**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:**

Since the engine has to be designed for automotive application, so the data already given in the question and needed as per the application of engine is as follows:

**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 maximum torque
2. We get best possible combustion efficiency at this engine speed which minimizes the fuel consumption.
3. On the same curve for BSFC when we go towards the idle speed or towards the rated speed for maximum power – the BSFC increases in both directions with a corresponding drop in combustion efficiency
4. Therefore for the Rated Speed under consideration – Let us assume the BSFC = 300 g/KWh

**Let**
**Volumetric Efficiency = 86 percent**

Reason:
The volumetric efficiency is less than 100% for naturally aspirated engines.
Typical Maximum Values For Volumetric efficiency for Naturally Aspirated Engines as per literature is as follows:
Volumetric efficiency = 80 to 90 Percent

**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

$\frac{\dot{m}_f}{P}$ = 300 g/KWh

**Power = 100 KW**
**(Decided as per engine application)**

Therefore substituting above:
$\dot{m}_f$ = 300 g/KWh * 100 KW
$\dot{m}_f$ = 30,000 g/h
$\dot{m}_f$ = 0.5 Kg/min

**Mass flow rate of fuel = 0.5 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**
5. **Therefore Let A/F = 12.5**

Air Fuel Ratio is written as:

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 * 0.5
**Mass flow rate of Air = 6.25 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:**

$\eta v = \frac{\dot{m}_a}{\rho_{a,i} V_d N}$

Where

$\dot{m}_a$ = Actual mass flow rate of air
$\dot{m}_a$ = 6.25 Kg/min
$\rho_{a,i}$ = ambient inlet air density
$\rho_{a,i}$ = 1.18 Kg/m$^3$
$V_d$ = Engine displacement volume ---- ?

**$V_d$ = 2200 cc**

**Displacement Volume Required = 2.2 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