**Biomass boilers** in Power Generation, District heating and Manufacturing.

Why is everyone buying / converting to biomass fuel, is the fuel really carbon-neutral and what are the issues seen from the insurance industry this article will briefly look at the wood storage and fuel transport to the boilers?

## What is Biomass?

Biomass is any fuel type derived from recently living tissue.

Examples of biomass are:

a, Virgin wood (such as willow and poplar: which have a 3 year crop rotation)
b, Energy crops (straw from wheat and miscanthus grasses: annual renewal)
c, Industrial wastes such as sawdust.

## Why is everyone buying / converting to Biomass Fuel?

The short answer to this question is that the UK government agreed under the Kyoto agreement to reduce greenhouse gas emissions.

The government developed a two pronged approach using legislation to penalise or force out of the market those boilers that were producing excessive man made greenhouse gases and to give subsides to encourage the use of other fuels and renewable energy sources.

a, Legislation / Taxes

Two examples of legislation which affect boiler users burning coal, oil or gas

1, The “Large Combustion Plant Directive” - UK power plants over 50MW need to reduce emissions of sulphur dioxide ($SO_2$) and nitrogen oxides ($NO_x$) and dust (particulate matter (PM)). To do this they require up grade such as fitting Flue Gas Desulpurisation units; otherwise the plant would only be permitted to run for a further 20,000 hours per chimney from 2008, with a closing date due on 31$^{st}$ December 2015.

This legislation has resulted directly in plant closures such as the Kingsnorth Power Station

2, The “Climate Change Levy” other wise known as the Carbon tax - The UK government set a minimum carbon price which all companies have to pay to emit carbon dioxide. (Domestic users and non business charities are exempt.)

The carbon tax rates are set to rise each year; in 2013 the cost is £4.94 / tonne, this will rise to £9.55/tonne in 2014 and by 2017 the government is estimating a charge of £24.62/ tonne

With this legislation users are moving away from gas fired heating and electrical generation systems to biomass fuels.

b, Subsides

Large plants such as power stations are eligible for Renewable Obligation Certificates (sometimes referred to as ROC's / Green certificates). When they burn or co-fire with biomass a rate is set. This is currently 0.5 or as a primary fuel 1.0. But it has been recently capped at 400MW for dedicated conversion biomass plants. The value of ROC's follows the market but is currently worth just over £43 / MW. So if the traded price of electricity is £48 / MW the station would earn £92 / MW (if burning solely biomass).

Smaller non domestic plants burning biomass are eligible for a subsidy called feed in tariff for a period of 20 years from installation. To give an example, a biomass boiler producing over 1,000kW is eligible for 1 p / kWh.

Perhaps of more interest to the readers is that the government is going to introduce a subsidy into the domestic biomass market, the proposal is 12.2p/kWh

Is Biomass carbon neutral?

Energy produced from Biomass is said to be **CARBON NEUTRAL** because the carbon released into the atmosphere when the material is burned is equivalent to the amount absorbed by the plant during its growth cycle.

As such most countries treat biomass as a renewable energy fuel.

In terms of power generation, plants that have converted from coal firing to 100% biomass state that overall their emissions (including Carbon) reduced.

Advantages / Disadvantages of using Biomass for plants

Advantages

i, Reduces the need for fossil fuels.
ii, Biomass crops produce oxygen and absorb carbon dioxide.
iii, Biomass waste is used in the production of steam rather than going to landfill.
iv, Local generation of electricity reduces losses normally experienced in the transfer of electricity from large power stations to users.
v, The use of biomass fuels provide an economic incentive to manage woodland, which improves diversity.
vi, Compared with other renewable energy generation, the availability of biomass generating plants is above 90% compared to say on shore wind generation at 30%.
vii, A biomass plant can base load, respond to frequency changes and load demand.

Disadvantages

i, It is using land which might be better used for food crops
ii, The surrounding neighbours may raise issues with the number of lorries visiting the plant to bring feedstock (an example being a 25MW plant using 180,000 tonnes of fuel/year: requiring 33 lorries a day delivering 20 tonnes of wood at time).

iii, The plant needs to be well maintained. The consequences of not controlling the plant can lead to plant failures, explosions and serious pollution events.

Types of Plant

Four main types of plant use biomass

- Large generating plant such as Tilbury (each unit rated at 350MW but now closed) and Ironbridge (each unit rated at 500MW) power stations. These plants have been converted from burning coal to wood pellets. They have traditional water tube boilers and steam turbines. Due to the volume of wood pellets required in this size of power station the fuel has been shipped from the major forests areas such as USA / Canada

- Medium sized generating plants such as Stevens Croft power station (rated at 50MW) are purpose built using water tube boiler and steam turbine. The fuel being wood chips is delivered from the local area

- Small Combined Heat and Power plants, mainly seen in Europe, using either wood pellets or wood chips as the fuel feeding into special designed auxiliary type boilers heating hot water to heat large district heating schemes. They may also use Biogas / Natural Gas to fuel on site gas engines generating electricity to export into the national grid.

- Small biomass auxiliary boilers using wood pellets as the fuel. The picture below shows a typical boiler. Note the fire protection fitted on the left and right which can feed water into the fuel supply in the event of overheating/fire.

These type of boilers are growing in demand and use in Europe. Seen in the UK they are being used to heat water to supply to business / large schools / colleges, sports facilities and are replacing gas fired boilers.

Another type of plant uses wood as a fuel, in a process known as Gasification. This type of plant whilst regularly seen for insurance quotation, in the UK, is not common in use.

