INETI's Experience in the Co-Combustion of Coal with Different Wastes

IEA-FBC MEETING

21-22th November 2001

Co-Combustion with Several Kinds of Wastes

Domestic Origin

- Pre-dried Granulated Sewage Sludge
- Municipal Solid Waste

Industry Origin

- Sawdust
- Mixture of Plastic and Paper Wastes
- Textile Wastes

Agriculture Origin

- Several Biomass Wastes – Olive stones, Chicken Litter, Cork dust, others.

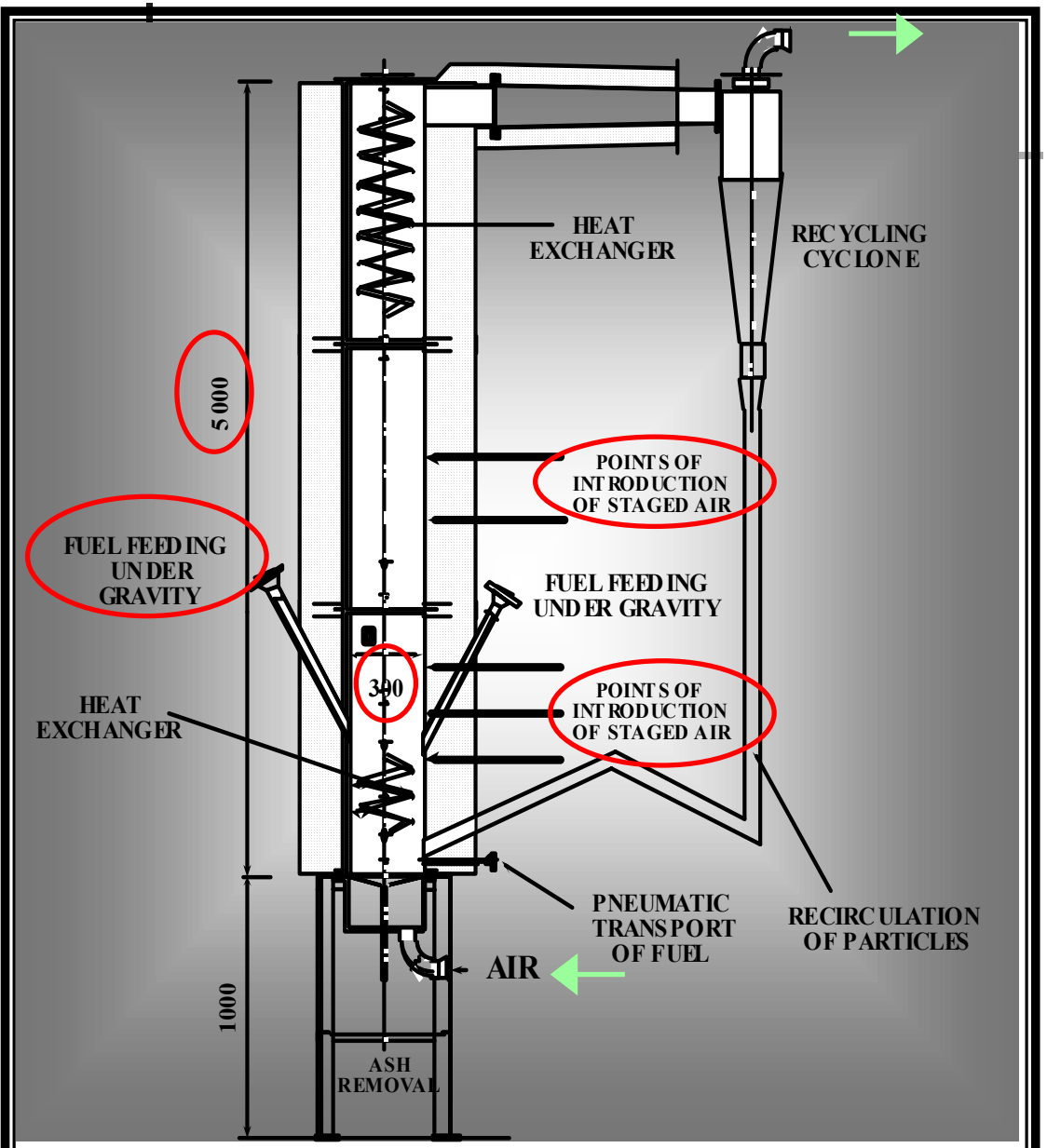
Fuel Characterization Tables

Fuel:	Different Coals			Different Wastes			
	SA Coal	US Coal	JW Coal	Sewage Sludge	Sawdust	Plastic & Paper	MSW
Proximate Analysis (db, %Wt)							
Ashes	14.2	7.5	10.7	45.6	1.6	16.7	25.0
Volatile Matter	29.9	33.3	19.7	47.8	80.8	72.4	60.0
Fixed Carbon	55.9	59.2	69.6	6.6	17.6	10.8	15.0
Ultimate Analysis (daf, %Wt)							
C	77.0	80.9	84.0	51.9	52.9	59.2	57.7
H	5.0	5.5	3.8	8.1	6.1	10.0	8.5
N	1.7	1.2	1.5	6.0	0.2	0.3	1.3
S	0.8	2.2	0.3	1.2	0.08	0.1	0.3
Cl	0.08	n.d.	n.d.	0.5	0.02	0.1	0.9
O	15.4	10.2	10.4	32.3	40.7	30.1	31.2

Objectives

- Investigate the combustion behaviour of the different fuels having distint characteristics.
- Emission study of gas pollutant compounds like CO, NO_X, SO_2 and VOC's.
- Provision of information on the sensitivity of key operational parameters to the process and environmental performance.

