

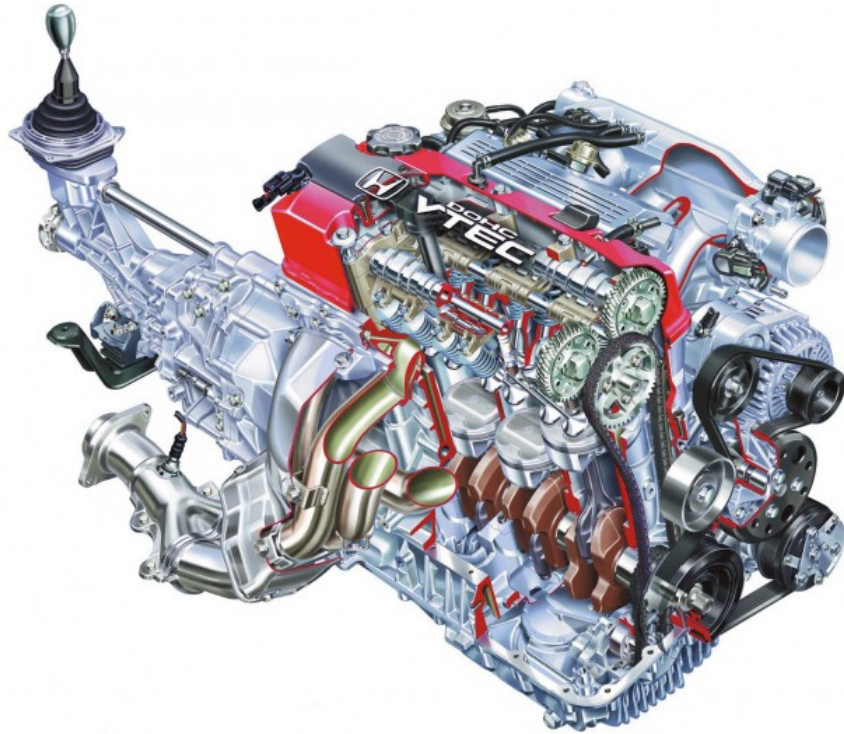
Powertrain and Control

M5X00404

Week 3

Introduction

- Recap last weeks calculations
- Look at valve train analysis.



Honda S2000, 2 litre inline 4 Cylinder.

Each cylinder has a displacement of $\frac{2.0}{4} =$
 $0.5l = 500cc$

Piston Force

- The total downforce at peak pressure = Pressure x Area

E.g. Pressure = 70 Bar = $70 \times 10^5 \text{ N/m}^2$

Bore Area = 87mm

Therefore total downforce = $(70 \times 10^5) \times \frac{\pi \times 0.087^2}{4} = 41618 \text{ N} = 42 \text{ KN} = 4.2 \text{ Tons}$

