THE LONG-TERMS EFFECTS OF DIFFERENT BIOMASS QUALITIES IN A GRATE BOILER

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PURE ENERGY

CONTENT

--> Biomass combustion unit

--> Fuels tested

--> Results

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COMBUSTION UNIT

Grate combustion unit with hot water boiler

- Marienborg plant
  - Supplier: KMW
  - Capacity: 9 MW
  - Installed: 2002
  - Designed for dry biomass fuel, but modification in refractory lining is performed in order to handle more moist fuel
  - Down-stream flue gas tube boiler
  - Muliti cyclon
  - Bag house filter

- Klæbu plant
  - Supplier: Hotab
  - Capacity: 1.5 MW
  - Installed: 2004
  - Designed for dry biomass
  - Down-stream flue gas boiler
  - Multi cyclon

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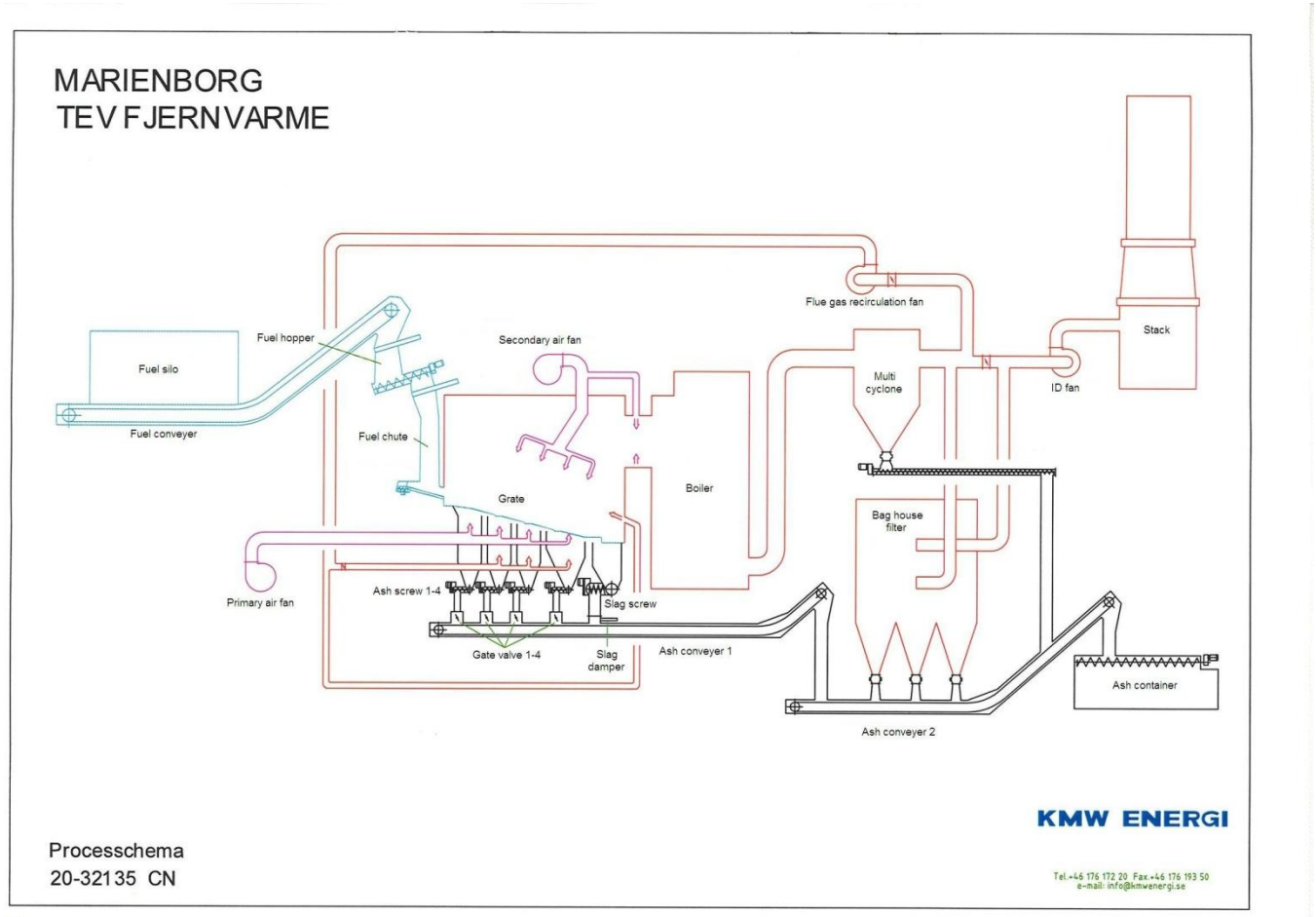
COMBUSTION UNIT - MARIENBORG



