Ciências ULisboa

Departamento de Engenharia
Geográfica, Geofísica e Energia

Combustion Tecnhologies – MIEEA

6-6-2018 (1ª chamada)

NAME: **N^{er}:**

Part I (10 val)
10 questions true or false (discounts 0.5 val for each wrong answer)

1. The adiabatic flame temperature is higher in slightly poor mixtures with $\phi < 1$.
   True ☐
   False ☐
2. The combustion occurs at constant pressure or volume. In the case of boilers, gas turbines and Diesel engines it occurs at constant volume.
   True ☐
   False ☐
3. NOx emissions are NO, NO_2 and N_2O.
   True ☐
   False ☐
4. NOx (~1500 ppm) in coal powerplants are mainly due to nitrogen present in coal particles and due to Zeldovich thermal mechanism.
   True ☐
   False ☐
5. CO emissions are highly correlated with the richness of the mixture.
   True ☐
   False ☐
6. The compression ignition engines need a spark for the combustion to begin.
   True ☐
   False ☐
7. The turbulent flame propagation speed in a gasoline engine is higher when the reactants temperature is higher and the closest to stoichiometry reactants are.
   True ☐
   False ☐
8. daf proximate analysis of a coal allow us to know directly the amount of ashes.
   True ☐
   False ☐
9. The main issue with coal powerplants is the accumulation of fixed carbon in the heat exchangers, known as *slagging* and *fouling*.
   True ☐
   False ☐
10. The homogeneous reaction that occurs in a coal particle after the volatile matter combustion is C+O2->CO2.
   True ☐
   False ☐

Part II (10 val)

The UK and Italy have been increasing its *pellets* consumption, 35% for electricity generation and 75% for heat. According to the graph below Pellets consumption in the UK increased steeply due to the Conversion of coal power plants in biomass powerplants. In 2017 the pellets consumption was 7 800 000 Mton in UK.

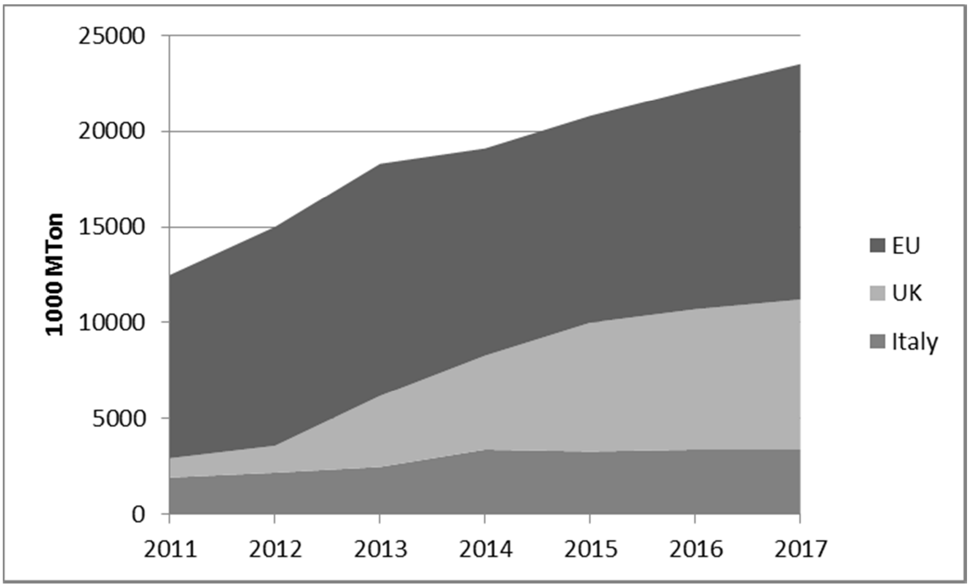


fig 1 Wood *pellets* consumption in UK, Italy and overall EU

A laboratory gives the following data represented in table 1.

	proximate analysis					**ultimate analysis**						
	Moisture (wt%)	VM (wt%)	FC (wt%)	Ash (wt%)		C (wt%)	H (wt%)	N (wt%)	O (wt%)	S (wt%)		**CV (MJ/kg**
Coal	1.233	33.55	62.62	2.593		76.33	4.801	1.446	15.598	1.825		30
Pellets	4.634	74.3	20.8	0.2611		49.06	6.311	2.079	42.55	0		18

VM-Volatile matter; FC-Fixed carbon; CV-Calorific value or heating value

a) Mark the point of the coal and pellet in the Seyler diagram, justify with calculations. **1 val**
b) Knowing that CV corresponds to the higher heating value estimate the lower heating value for the two fuels. **2 val**
c) How much CO_2 in g/MJ is emitted with the combustion of each fuel? And SO_2? **2 val**
d) Which of the fuels tend to generate more NOx emissions? Justify? **2 val**
e) Estimate the minimum particles emitted by the two fuels in mg/Nm3. Compare with the legal limit of 100 mg/Nm^3 (O_2 6%) when used in a 100 MW facility. Are they complying with the limit? In case they don't which mechanisms you know that could be put into practice? **3 val**