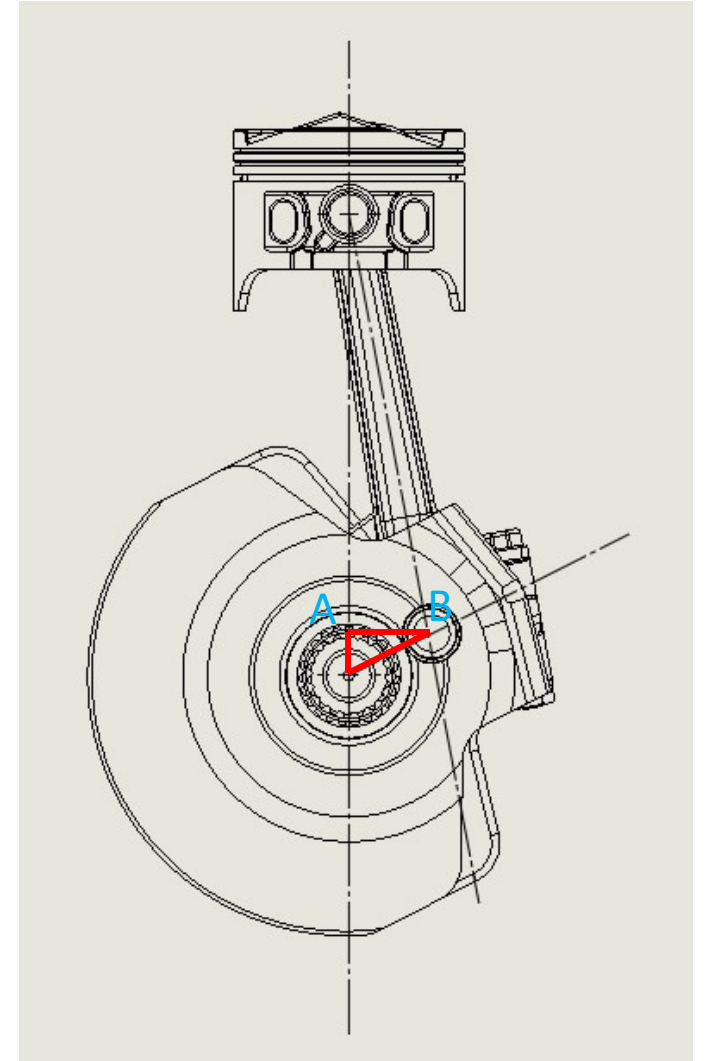
Torque

Θ = Crank Angle

Torque from vertical force = $41618 \times A.B$ (Nm)

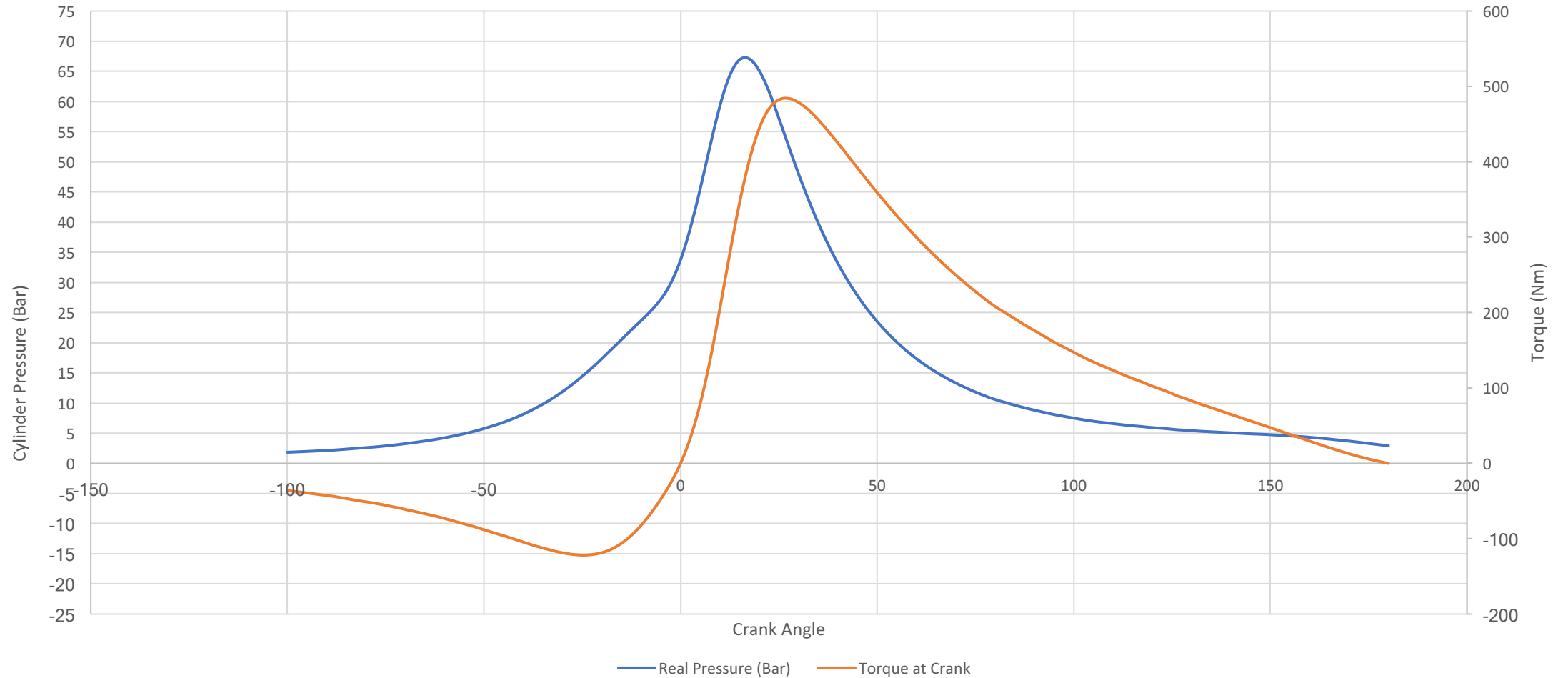
= $41618 \times R.\sin\theta$

Therefore Torque = $P \times \frac{\pi \times B^2}{4} \times R.\sin\theta$ (Nm)