So what are the issues as seen from the insurance industry

Plant that use wood as a fuel have a number of problems (as well as the traditional machinery breakdown elements) particularly exposures from fire and explosion risks.

Where the process or handling equipment involves biomass materials with particle size less than 80 mesh (0.177mm) and with moisture content less than 30 percent by volume, a potential explosion hazard exists**.**

Therefore initial /retrofit plant design and good practices in commercial operation is critical for safety and some of the issues are highlighted in the following pages.

Fuel

A plant should clearly specify the fuel quality that is brought on site. They should have regular checks made to ensure the supplier complies with the contract terms and conditions for this.

An example of a wood pellet contract specification would be as follows

Diameter 6-8mm, length < 40mm, water contents < 10%, bulk density > 600 kg/$m^3$, maximum bulk temperature 60 degrees centigrade, ash content < 1% by weight, melting temperature> 1200 degree centigrade, dust < 1%.

The amount of dust is key in delivery and if the tests show excessive amounts, the delivery should be rejected

Fuel storage

The storage of the wood requires careful consideration, the below picture gives an example of a good wood chip installation

It is well ventilated, the amount stored is limited, the wood is regularly checked for moisture content and temperature, moved in sequence so within reason the wood is always fresh. Sprinkler system pipe work under the roof can just be seen. The sprinkler system is designed to contain a fire should it be detected. The storage area is well away from the power plant.

The concern with wood chips are two fold

1, If the wood becomes too wet it biodegrades rapidly leading to a loss of energy content. It may also potentially form moulds and spores from this if inhaled may be dangerous to health.

2, Spontaneous heating may occur: caused by the oxidation of unsaturated fatty acids releasing carbon monoxide, carbon dioxide and methane

For wood pellets used in power generation the storage tends to either be silo's or storage areas. The concern with this type of fuel is it can degrade if moved excessively breaking the pellet down creating dust which with an ignition source can cause an explosion.

So for silo's they tend to have smooth sides. If the chips are blown into the silo the duct work should have smooth gentle bends with padding to absorb the pellet impact. The silo will be fitted with vents for filling and explosion/over pressure release device. The silo should be located to avoid direct sunlight and/or of a colour / construction to avoid excessive sun heat penetrating and heating the wood.

The picture below shows a wood pellet store

A number of issues exist with this storage, you would want the design of the store to reduce the ability of wood dust to settle: but as can be seen wood dust is lying on the building structure. The normal guidance is that you must keep dust levels to a minimum in any storage facility by good housekeeping, using vacuum techniques to ensure the dust level is kept below 3.2mm over a maximum 5% area of the storage area.

The plant also does not comply with the ATEX directive: the overhead crane seen on the left has the potential to cause a spark igniting the dust. Also this plant room has no fire detection system.

Transporting the fuel to the boiler

A number of methods are used to transport the wood to the boilers, perhaps the most common is the use of conveyors.

It is worth briefly discussing the design of the plant areas. In order to reduce the risk of explosion, we previously mentioned the importance of building design to reduce surface areas on which dust might settle and to improve housekeeping.

It is also important that the plant has complied with the ATEX directive (ATEX is an acronym, derived from the French title of the 94/9/EC Directive). This zones the plant into explosion risk areas. Correctly rated electrical equipment should then be used dependent on the zone including electrical motors and switchgear. ATEX also covers lighting systems. The equipment will then be suitably insulated from the hazard present.

The use of conveyors also raises concerns with the electric motors, switch gear and lighting needing to be suitable rated under the ATEX directive.

The design of the conveyor system should be such that it uses non combustible belts and avoids sudden changes in direction. This will reduce damage to the pellets and reduce dust.

The roller bearings used in conveyor systems can overheat due to excessive dust/ lack of cooling and / or lack of internal lubrication. This leads to collapse and creation of hot spots. The guidance is to keep all dust exposure from machinery to a temperature below $260^0$C. Conveyors therefore need regular maintenance and cleaning and it would be common/good practice to use thermography to detect any hot spots.

The conveyor should also be protected by sprinkler system and may also have a system such as “firefly” which uses infra red detectors to detect any flame and ignition particles. A linear temperature cabling system may also be installed so that in the unfortunate event of a fire the conveyor will stop and the sprinkler system will have a chance to operate and contain the blaze.

The picture below is from a recent fire at Avedore power station which was transporting pellets by a conveyor system

It was unfortunate that the fire started on the conveyor system and the burning fuel was transported in to the pellet storage silo, it took over a month to finally extinguish the fire in the silo. It is believed that the fire started due to an overheated roller bearing, the sprinkler system did not operate and the loss is estimated at £12.36M.

Other fires in power stations using wood pellets as a fuel included Tilbury power station as shown in the picture below.

The insurance industry is very keen on compliance with guidance provided by legislation and other recognised fire protection bodies which are available to all.

For example the National Fire Protection Association (NFPA) publishes guidance including two guidance documents used by those in the power generation business:

NFPA 664 Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

NFPA 850 Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current. Converter Stations

Insurance company guidance which is available to all

Factory Mutual Insurance Company FM 8-27 Storage of Wood

Factory Mutual Insurance Company FM 7-11 Belt Conveyors

In summary the use of biomass, pellets and wood chips for use in boilers will continue to grow as long as subsidies exist and legislation increases the cost of carbon emissions affecting other types of fuels. The use of biomass fuels presents additional challenges to operational staff and insurers.

The insurance industry has guidance on how to use biomass fuels safely and the guidance is available to all.

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