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CO-COMBUSTION OF REED CANARY GRASS AND MILLED PEAT IN A BIOENERGY COMBINE

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SUMMARY

Skellefteå Kraft AB is one of Sweden's largest producers of renewable energy from hydropower, wind and biomass. In the unique bioenergy combine - heat, electricity and pellets are produced in the same facility with high efficiency and low environmental impact. Biomass from forests and by-products from sawmills are mainly used as fuel and raw material for pellet production. About 10 % of peat is blended with biomass to increase the electricity production and reduce problems with ash sintering in the 98 MW (CFB) fluidised bed boiler. Reed canary grass is one of the most promising energy crops in Northern Europe. In 2009, 260 hectares of reed canary grass were established in the community of Skellefteå. However, the low bulk density of this fuel has caused a lot of problems in handling and many boilers in Sweden cannot use reed canary grass because of the ash properties. By using milled peat in blends with reed canary grass Skellefteå Kraft AB can demonstrate a reliable handling system for the fuel chain supply and also efficient combustion.

KEY WORDS: milled peat, reed canary grass, co-combustion, fluidised bed boiler

INTRODUCTION

In 1989 a new concept *delayed harvest* was introduced for the harvesting of reed canary grass in the springtime of the following year[1]. This harvesting system allows for reaching sufficiently low moisture content for storage and improved fuel quality through high losses of alkali and chlorine compared to summer harvested grass[2]. Alkali and chlorine in biofuels are involved in ash fouling, slagging processes and deposit formation during combustion as well as corrosion on super heaters. Therefore this improved fuel quality is important for large scale use in combined heat and power plants. During the last five years the price for wood fuel has increased as much as 50 % in many regions in Sweden and therefore reed canary grass for large scale use has become more profitable for farmers to grow. In Northern Sweden there are thousands of hectares of set-aside land that could be used for growing reed canary grass. In the period from 1850 to 1955 approximately 60.000 ha of peatland in Northern Sweden were drained and used for the production of grass as animal fodder. Since then none of this land has been used for any purpose at all and some areas have turned into low production forest with low economical value. However this land has potential for growing reed canary grass. Approximately 250 hectares of reed canary grass are now established in Glommersträsk, 90 km west of Skellefteå.

Since reed canary grass is harvested in the late spring when the heat and power plants reduce output, there is a long storage time to the autumn when the production of heat and power

starts again. The bulk density is low for reed canary grass: approximately 160 – 200 kg/m^3 in round and square bales and 70 – 100 kg/m^3 as cut material. Therefore there are high costs for handling and transportation. Cut grass is cheaper to produce and can be acceptable for transportation within 30 km from the end user. The low bulk density also contributes to the problem of feeding the boiler with sufficient fuel to secure the heat and power production. Milled peat has been tested in blends with reed canary grass to improve the feeding and combustion behavior. The high content of reactive minerals in peat means less risk of agglomeration inside the boiler and corrosion on the super heaters[3].

MATERIALS AND METHODS

Technical overview of the plant

The combined power and heating plant primarily consumes the by-products of natural materials harvested from the surrounding environment, the plant's operation is completely automated and employs fluidized bed technology - an ultra-modern, highly efficient technology which allows the process to be finely controlled and which is also eco-friendly. The generated steam is led through two turbines - one high-pressure and the other low-pressure, which operate at different speeds so as to achieve maximum output. Both turbines power a generator which produces energy in the form of electricity. The steam is then led away to a heat condenser, where it warms the water used for district heating.

Some of the steam produced is piped from the plant's high-pressure turbine over to the pellet factory, where it is used to dry raw materials. The pellet factory's low-pressure turbine also makes it possible lo utilize waste heat from the drying process to generate electricity. The pellet factory uses raw materials in the form of by-products from the region's sawmills - forest raw materials of the very highest quality.

The Hedensbyn operation is designed to have as little impact on the environment as possible. It uses biofuels primarily harvested from nearby areas, and thanks to an electro filter, which filters exhaust gases from the boiler before they are expelled from the chimney stack, 99.98 per cent of material contained in the gases can be removed. As a result, the chimneys emit mostly harmless water vapor. Generating district heating, green electricity and biopellets at the same plant increases the efficiency of the combined power and heating plant, which would otherwise operate at an overcapacity during the warmer months of the year.

Table1. Technical data Bioenergy combine

Bioenergy combine
98 MW boiler 34 MW steam turbine, 24 tonne/hr pellets
Annual production
260 GWh heat 170 GWh electricity 130,000 tonnes biopellets

Pic1. The bioenergy combine in Hedensbyn, Skellefteå.

