Thermochemical Power Group

Master Degree in InnovativeTechnologies in Energy Efficient Buildings for Russian & Armenian Universities and Stakeholders

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MARUEEB

Biomass fuels

Biomass fuels

Olive pomace

Corn

Wood sticks

Animal manure

Urban waste

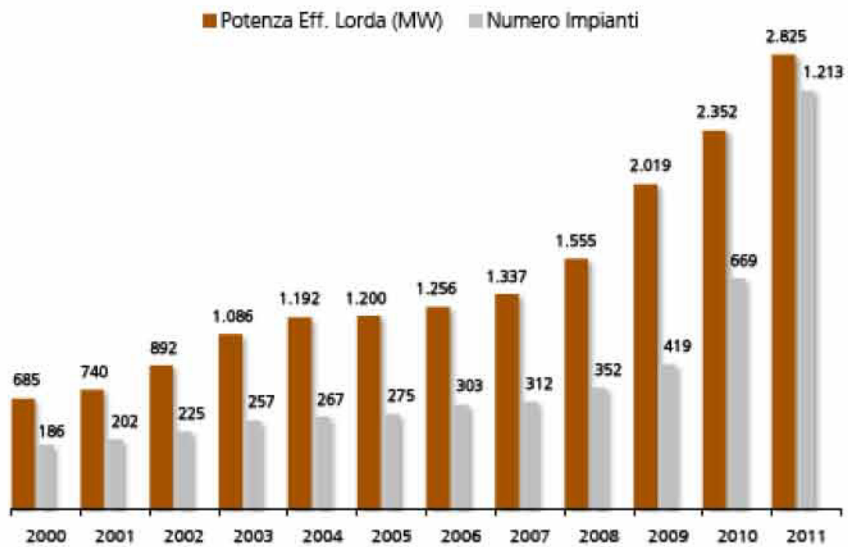
Wood chips

Fast rotation forest
(e.g. Eucaliptus)

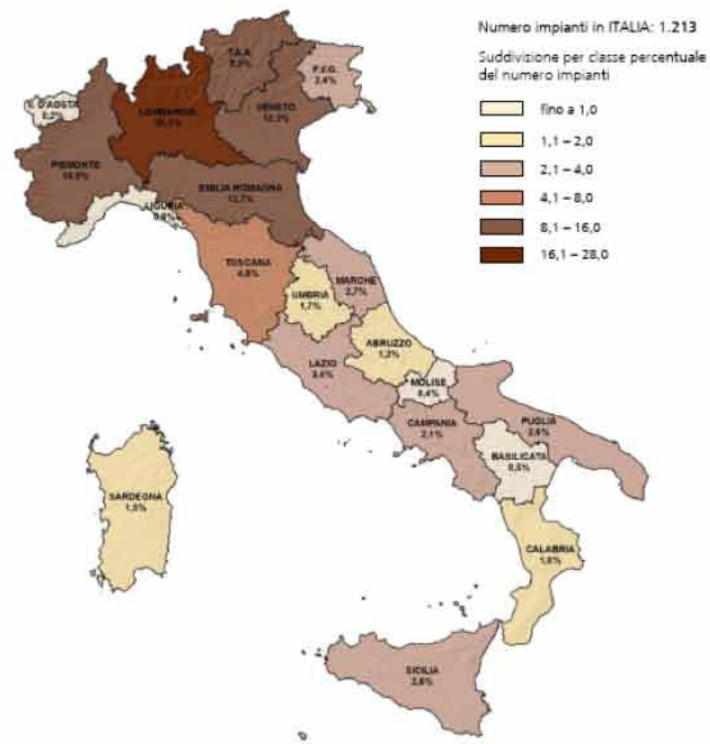
Biomass energy cultivation
(e.g. Miscantus)

Biomass fuels

Evoluzione della potenza e della numerosità degli impianti a bioenergie in Italia