Experimental Apparatus



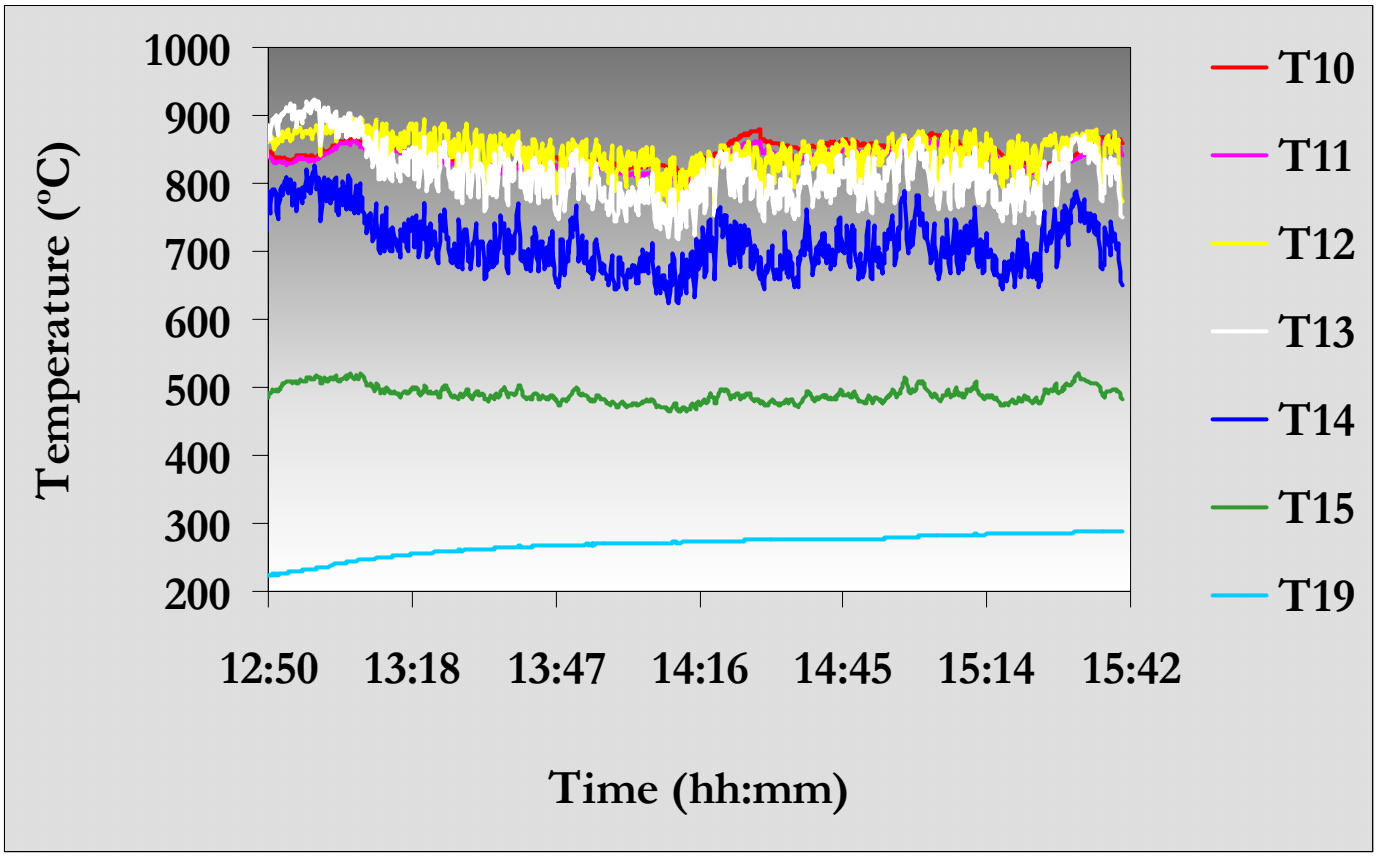
- Air feeding system:
  - 1º air - 2 ventilators
  - 2º air - compressor
- Combustible feed:
  - screw feeder
- Temperature:
  - bed cooling
  - freeboard cooling
- Mechanical dust collectors

Operating Conditions (Coal AS with Plastic+Paper)

- Parameters
  - **Temperature (700, 850 ºC)**
  - **Excess air (25-50%)**
  - **Plastic+Paper mixture density**

Experimental Results – 40% Plastic+Paper

Tbed=850º and 50% of air excess



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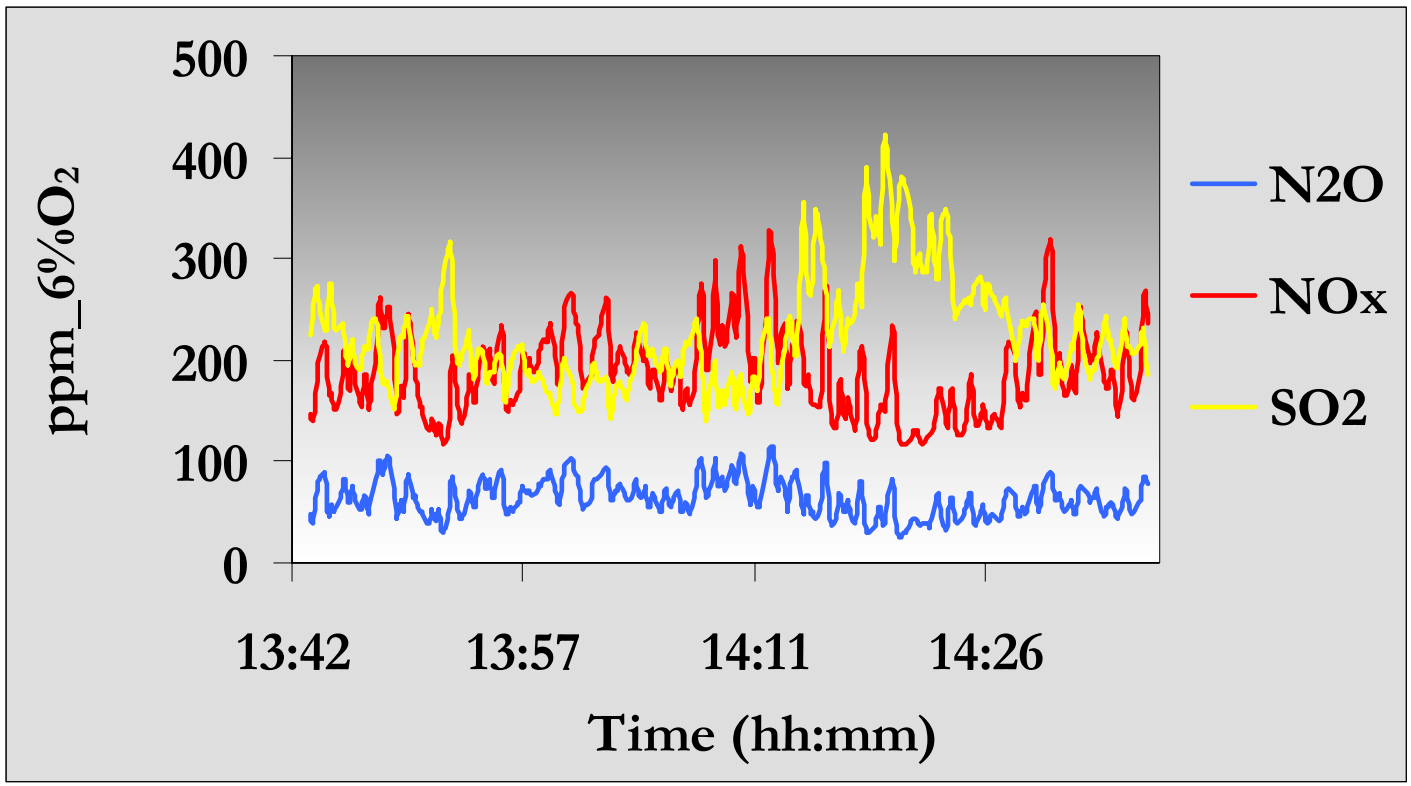

