OPERATING EXPERIENCES ON THE FIRST BFB BOILER BURNING BIOMASS FUELS IN POLAND

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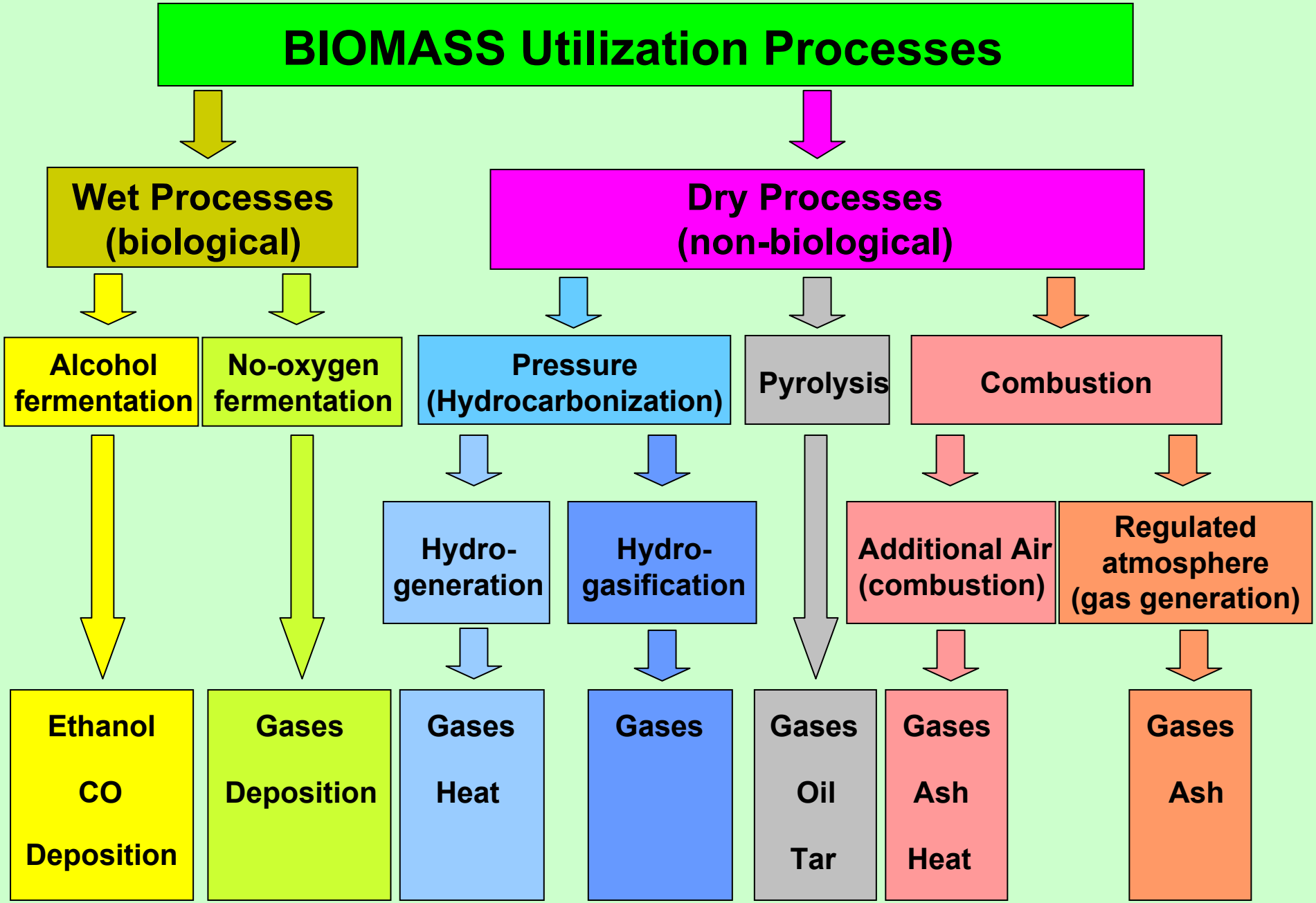

BIOMASS Utilization Processes
Wet Processes (biological)
Dry Processes (non-biological)
Alcohol fermentation
No-oxygen fermentation
Pressure (Hydrocarbonization)
Pyrolysis
Combustion
Hydro-generation
Hydro-gasification
Additional Air (combustion)
Regulated atmosphere (gas generation)
Ethanol
CO
Deposition
Gases
Deposition
Gases
Heat
Gases
Gases
Oil
Tar
Gases
Ash
Heat
Gases
Ash

Biomass Potential & Danger

Low sulfur content (<0.1 %):
less SO_2 emitted compared to coal

'Zero CO_2 emission': no carbon tax ?

