Co-firing of refined biomass pellets at Nordjylland Unit 3

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Nordjylland Unit 3 – USC unit with world class efficiency

- Hard coal fired tower boiler: 850 MW_{thermal}
- Double reheat steam cycle:
  290 bar, 582°C/580°C/580°C
- Net electric efficiency: 47%
- Tower boiler
- 4 burner levels
  - Babcock (Hitachi) MPS 212 roller mills
  - Tangential firing
  - Low NOx burners
- deNOx catalyst, ESP and wet desulperisation
Biomass: Refined pellets

- Steam exploded pellets
  - Wood chips mixed with high pressure steam for few minutes.
  - Relief of pressure creates steam explosion which breaks fibres
  - Energy content is higher
    - 20-25% higher LHV than white pellets
    - Maintain power station max. load
    - Higher energy content pr. transport
- Can be stored outdoor
- Improved grindability
Test: Storing refined pellets outdoor during autumn

› Test period 48 days
› Precipitation 360 mm (rain)
  › 75% absorbed in the pellets
  › 25% percolate
› Pellets did not disintegrate
Test: Storing refined pellets outdoor during autumn

 › Increased moisture in top layer (50 cm)
   › Moisture content increased 6% to 18%

 › Percolate
   › High chemical oxygen demand (>300 g/L)
   › Must be burned with the pellets
Test: Co-firing tests

› 100% refined pellets in one pulveriser
   › Two pulverisers fed by coal

› Aim of test
   › Pulveriser load min. to max
   › Pulveriser gradient
   › Assessment of
     › Flame stability
     › LOI
     › Emissions
     › Limits on plant load
Safety – main issues of HAZID

› **ATEX**
  › Hot air to pulverise at max 250°C
  › Water spray at bunker to reduce dust at conveyers
  › All mills equipped with Kidde-Deugra explosion suppression system
  › ATEX precautions when emptying pulveriser rejection box

› **Sampling of hazardous gasses**
  › Mostly undetectable and far below limits
Plant modifications

› Coal forms an air tight seal in silo
  › Refined pellets don't
  › Dust can flow from pulveriser to feeder
  › This eventually blocks the feeder

› Installation of rotary valve
  › Prevents flow of dust from pulveriser to feeder
Firing 30 mass% refined pellets

› Refined pellets compared to coal
  › Lower density
  › Lower LHV
› Therefore
  › Pulveriser unable to meet 33 mass%
  › Energy basis 25%
› Unit max load
  › Normally 100% load with 3 pulverisers
  › Refined pellets limits this to 95-97%
  › 4 Pulverisers needed for max. load
Test with 100% refined pellets in one pulveriser
Adjustment of flame scanners were necessary

- LAND flame scanners
- Bio flame was slightly different from coal flame
- Visual inspection verified stable flames
- Adjustment of scanner proved sufficient to ensure safe operation of pulveriser
The pulveriser performed very well during the test

Changes in mill control
› Rotating classifier stopped to reduce recycling of particles
› Max. 250°C air inlet temperature (ATEX requirement)

Key observations
› Max. grinding pressure, (roller height above 40 mm set point)
› Motor power high but still 10% margin
› No significant amount in rejection box
Emissions

- Concentration of NOx and SOx were below coal reference
- This is similar to white pellets
- Unburnt carbon in flyash < 3%
- Electro static Precipitator at same level as coal
Operation of wet DeSO\textsubscript{X} unit at low sulphur load

› Gypsum crystallization
  › Low load leads to slow crystal growth, which leads to high moisture content and low gypsum quality

› Gypsum purity
  › At low sulphur load the ratio between flyash and gypsum is less favourable
  › At low sulphur load the mean crystal diameter diminishes, i.e. less efficient gypsum-ash separation.

› COWI has recent experience with selection of crystal growth modifiers and control and regulation of the concentration to solve the problem
Conclusions

› Successful test
  › 100% pellets in one pulveriser
  › Max and min pulveriser load
  › Gradient test at max. feeder gradient

› Recommendations
  › Flame scanner needs adjustment
  › Rotary valve between pulveriser and feeder is necessary
  › Pulveriser operated at max. grinding pressure – probably wear will increase

› COWI's expert assisted the customer by
  › Planning of tests
  › HAZID and ATEX screening
  › Authorities environmental permissions
  › Detailed instructions, supervision and decisions during test in direct cooperation with control room personnel
  › Evaluation and reporting of the test