The firing and co-firing of biomass in large pulverised coal boilers.

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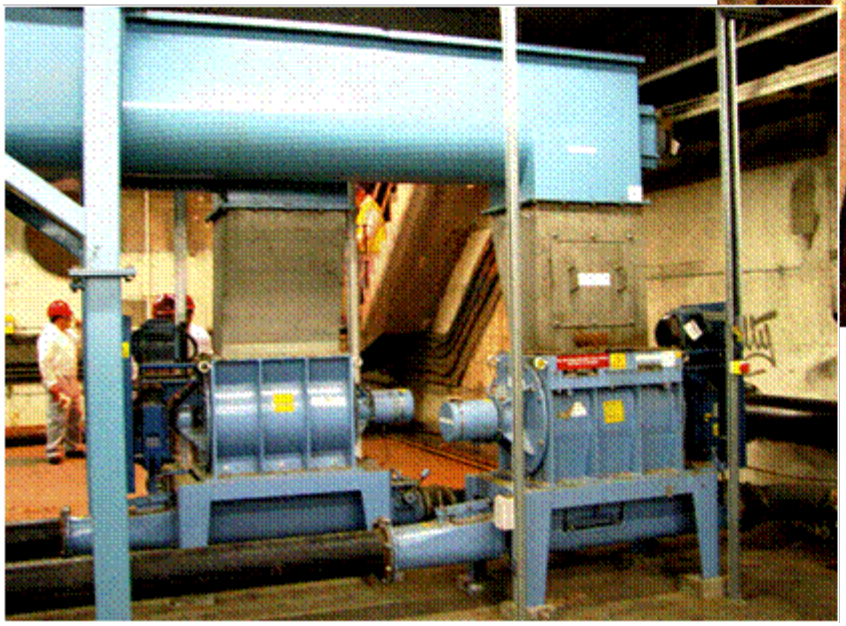
Biomass pre-mixing system

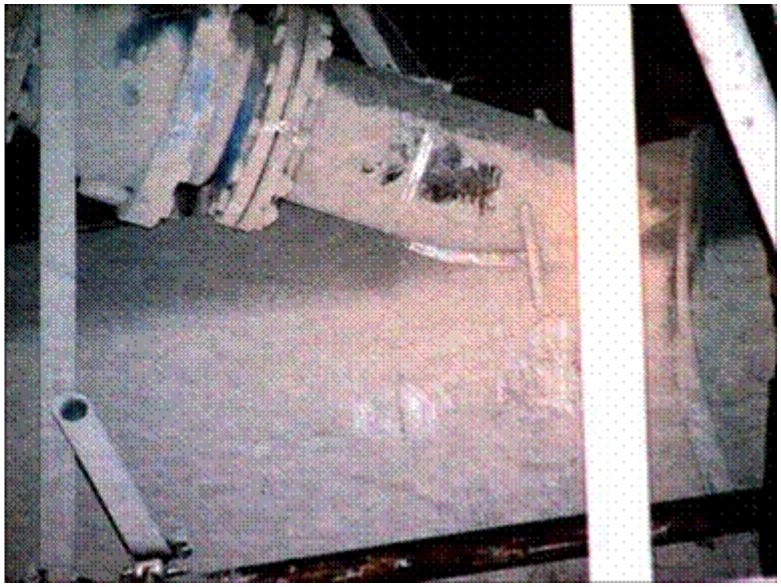
Drax Direct Co-firing
The biomass metering and feeding system

The prototype direct co-firing system has been in successful operation since summer 2005, firing a range of pre-milled biomass materials.



Drax Direct Co-firing
The biomass pipes and the injection point

- The injection point is in the mill outlet pipes, just downstream of the product dampers. The injection point is a simple shallow angle T-in, fitted with an actuated shut-off valve for the biomass,
- Both the mill and the burners are maintained within their normal operating envelopes for both the heat input and primary air flow rate. The maximum heat input from the mill group is not affected.



Milling biomass pellets in converted coal mills

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Milling pelletised biomass in coal mills

- The milling of wood pellets in coal mills, and the firing of the mill product through the existing pipework and burners, is done at a small number of power stations in Europe, including Hasselby in Sweden
- The coal mills are very robust, and have high availability and low maintenance requirements
- Hammer mills are more sensitive to tramp material and have a much higher maintenance requirement, depending on the fuel quality
- The coal mill depends on a crushing mechanism, and tends only to break the pellets back to the original sawdust size distribution
- The mill has to be modified to operate with cold primary air and to maximise the fuel throughput
- There are generally no requirements for modifications to the coal mill grinding elements
- The maximum heat input from the mill group is significantly derated, commonly to around 50-80% of that with coal, depending on the mill configuration
- With torrefied materials or chars there is likely to be a finer product and a smaller derate.