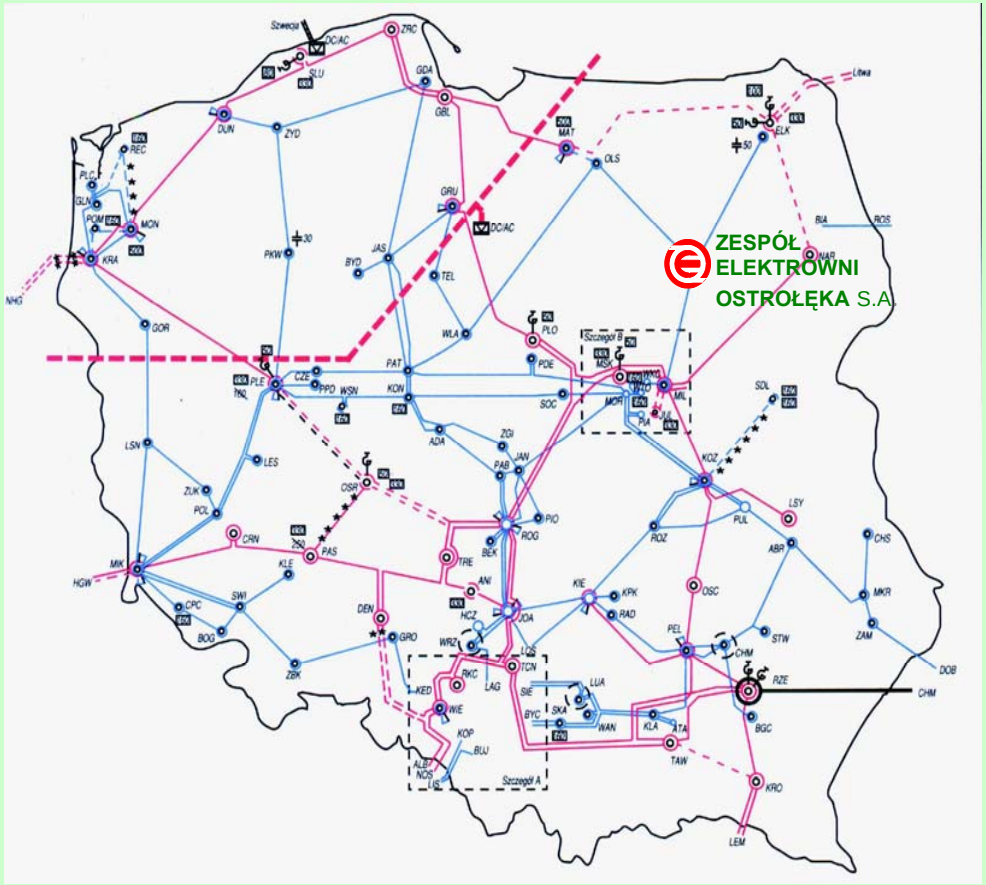
ZECA, Los Alamos – any good solution in general ?

Other elements: NO_x, DXN ?

Issue: price/costs of biomass compared to other fuels

Ostrołęka Power Station

- Type: Power Station + Local Heat Station
- Fuel: Coal - 1,201,000 t/y
  Biomass - 8,000 t/y
- Power installed:
  724 MW_e + 387 MW_t
- Production net:
  2179 GWh + 4349 TJ
- Market share: 1.8 %
  (net, 2003)
- Staff: 1,200



Ostrołęka Power Station consists of:

- Heat and Power Station „A” (since 1956):

  367 MW_t heat power,
  including 32 MW_t biomass boiler

  75MW_e electric power

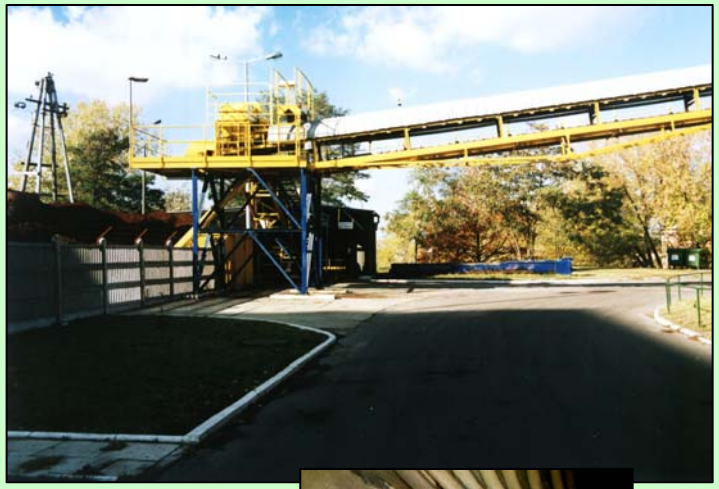
- Power Station „B” (since 1972):

  1 x 226 MW_e (modernized)

  1 x 221 MW_e (modernized)

  1 x 200 MW_e

Power Station 'A', Reasons for action toward a BFB at unit #4:

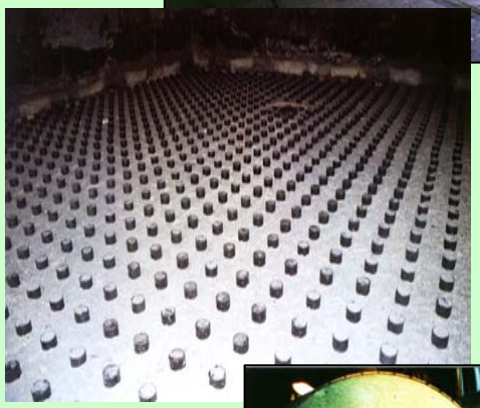


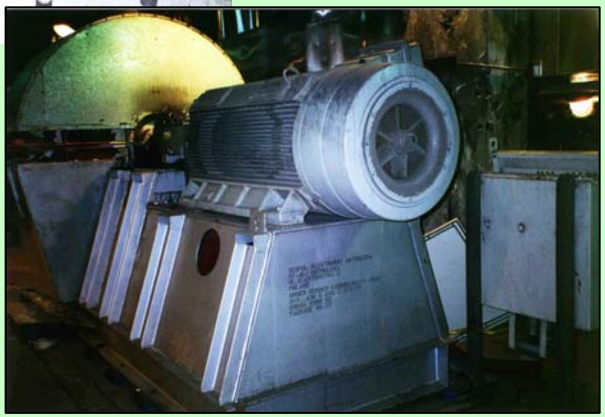
- Utilization of bark produced by neighbouring Intercell Corp.
- Start of fuel diversification at the Power Station
- Introduction of a new combustion technology & maximum utilization of the existing PC boiler equipment
- More environmental friendly operation & adapation to effective combustion of biomass fuels

Modernization of old PC-fired unit into BFB done by FOSTER WHEELER Corp. in 1996-1997

Works Performed

- Manufacturing of biomass and silica sand feeding systems
- Modernization of water/steam section of the old boiler, including cutting off of one section of water preheater
- Modernization of flue gas outlet system & air preheaters
- New lower part of the furnance, including PA nozzles, PA & SA systems and FG recirculation system
- Montage of start-up burner and BA drainage system
- Installation of automatic microprocessor-based control systems