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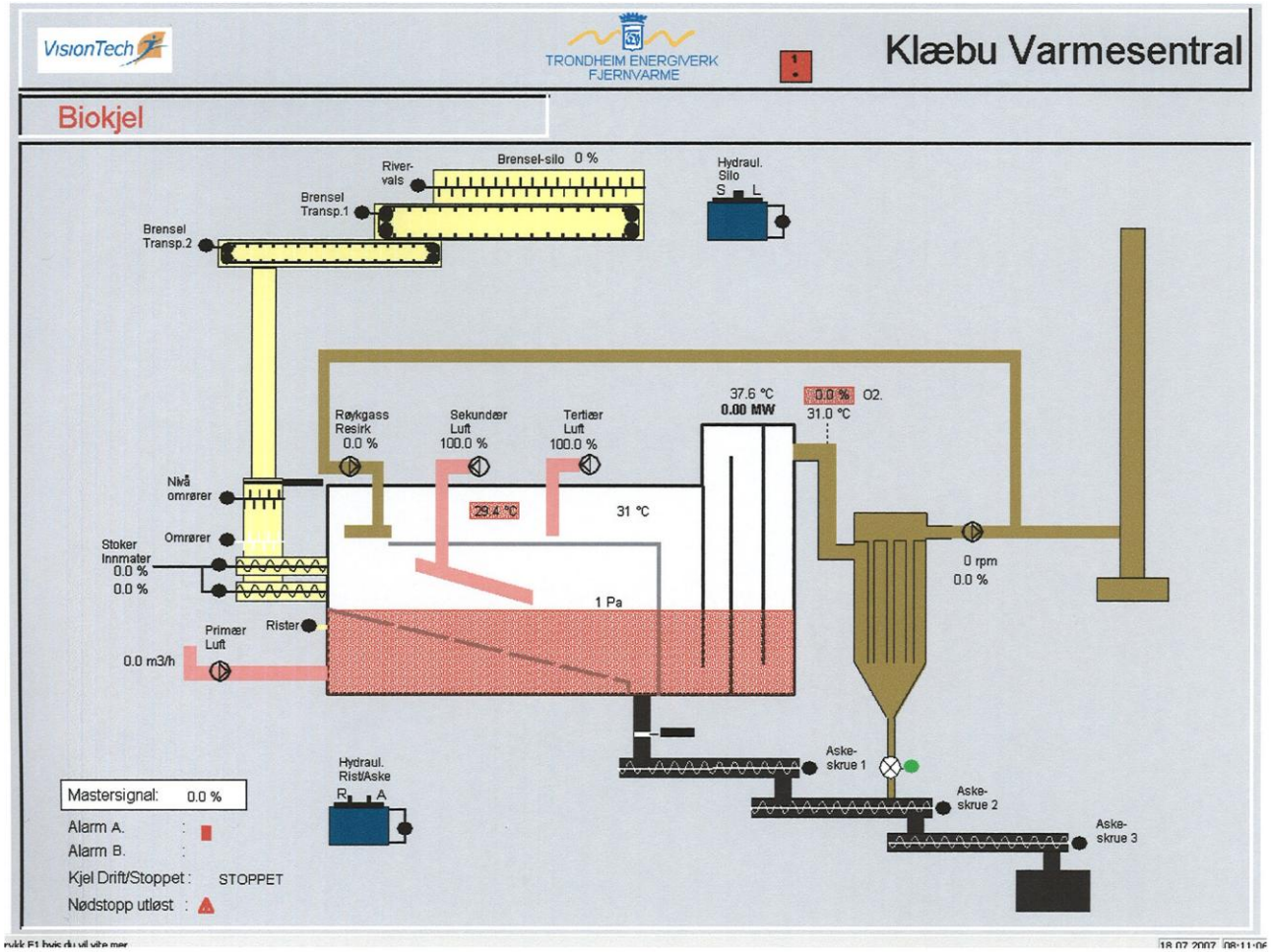
COMBUSTION UNIT - KLÆBU



