



MAK 3031- İçten Yanmalı Motorlar

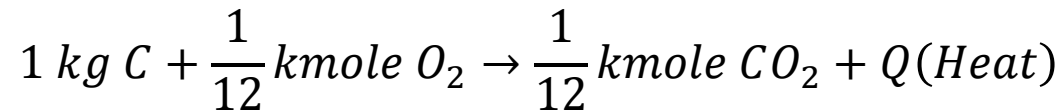
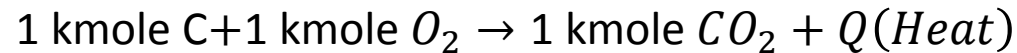
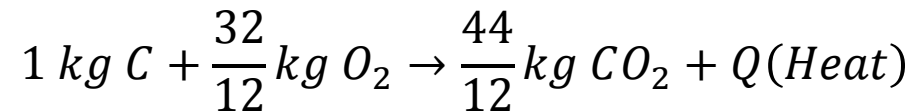
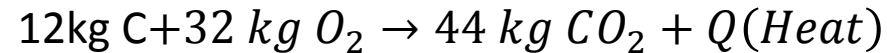
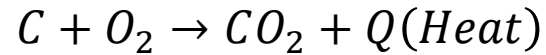
Doç. Dr. Levent YÜKSEK



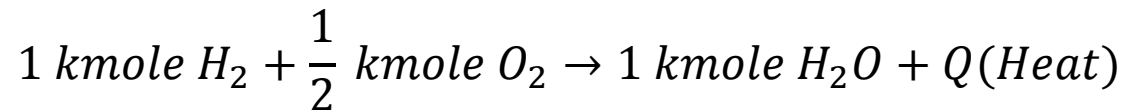
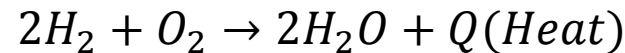
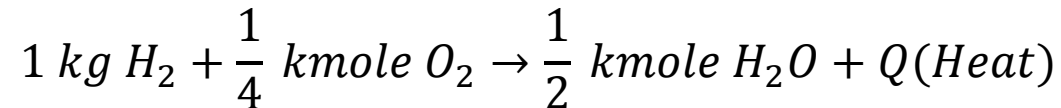
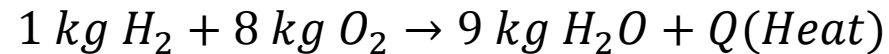
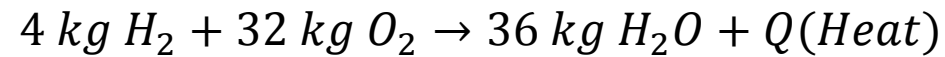
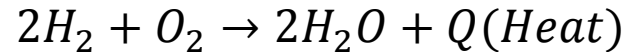
MAK 3031- Internal Combustion Engines

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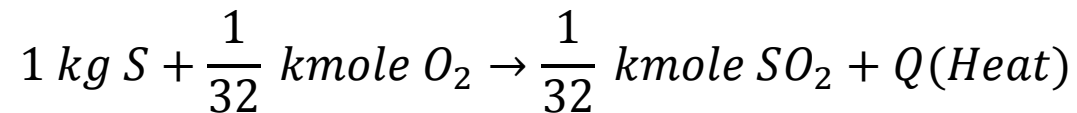
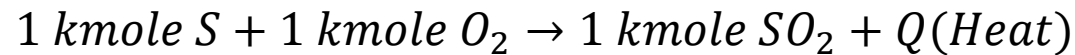
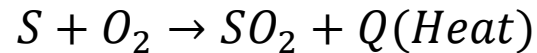
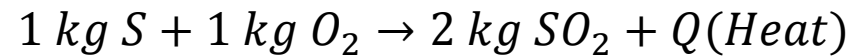
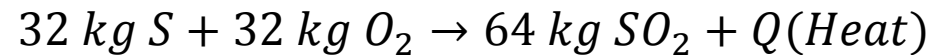
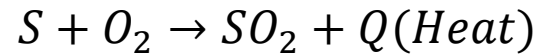
Combustion reactions



