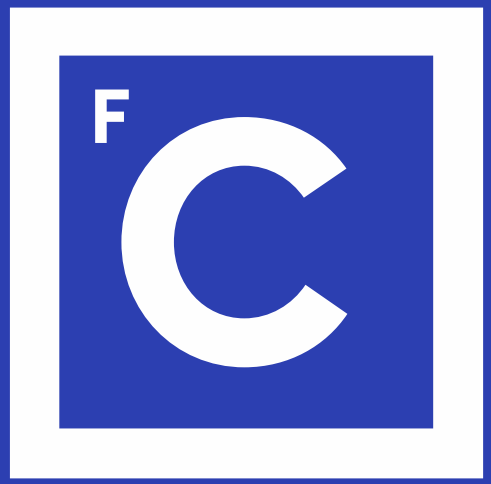

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DISCIPLINA MIEA 2018

Technologies of combustion

Corpo docente

Carla Silva (Teóricas e práticas) /Theory and practice

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Emissions

P#21 The following sentences are true or false?

a) The molar mass of an ideal mixture is equal to the sum of each species molar mass weighted by its molar fractions.

b) In a rich mixture $\phi>1$.

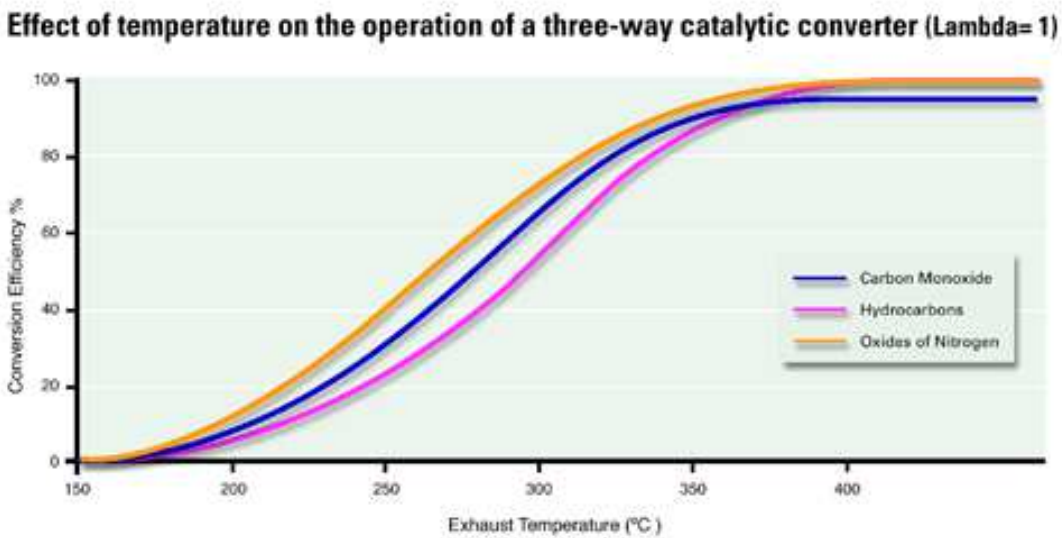
c) The adiabatic flame temperature, at constant pressure, increases with the increase in the reactants temperature.

d) At 3000 K H2 is more likely to dissociate to its monoatomic form, than N2.

e) In 2 adiabatic recipients, different dimensions, it was introduced the same mass of air and fuel at Tamb. After ignition, and once reached the equilibrium, the dissociation is higher in the smallest recipient.

Emissions

P#13 A mixture of methane gas and air at 25ºC and 1 atm is burned in a water heater at 100% theoretical air. The mass flow rate of methane is 1.15 kg/h. The exhaust gas temperature was measured to be 500 º C and approximately 1 atm and is subjected to exhaust aftertreatment. The volumetric flow rate of cold water (at 22 º C) to the heater is 4 L/min.



(a) Determine the combustion efficiency.
(b) Calculate the temperature of the hot water if the heat exchanger were to have an efficiency of 1.0, i.e., perfect heat transfer.
(c) Consider the following concentrations of emissions at the combustion products: 5000 ppm NO. Estimate the NO exhaust gas emissions in g/h.