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Plant Experience of 100% biomass conversions

Hasselby in Stockholm, Sweden

- Heat and power plant successfully converted from coal firing to 100% biomass firing in 1993, and is still in operation
- Experience from Hasselby, and elsewhere, has indicated that the heat input from the converted mills is significantly derated, to around 50-70% of that with coal, but this can be supplemented with additional hammer mills.

- This approach to biomass firing is now being replicated in other stations in Britain and elsewhere.
- Two large ball and ring mills in a British power plant were successfully converted by Doosan Power Systems to 100% biomass pellet firing in 2010, with a further 2 mills converted in 2012.
- Doosan Power Systems has an ongoing involvement with a British Client in both Phases 1 and 2 of current biomass conversion project which involves the conversion of roller mills to processing wood pellets.
- Doosan Power Systems is currently working on a contract for a 100% biomass conversion project in Canada, involving the conversion of roller mills to the processing of biomass pellets and the supply of new burners for biomass firing.

Physical modifications to ball and ring mills

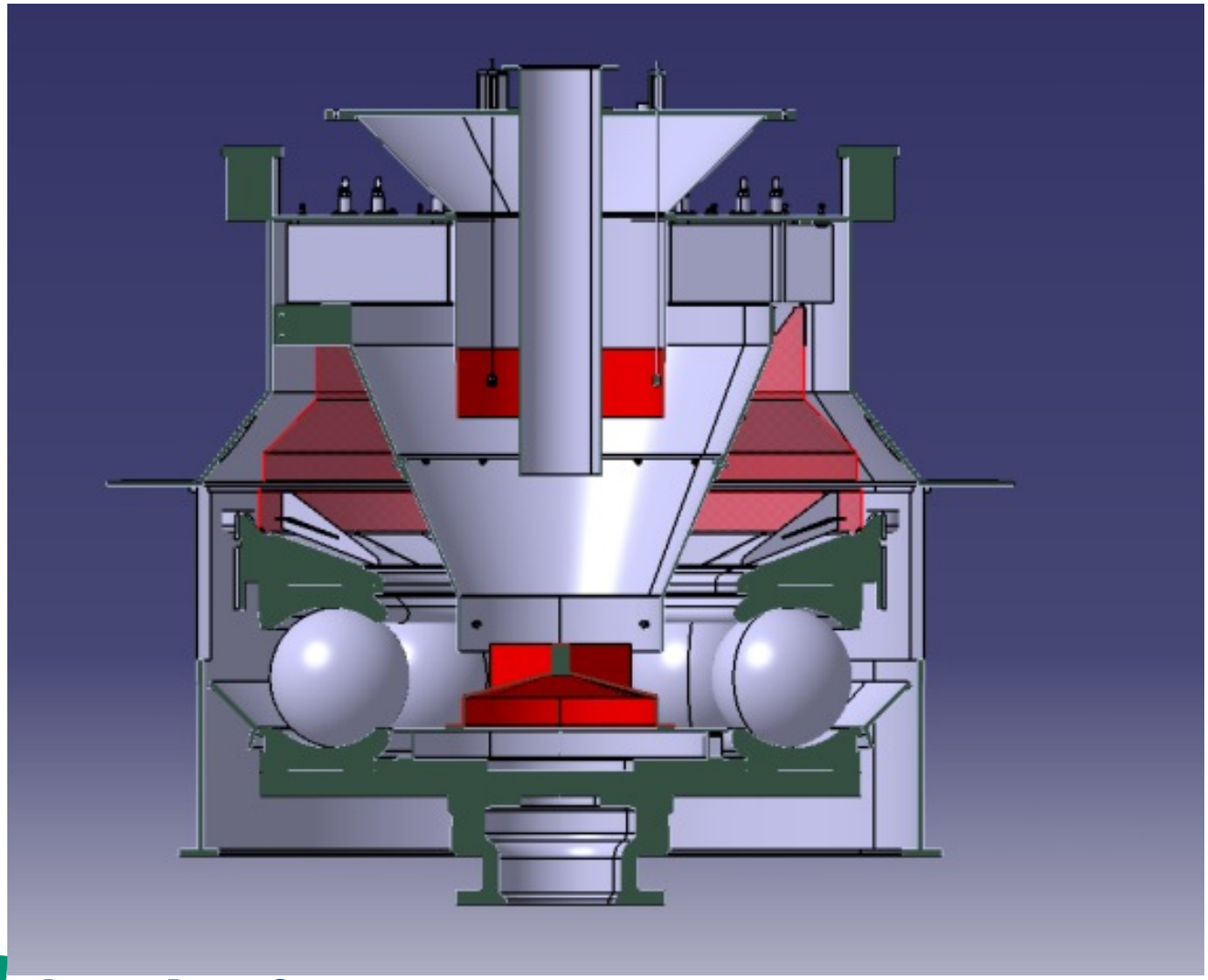
- The modification of the installed feeder, and recalibration, to take into account the nature and behaviour of the biomass pellets

- The installation of a rotary valve in the coal chute between the coal feeder outlet and the mill inlet is recommended to form an effective seal between the mill and the bunker hall
- The rotary valve would be brought into service prior to start-up of the fuel feeder and would stay in service for a short period after the fuel feeder was taken out of service.