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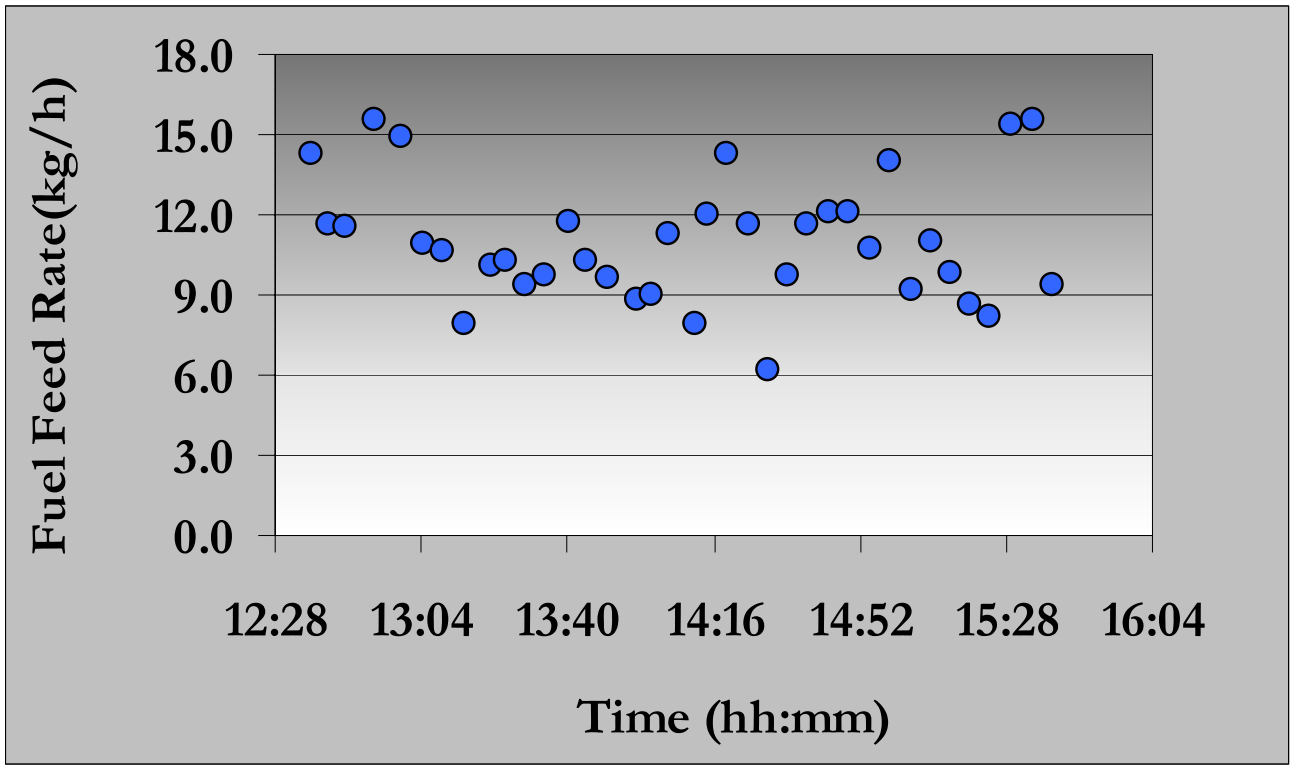
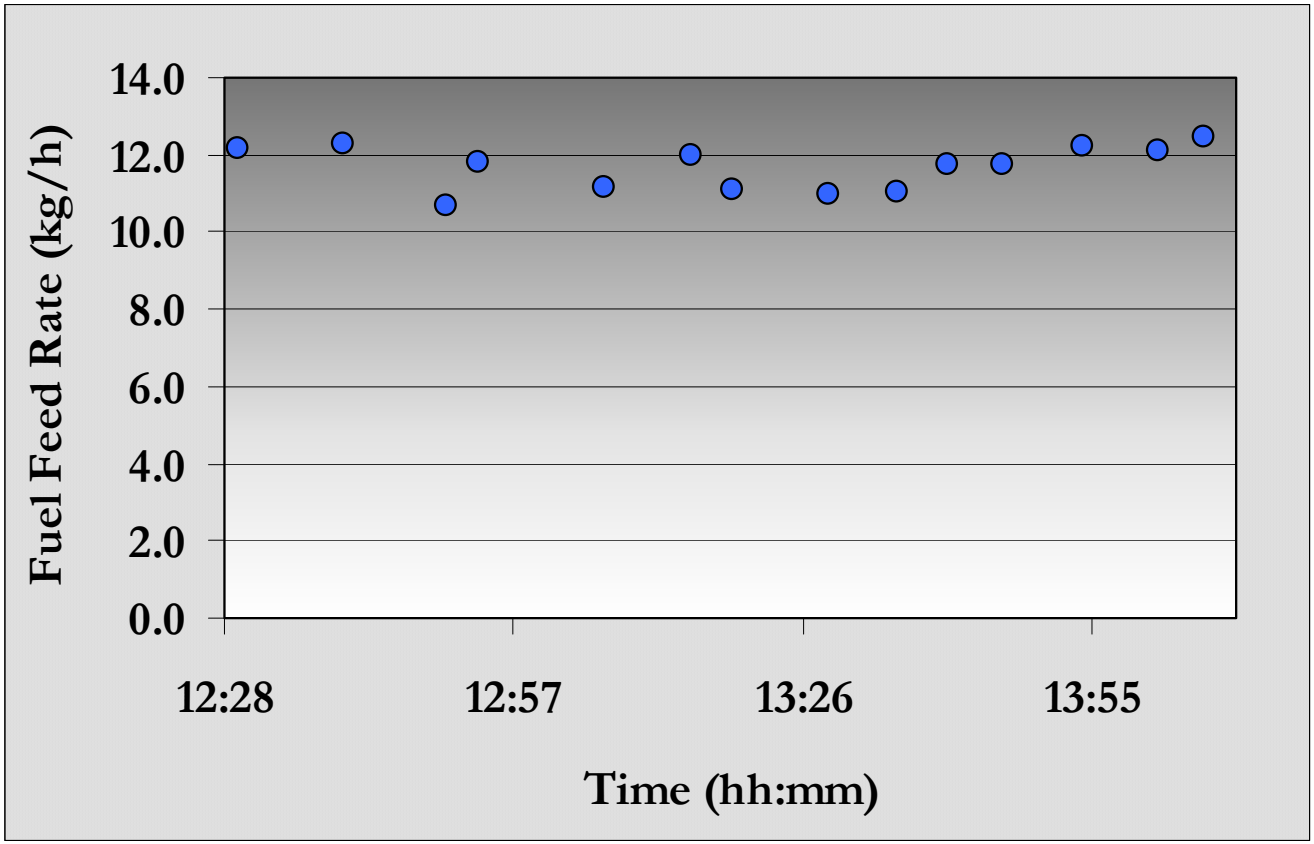