Production of reed canary grass

Approximately 260 hectares of reed canary grass were established in the community of Skellefteå. This grass can also be grown on drained peatland.

Pic 2. Reed canary grass on drained peatlands. Left: first year, middle: second year, right: third year

Pic 3. Cutting wagon, for harvesting

Pic 4. Particle size suitable for blends with milled peat

RESULTS

Combustion

During the test period the boiler ran at 45 – 55 MW, approximately 50 % of maximum power. The amount of reed canary grass in the fuel mix was between 10 – 20 percent weight, with 30 - 40 percent weight of milled peat and 50 percent weight of wood fuels. The test period lasted for 3 weeks. No problems were noticed during the test period and the combustion was stable, see fig 1 and fig 2.

Pic 5 Storage of cut reed canary grass

Pic 6. Blends of fuels in the fuel hopper.

Table 2. Energy content in fuels

Fuel	Bulk density Kg/m^3	Energy content MWh/m^3
Reed canary grass	100	0,4
Milled peat	400	0,9
Wood fuels	350	0,8

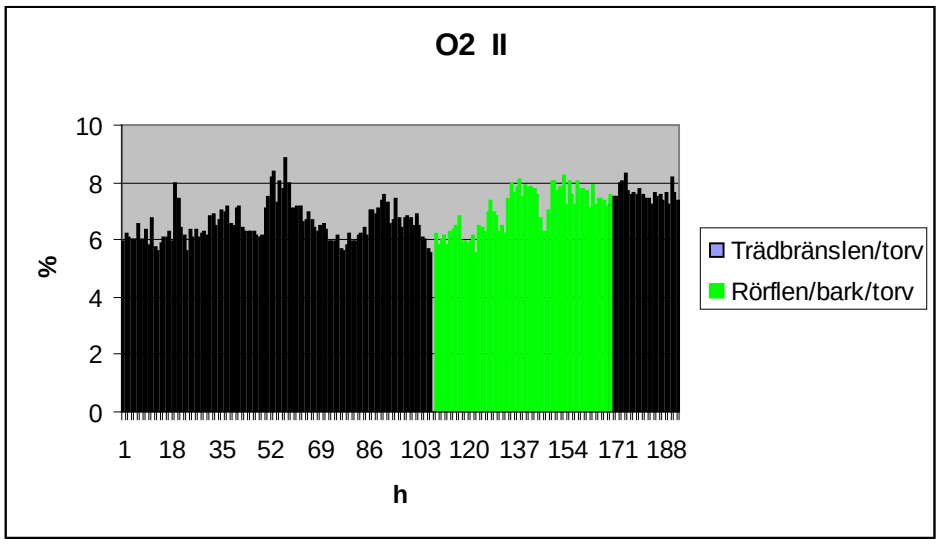

Fig 1. The oxygen content in flue gas. The “green” period contains reed canary grass in the fuel mix.

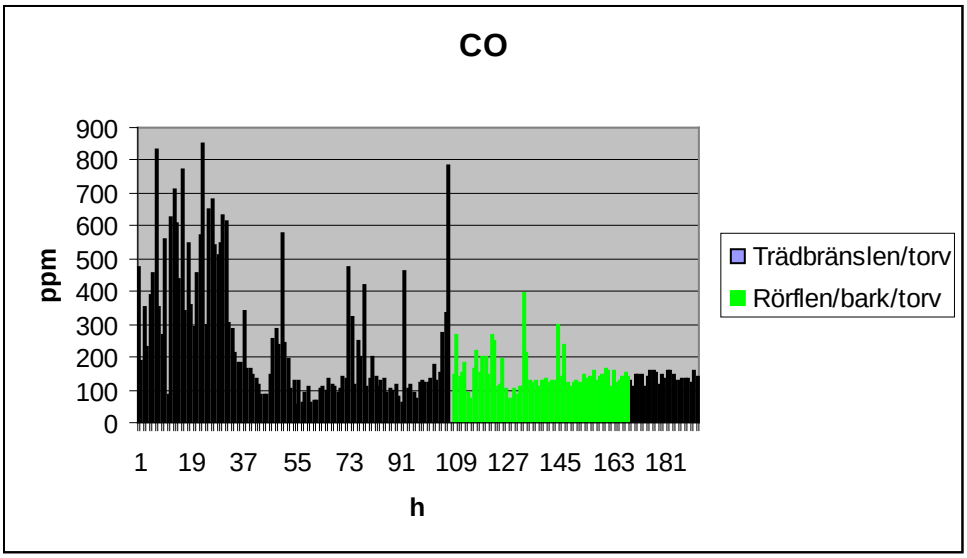

Fig 2. The carbon monoxide content in flue gas. The “green” period contains reed canary grass in the fuel mix.