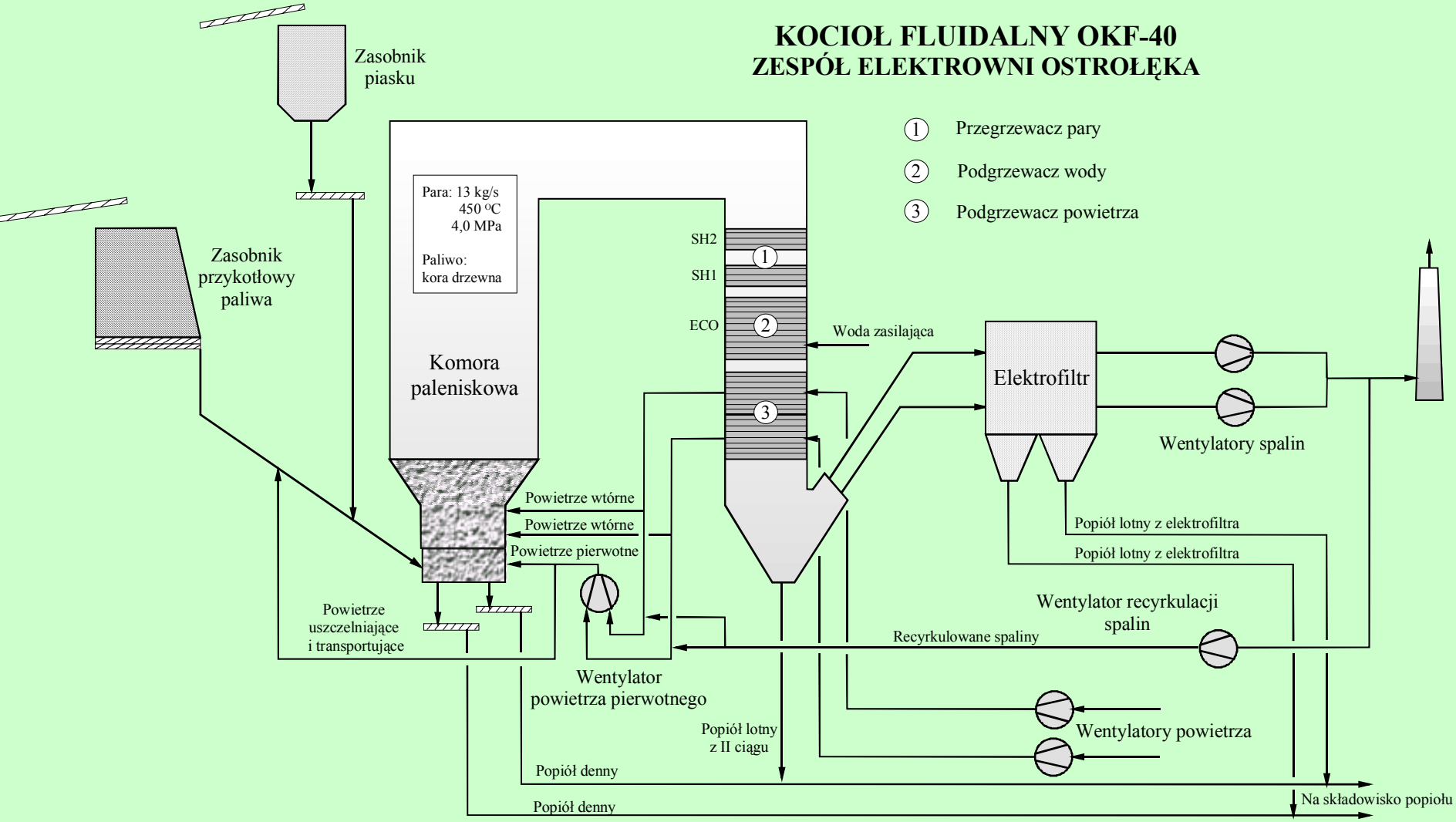
BFB at Ostrołęka Power Station, Poland

Type:	Modification of PC unit OP-100
Fuel:	bark, refuse coals
Power:	35 MW_t
Steam Flow:	47 t/h
Steam Pressure:	4 MPa
Steam Temperature:	450^0C
Gas velocity:	1 – 1.5 m/s
Bed Height:	0.5 – 1.2 m
Chamber width:	6.05 m
Chamber length:	6.5 m
Chamber width at the grate:	4.19 m
Chamber length at the grate:	6.1 m
No. of Nozzles:	1261
Bed ash drainage ports:	2
Modification Year:	1997
Company:	Foster Wheeler

Bed material:
Silica Sand,
100 % < 1.2 mm;
80 % < 0.8 mm
+ Biomass Ash

Fuel fed from a 14 m^3 silo (15-30 min. of boiler operation)

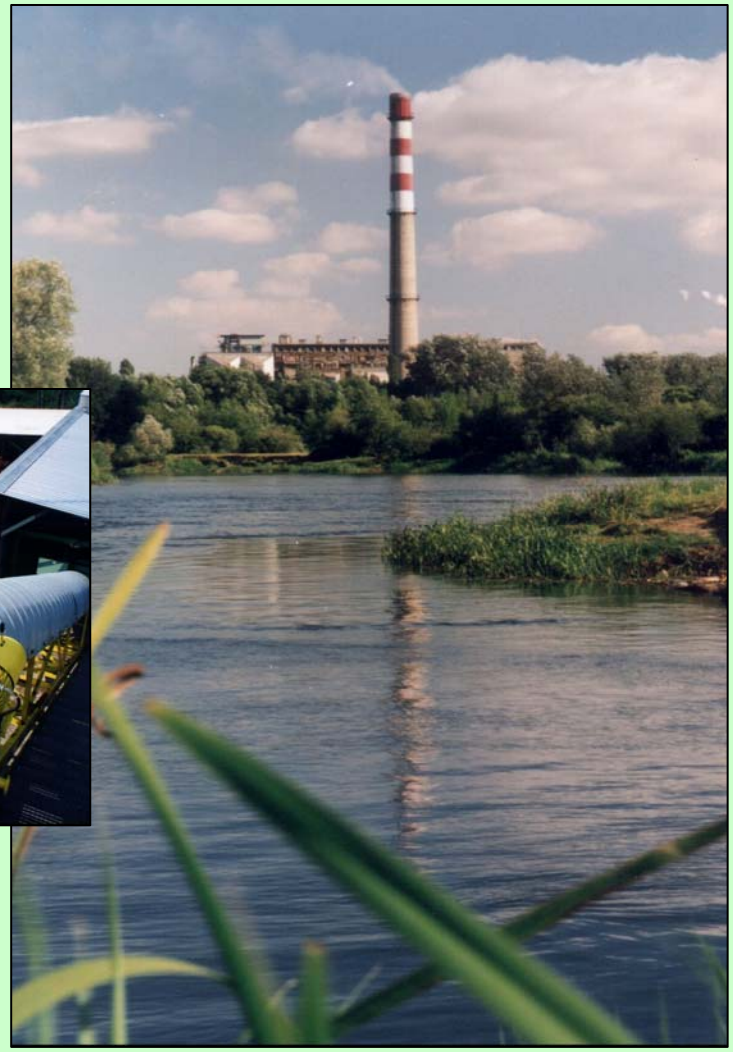
Schetch of BFB unit at Ostrołęka Power Station



TECHNICAL AND ECOLOGICAL EFFECTS, Modernization of PC OP-100 into BFB

Technical effects:

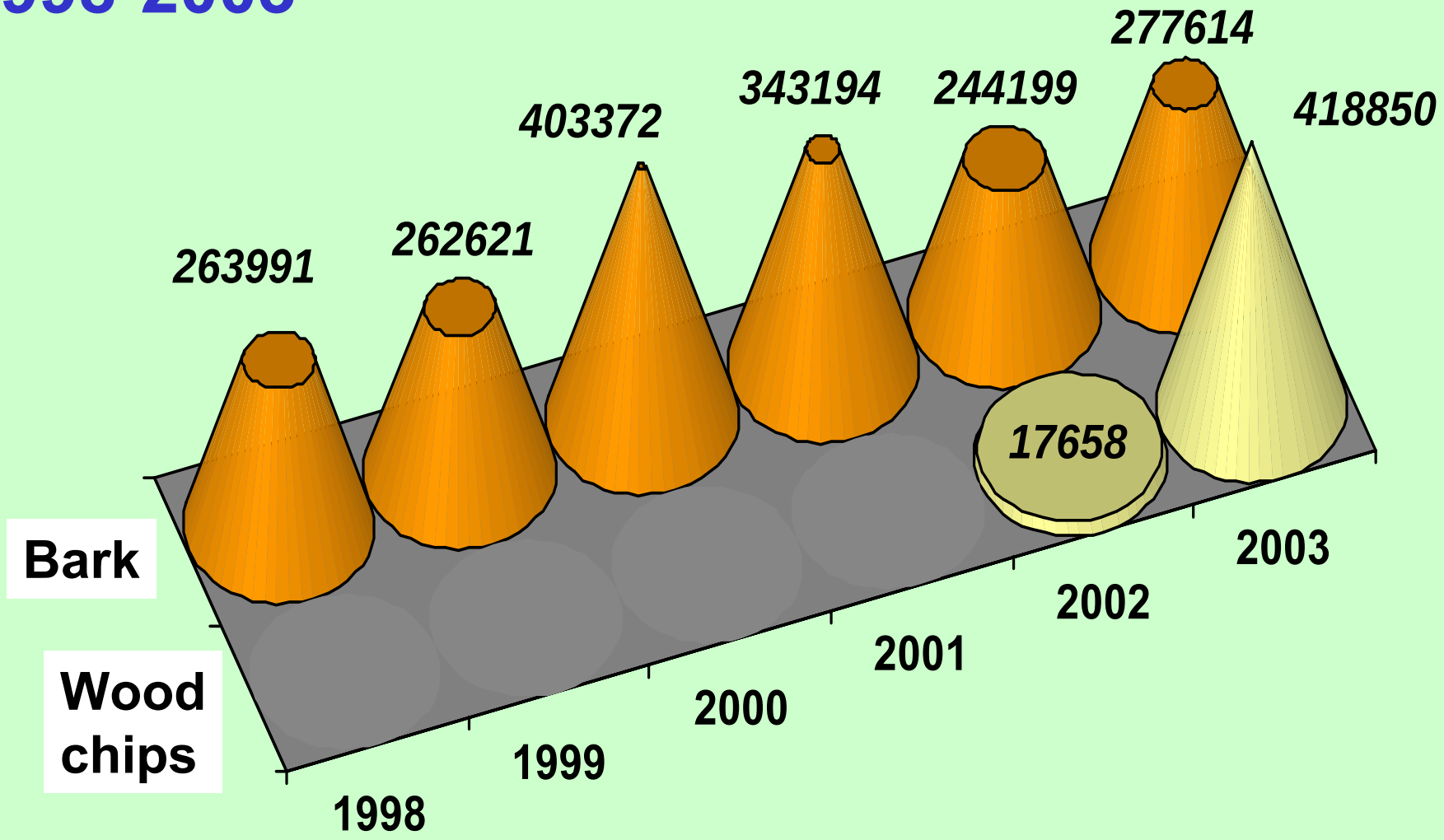
- Higher efficiency
- Wider load range
- Possibility to burn low-quality fuels
- High availability
- Low investment costs



Ecological effects:

- 280 t/y less SO_2
- 100 t/y less NO_x
- 46,000 t/y less CO_2 from fossil fuels
- 23,000 t/y less hard coal burnt
- 4,000 t/y less ash

Biomass usage [GJ]
Ostrołęka Power Station ‘A’
1998-2003



Latest Difficulties:

Fuel change from Bark to Wood Chips

Effect:

Temperature increase &
Bed agglomeration

Research (2003.01.20 – 2003.01.25):

Solid samples taken: bottom ash (R & L), backpass ash, fly ash

Fuels burnt:

Bark (100%)	2003.01.20, 0:00 - 2003.01.21, 8:00
Wood chips (100%)	2003.01.22, 3:00 - 2003.01.23, 15:00
Paper Mill Sludge (40%) + Wood chips	2003.01.23, 16:00 - 2003.01.24, 8:00
Biosludge I (15%) + Wood chips	2003.01.24, 9:00 - 2003.01.25, 8:00
Biosludge II (10%) + Wood chips	2003.01.25, 9:00 - 2003.01.25, 16:00

Sampling Time:
20.01.2003, 18:30
22.01.2003, 9:00
22.01.2003, 15:00
22.01.2003, 21:00
23.01.2003, 9:00
23.01.2003, 17:00
23.01.2003, 21:00
23.01.2003, 24:00
24.01.2003, 12:00
24.01.2003, 15:00
25.01.2003, 10:00
25.01.2003, 12:30