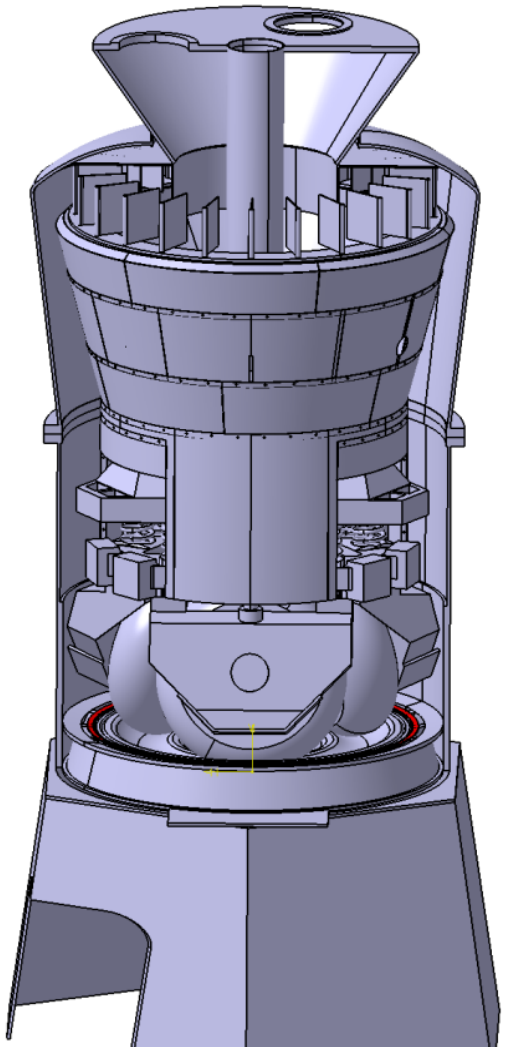
- The modification of the bottom of the classifier return cone to provide more positive removal of the returned material
- The installation of internal modifications to the mill throat to maintain the correct air velocities
- The installation of internal baffles within the mill body to permit optimisation of the biomass throughput

- The modification of the classifier vanes and the mill outlet pipe to permit the optimisation of the biomass throughput.

Mill modifications



Atikokan – proposed mill modifications



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Mill safety issues

- The maintenance of control over the mill inlet and outlet temperatures at level appropriate to biomass materials is the key mill safety measure,
- There will be a requirement for modest modification of the coal mill operating procedures,

- The installation of steam inerting and water misting systems has not generally been required for biomass conversion projects.

- The installation of explosion detection and suppression systems has been carried out in some instances, as a client preference.

Combustion issues

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Potential burner modifications

- The modification of the Doosan Babcock Mark III low NO_x burners for the combustion of milled biomass has been achieved successfully at a number of plants.

- There is a tendency for the flame produced when firing milled biomass with a topsize in the range 1- 3 mm to have the ignition plane located further out into the quarl than in a pulverised coal flame.
- This is considered to be a result of the longer heating times required for the larger biomass particles compared to pulverised coal.
- The result is that the flame monitor signal for the unmodified burners may be poorer than for a coal flame, particularly at reduced mill loads.
- There is no indication that the flames are unstable.

- The burner modifications are designed to bring the ignition plane back into the burner quarl, and improve the flame monitor signals.

Summary

- Vertical spindle mills have been modified successfully to process pelletised wood and produce an acceptable mill product.

- The combustion quality and efficiency is determined by the fineness of the milled biomass.
- There may be a requirement to modify the installed pulverised coal burners to ensure well anchored flames and good flame detector signals.

- The bottom ash and fly ash make will be much lower than with coal, and the carbon in ash may be significantly higher than with coal.

- Based on the experience at Hasselby and elsewhere, no significant changes to furnace and boiler performance are anticipated, and there should be no major pressure part modifications due to changes in boiler performance.
- The risks of excessive ash deposition and corrosion are controlled by the fuel specification, i.e. ash content and ash composition, and with the use of fuel additives.

- Uncontrolled dust, SO_x and NO_x emissions will be much lower than for coal firing and will depend on the fuel quality.

Questions?

Thank You
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