Combustion reactions



Combustion reactions



Combustion reactions

It can easily be seen that we need

$$\frac{1}{12} \text{ kmole of } O_2 \text{ for 1 kg of } C$$

$$\frac{1}{4} \text{ kmole of } O_2 \text{ for 1 kg of } H_2$$

$$\frac{1}{32} \text{ kmole of } O_2 \text{ for 1 kg of } S$$

for complete combustion

Combustion reactions

C % (Ratio of carbon) is designated as c or $\bar{C}$

H % (*Ratio of hydrogen*) is designated as h or $\bar{H}$

S % (Ratio of sulphur) is designated as s or $\bar{S}$

O_y % (Percentage of Oxygen content in fuel) is designated as o_y or $\bar{O}_y$

Combustion reactions

$$O_{\min} = \frac{1}{12}.c + \frac{1}{4}.h + \frac{1}{32}.s - \frac{1}{32}.O_y \quad [\text{kmole O}_2 \text{ per kgfuel}]$$

$$O_{\min} = \left[\frac{1}{12}.c + \frac{1}{4}.h + \frac{1}{32}.s - \frac{1}{32}.O_y \right].32$$

[kg O₂ per kgfuel]

Combustion reactions

@0 degree Celcius and 760 mm Hg
(Mercury column) pressure a
kmole of an ideal gas has **22.4** Nm³ volume

@15 degree Celcius and 760 mm Hg
(Mercury column) pressure a
kmole of an ideal gas has **24** Nm³ volume

Combustion reactions

$$O_{min} = 0.232 * L_{min} \quad [\text{kg O}_2/\text{kg fuel}]$$

$$L_{min} = \frac{O_{min}}{0.232} \quad [\text{kg air} / \text{kg fuel}]$$

Combustion reactions

L_{min} can be defined as the amount of air needed for complete combustion of a given fuel.

L_{real} is the actual air reacted in a combustion system.

L_{real} < L_{min} charge/air-fuel mixture is **RICH**.

L_{real} = L_{min} charge/air-fuel mixture is chemically ideal or so called **STOICHIOMETRIC**.

L_{real} > L_{min} charge/air-fuel mixture is **LEAN**

$$\lambda = \frac{L_{real}}{L_{min}}$$

Combustion reactions

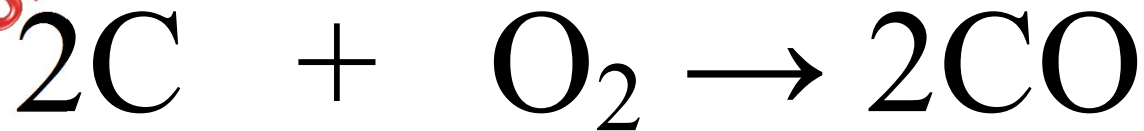
Excessive rich <<<< 0,4 ≤ λ ≤ 1,4 <<<< Exc. lean

