Lecture 6

3rd Semester M Tech. Mechanical Systems Design

Mechanical Engineering Department

Subject: Advanced Engine Design

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Topic: Estimating Engine Displacement Volume Required – 30-09-2020

Numerical Example:

Q1 Design a new spark ignition engine for an automobile application.

The engine is to have a rated power of 100 KW at 5500 rpm.

Solution:

Power = 100 KW

Rated Speed = 5500 rpm

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

Let

BSFC = 300 g/KWh

Reasons –

Refer the chapter: characteristics Performance Curves of S I engines under variable speed operation

1. From the curves we see that the best possible BSFC or minimum BSFC is towards the speed for
2. maximum torque
3. We get best possible combustion at this engine speed
4. Towards the idle speed as well the rated speed for maximum power – the BSFC increases with a
5. drop in combustion efficiency
6. So finally for the Rated Speed – Let us assume the BSFC = 300 g/KWh

Let

Volumetric Efficiency = 86 percent

Reason:

The volumetric efficiency being lower than 100% for naturally aspirated engines in general

Typical Maximum Values For Naturally Aspirated Engines – As per literature

Volumetric efficiency = 80 to 90 Percent

So using the equation for the definition of BSFC

BSFC = Mass flow rate of fuel / Power

300 g/KWh = mass flow rate of fuel / Power

Power = 100 KW

Already decided as per requirement based on engine application

Therefore

Mass flow rate of fuel = 300 g/KWh * 100 KW

Mass flow rate of fuel = 30,000 g/h

Mass flow rate of fuel = 0.5 Kg/min

This will help us to design the fuel supply system

Let

A/F ratio = 12.5

Reasons:

1. The engine produces maximum power with slightly rich mixtures
2. The Stoichiometric A/F for Petrol fuel = 14.6
3. The operating range of A/F for SI engine = 12 to 16
4. We can initially use a value below between 12 and 14.6
5. Then optimize it

A/F = mass flow rate of Air/ mass flow rate of Fuel

From the above equation:

Mass flow rate of Air = A/F * mass flow rate of Fuel

Mass flow rate of Air = 12.5 * 0.5

Mass flow rate of Air = 6.25 Kg/min

Now using the equation for the definition for Volumetric efficiency

We can calculate

Engine Displacement Volume Required

Displacement Volume = 2.2 liters

Displacement Volume = 2200 cc

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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