FORM

- **Constants and Conversion factors**

R = 0.314 KJ/(Kmol K)
1 kWh = 3.6 MJ
1^{o}C = 273.15 K

- **Perfect gas law**

PV=nRT
P e T referência: 1 bar and 298 K

- **Dry and wet O2 corrections**

$$xi_{6\%} = xi * \frac{n}{n_{6\%}}$$

Fuel CxHy

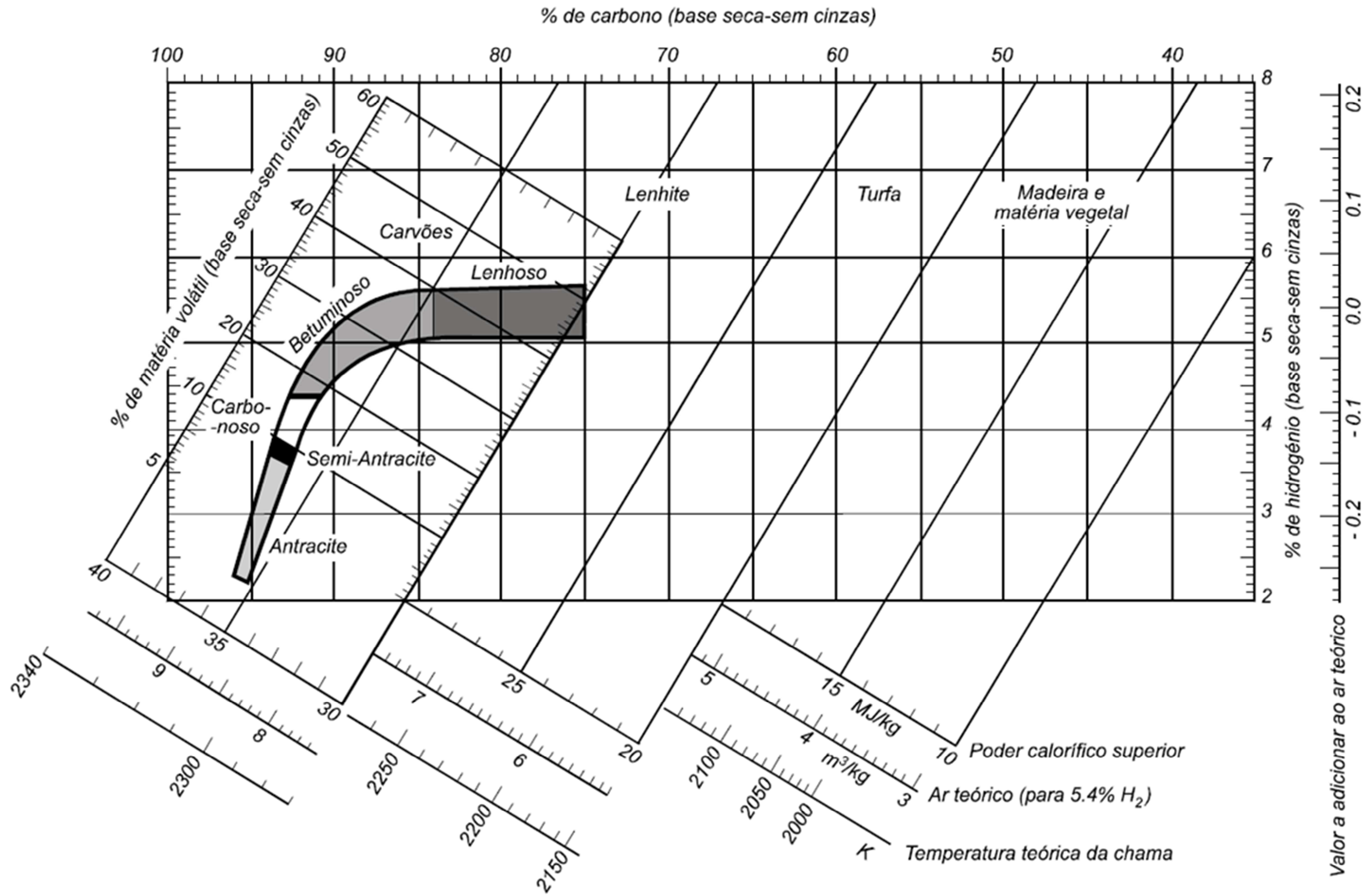
$$n_{xO2=}4.76*\left[\frac{x+(1+xO2)\frac{y}{4}}{1-4.76xO2}\right]+\frac{y}{4} \quad \text{(wet)}$$

$$n_{xO2=}4.76*\left[\frac{x+(1-xO2)\frac{y}{4}}{1-4.76xO2}\right]-\frac{y}{4} \quad \text{(dry)}$$

- **Others**

Heat of vaporization: 44010 KJ/kmol or 2445 KJ/kg

NAME: **N^er:**


% de carbono (base seca-sem cinzas)
100
90
80
70
60
50
40
Lenhite
Turfa
Madeira e
matéria vegetal
Carvões
Lenhoso
Betuminoso
Carbo-
-noso
Semi-Antracite
Antracite
% de matéria volátil (base seca-sem cinzas)
% de hidrogénio (base seca-sem cinzas)
Valor a adicionar ao ar teórico
Poder calorífico superior
MJ/kg
m3/kg
Ar teórico (para 5.4% H2)
K
Temperatura teórica da chama