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Biofuels in lime kilns

Niklas Berglin, Innventia

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Survey

- Main objective
  - Compiling and comparing mill experience from biofuels firing
- How?
  - Collection of basic data through a questionnaire
  - Interviews with operations managers
  - Mill visits
  - Focus on solid fuels

(Wadsborn, Berglin, Richards, 2007)
Download at www.varmeforsk.se

Two general approaches

Gasification

- Three installations in Sweden
- Experience also in Finland, Austria, Portugal
- Some of the largest biomass gasifiers in the world (20-30 MW)

Direct firing

- Two installations in Sweden

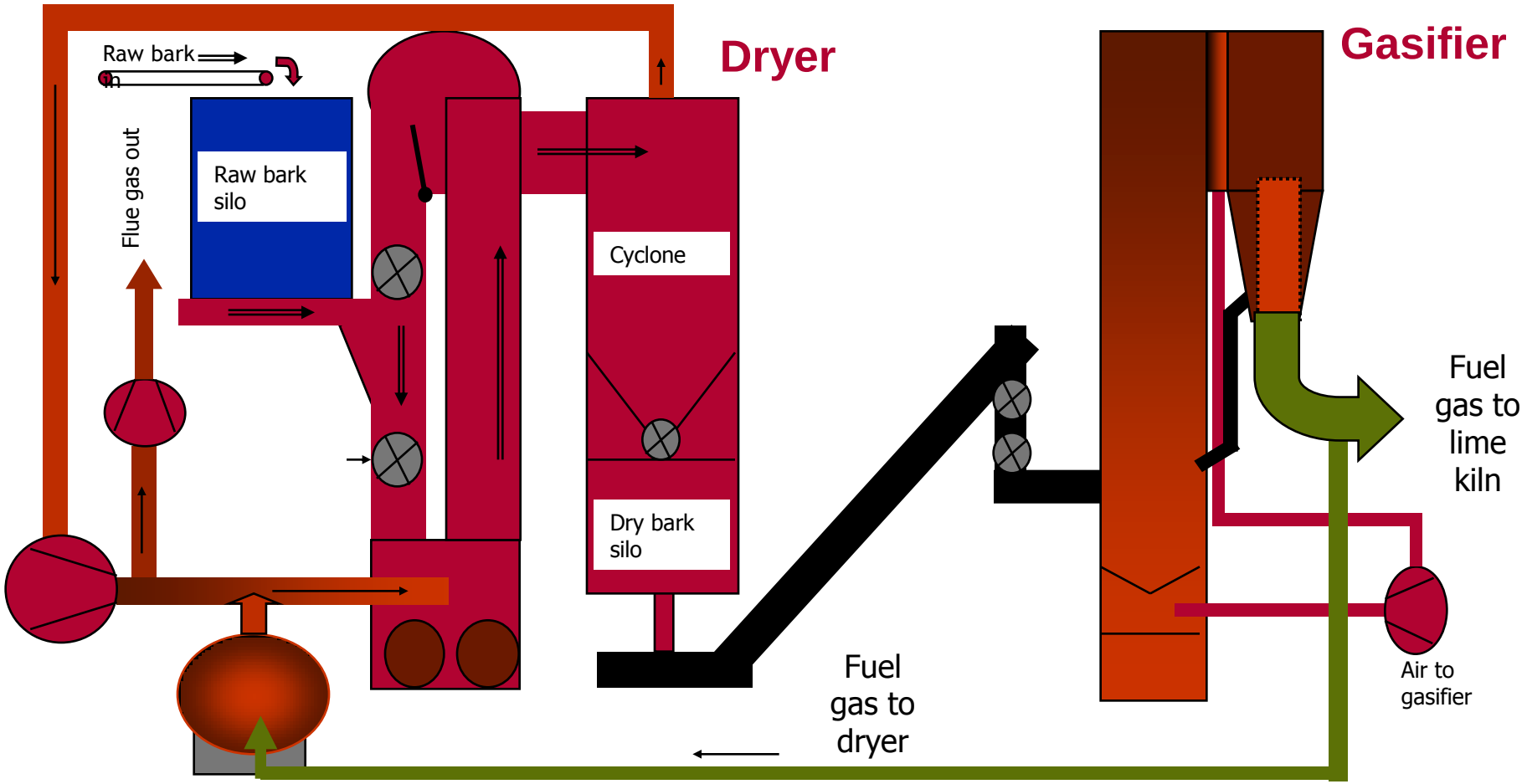
Burners

- Powder burner used for bark or wood powder
- Powder transported with compressed air

