

Ciências ULisboa

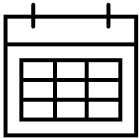
Faculdade
de Ciências
da Universidade
de Lisboa

Eng Energy & Environment



Combustion

Carla Silva (Teóricas e práticas) /Theory and practice
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Thursday

9h-11h 6.2.44

15-17h 6.2.46

- Watch recorded lessons

- Doubts, experiments

4 assignments + oral evaluation

Content

Introduction to combustion, definition, applications, world fuels and projections, problems of combustion

Thermochemistry: stoichiometry, chemical reactions, mass and molar concentrations, CO₂ emissions estimation

Thermochemistry: Heating value, chemical equilibrium, flame temperature

Fuels and properties, examples

Ignition- spontaneous and forced, examples Internal combustion engine

Flame types: pre-mixture, diffusion , laminar and turbulent, examples Internal combustion engine

Liquid fuel and solid fuel combustion, examples internal combustion engine, power plants

Pollutant control/standards

Pollutant control/standards

Pollutant formation and estimation

Pollutant formation and estimation

Internal combustion engine

Biomass/Coal/combined cycle natural gas Power plant

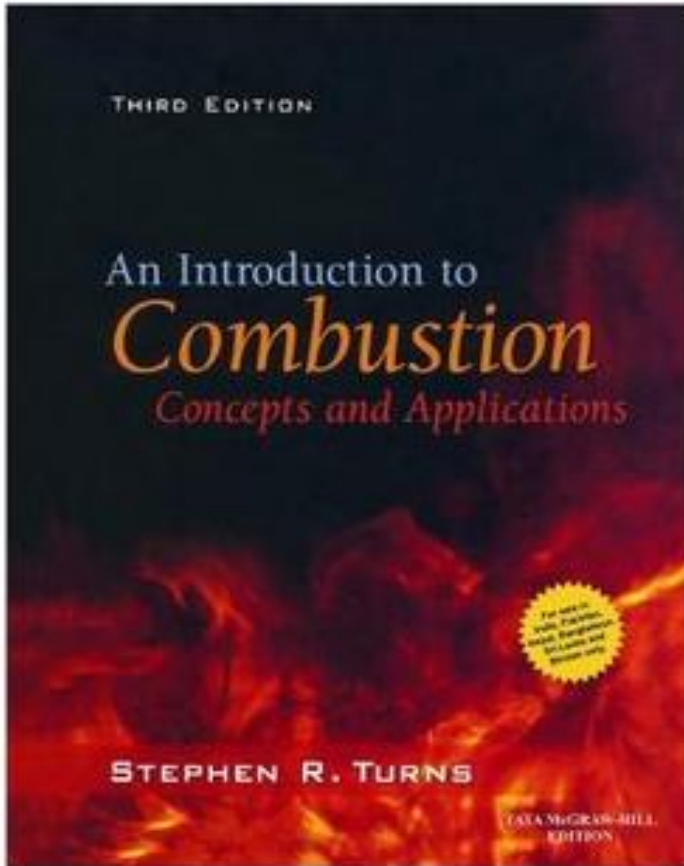
Biogas Power plant

At the end you should:

- ✓ Know the contribution of combustion to world energy generation and its contribution to emissions;
- ✓ Distinguish between local and global emissions;
- ✓ Know typical values of energy efficiency and typical emission factors e.g. $\text{g}/(\text{kWh}_{\text{electricity}})$; g/km ; $\text{g}/\text{MJ}_{\text{heat}}$;
- ✓ Know the main combustion technologies, advantages and disadvantages and potential for improvement;
- ✓ Know how internal combustion engines work;
- ✓ Know how a gas turbine work;
- ✓ Estimate emissions from thermoelectric powerplant and compare with regulation;
- ✓ Propose measures to minimize emissions.

1. **Pedro Coelho e Mario costa. Combustão. 2012.Edições Orion.**
2. Stephen R. Turns. An introduction to combustion. Concepts and applications. 1996. McGraw-Hill.
3. EMEP/EEA air pollutant emission inventory guidebook – 2013. European Environment Agency.
4. John Heywood. Internal Combustion Engine Fundamentals. 1988. McGraw-Hill.
5. M.K. Gajendra Babu,K.A. Subramanian. Alternative Transportation Fuels: Utilisation in Combustion Engines. 2013. CRC Press.

Stephen R. Turns. An introduction to combustion. Concepts and applications. 1996.
McGraw-Hill.