Fuel burnt

Bark

Wood Chips

Paper Mill Sludge

Biosludge I

Biosludge II

Results of Proximate Analisis

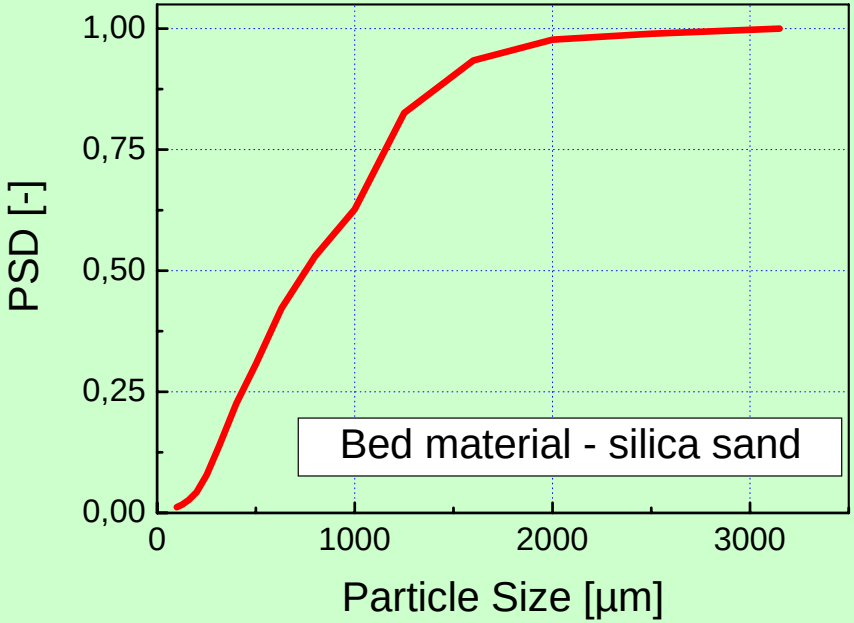
As received

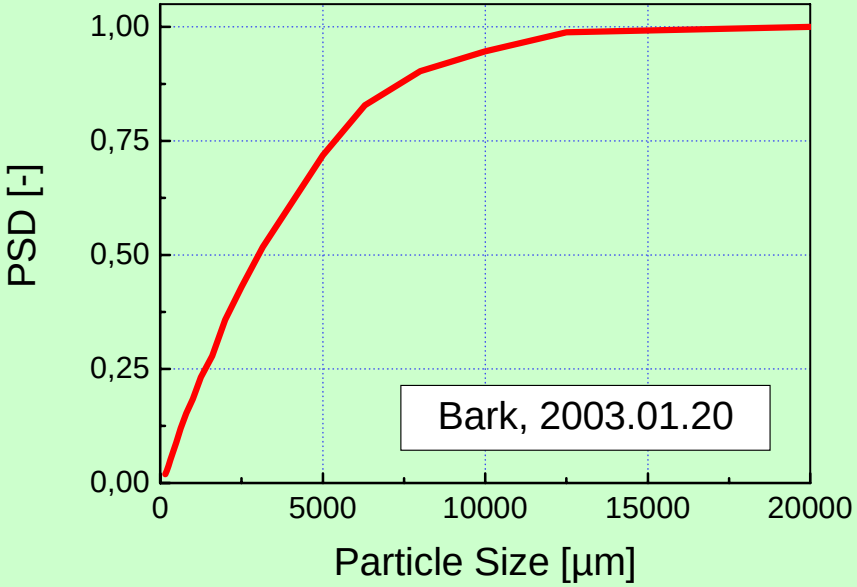
	M_p [%]	M_h [%]	Volat. [%]	Ash [%]	F.C. [%]	C [%]	S [%]	HHV [kJ/kg]	LHV [kJ/kg]
Silica Sand	2.7	0.1							
Bed ash	0.05	0.2							
Bark	58.6	7.5	26.3	1.0	6.5	7.4	0.01	6240	6103
Wood chips	44.2	7.1	43.2	0.4	5.1	11.1	0	8329	8213
Paper Mill Sludge	61.3	8.2	20.8	7.4	2.3	5.5	0.02	4017	3775
Biosludge I	43.7	7.4	42.6	0.3	5.9	12.3	0.02	8488	8361
Biosludge II	48.1	5.9	39.9	0.7	5.4	10.1	0.03	8198	8081