- Fuel gas burner used with gas from gasifier
- Large volumes, hot gases

Billerud Karlsborg Mill

- Operated 1986 - 2002



Source: Häggström 1999

Södra Cell Värö Mill

- Rotary dryer fired with fuel gas from the gasifier

- Start-up in 1986
- One kiln fired with fuel gas from bark

Smurfit Kappa Kraftliner Mill

- Start-up in 1979
- Both kilns fired with powder

- Hammer mills used to produce powder finer than 1 mm

Examples of fuels used

		Bark	Tall oil pitch	Peat	Sawdust
Composition					
C	% of DS	50.70	81.90	55.30	50.30
H	% of DS	5.90	11.40	5.80	6.20
O	% of DS	39.90	5.80	36.00	42.80
S	% of DS	0.03	0.28	0.21	0.01
N	% of DS	0.48	0.06	1.10	0.10
Ash	% of DS	3.00	0.51	1.60	0.60
Lower Heating Value	MJ/kgDS	18.9	37.8	21.5	19.1

Installations at five Swedish mills

Biofuel System					
Technology	powder	powder	gasifier	gasifier	gasifier
Fuel	bark/sawdust	sawdust	bark	sawdust	bark
Drying	recovery boiler flue gases	recovery boiler flue gases	hot gas gen. from the fuel gas	hot gas gen. from the fuel gas	hot gas gen. from the fuel gas
Milling	hammer mill	hammer mill	hammer mill	hammer mill	hammer mill
Availability	80%	90%	70%	75%	70-75%
Common causes of unavailability	replace hammers in mills, filter plugging, fires	replace hammers in mills, plugging of mill, fires	fires, leakage in cell feeder, bed sintering	fires in dry storage silo, fuel gas valve	fires, leaking fuel gas pipe

Effects in the kiln

Lime Kiln

Oil replacement max	100%	100%	100%	100%	65-70%
Oil replacement on annual basis (excl. tall oil)	35%	60%	40-45%	50%	40%
Emissions compared to oil					
- NOx	higher	unchanged	higher	unchanged	higher
- CO	unchanged	higher	unchanged	higher	unchanged
- H2S	unchanged	unchanged	unchanged		unchanged
- SO2	unchanged	unchanged	unchanged	higher	unchanged
Capacity compared to oil	lower	lower above 70% replacement	unchanged	lower	lower
Ring formation	not a problem	every two months	not a problem	not a problem	problems 6-8 week intervals
Repair of lining	ca 3 times per year	every two years	ca 3 times per year	ca 2 times per year	ca 1 time per year
Flue gas temp compared to oil	higher	higher	higher	unchanged	higher
Other fuels to lime kiln					
- tall oil	yes	no	no	no	no
- tall oil pitch	no	yes	yes	no	yes
- methanol	yes	no	not normally	no	not normally
- non-condensable gases	not normally	no	not normally	yes	not normally

Effects in the lime and liquor cycles

Liquor Cycle					
Lime mud dryness compared to oil	lower	lower	lower	unchanged	lower
Lime quality	no obvious effects	with bark green/black lime mud, greenish lime	darker, greenish	unchanged	poor, more residual carbonate
Lime availability	90-93%	87-90%	85-90%		
Purchased lime, kg/ADt	5-6	4-5	ca 10	35	20-25
NPEs					
- P	increases	increases	increases	not a problem	increases
- Mg	increases	monitored	increases	not a problem	increases
- Si	monitored	monitored	small effects	not a problem	monitored
- Al	monitored	monitored	increases	not a problem	monitored
- K	high levels	not a problem	not a problem	not a problem	not a problem