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FUELS TESTED

- Briquettes
  - 100% sorted demolition wood
- Mixture of briquettes and wood chips
  - App. 42 % briquettes and 58 % wood chips
- Wood chips
  - Wood chips I: Mixture of Norwegian spruce and Baltic hardwood
  - Wood chips II: Norwegian spruce
- Wood chips
  - 100% sorted demolition wood
- Pellet
  - Tests were cancelled due to problems with the feeding system.

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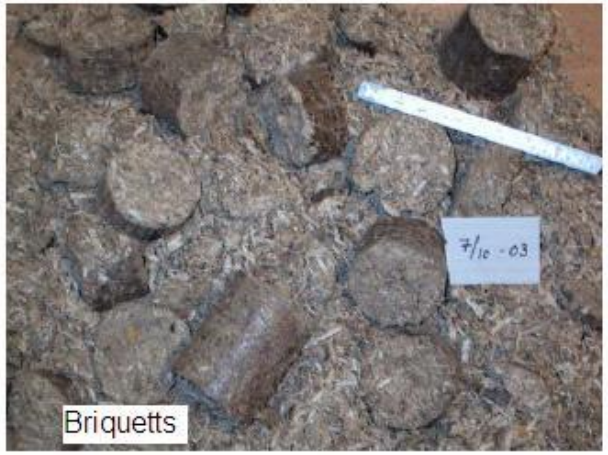
FUELS TESTED



Briquetts

Wood chips, mix of Norwegian spruce and Baltic hardwood

Wood chips, Norwegian spruce

Pellet

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FUEL ANALYSIS - MARIENBORG

Fuel type	Briquettes	Wood chips I	Wood chips II	Pellet
Moisture (% wt)	10.9	39.0	39.0	8.7
Ash (% wt, d.b.)	2.2	0.95	0.6	0.37
S (% wt, d.b.)	0.087	0.014	0.012	0.006
Cl (% wt, d.b.)	0.041	0.005	0.008	0.0016
N (% wt, d.b.)	0.5	<0.3	<0.3	<0.3
Heff (MJ/kg w.b.)	16.5	10.5	10.3	17.1
Ash melting temp (^{0} C)	1060 - 1118	1145-1325	1150-1210	1200

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FUEL ANALYSIS - KLÆBU

Fuel type	Wood chips from sorted waste wood	Residue products from saw mill etc.
Moisture (% wt)	13.4	11.1
Ash (% wt, d.b.)	1.4	0.3
S (% wt, d.b.)	0.038	0.01
Cl (% wt, d.b.)	0.0054	<0.01
N (% wt, d.b.)	0.3	<0.2
Heff (MJ/kg w.b.)	16.3	16.8

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FUEL AND ASH ANALYSIS

- Metals
  - Al, As, B, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, P, Pb, Sb, Se, Sn, Tl, V, Zn
- Lanthanides
  - Ce, Dy, Er, Eu, Gd, La, Lu, Nd, Pr, Sm, Tb, Tm