Cylinder Pressure and Torque

Cylinder Pressure & Torque Vs. Crank Angle

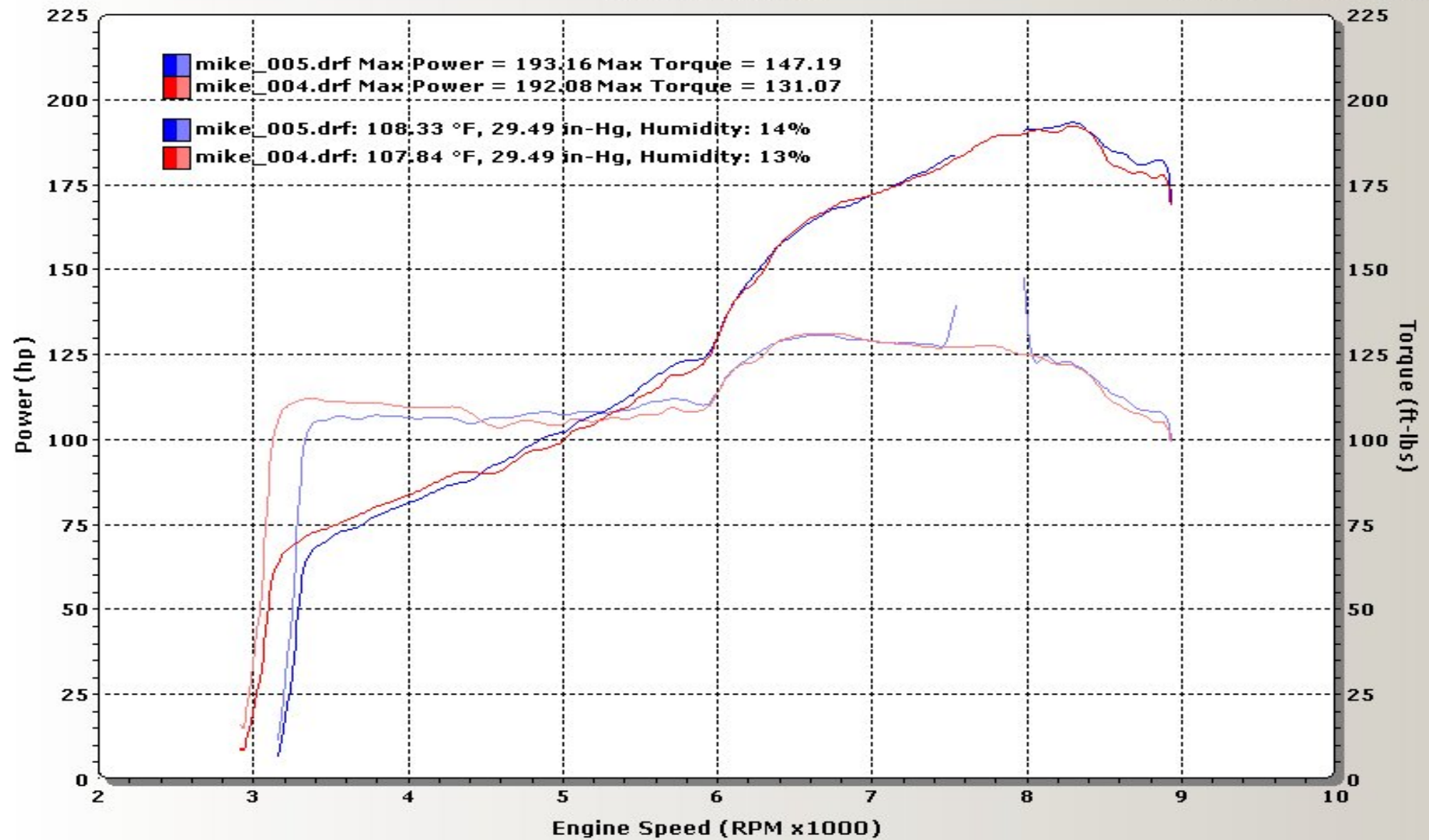


Engine Power Calculations

- Honda S2000, max power is at 8200 RPM
- 4 Cylinder engine, so each cylinder = $\frac{2000}{4} = 500\text{cc/cylinder}$.
- Each cylinder sucks in air once in 2 revolutions, in 1 revolution the engine intakes 1000cc of air (if volumetric efficiency is 100%).