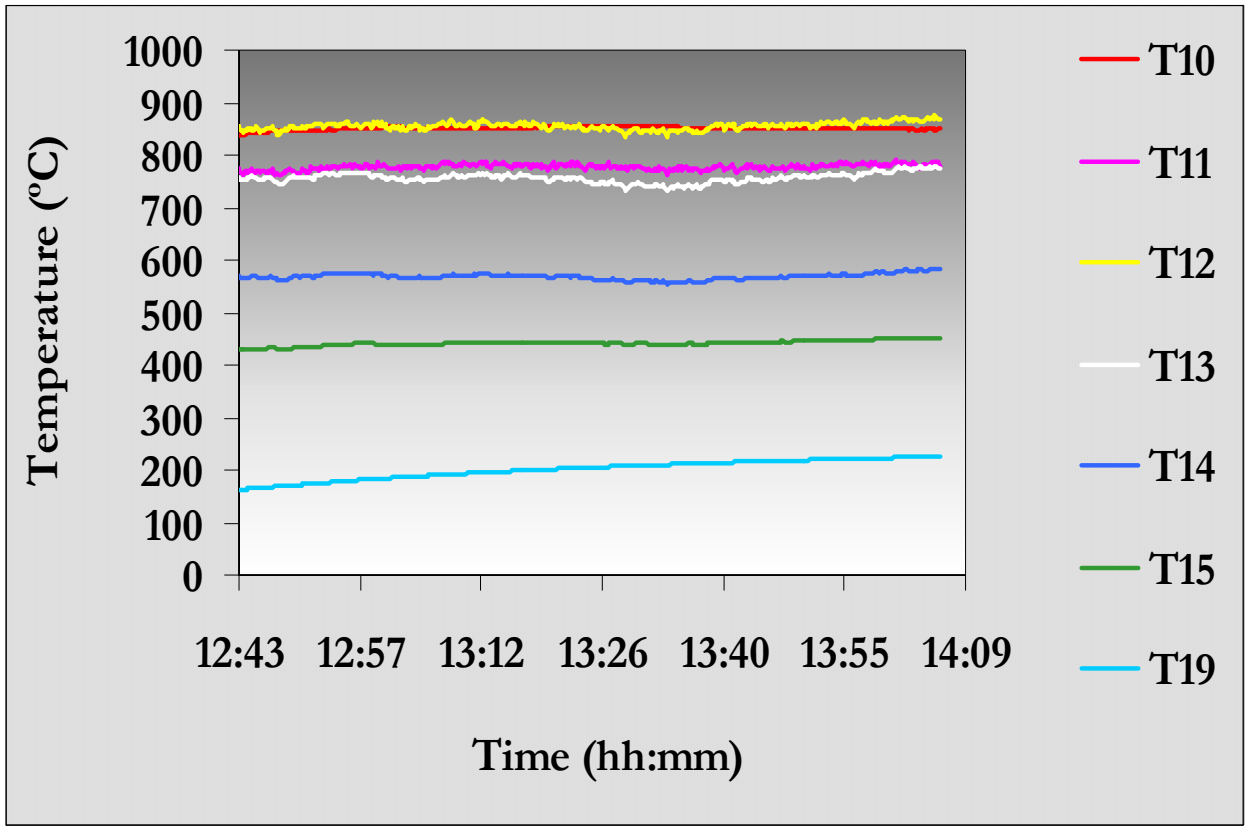
Experimental Results - fuel density

		Plastic +Paper		
	SA_Coal	**Pellets**	**Shredered Pellets**	**Shredered**
Particle size (mm)	0.5 - 4	as arrived	0 - 8	0 - 8
Bulk density (kg/m3)	743	610	321	78

Experimental Results – 40%Plastic+Paper
Shredered Pellets



Experimental Results – 40%Plastic+Paper
Shredered Pellets (*Tbed=850º and 50% of air excess*)