Distribuzione regionale numero impianti a bioenergie a fine 2011



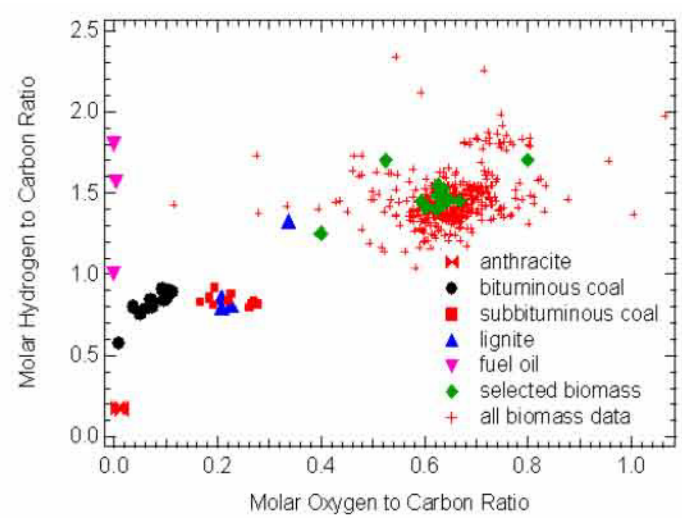
GSE data

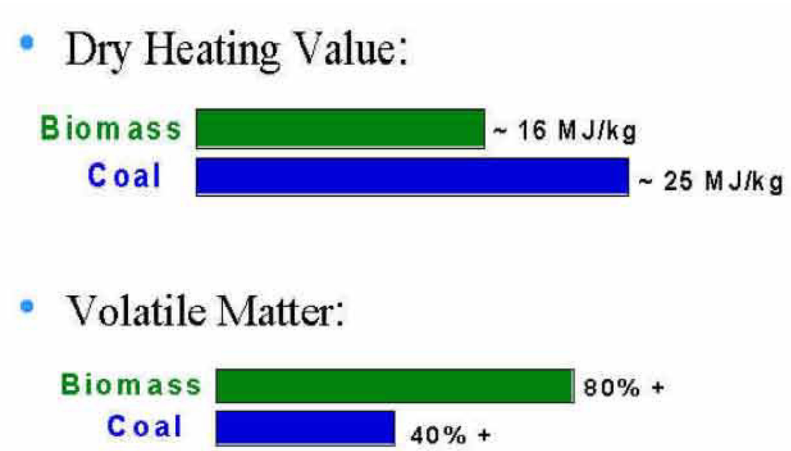
Biomass fuels

Database on biomass composition:
Phyllis database for biomass and waste
Energy Research Centre of the Netherlands

http://www.ecn.nl/phyllis

About 2.500 biomass types are reported





Biomass fuels

Biomass fuel characterization is typically done in two ways: "Proximate and Ultimate analyses".
Proximate analysis provides the humidity content, the volatiles, fixed carbon (at 950 °C) and ashes (minerals), and the higher and/or the lower heating value (HHV or LHV).
The **ultimate analysis** provides biomass composition as mass fractions of carbon (C), hydrogen (H), oxygen (O), sulphur (S) and nitrogen (N).

The updated DuLong correlation is an example of equation to obtain the HHV for a solid fuel (letters are % mass fractions):

$$\text{HHV [kJ/g]} = 0.3491C + 1.1783\,H - 0.1034\,O - 0.0211\,A + 0.1005\,S - 0.0151\,N$$

$$\text{LHV} = \text{HHV} - 2.400 \cdot (18/2 \cdot H/100)$$

Biomass fuels

Name	Fixed Carbon %	Volatiles %	Ash %	C %	H %	O %	N %	S %	HHV MEAS kJ/g	HHV CALC kJ/g
WOOD										
Beech	-	-	0.65	51.64	6.26	41.45	0.00	0.00	20.38	21.10
Black Locust	18.26	80.94	0.80	50.73	5.71	41.93	0.57	0.01	19.71	20.12
Douglas Fir	17.70	81.50	0.80	52.30	6.30	40.50	0.10	0.00	21.05	21.48
ENERGY CROPS										
Eucalyptus Camaldulensis	17.82	81.42	0.76	49.00	5.87	43.97	0.30	0.01	19.42	19.46
Sudan Grass	18.60	72.75	8.65	44.58	5.35	39.18	1.21	0.01	17.39	17.62
PROCESSED BIOMASS										
Plywood	15.77	82.14	2.09	48.13	5.87	42.46	1.45	0.00	18.96	19.26
AGRICULTURAL										
Walnut Shells	21.16	78.28	0.56	49.98	5.71	43.35	0.21	0.01	20.18	19.68
Almond Prunings	21.54	76.83	1.63	51.30	5.29	40.90	0.66	0.01	20.01	19.87
AQUATIC BIOMASS										
Water Hyacinth (Florida)	-	80.40	19.60	40.30	4.60	33.99	1.51	0.00	14.86	15.54
AVERAGE				**47.91**	**5.74**	**40.98**	**0.52**	**0.05**	**19.11**	**19.15**