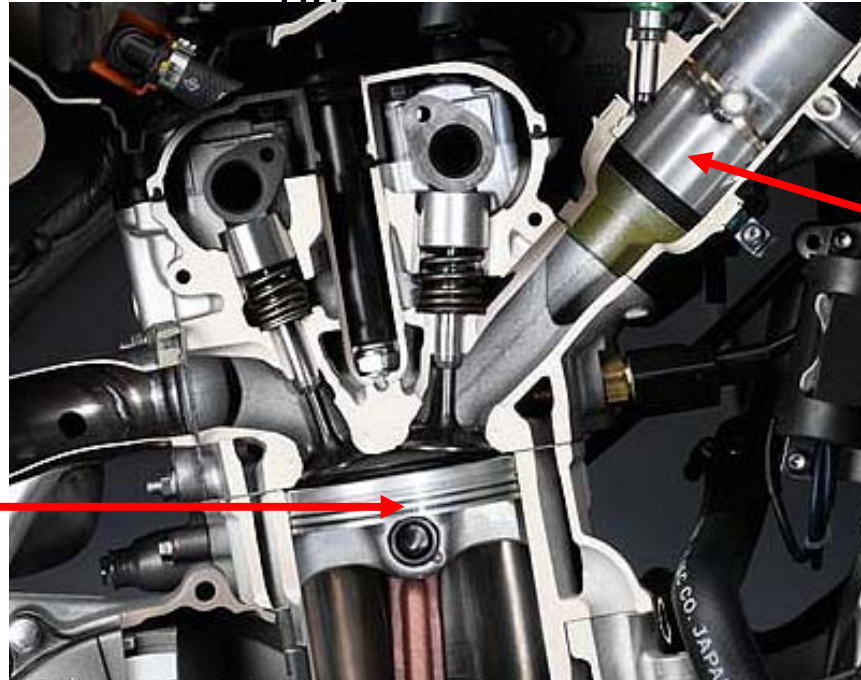
Engine Power Calculations

- Air/fuel ratio = 14.7:1 (Stoichiometric)
- Calorific value of Gasoline $\approx 44 \times 10^6 \text{ J/kg}$
- 1 HP = 0.746 kw



Naturally Aspirated Engines

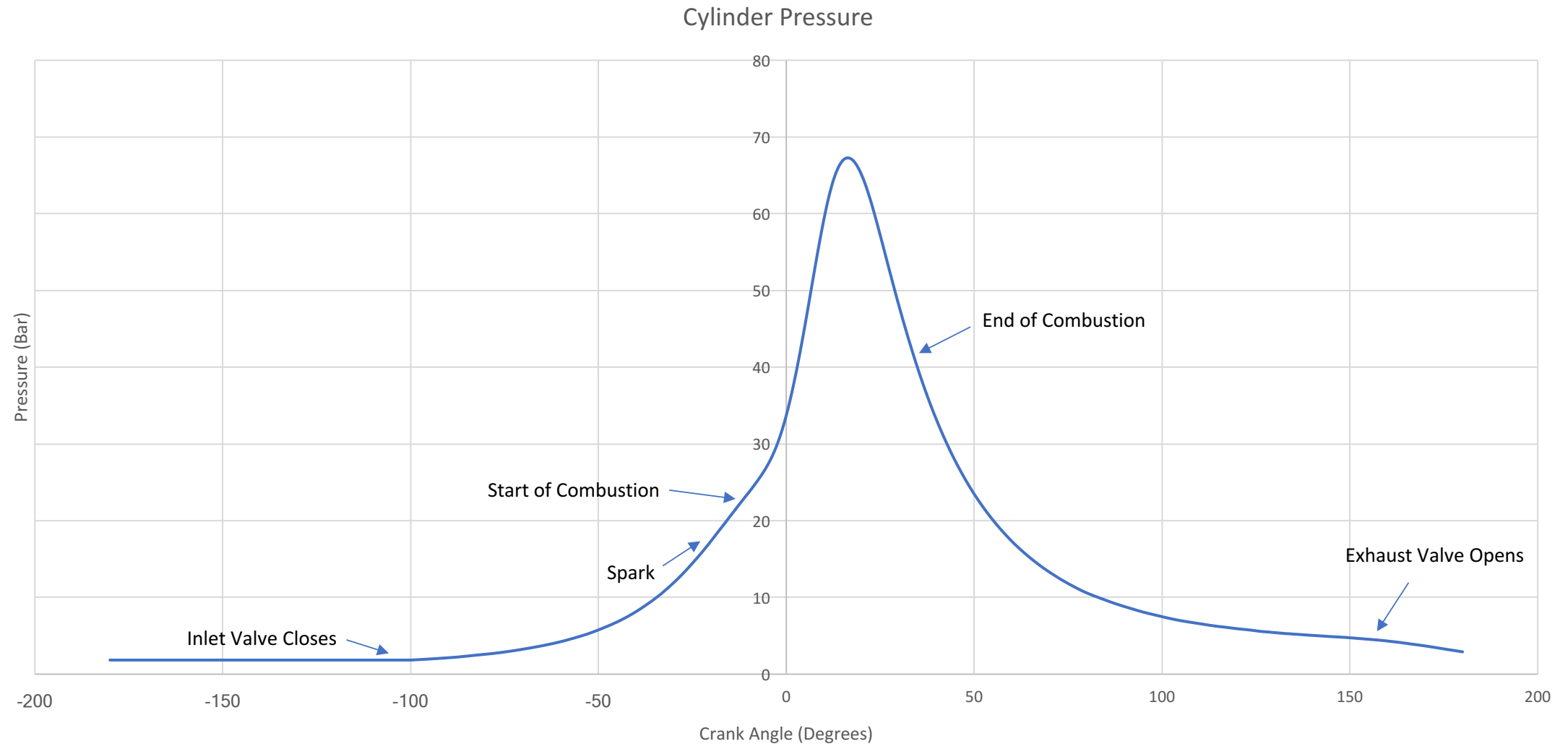
- Volume of Air/Sec in NA Engine = $\frac{\text{Total Displacement}}{2} \times \text{Volumetric Efficiency} \times \frac{\text{RPM}}{60}$