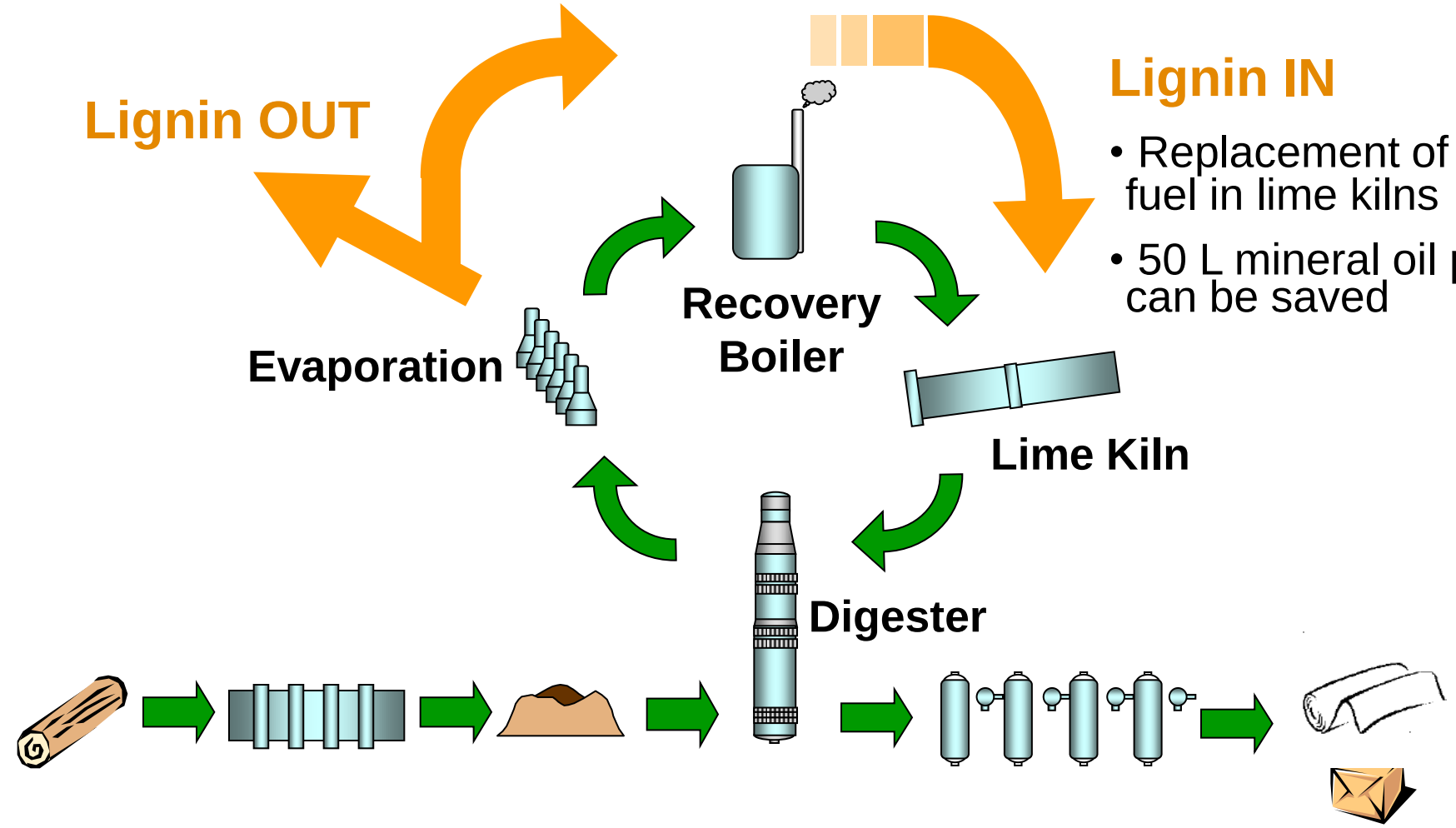
Summary

- 100 % biofuel firing fully possible
- Maintenance requirements increase considerably
  - major cause of unplanned stops is in the drying, e.g. fires are common
  - bed agglomeration common cause of shutdowns in the gasifiers
- Risk for decreased capacity
- Availability low compared to other parts of a modern mill
- Make-up lime requirements increase, in particular with bark firing