Emissions

P#22 Ultimate analysis tree d (dry basis wt%)

C	H	O
52.60	7.00	40.10

Proximate analysis			ar	dry	daf
	Moisture content	wt%	3.87		
	Volatile matter	wt%	76.90	80.00	80.48
	Ash content	wt%	0.58	0.60	
	Fixed carbon	wt%	18.65	19.40	19.52

a) Determine the **ar** and **daf** ultimate analysis.

b) Is this in accordance to the Seyler diagram?

c) What would be the (A/F)s in mass and molar basis?

d) What will be the first thing that is burned? Estimate its chemical formula.

e) What would be the colour of the flame in a forest fire situation? Justify.

Chemical Equilibrium

K is tabulated as a function of temperature for different equilibrium reactions

APÊNDICE 4
CONSTANTES DE EQUILÍBRIO

$H_2+1/2O_2 \Leftrightarrow H_2O$ $CO+1/2O_2 \Leftrightarrow CO_2$ $CO+H_2O \Leftrightarrow CO_2+H_2$ $OH+1/2H_2 \Leftrightarrow H_2O$ $1/2O_2+1/2N_2 \Leftrightarrow NO$ $2H \Leftrightarrow H_2$ $2O \Leftrightarrow O_2$ $2N \Leftrightarrow N_2$

T (K)	$\log_{10} K_p$ com as pressões parciais em atmosferas							
	$\frac{p_{H_2O}}{p_{H_2}\sqrt{p_{O_2}}}$	$\frac{p_{CO_2}}{p_{CO}\sqrt{p_{O_2}}}$	$\frac{(p_{H_2O})(p_{CO})}{(p_{H_2})(p_{CO_2})}$	$\frac{p_{H_2O}}{p_{OH}\sqrt{p_{H_2}}}$	$\frac{p_{NO}}{\sqrt{p_{O_2}}\sqrt{p_{N_2}}}$	$\frac{p_{H_2}}{(p_H)^2}$	$\frac{p_{O_2}}{(p_O)^2}$	$\frac{p_{N_2}}{(p_N)^2}$
298	40,048	45,066	−5,018	46,181	−15,171	71,232	81,202	159,600
300	39,786	44,760	−4,974	45,876	−15,073	70,762	80,664	158,578
400	29,240	32,431	−3,191	33,600	−11,142	51,758	58,944	117,408
600	18,633	20,087	−1,454	21,264	−7,210	32,676	37,146	76,162
800	13,289	13,916	−0,627	15,060	−5,243	23,082	26,202	55,488
1000	10,062	10,221	−0,159	11,322	−4,062	17,294	19,612	43,056
1200	7,899	7,764	0,135	8,822	−3,275	13,416	15,208	34,754
1400	6,347	6,014	0,333	7,030	−2,712	10,632	12,054	28,812
1600	5,180	4,706	0,474	5,686	−2,290	8,534	9,684	24,350
1800	4,270	3,693	0,577	4,638	−1,962	6,896	7,836	20,874
2000	3,540	2,884	0,656	3,799	−1,699	5,582	6,356	18,092
2200	2,942	2,226	0,716	3,113	−1,484	4,504	5,142	15,810
2400	2,443	1,679	0,764	2,541	−1,305	3,602	4,130	13,908

Tabela A4.1
Constantes de equilíbrio. (Dados extraídos de Rogers e Mayhew, 1994.) (continua)

K is the **equilibrium constant**

$$Kp = Kc * \left(\frac{RT}{P_{ref}}\right)^{nprod - nreag}$$

$$kf(T)/kr(T) = Kp(T) = \frac{X_C^{n_C} \cdot X_D^{n_D}}{X_A^{n_A} \cdot X_B^{n_B}} \left(\frac{P}{P_{ref}}\right)^{n_C + n_D - n_A - n_B}$$