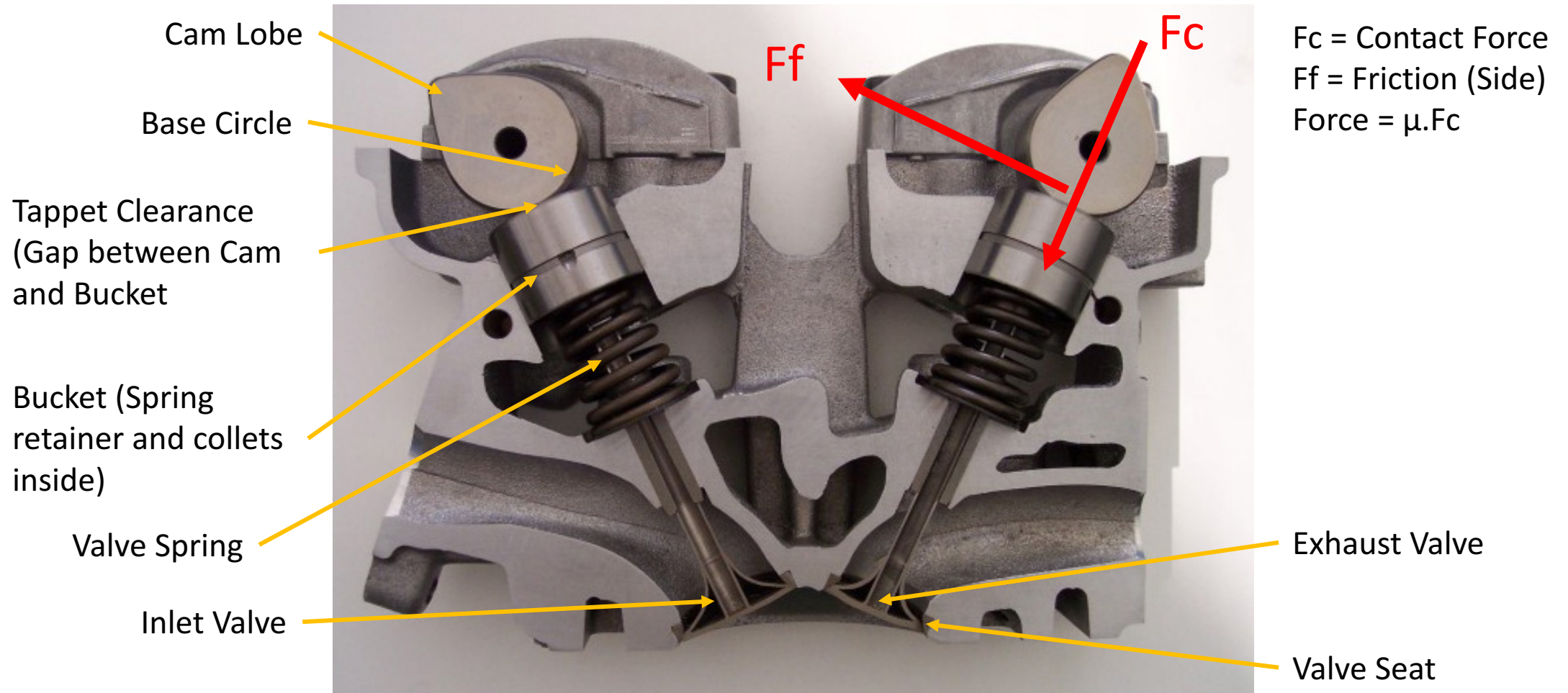
Min Cylinder Pressure = 0 Bar

Max Inlet Pressure = 1 Bar
(Atmospheric)