Experimental Results – 40%Plastic+Paper
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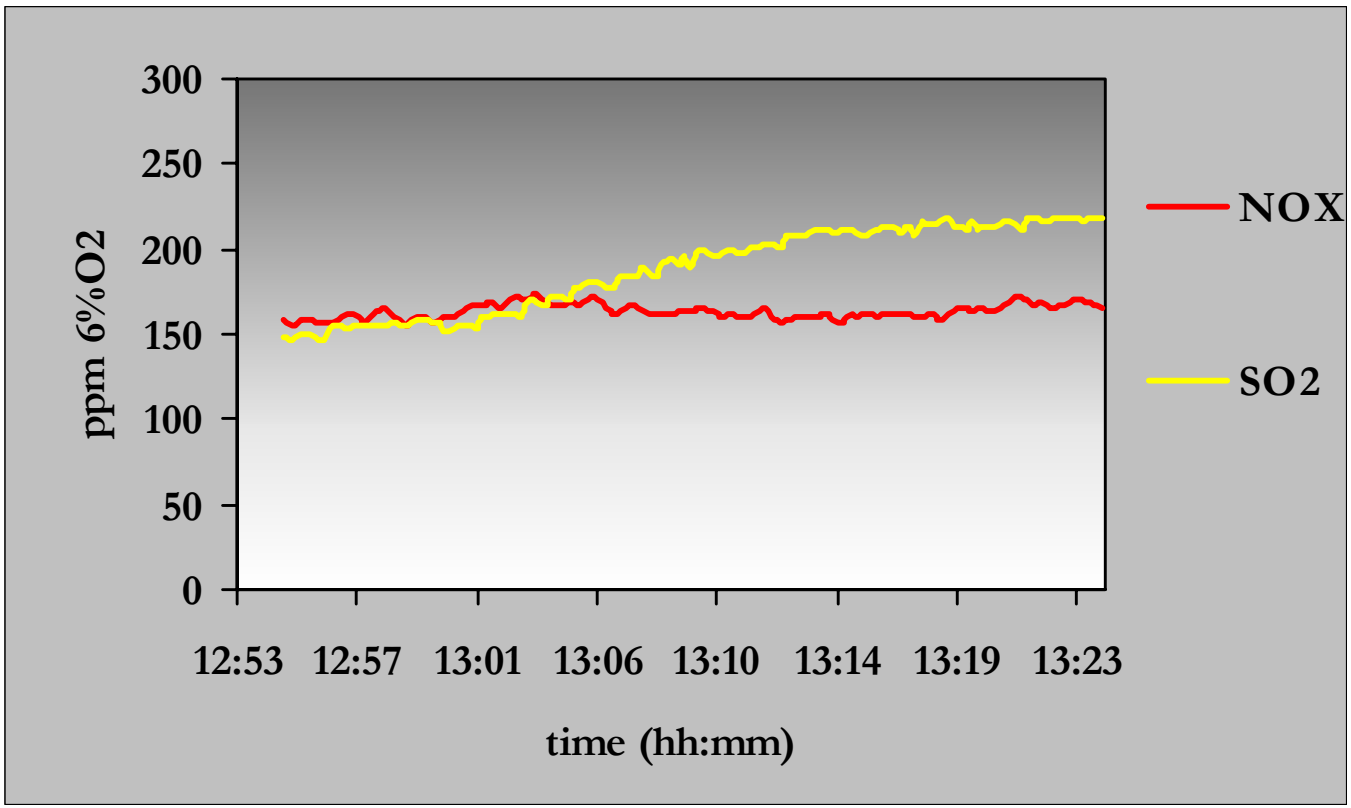
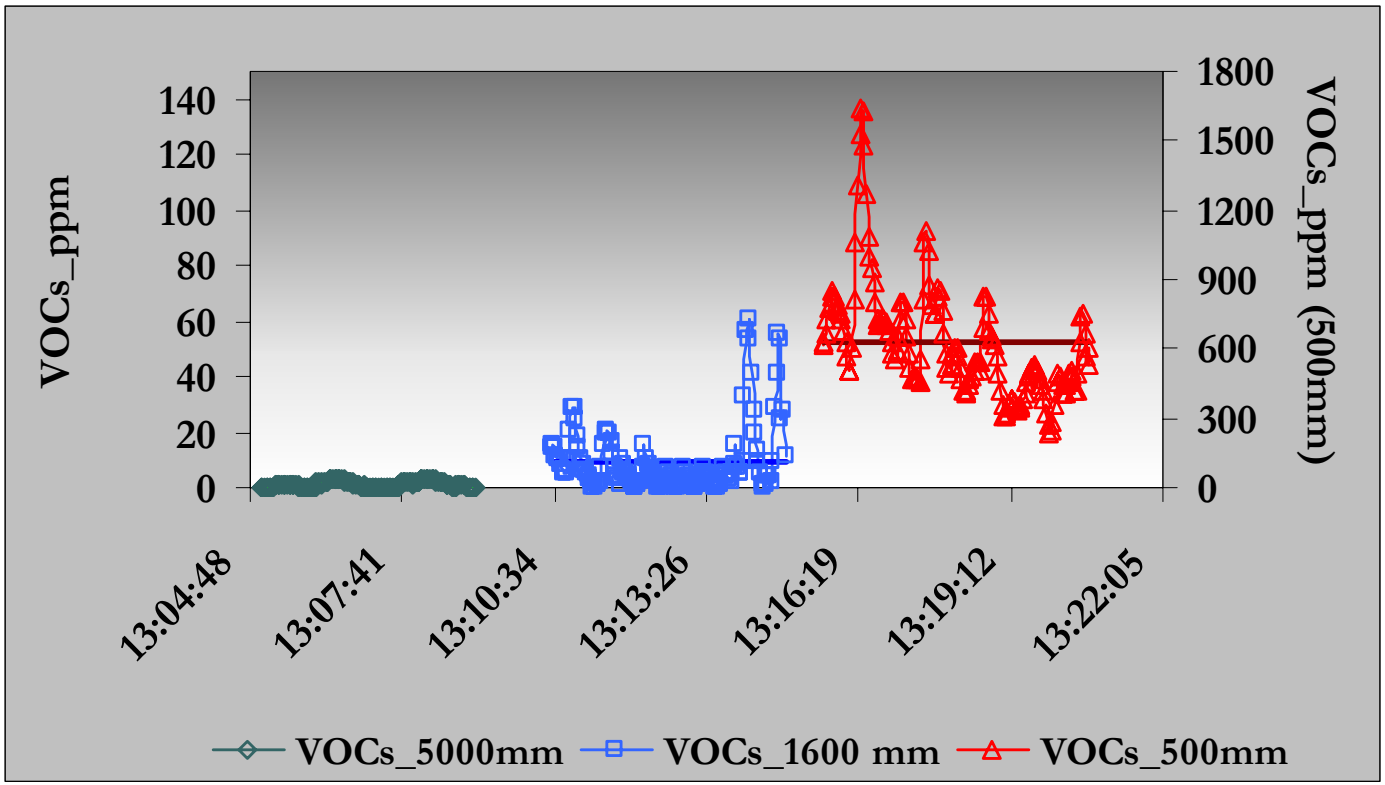
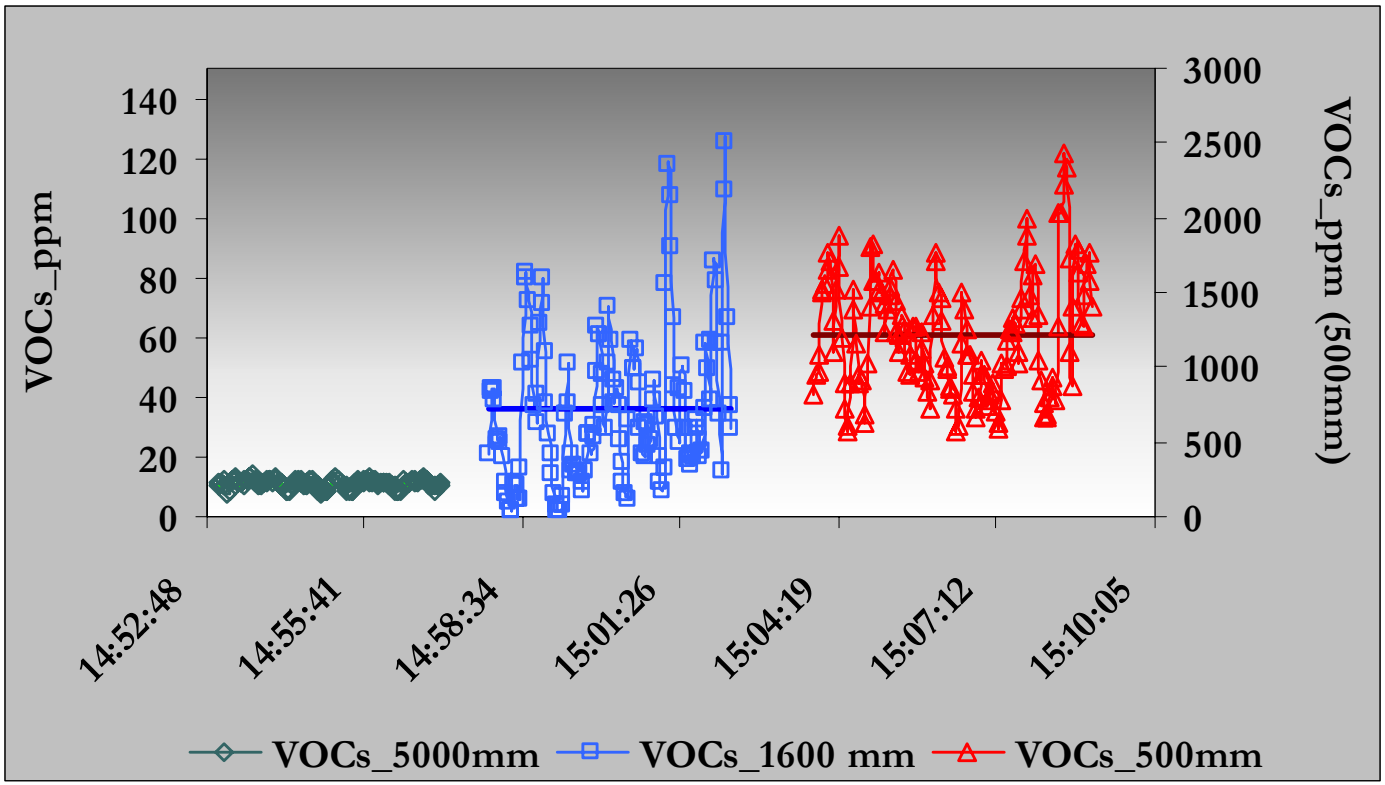


