

Exercise II: Gas engine

Data:

Consider the following cogeneration engine:

Nominal engine speed:	$N = 1500$ [rpm]
Total displacement:	$V_{cyl} = 9.96$ [L]
Engine type:	L6 (6 in-line cylinders)
Supercharging:	Turbocompressor without exchanger

This engine normally operates with natural gas but for the purpose of this exercise we consider that the fuel is only constituted of methane (CH_4).

Questions:

1. Complete the following table:

Stroke: L	142 [mm]
Bore: D	-
Compression ratio: χ	12:1
Connecting rod length: l	228 [mm]
Ratio of connecting rod : λ	-
Clearance volume: V_0	-
Displaced volume V_u	
Cylinder volume V_c	-

2. Calculate the total air mass flow rate of the engine at standard conditions knowing that the volumetric efficiency and the compression ratio are given ($P_0 = 1013$ [mbar], $T_0 = 25^\circ\text{C}$) : $\eta_{\text{vol}} = 0.92$, $\pi_c = 1.5$.

$$M_{A, \text{real}} = M_{A, \text{ideal}} \cdot \eta_{\text{vol}} \text{ where } M_{A, \text{ideal}} = \frac{P_{\text{Intake}}}{r \cdot T_{\text{Intake}}} \cdot V_{\text{Cyl}}$$

3. If the relative Air/Fuel ratio λ is equal to 1.7, what is the mass flow rate of fuel?
4. Option (See Chapter 4). What is the operating mode of this engine (i.e. the combustion mode)?
Fuel data: $LHV_{\text{CH}_4} = 50'020$ [kJ/kg], $\text{RON} = 120$, lower flammable limit: $L_{\text{inf}} = 2.0$
5. Calculate the following values,

- Effective power and torque of the engine: \dot{E}_e , C_e
- Brake mean effective pressure: $BMEP$ (fr: PME)
- Brake specific fuel consumption: $BSFC$ (fr: CSE)

knowing that the global efficiency η_e is equal to 0.40 at nominal operating conditions.

6. Calculate the following values, knowing that the friction efficiency is equal to 0.90,
- Indicated efficiency of the engine: η_i
 - Indicated power: \dot{E}_i
 - Indicated mean pressure: $IMEP$ (fr: PMI)
 - Indicated specific fuel consumption: $ISFC$ (fr: CSI)
7. What would be the effective power if this engine was equipped with a supercharged air exchanger that cooled down the air intake to 40°C ?