Lignin may be next biofuel for lime kilns

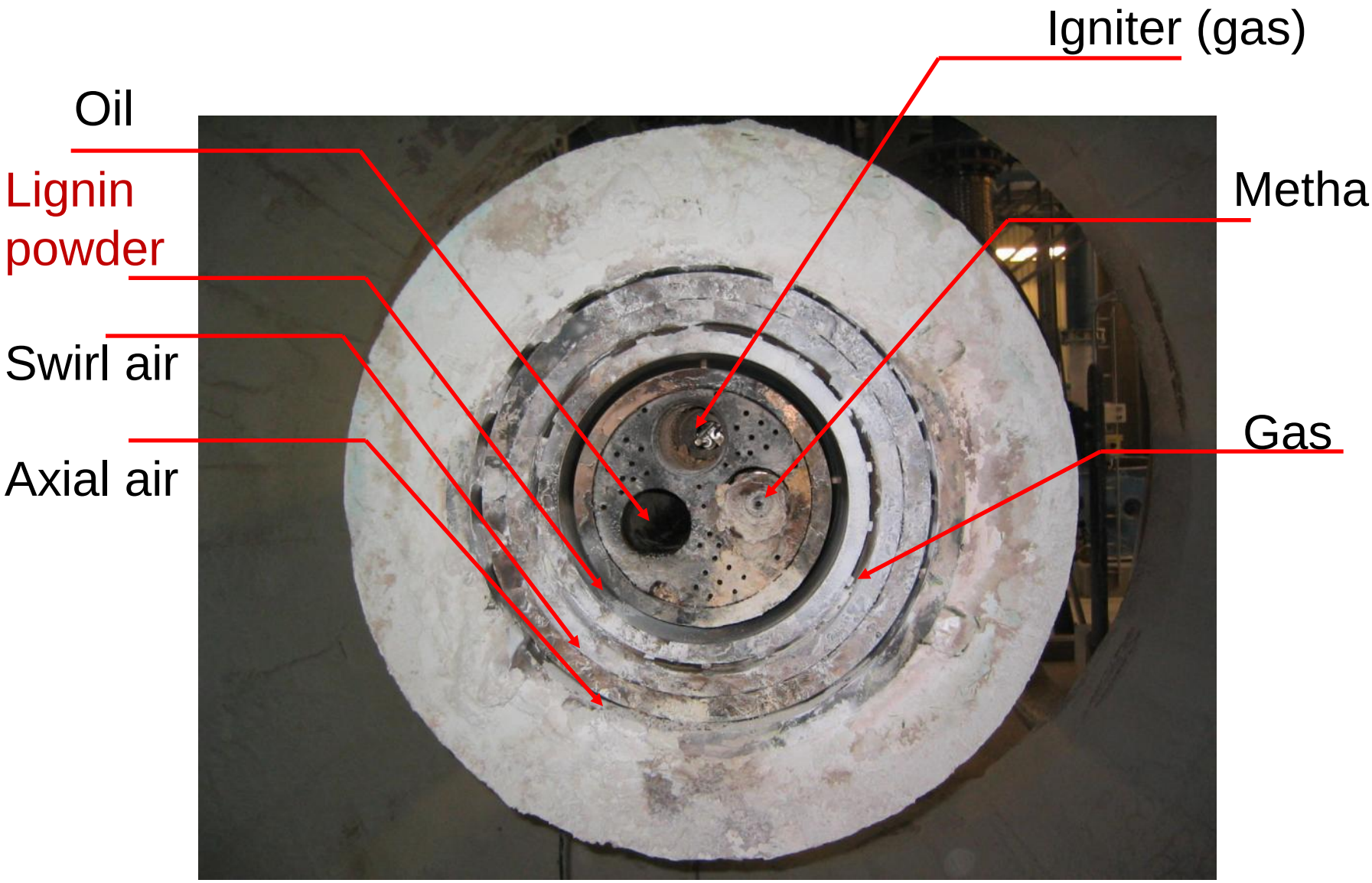
- Full scale trial April 2008
- 40 tonnes
- 2 days
- Up to 100 % oil replacement