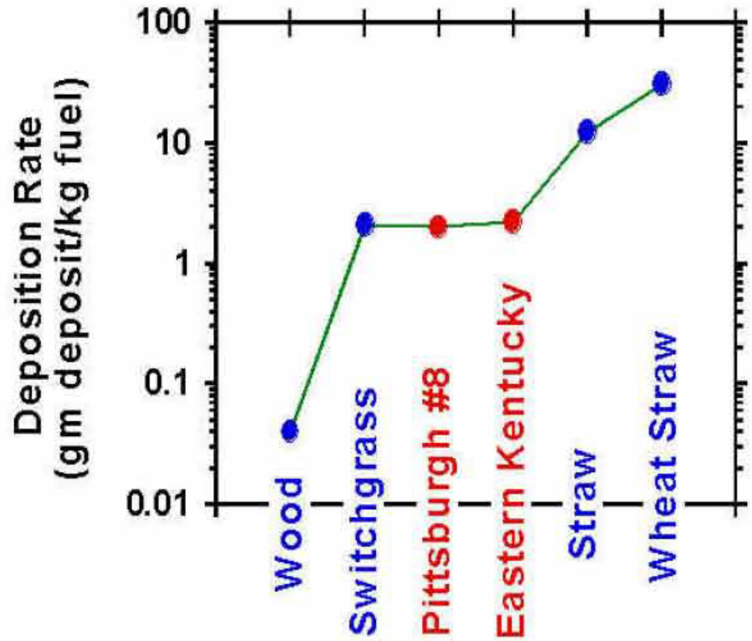
Biomass fuels

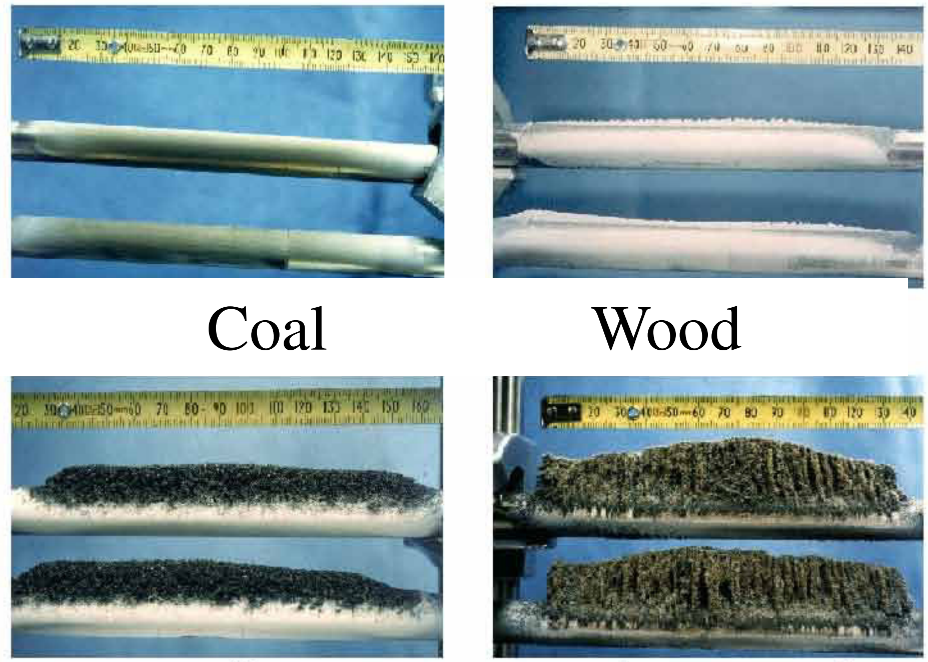
Name	Fixed Carbon	Volatiles	Ash	C	H	O	N	S	HHV MEAS	HHV CALC
	%	%	%	%	%	%	%	%	kJ/g	kJ/g
LIQUID FUELS										
Motor Gasoline	0.00			85.50	14.40	0.00	0.00	0.10	46.88	46.83
Kerosene	0.00		0.01	85.80	14.10	0.00	0.00	0.10	46.50	46.58
Methanol, CH3OH	0.00		0.00	37.50	12.50	50.00	0.00	0.00	22.69	22.65
Ethanol, C2H5OH	0.00		0.00	52.20	13.00	34.80	0.00	0.00	30.15	29.94
PYROLYSIS OILS										
BOM wood oil			0.66	82.00	8.80	9.20	0.60	0.00	36.80	38.02
SOLID FUELS										
Coal - Pittsburgh Seam	55.80	33.90	10.30	75.50	5.00	4.90	1.20	3.10	31.75	31.82
Charcoal	89.31	93.88	1.02	92.04	2.45	2.96	0.53	1.00	34.39	34.78