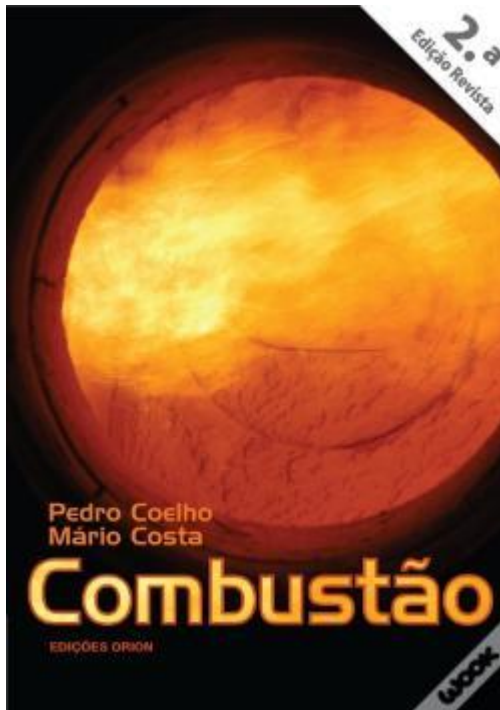
Main chapters 1, 2, 5, 15 (importance of combustion, thermochemistry, mass balances, energy balances, GHG emissions and pollutants)

And some notions of 10, 14 (solid and liquid burning)

Diesel, Gasoline, jetfuel, Coal, natural gas, biogas, biocoal, biomass

Pdf available

Pedro Coelho e Mario costa. Combustão. 2012. Edições Orion.



Main chapters 1, 2, 5, 12

And some notions of 6,10
(gas, solid and liquid burning)

Diesel, Gasoline, jetfuel, Coal, natural gas, biogas,
biocoal, biomass

Pdf available

Why “controlled” combustion is important????

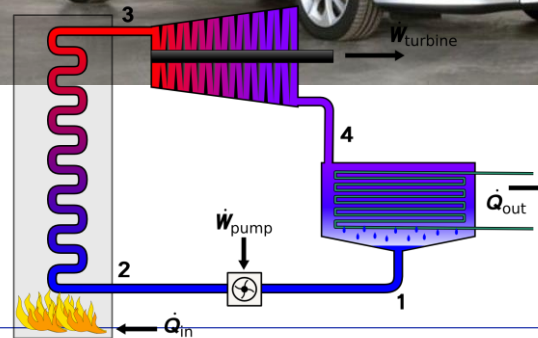
HEAT



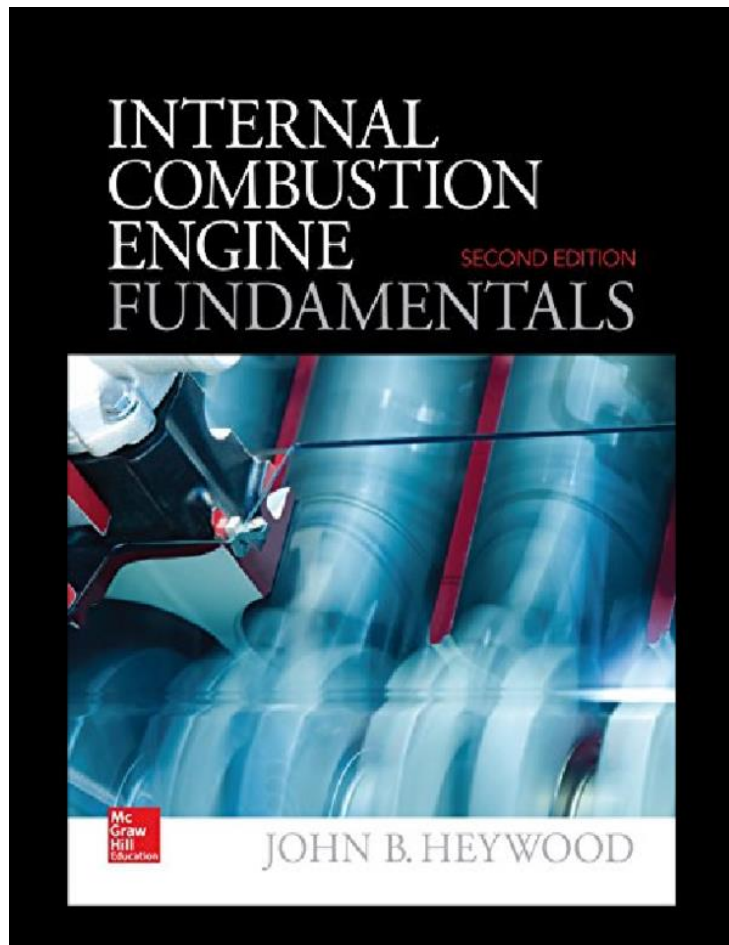
MECHANICAL ENERGY



ELECTRICITY



John Heywood. Internal Combustion Engine Fundamentals. 1988. McGraw-Hill.



Technology to transform
chemical energy into
mechanical energy and heat

Pdf available

Candle (birthday, sent, etc)

Glass limiting



Moisture in the candle wick vs no moisture

Magic/Trick candles, how?