Combustion reactions

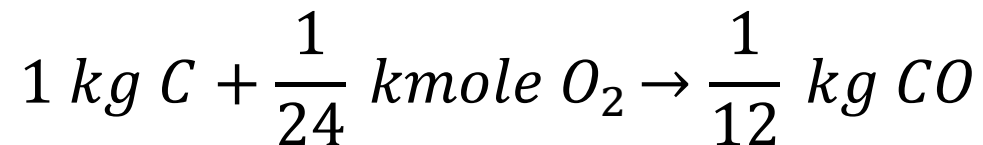
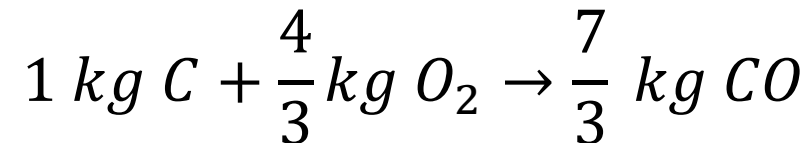
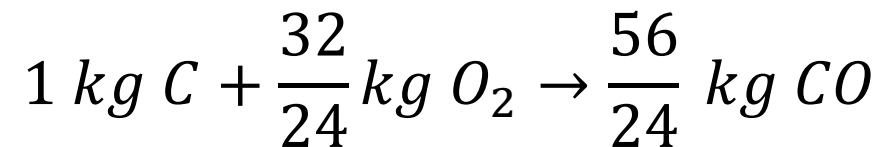
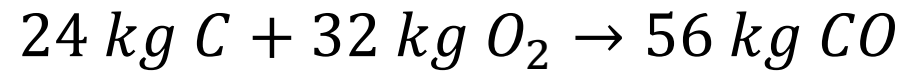
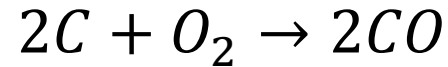
Complete
Comb.



Incomplete
combustion

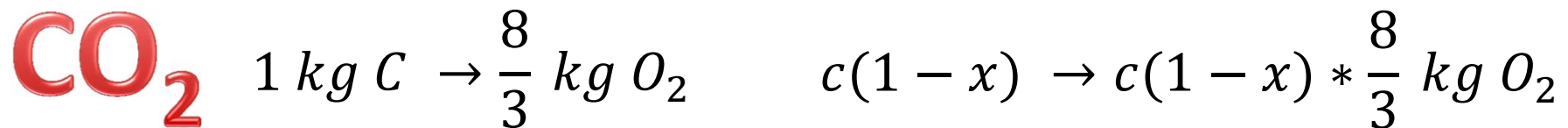
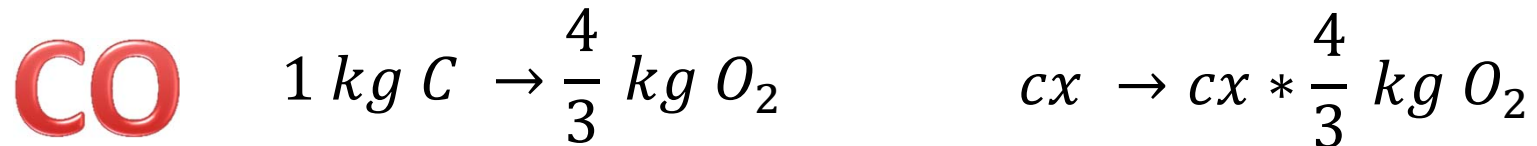


Combustion reactions



Combustion reactions

Incomplete fraction of a combustion reaction is calculated by measuring the amount of CO exhausted. Which can be formulated as the CO mole fraction as x while CO_2 fraction can then be $(1-x)$.



$$O_{min} = \frac{8}{3} \bar{C}(1-x) + \frac{4}{3} \bar{C}x + 8\bar{H} + \bar{S}$$

Combustion reactions

$$O_{\ddot{o}n} = \lambda.O_{\min} + O_y = \lambda\left(\frac{8}{3}.c + 8h - O_y\right) + O_y$$

$$\lambda\left(\frac{8}{3}.c + 8h - O_y\right) + O_y = \frac{8}{3}.c(1 - x) + \frac{4}{3}c.x + 8h$$

Combustion reactions

$$x = \frac{3}{4c}(1 - \lambda).O_{\min} \quad O_{\min} = 0,232.L_{\min}$$

$$x = \frac{3}{4c}(1 - \lambda).0,232.L_{\min}$$

$$\lambda_{kr} = 1 - \frac{4c}{3.0,232.L_{\min}}$$