Emissions

Sulphur as SO_2

The SO_2 emissions are very low even if the amount of milled peat was 40 – 50%.

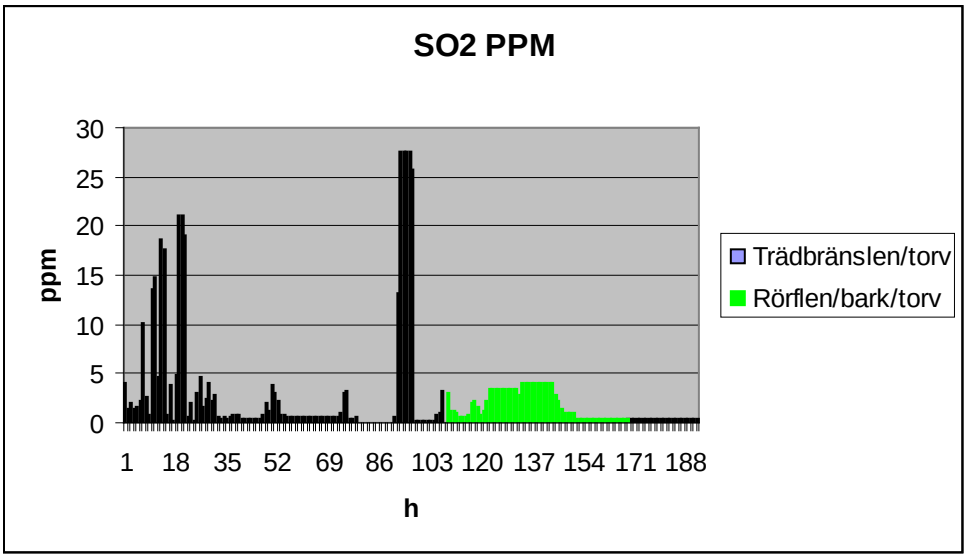

Fig 3. The SO_2 content in flue gas. The “green” period contains reed canary grass in the fuel mix.

Emissions of NOx

The NO_x content is relatively low; however a small increase was noticed, mainly caused by the high content of nitrogen in peat, about 2 %. Reed canary grass contains 0, 7 % of nitrogen and wood fuels 0, 1 % of nitrogen all values in DM.

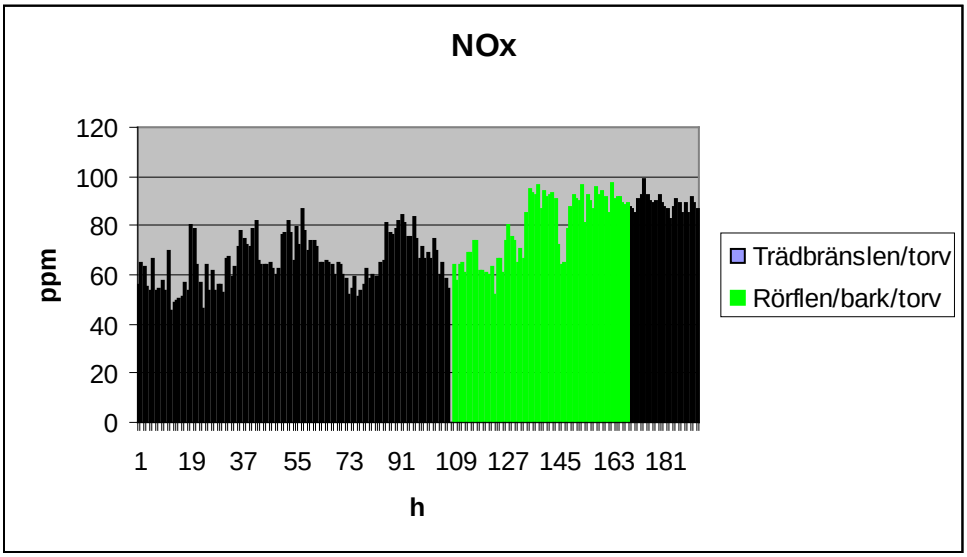

Fig 4. The NO_x emission in flue gas. The "green" period contains reed canary grass in the fuel mix.

CONCLUSION

Milled peat in blends with wood fuels and reed canary grass improves the feeding of the fuel into the boiler and the combustion behavior. The high content of reactive minerals in peat means less risk of bed agglomeration and corrosion on the super heaters.

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