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FUEL ANALYSIS

	2003-466- (mg/kg)								
	36 Bl. Brik. 7-17/10	37 Bl. Brik 22-29/10	38 Bl. flis 22-29/10	39 Bl. flis 4-7/11	40 Bl. Flis 10-13/11	41 Bl.flis 18-20/11	42 Br. 42 løvirke	43 Bl. Pellet 18-20/11	LOD
Al	366	414	39	43	113	58	40	30	2
As	71	63	<2	<2	<2	<2	<2	<2	2
B	<1	3	3	3	2	4	4	1	1
Ca	2070	1885	1525	1759	1613	1303	1649	804	10
Cd	<1*	<1*	<0,1	<0,1	<0,1	<0,1	<0,1	0,2	0,1
Co	1,4	0,8	<0,3	<0,3	<0,3	<0,3	<0,3	<0,3	0,3
Cr	57	60	0,2	0,3	0,3	0,3	<0,2	0,4	0,2
Cu	48	50	1,0	1,2	1,6	1,3	1,4	1,2	0,4
Fe	580	608	54	69	145	91	56	39	5
Hg	0,11	0,12	<0,01	<0,01	<0,01	<0,01	0,03	<0,01	0,01
K	532	689	685	833	786	703	986	422	5
Mg	415	385	196	234	237	188	284	118	1
Mn	91,2	85,0	106	62,6	69,9	92,1	28,9	115	0,3
Mo	<1	<1	<1	<1	<1	<1	<1	<1	1
Na	330	431	15**	17**	20**	18**	11**	26	5**
Ni	3,8	1,5	<0,3	<0,3	<0,3	0,3	<0,3	<0,3	0,3
P	52	54	70	110	104	83	171	35	2
Pb	37,3	31,2	0,7	<0,5	<0,5	<0,5	<0,5	<0,5	0,5
Sb	<2	<2	<2	<2	<2	<2	<2	<2	2
Se	<2	<2	<2	<2	<2	<2	<2	<2	<2
Sn	0,6	0,9	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4	0,4
Tl	0,7	<0,3	0,6	0,7	0,5	0,5	0,7	0,8	0,3
V	1,3	1,7	<0,3	<0,3	0,3	<0,3	<0,3	0,3	0,3
Zn	418	334	19	17	16	21	17	13	4
Ce	0,41					0,048	0,062	0,032	0,0005
Dy	0,027					<0,007	<0,007	<0,007	0,007
Er	0,018					0,003	0,002	<0,002	0,002
Eu	0,007					0,001	0,0009	<0,001	0,001
Gd	0,032					<0,01	<0,01	<0,01	0,01
La	0,21					0,024	0,037	0,018	0,0004
Lu	0,002					0,0003	0,0002	0,0003	0,0002
Nd	0,16					0,023	0,019	0,015	0,005
Pr	0,050					0,006	0,009	0,0039	0,0005
Sm	0,034					0,005	0,004	0,0029	0,0003
Tb	0,007					0,001	0,0007	0,0005	0,00005
Tm	<0,004					<0,004	<0,004	<0,004	<0,004

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RESULTS

--> Emissions to air

-- Average values, mg/Nm^3, @ 11 % O_2, dry flue gas.

	Briquettes	Briquettes/ wood chips	Wood chips
NOx	166.7	168.4	125.0
SOx	28.9	17.4	0.1
CO	18.3	15.0	19.5
HCl	4.8	4.6	4.3
HF	6.8	4.1	7.2
SO_2	54.8	22.4	5.0

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RESULTS

--> Emissions to air

-- Average values, µg/Nm^3 (pg), @ 11 % O_2, dry flue gas.