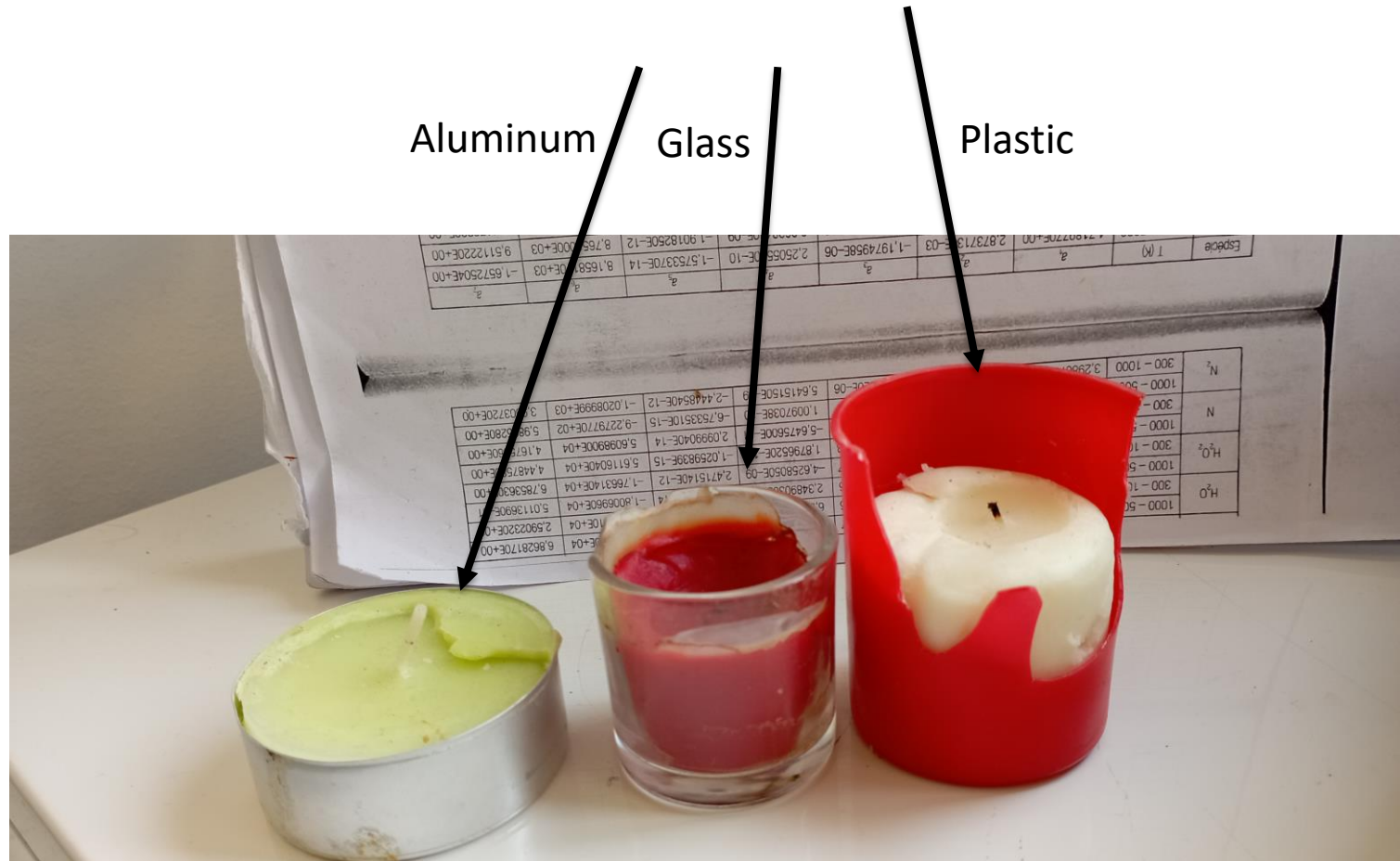
magnesium powder is incorporated into the candle's wick

It produces sparks at 430 °C

Magnesium + oxygen → magnesium oxide.
 $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$

Candle (birthday, sent, etc)

Different container materials, the red can burn but not aluminum or glass, why?



Candle (birthday, sent, etc)

Different container materials, the red can burn but not aluminium or glass, why?

Aluminum

Melts at
660 °C

Plastic

$(C_2H_4)_n$,
Polyethylene
120 °C

Glass melts at
1700 °C

Candle (birthday, sent, etc)

Flame colour, wick colour



Dark wick, why?

