist in maintaining the desired primary combustion conditions.

The measures taken to minimize NOx also tend to address the production of CO because in regions of low excess air, CO generation will increase. However, the general level of excess air in a well controlled furnace is generally above that which would allow low excess air to exist; secondary and sometimes tertiary overfire air would further act to reduce the production of CO. Generally, smoke and CO will go hand in hand so a low CO will also result in a clear stack gas emission.

Fly Ash

Of course, dust and fly ash are entirely a matter of collection, both in the boiler proper and in the flue-gas passes on the way to the stack.

When considering clean woodchips, the amount of ash is so low that it can be considered to be mostly carried away with the flue and, therefore, require collection. The type of ash will impinge on the grate and furnace design around the grate. However, for this fuel, it is mainly a matter of avoiding local slagging due to ash fusion and build-up. Again, judicious surface design and fuel and air distribution in the grate region will reduce this problem to a minimum; keeping combustion temperatures low in the furnace will ensure that slagging and deposits will be minimized downstream.

Waste Minimisation

Whilst the *concentrations* of emissions can be controlled to acceptable levels, the matter of *quantities* is addressed by maximizing the utilization of the available energy from the fuel.
A Power Station boiler, when compared with a Process Steam boiler, is subject to several additional degrees of freedom as far as the utilization of the fuel energy is concerned. In a Power Station the amount of fuel used and, therefore, the emissions generated, are subject to the Overall Heat Rate of the Power Station. The Overall Heat Rate is the result of the combined effectiveness of each plant item in the system, together with the inclusion of, or the omission of, various plant

items which contribute to the Overall Heat Rate. Whilst the boiler is one of these items, it is only a part contributor. The judicious selection of the Power Station system components, where judicious includes the economic considerations, is equally important as far as the utilization of the fuel energy available.

Lower fuel moisture results in reduced fuel usage and consequently results in reduced emissions.

Conclusions

In conclusion, for clean woodchips and base-load operation of the Power Station, the wood-fired boilers' grate-type designs being currently considered, if properly sized, laid out, and matched to good fuel feeding mechanisms, can be considered to be AMT.

The effectiveness of the Boiler Plant's AMT is closely linked with the overall Power Station's AMT in that the quantity of emissions is also significantly dependent of the rest of the Power Station's AMT, as reflected in the Overall Heat Rate. It follows that the Heat Rate specified for the Power Station needs to represents AMT for wood fired power generation worldwide.

As for the case of the Process Steam Boiler plant, one should not necessarily take existing Power Stations as the paragon of "good" or "bad" references of the grates' technologies considered. It is well known that performance can be subject to bad application of the fundamental principles and / or misapplied fuel specifications, capacity, loading ("to achieve that little bit extra"), and many other reasons. Suffice to say that where the plant does not perform there will be good reasons for this.

Accordingly, it is the process of the selection of the plant offered which is the major step in ensuring that the plant meets its expected AMT status; and, in the case of a Power Station, the economic application of AMT may well bias the expenditure of funds towards more effective means of reduction of emissions away from the grate type of the boilers and into other Power Station components, such that the Overall Heat Rate is minimized.