Cylinder pressure



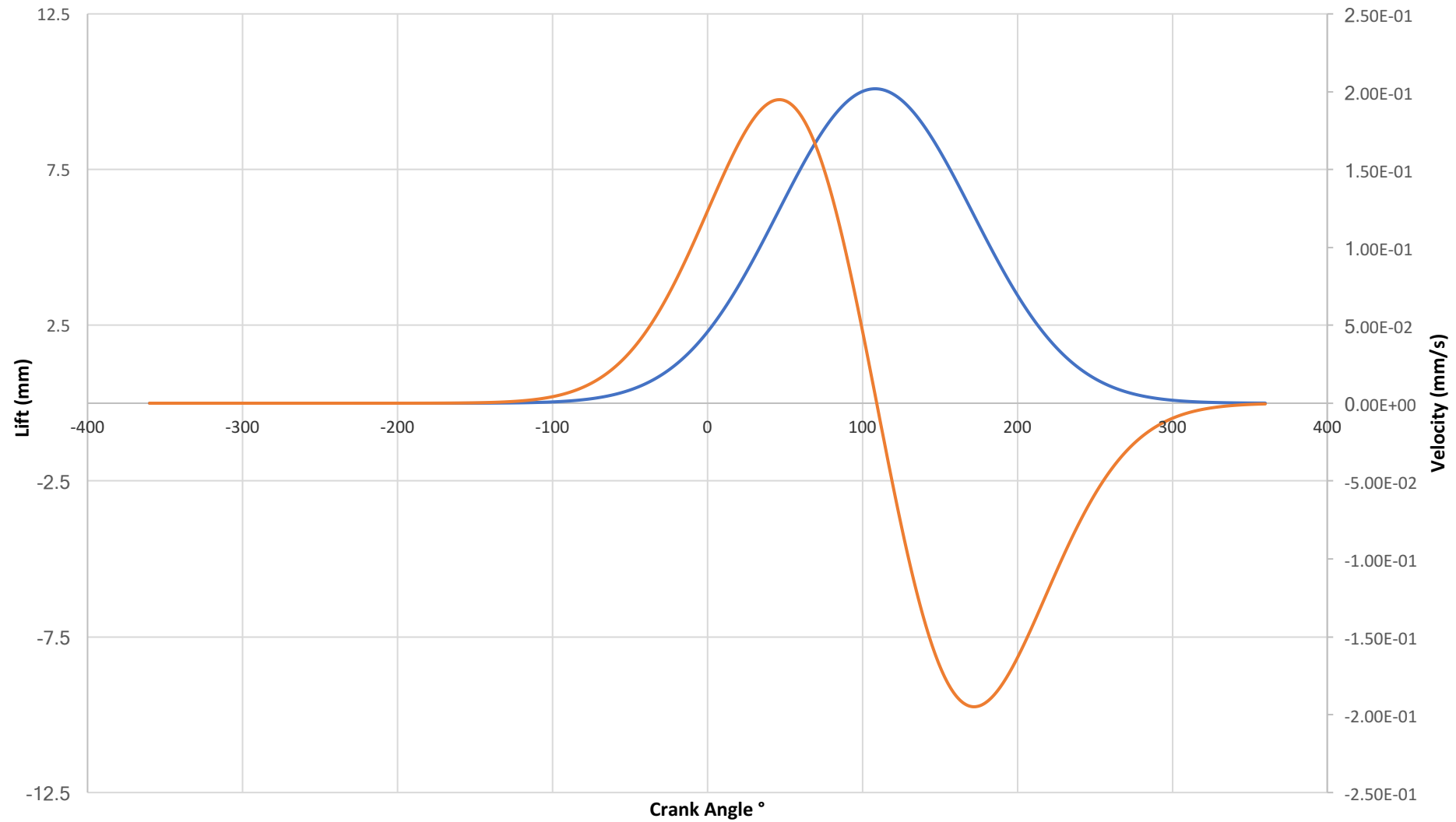
Valve Train



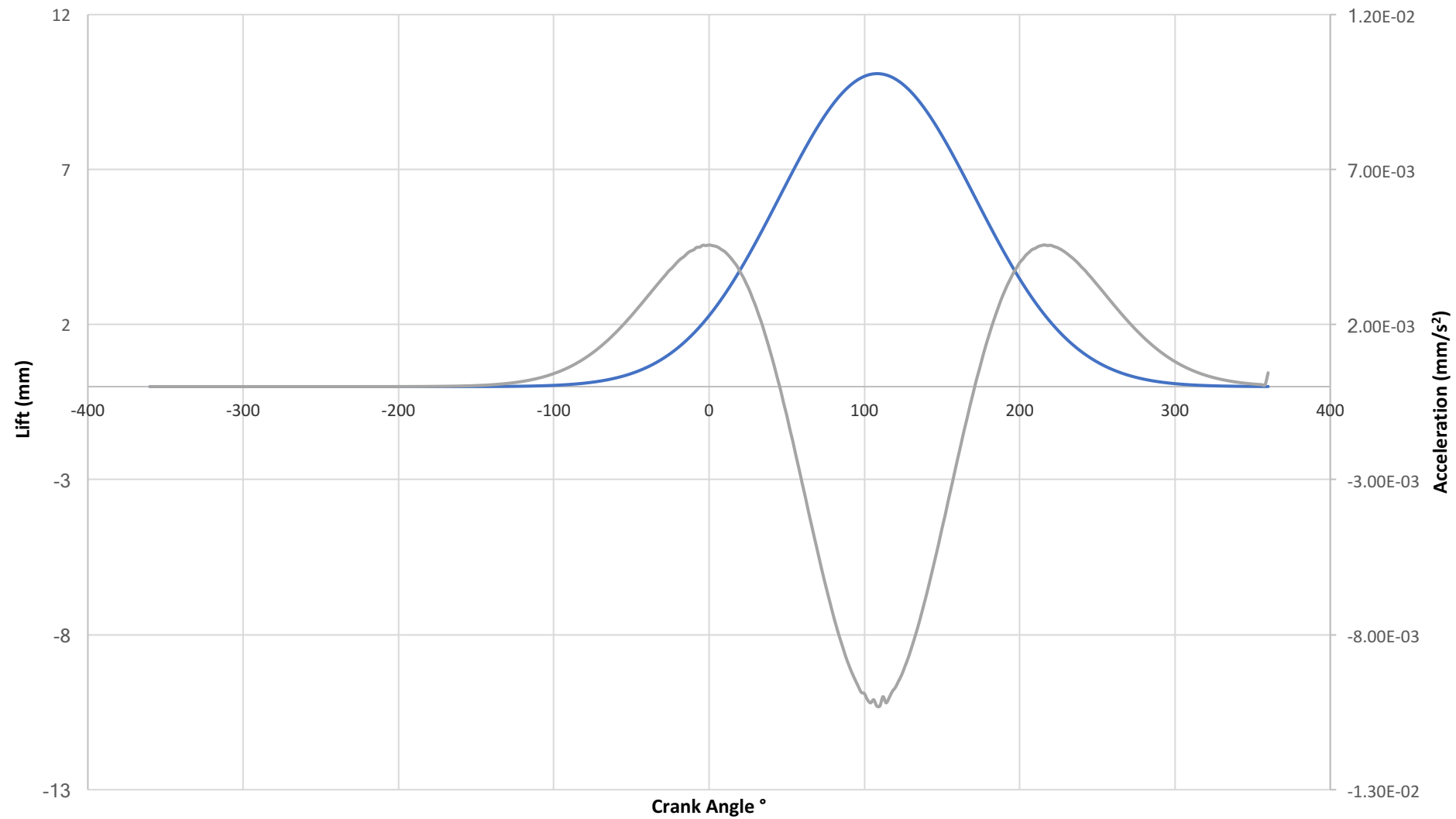
Plot in Excel

Cam Angle °	Valve Lift (mm)	Valve Velocity (mm/°)	Valve Acceleration (mm/°/°)	Valve Acceleration (mm/s ²)
0	L0			
1	L1	L1-L0	V1-V0	$A1 \times (6.RPM)^2$
2	L2	L2-L1	V2-V1	$A2 \times (6.RPM)^2$
3	L3	L3-L2	V3-V2	$A3 \times (6.RPM)^2$
4	L4	L4-L3	V4-V3	$A3 \times (6.RPM)^2$