Biomass ashes

Material	Initial softening Point °C	Melting point °C	Ash fluid point °C	Ref.
Miscanthus sample 1 Miscanthus sample 2 Miscanthus sample 3 Miscanthus sample 4	1040 - 1060 1000 - 1020 840 - 880 940 - 1000	1140 1080 960 1100	1200 1140 1000 1210	2 2 2 2
Maize sample 1 Maize sample 2 Maize sample 3	880 - 900 980 - 1010 900 - 940	1010 1060 1010	1120 1160 1070	2 2 2
Straw (undefined)	850 - 1100	n.a.	n.a.	41
Finnish peat Fuel peat, nordic	n.a. n.a.	1120 1100 - 1200	n.a. n.a.	136 136
Wood (undefined)	n.a.	1350 - 1450	n.a.	136

Biomass ashes





Coal Wood

Straw Coal and Straw

Fuels with low ash content and low alkali and clorins contents should be preferred as the boiler fouling is lower.

Biomass ashes

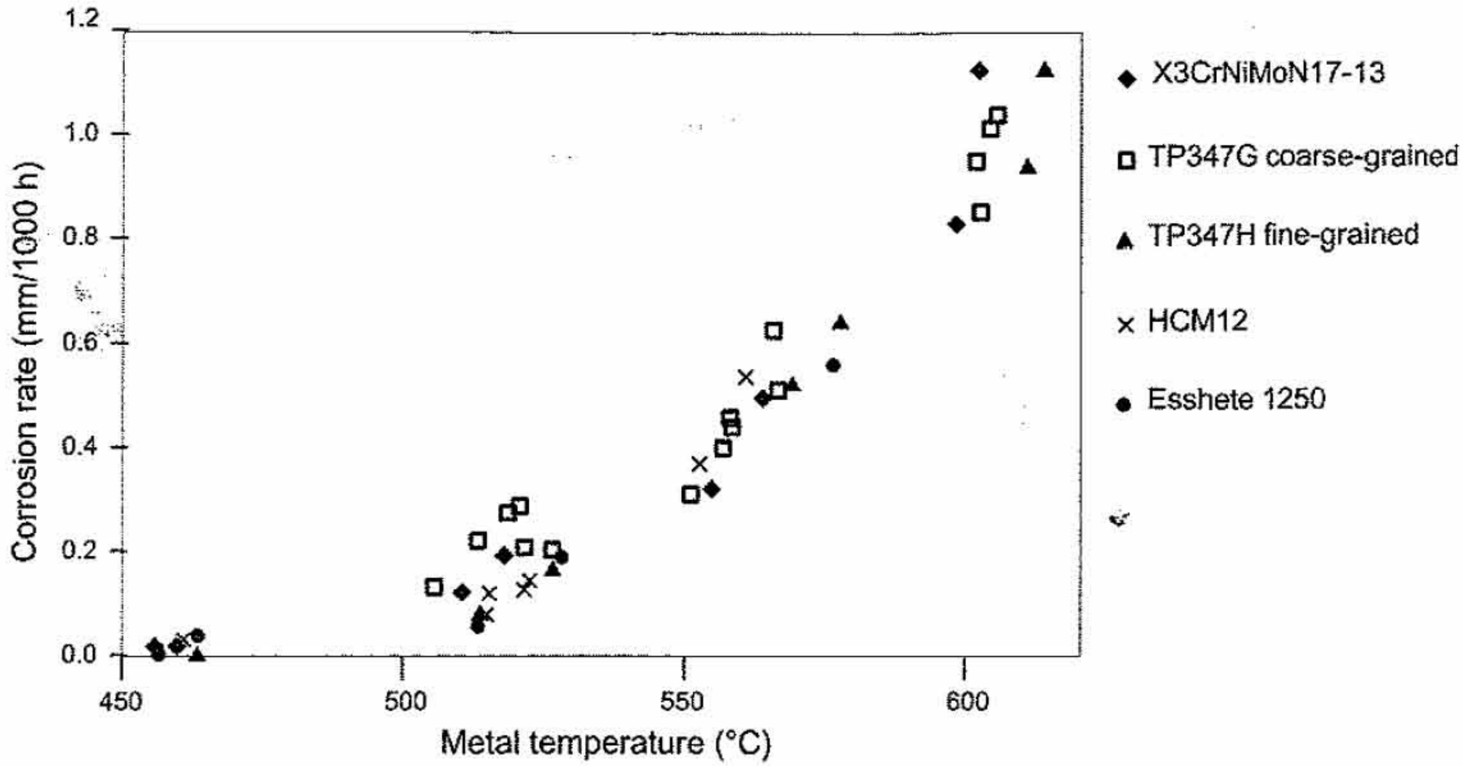
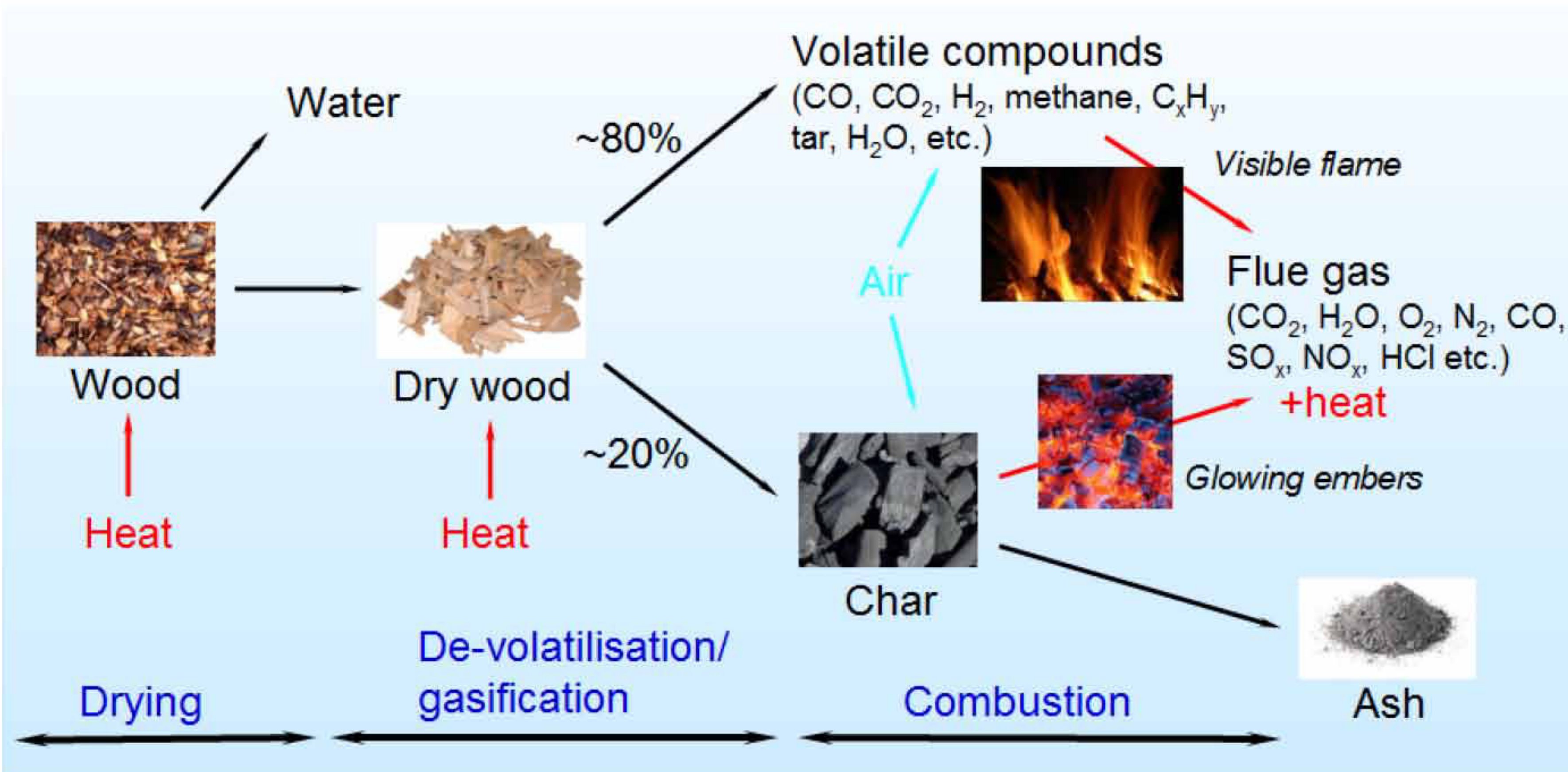