Forward reaction

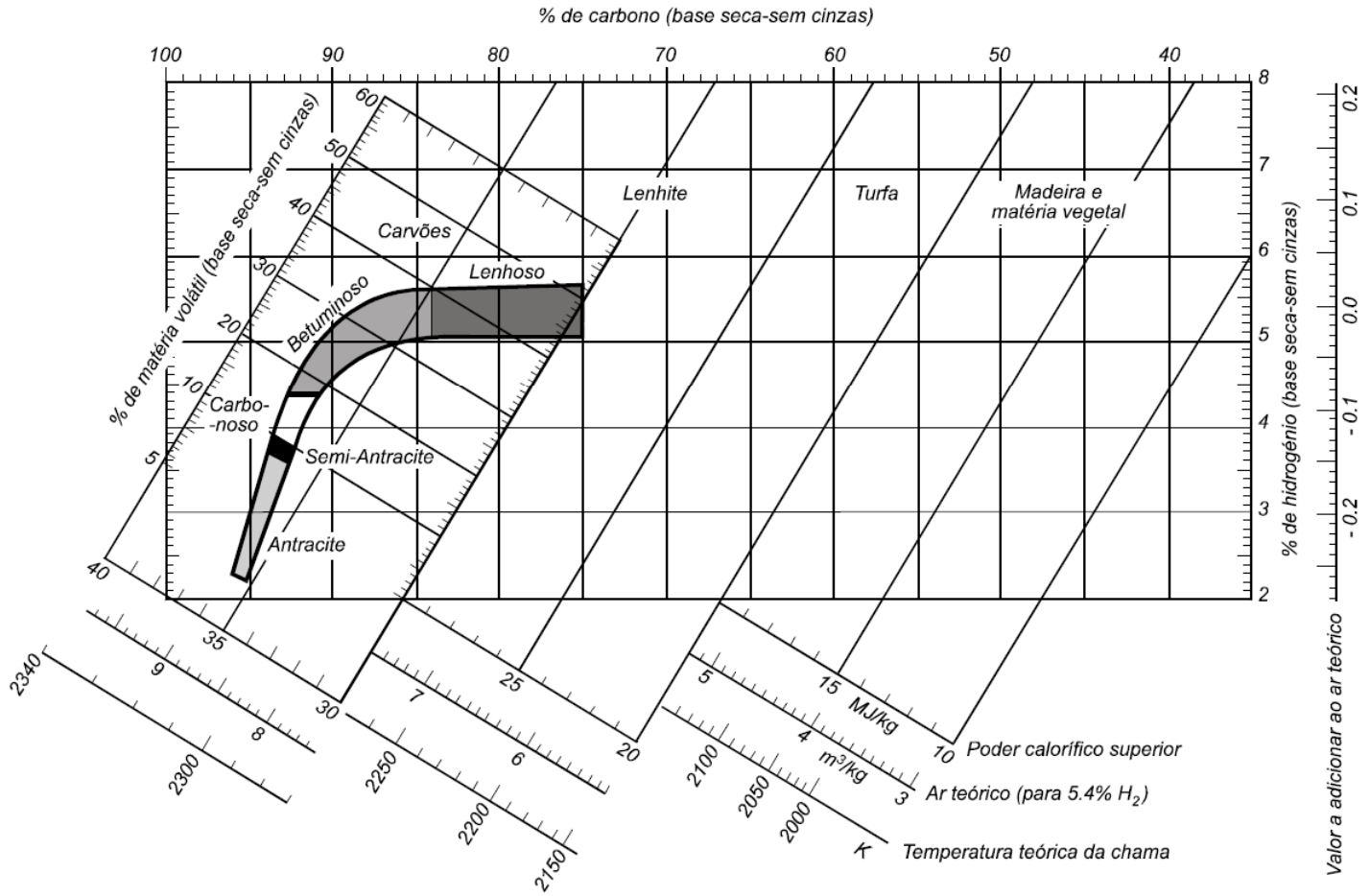
Reverse reaction

$$Note \quad X_A = \frac{n_A}{n_A + n_B + n_C + n_D} * p/RT = concentration$$

mol/m3

Fuel types

Diagrama de Seyler (adaptado)