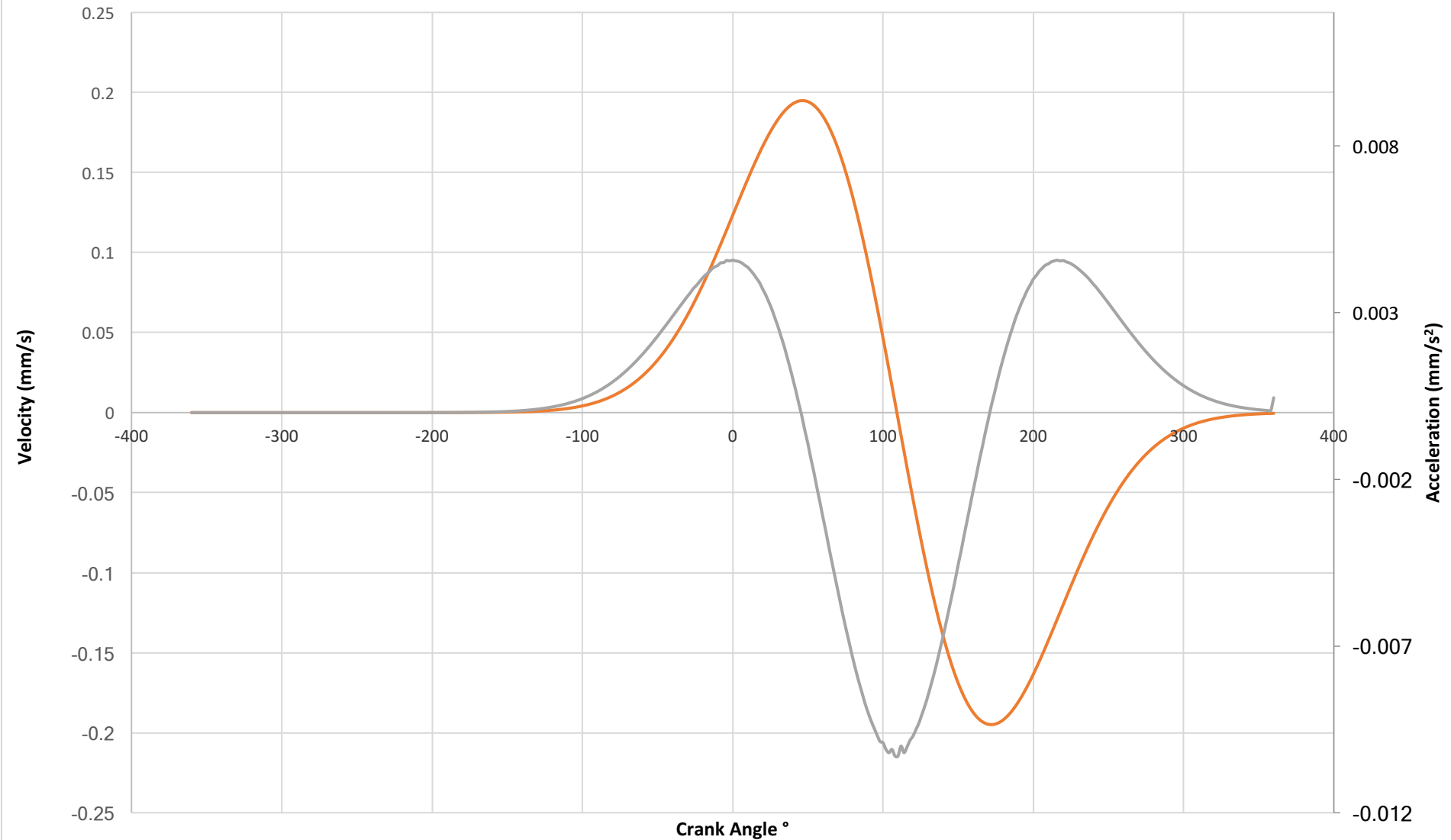
Valve Lift and Velocity Vs. Crank Angle



Valve Lift and Acceleration Vs. Crank Angle



Valve Velocity and Acceleration Vs. Crank Angle



Contact Force

- From before –

$$F_c = \text{Moving Mass} \times \text{Vertical Valve Acceleration}$$

- With opposing spring force –

$$F_c - \text{Spring Force} = \text{Moving Mass} \times \text{Vertical Valve Acceleration}$$

- With initial compression and valve lift –

$$F_c = M \times A + k(Y_0 + Y)$$

A Chart To Show Contact Force Against Crank Angle