The LignoBoost process



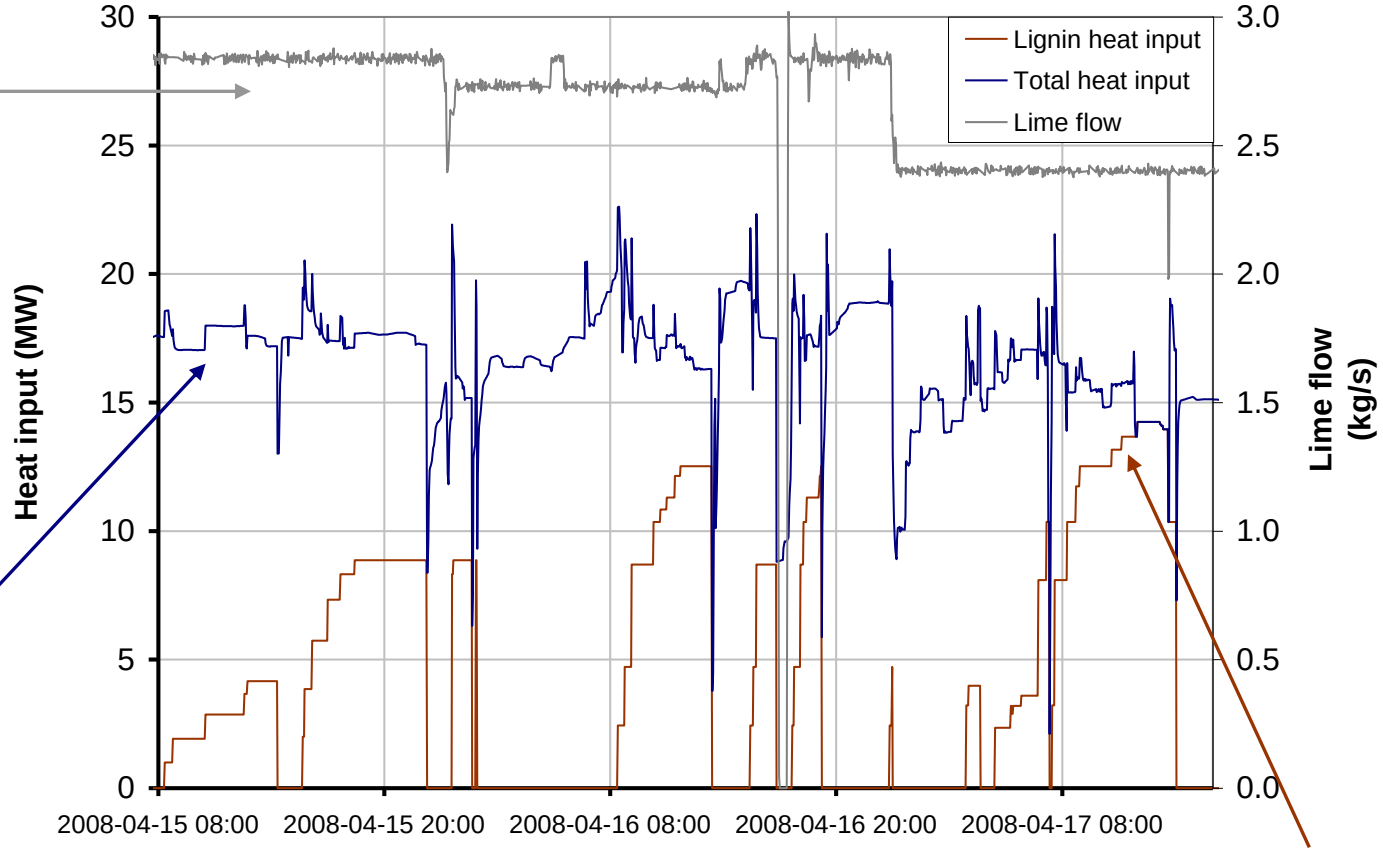
Trial preparation

- Installation of a silo with dosage screw and cell feeder
  - Hooked up to existing powder burner at the mill
  - Separate oil burner
  - Feeding with compressed air


Igniter (gas)
Oil
Lignin powder
Swirl air
Axial air
Methanol
Gas

Replacing all the oil!