Fuel Component	Briquettes	Briquettes/ Wood chips	Wood chips
Hg	2.9	1.1	<1
Co	<0.5	<0.5	<0.5
Cr	0.9	0.7	1.2
Cu	3.9	2.4	2.4
Mn	1.0	1.8	1.7
Ni	<1	<1	7.2
Pb	<10	<10	<10
Sb	<2.5	<2.5	<2.5
Ti	<1	<1	<1
V	<1	<1	<1
Cd	<1	<1	<1
As	<5	<5	<5
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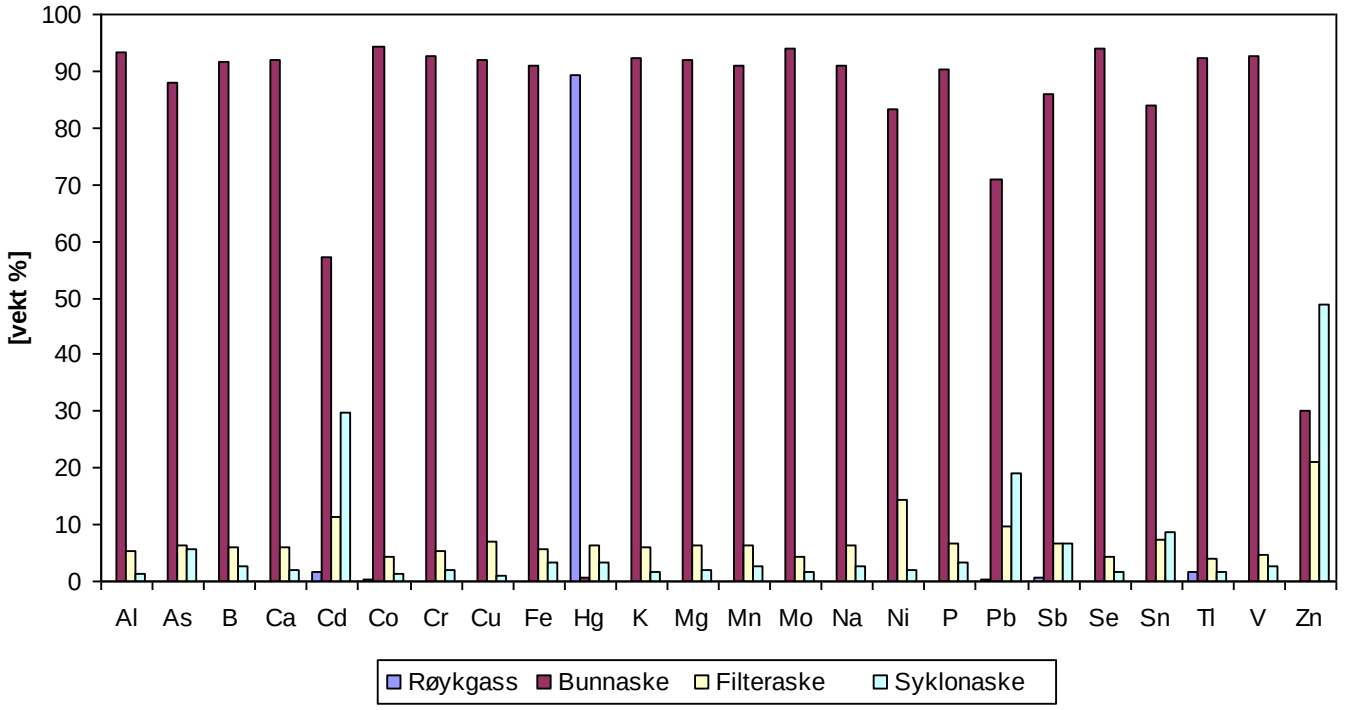
RESULTS

--> Ash analysis

-- Average values, %wt

Briquettes and wood chips



OPERATIONAL EXPERIENCES

- Marienborg plant
  - Briquettets and briquettes/wood cips
    - Severe slagging on grate
    - Fouling in the convective section of the boiler
    - High level of char in bottom ash
- Klæbu plant
  - Wood chips from sorted waste wood
    - Serious sintering problems on the grate and the furnace walls
    - Fouling in the convection section of the boiler
    - Operation between stop for cleaning was 8-10 days, for virgin wood material the plant runs for about 12 weeks before cleaning is needed.

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OPERATING EXPERIENCES MARIENBORG

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OPERATING EXPERIENCES KLÆBU

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