Lecture 7

3rd Semester M Tech. Mechanical Systems Design

Mechanical Engineering Department

Subject: Advanced Engine Design

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Topic: Design Of Sports Car Engine

A Spark Ignition Engine Design

Objective: Estimate Engine Displacement Volume Required – 01-10-2020

Numerical Example:

Q1 Design a Sports Car Engine.

The engine is to have a rated power of 100 KW at 7200 rpm.

Solution:

The engine has to be designed for a sports car:
This is an S.I engine based Sports Car

Given Data:

Rated Power = 100 KW

Rated Speed = 7200 rpm

We Know - The best possible Brake Specific Fuel Consumption for S.I engine = 270 g/KWh

Let

BSFC = 320 g/KWh

Reasons –

Refer to the previous design of an engine for automobile application.

1. Rated Power = 100 KW
2. Rated Speed = 5500 rpm
3. BSFC = 300 g/KWh

When we compare the previous design numerical with this design numerical we can see the following:

Power: same for automobile engine and the sports car engine

Rated Speed: Higher for the Sports Car engine.

BSFC = $\frac{\dot{m}_f}{P}$

Higher rated speed for sports car means:

1. More number of power cycles per unit time.
2. More number of power cycles per unit time means mf will be higher

Since power for both the cases:

P = same
$\dot{m}_f$= higher for sports car
Let

BSFC = 320 g/KWh

Let

Volumetric Efficiency = 90 percent

Reason:
1. The intake manifold design is better in terms of the volumetric efficiency, this is known as tuned intake manifold
2. The valve train design is better

By using the equation for the definition of BSFC

BSFC = $\frac{\dot{m}_f}{P}$

Where

$\dot{m}_f$ = mass flow rate of fuel

P = Power developed by the engine

Or

$\frac{\dot{m}_f}{P}$ = 320 g/KWh

Power = 100 KW

(Decided as per engine application and comparison with previous example)

Therefore substituting above:

$\dot{m}_f$ = 320 g/KWh * 100 KW

$\dot{m}_f$ = 32,000 g/h

$\dot{m}_f$ = 0.533 Kg/min

Mass flow rate of fuel = 0.533 Kg/min

The above computed data will help us to design the fuel supply system
Again
Let A/F ratio = 12.5
Reasons:
1. The Operating Range of A/F ratio for S.I engines is (12 to 16)
2. The Stoichiometric A/F ratio for Petrol fuel = 14.6

3. The engine produces maximum power with slightly rich mixtures
4. **We are designing the engine for maximizing power**
   Therefore Let A/F = 12.5

A/F = $\frac{\dot{m}_a}{\dot{m}_f}$

Where
$\dot{m}_a$ = mass flow rate of air
$\dot{m}_f$ = mass flow rate of fuel

From the above equation:
$\dot{m}_a$ = A/F * $\dot{m}_f$
$\dot{m}_a$ = 12.5 * 0.533

Mass flow rate of Air = 6.662 Kg/min
The Above computed data will help us in the design of air supply system

Now by using the equation for volumetric efficiency we can calculate engine displacement Volume required.

Volumetric Efficiency is given by the equation:

ηv = $\frac{2*\dot{m}_a}{\rho_{a,i}V_dN}$

Where
$\dot{m}_a$ = Actual mass flow rate of air
$\dot{m}_a$ = 6.662 Kg/min
$\rho_{a,i}$ = ambient inlet air density
$\rho_{a,i}$ = 1.18 Kg/m^3
V_d = Engine displacement volume ---- ?

V_d = 1700 cc
Displacement Volume Required = 1.7 liters

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In charge Course:

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Text Book:
Vehicular Engine Design
By Kevin L. Hoag
Published By: SAE International USA