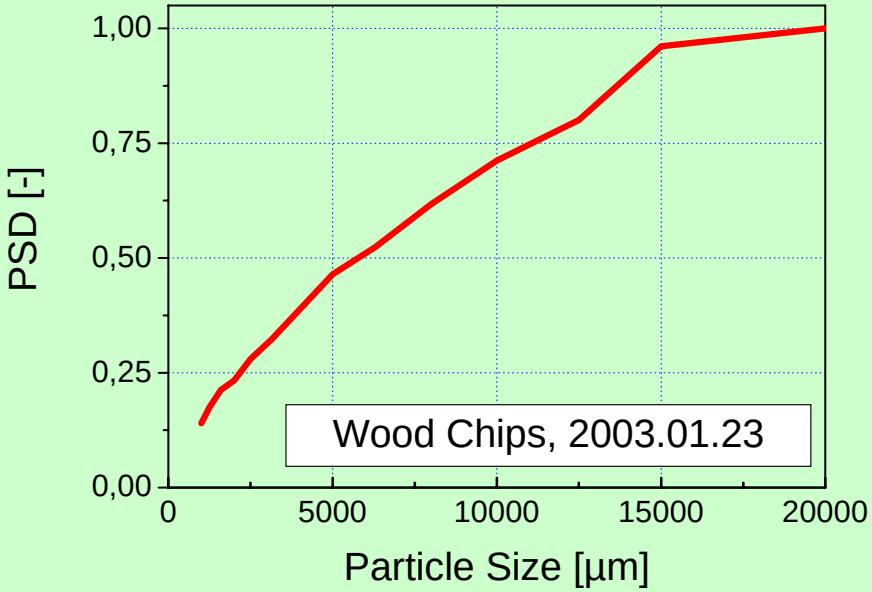
Air-dried

	M_p [%]	M_h [%]	Volat. [%]	Ash [%]	F.C. [%]	C [%]	S [%]	HHV [kJ/kg]	LHV [kJ/kg]
Bark	58.6	7.5	71.9	2.8	17.7	20.2	0.014	17049	16674
Wood chips	44.2	7.1	82.4	0.7	9.8	21.1	0.007	15886	15664
Paper Mill Sludge	61.3	8.2	62.6	22.3	6.9	16.5	0.049	12094	11366
Biosludge I	43.7	7.4	80.8	0.6	11.2	23.3	0.046	16079	15838
Biosludge II	48.1	5.9	81.6	1.3	11.1	20.7	0.064	16786	16547