Experimental Results – 40%Plastic+Paper Shredered Pellets (*Tbed=850º and 50% of air excess*)



Experimental Results – 40%Plastic+Paper Shredded Pellets (Tbed *=850º and 25% of air excess*)



Conclusions

- Excess air is an important parameter in the combustion performance, and there is a minimum value that is required for complete combustion – about 25%. Increasing this value will only contribute to augment the emissions of CO, NO_x and N_2O;

- Bed Temperature is also an important parameter. Increasing temperature the CO and N_2O decrease. However, NO_x will increase;

Conclusions

- SO_2 emissions are extremely dependent of the Sulphur content of the combustible and can be easily controlled by adding a sorbent (limestone), directly to the bed, in an appropriate amount;

- The gaseous emission from the co-combustion of coal and this Plastic+Paper, in fluidised bed combustors, can achieve values lower than the legal emission levels allowed, in terms of CO, NO_x SO_2 and VOC's;

Conclusions

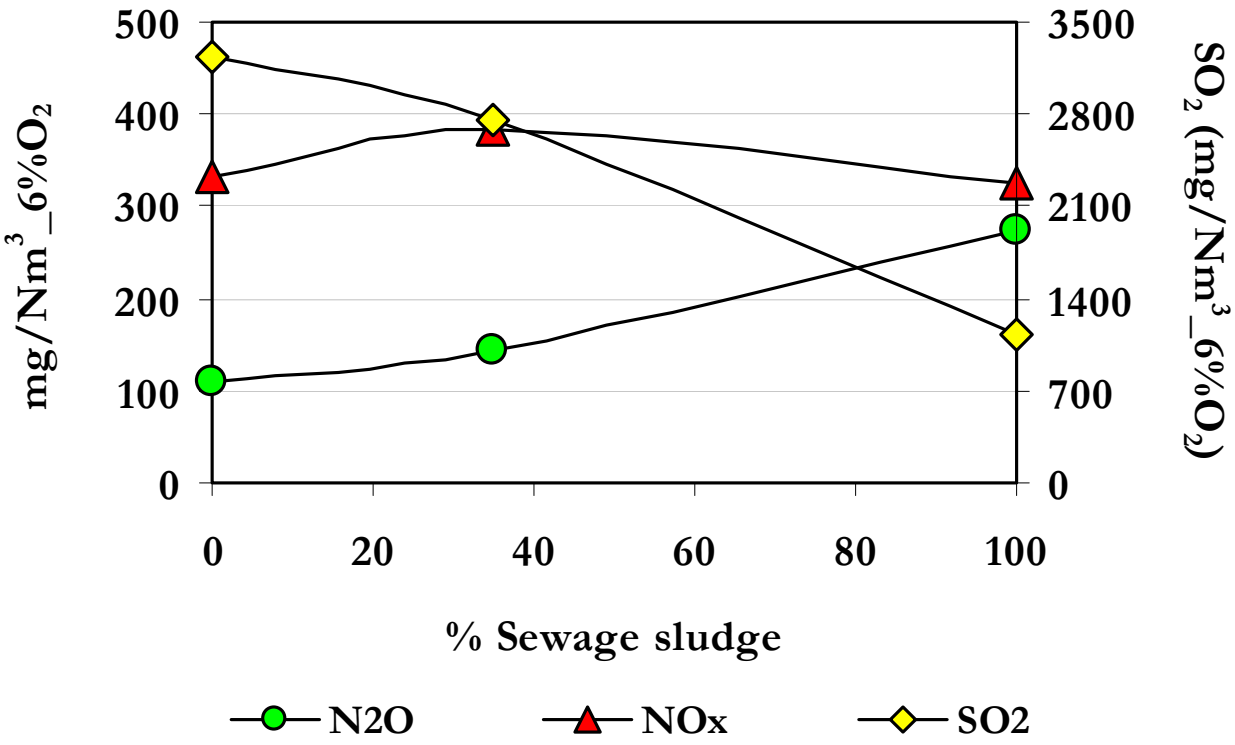
- Density of the Plastic+Paper is an important parameter in the combustion performance and a value of at least 300 kg/m3 should be obtained;
- The Plastic+Paper pellets constitutes a viable alternative fuel that can be easily feed into existing Fluidized Bed Combustors.
- The principal problem is to ensure a regular feeding which could, otherwise, influence the combustion efficiency.