Cantera

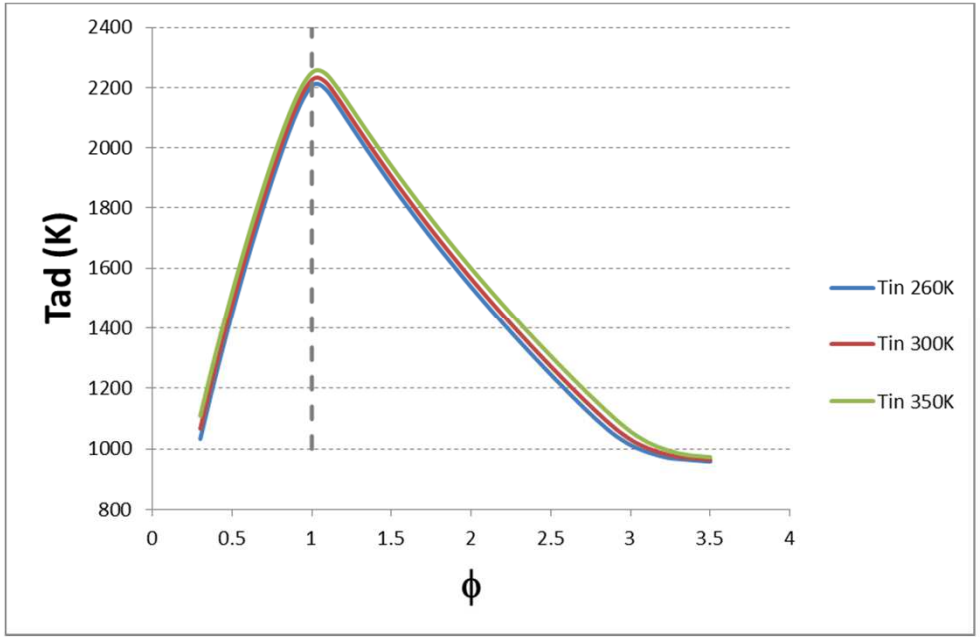
Chemical Kinetics • Thermodynamics • Transport Processes

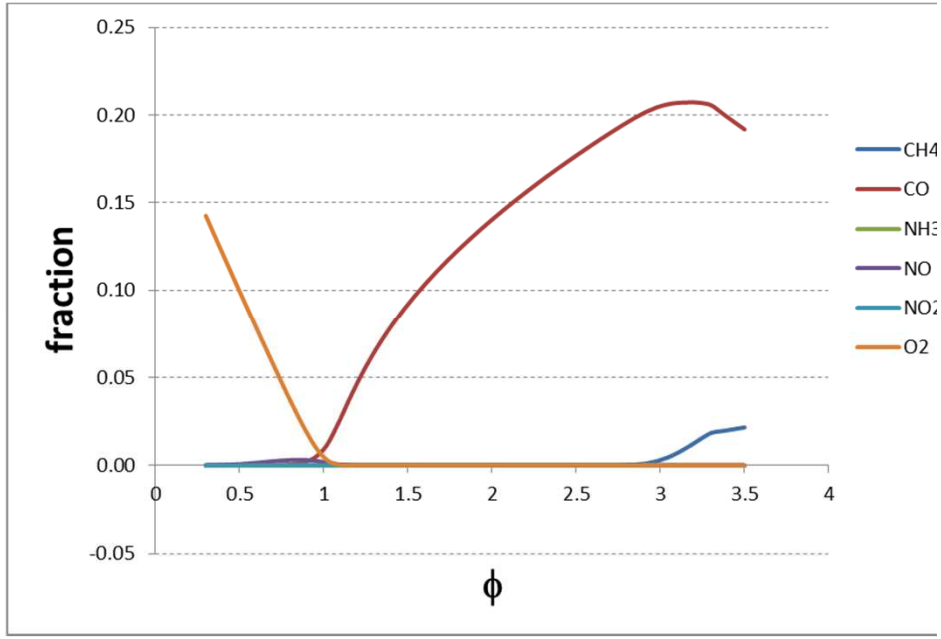
CONDA

http://www.cantera.org/docs/sphinx/html/cython/examples/multiphase_adiabatic.html