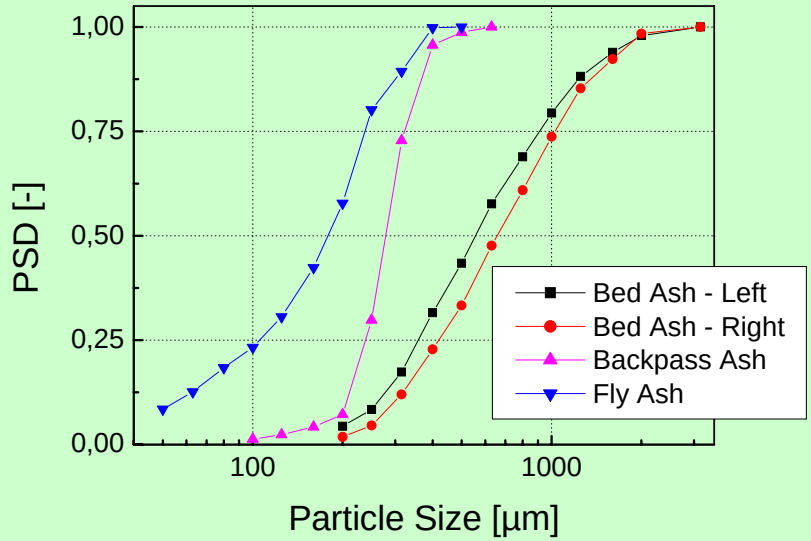
PSD of Solids



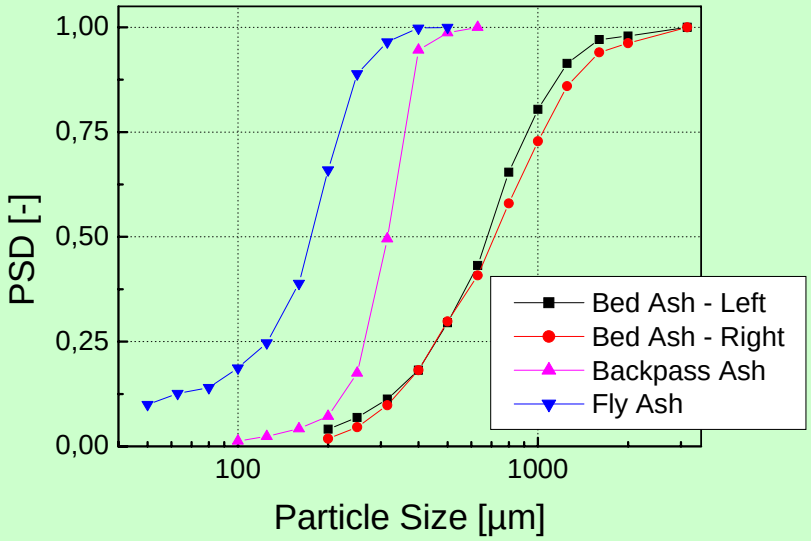




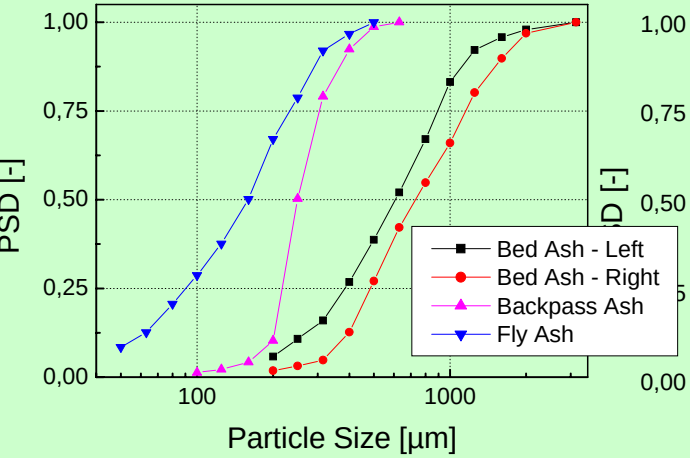
Particle Size Distributions



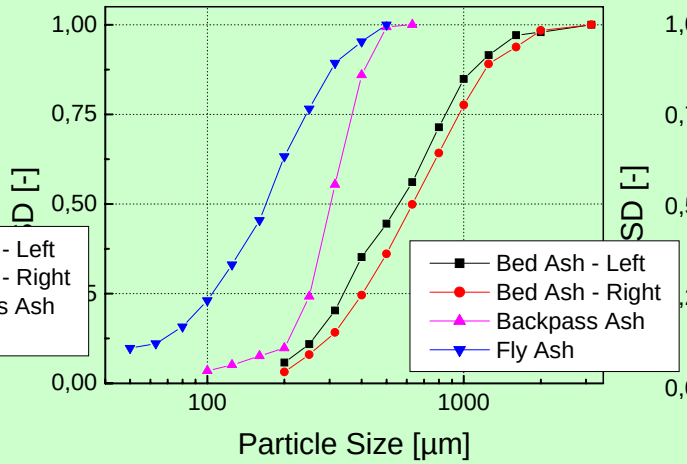
2003.01.20, 18:30



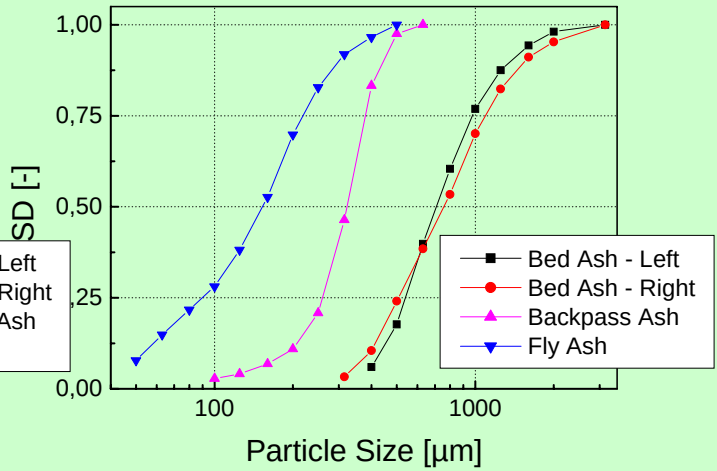
2003.01.22, 21:00



2003.01.23, 21:00



2003.01.24, 12:00



2003.01.25, 10:00

Ashes: 2003.01.22, 21:00; BFB fired with wood chips

Bed Ash - Right

Bed Ash - Left

Backpass Ash

Fly Ash

Bed Agglomeration Studies:

Combustion of Fuel/Sand mixtures
(El. Oven Nabertherm L3/C6)

Composition of Sand/Fuel Mixtures:
50/50, 20/80 & 5/95

Combustion Time: **2h**

Combustion Temperature: **700, 800, 900, 1000 & 1100ºC**

No Agglomeration found anywhere!

Samples After Combustion

Bark

Wood Chips

Sand/Fuel Ratio: 5/95

Paper Mill Sludge

Biosludge I

Biosludge II

Bark

Wood Chips

Sand/Fuel Ratio: 50/50

Paper Mill Sludge

Biosludge I

Biosludge II

Temperature: 1100ºC, Combustion Time: 2h

CONCLUSIONS

1. BFB at Ostrołęka can be safely fired with bark, wood chips, paper mill sludge, biosludge I & biosludge II - no agglomeration should occur.

2. Bed temperature should be kept below 900^0C. Depending on fuel LHV, the temperature may be regulated by adjusting the air flow, FG flow, BA flow + addition of new sand.

3. PSD of all solids has to be kept within the required values.

4. Maximum size of wood chips should not exceed 4-5 cm.

Agglomeration was due to poor control of fuel feed rate and lack of flue gas recirculation!!

PA & SA flows have to be carefully designed with respect to gas velocity and elutriation.