Operating Conditions (Coal US with Sewage Sluge)

- Parameters
  - **Temperature (700, 850 ºC)**
  - **Excess air (25-50%)**
  - **% Sewage Sludge (0, 15, 35, 100%)**
  - **Ca\S ratio (0, 1.3, 2.5)**
  - **Ash reclycling**

Experimental Results – Sewage Sludge

Tbed=850º and 50% of air excess



Experimental Results – Sewage Sludge

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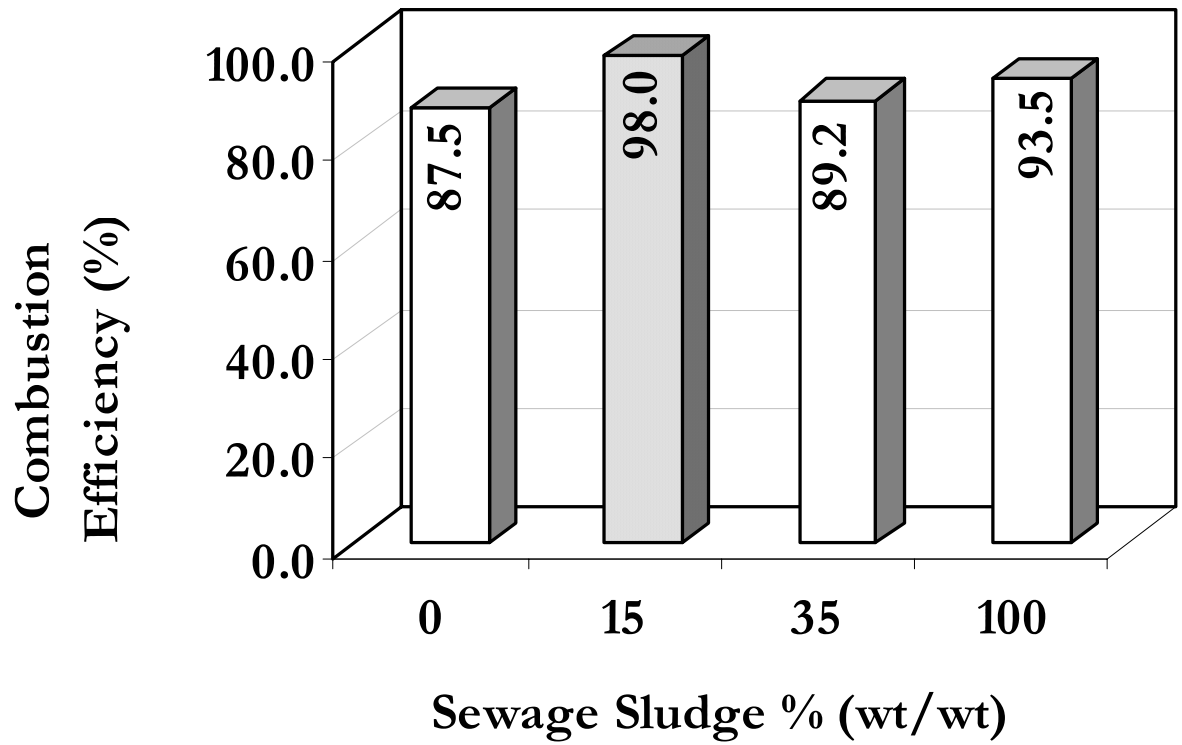
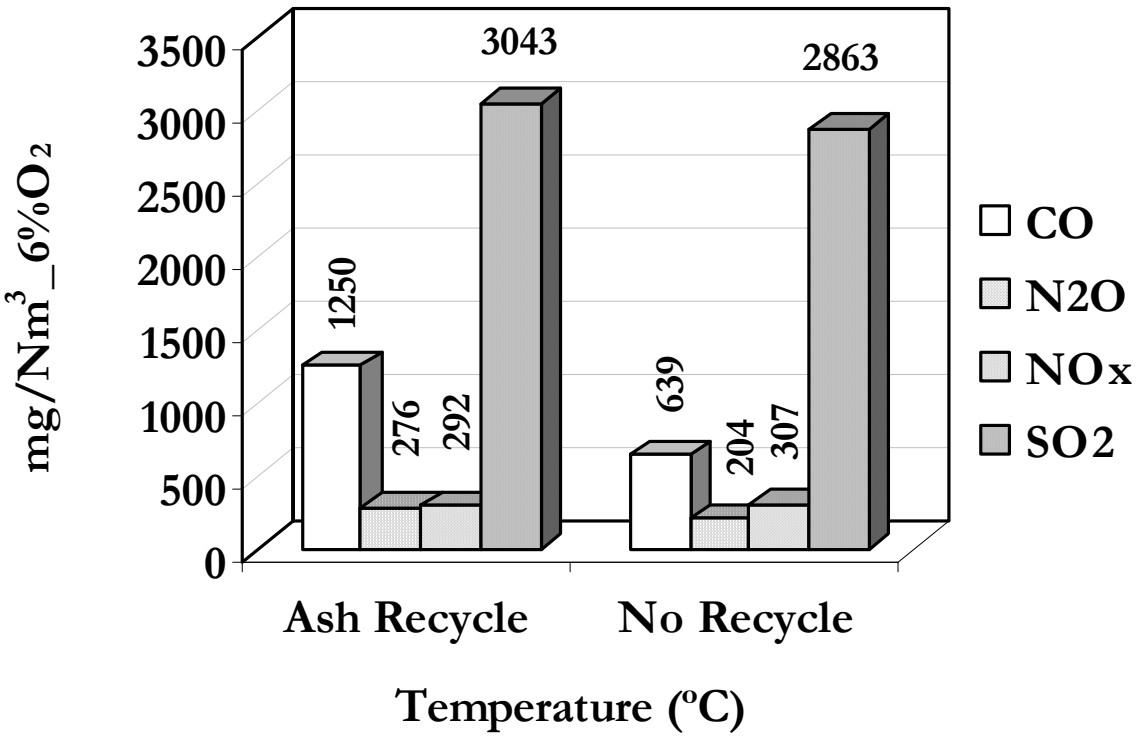