Carla Silva camsilva@fc.ul.pt

Cantera CH4





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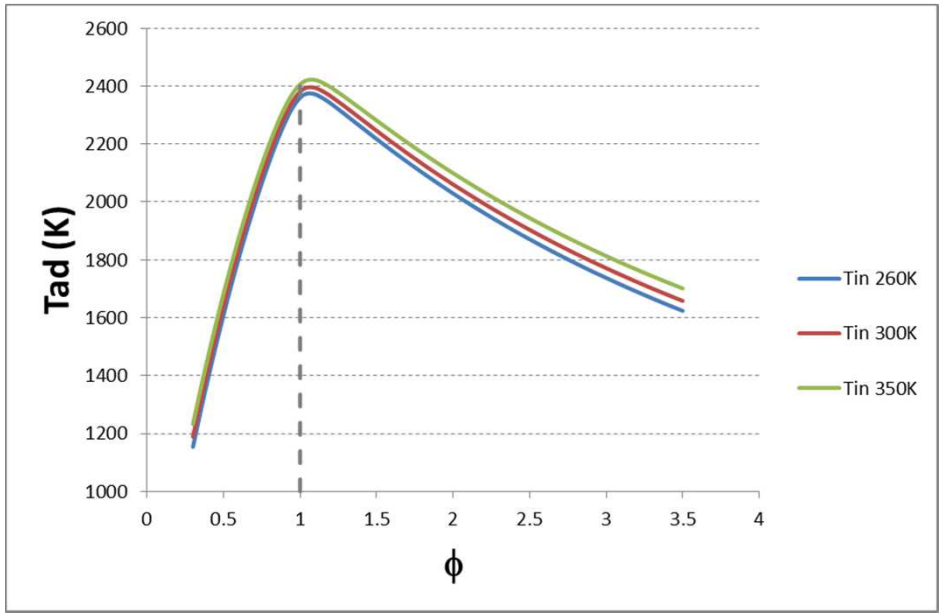
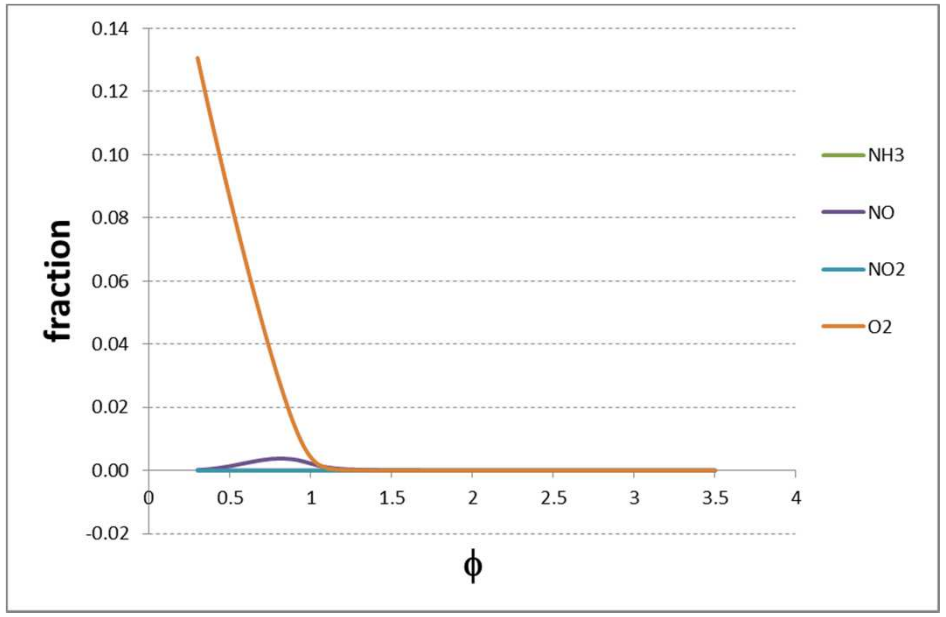
Cantera H2





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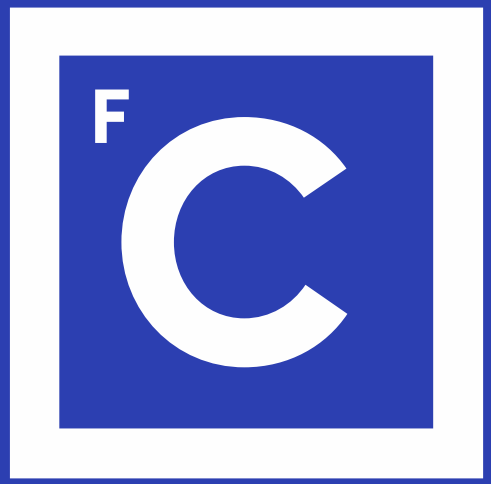
Obrigado



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