Figure 8.8 *Corrosion rates of boiler tube material specimens exposed to flue gases from straw combustion, plotted against the metal temperature*

Biomass ashes



Fonte AET, 2011

Biomass ashes

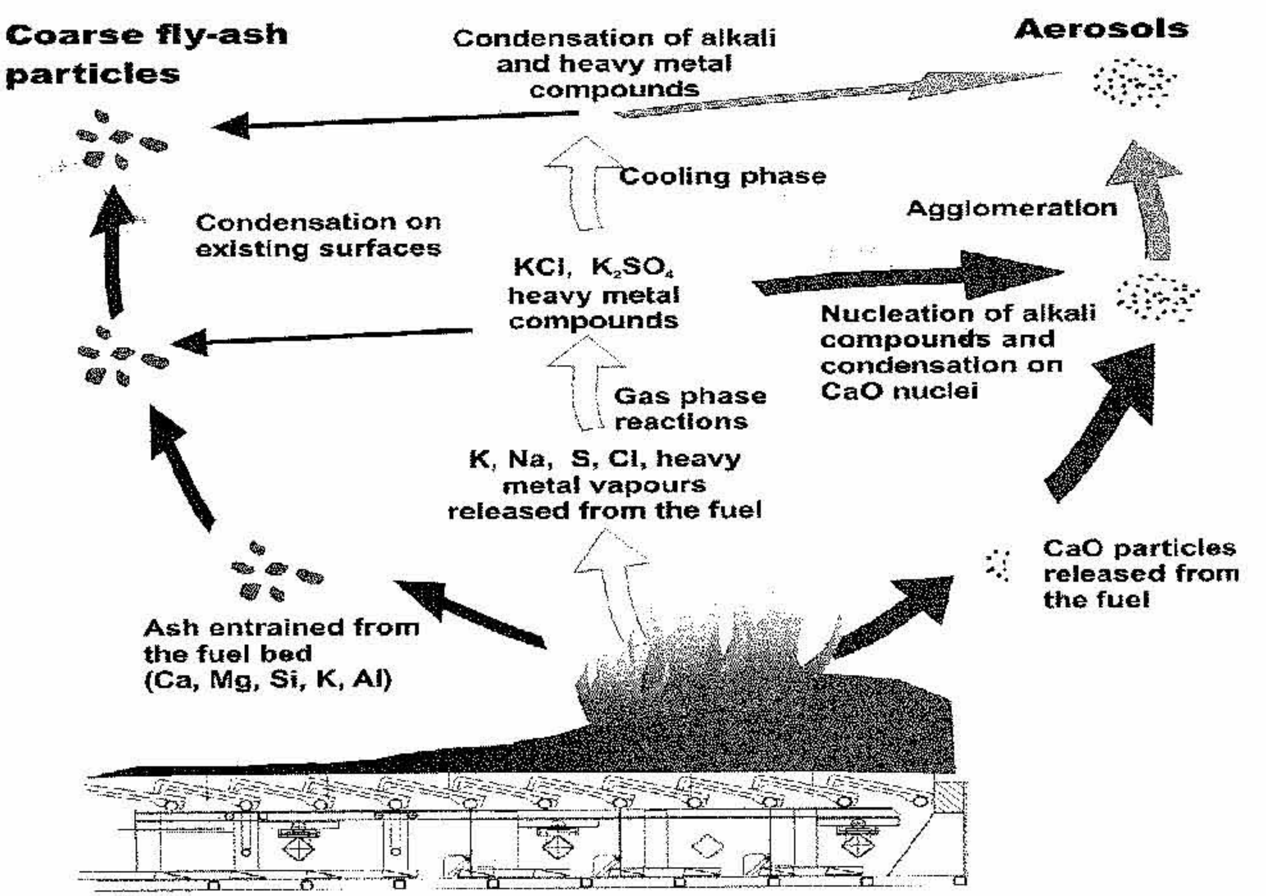


Figure 8.5 *Key processes involved in fly ash and aerosol release from the combustion of wood on a grate*