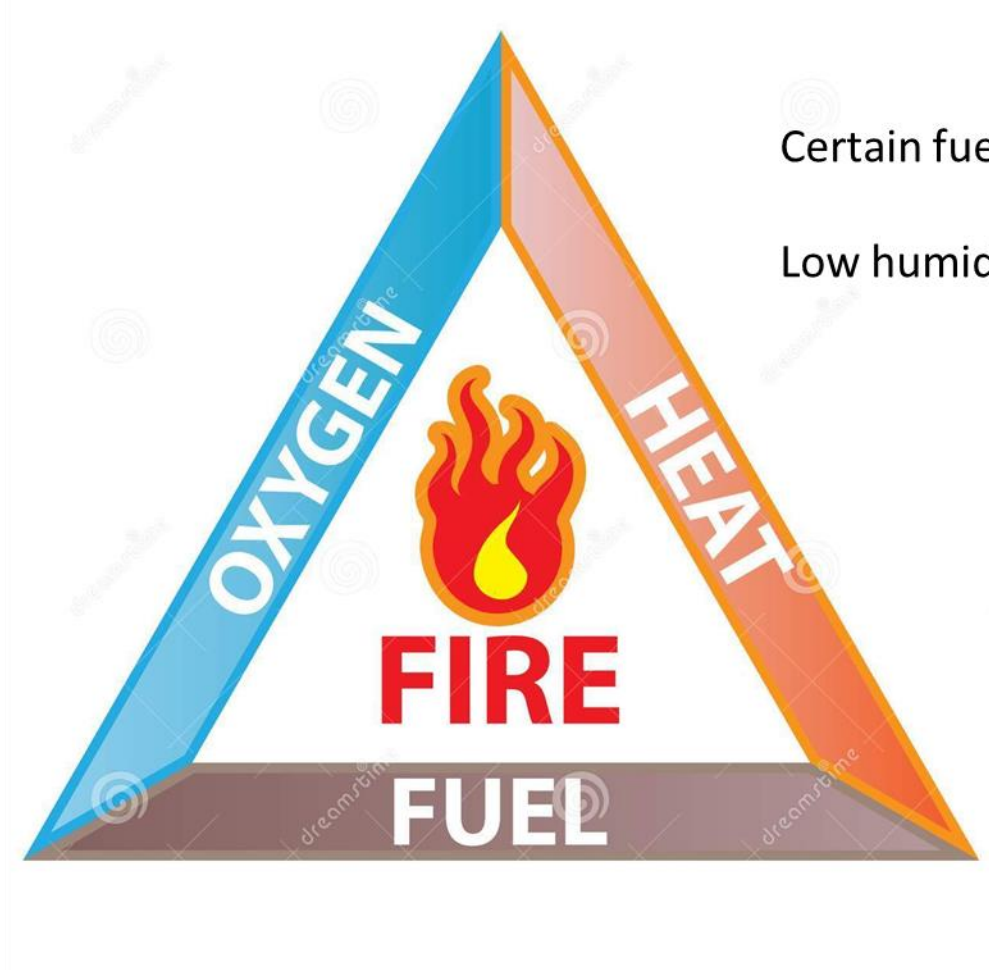
Wick is an absorbent and wax is the absorbate the liquid which gets absorbed. It goes black because it is mainly fixed carbon (char)

The candle paraffin: C_nH_{2n+2}

melting point $\sim 60\text{ }^\circ\text{C}$

Liquid vaporizes and burn at $310\text{ }^\circ\text{C}$

Combustion is essentially burning, fuels react with oxygen to release energy



Certain fuel/oxygen ratios

Low humidity

Retrieve the coal consumption, natural gas consumption and diesel for road, maritime and aviation consumption in the years 2017 to 2022. (DGEG -

<https://www.dgeg.gov.pt/pt/estatistica/energia/petroleo-e-derivados/vendas-mensais/>

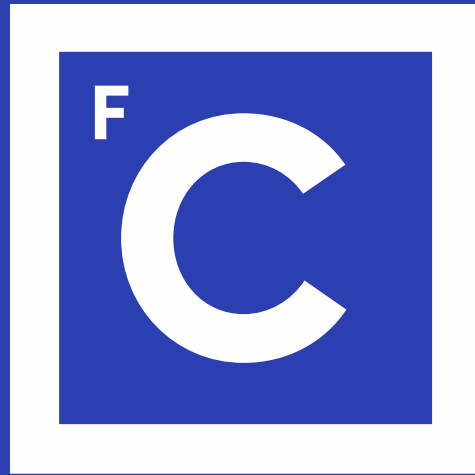
<https://www.dgeg.gov.pt/pt/estatistica/energia/gas-natural/consumos/>

<https://www.dgeg.gov.pt/pt/estatistica/energia/carvao/consumos/>)

- i. Coal is mainly used where?
- ii. Natural gas is mainly used where?
- iii. Comment COVID-19 impact, coal powerplant deactivation and decarbonization targets
Effect on the evolution of fossil fuel consumption.

excel and pdf 10 min presentation until 2 March – Presentation each

Thanks



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