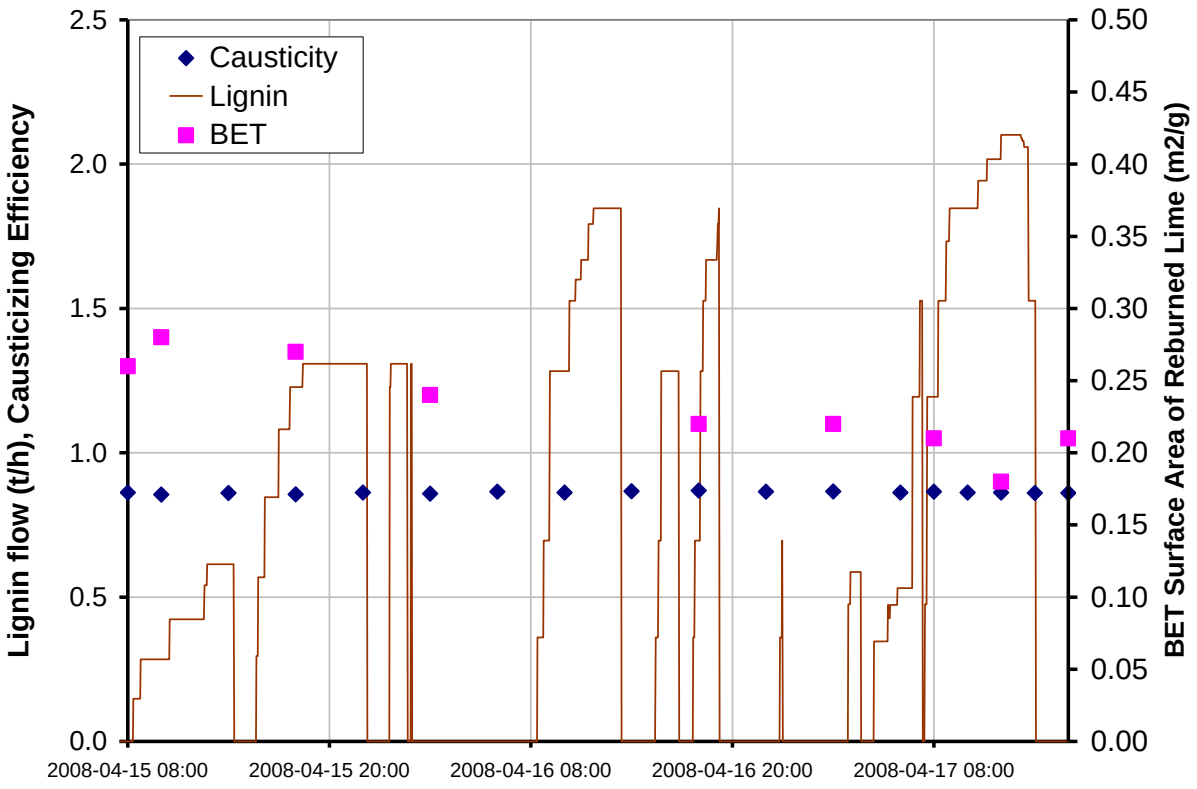
210-240 t lime per day



15-20 MW total heat input (oil + lignin)

Up to 100 % lignin

BET surface area and causticizing efficiency



- Decrease in surface area during trial indicates more hard-burned lime product
- Weak correlation between lignin firing and surface area

Conclusions

- Possible to achieve stable and continuous operation
- Possible to use standard powder burners and feeding equipment
  - Care needed to avoid dusting problems, and to provide sealing of bearings and shafts.
- Possible to produce lime with consistent quality
  - temperature reached in the burner zone sufficient for proper sintering of the lime nodules
- Same causticizing efficiency and same rate as during normal operation
- Based on the operators' opinion, the kiln can be easily controlled when firing lignin


Thank you!
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