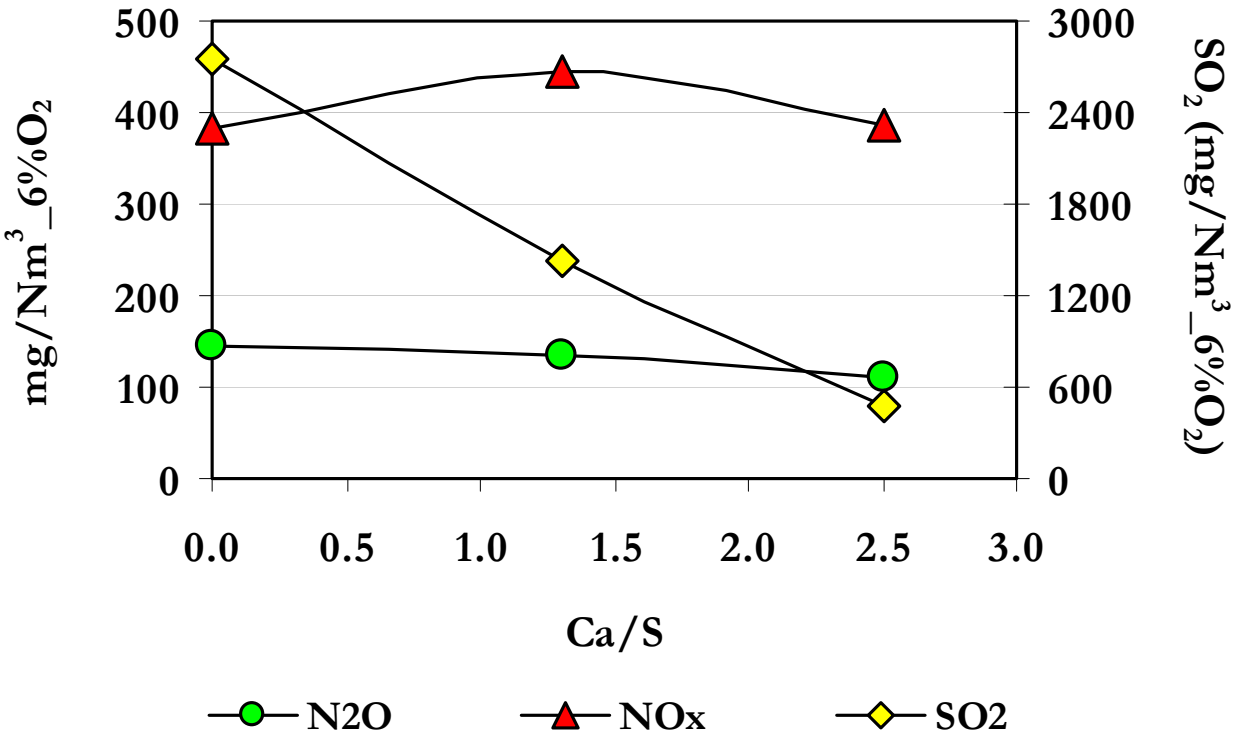
Experimental Results – 15% Sewage Sludge

Tbed=850º and 50% of air excess



Experimental Results – 35% Sewage Sludge

Tbed=850º and 50% of air excess



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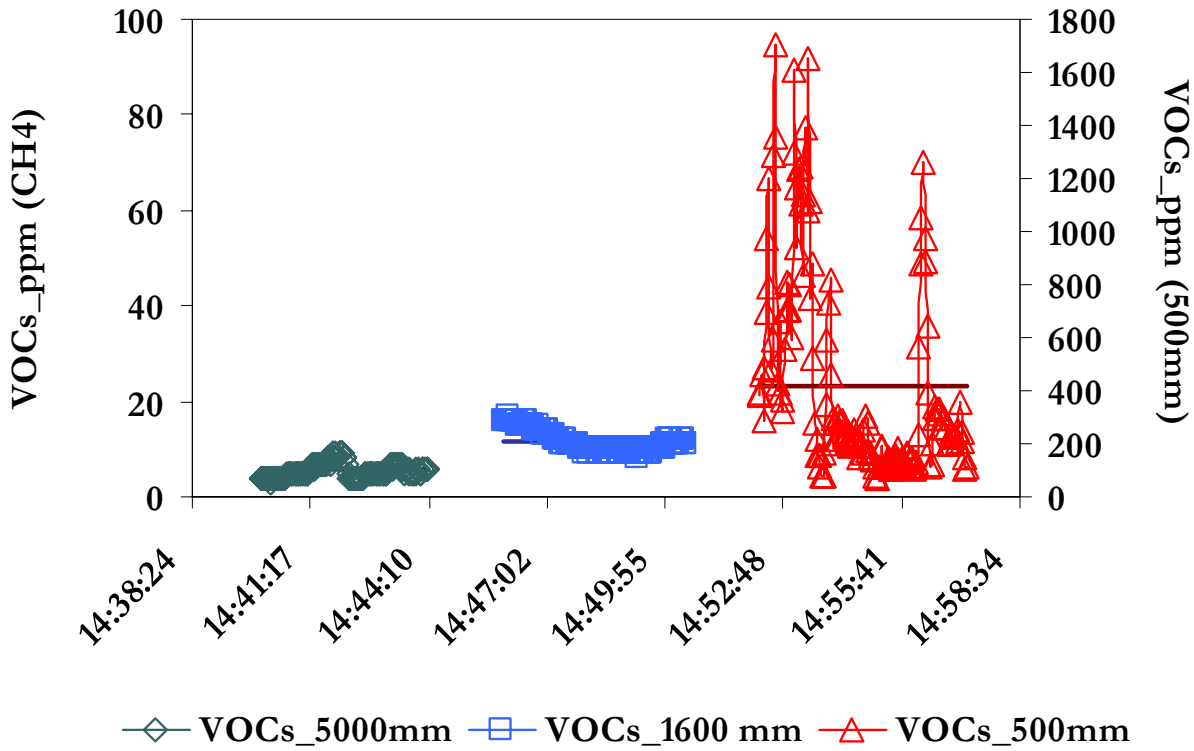

Conclusions

- Excess air is an important parameter in the combustion performance, and there is a minimum value that is required for complete combustion – about 25%. Increasing this value will only contribute to augment the emissions of CO, NO_x and N_2O;

- Bed Temperature is also an important parameter. Increasing temperature the CO and N_2O decrease. However, NO_x will increase;

Conclusions

- SO_2 emissions are extremely dependent on the Sulphur content of the combustible and can be easily controlled by adding a sorbent (limestone), directly to the bed, in an appropriate amount;

- The gaseous emission from the co-combustion of coal and this Sewage Sludge, in fluidised bed combustors, can achieve lower values than the legal emission levels allowed, in terms of CO, NO_x SO_2 and VOC's;

Conclusions

- The Sewage Sludge dried pellets promote high ash accumulation in bed zone – 40% ahs contents.

  It can produce fluidization problems.

Other Wastes - Conclusions

- Agriculture origin wastes like olive stones, chicken litter promotes ahs agglomeration problems that could be related with high potassium contents.

The solution is to operate the combustor with bed temperatures not higher than 800 ºC;

Other Wastes - Conclusions

- Sawdust is a valuable alternative fuel – low ash content, high volatile matter enhancing freeboard combustion in the case of some coals and medium calorific value.

- The gaseous emission from the co-combustion of coal and this kind of wastes, in fluidised bed combustors, can achieve lower values than the legal emission levels allowed, in terms of CO, NO_x SO_2 and VOC's.