INTERNAL COMBUSTION ENGINES II

FINAL PROJECT I

LOTUS PROGRAMME

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What is Lotus Engine Simulation?

Lotus engine simulation is a simulation program capable of predicting the complete performance of an engine system. The program can be used to calculate:

· the full- and part-load performance of the engine under steady-state and transient operating conditions;

· in-cylinder heat transfer data;

· instantaneous gas property variations within the engine manifolds;

· turbocharger and supercharger matching conditions.

The user constructing the simulation model enters the engine and manifold specifications. This includes data for:

· engine bore, stroke and connecting rod dimensions;

·compression ratio;

·valve sizes and valve event timing data;

·intake and exhaust port flow data;

· intake and exhaust manifold dimensions;

· maps defining the performance of turbines and compressors;

· engine operating speed;

·heat release data' characterizing the combustion event;

·air / fuel ratio and inlet air temperature and pressure.

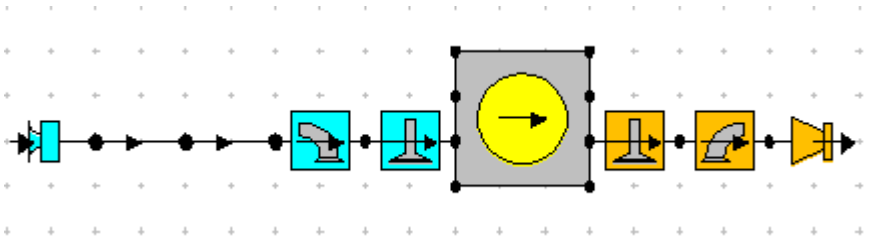
In this experiment, we will obtain to run the engine model with 2, 3, 4 valves with or without turbocharger, silencer air filter and so on.

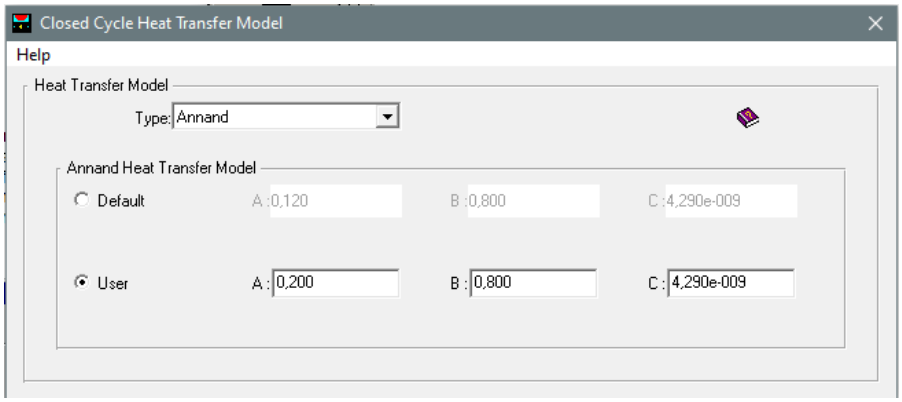
Engine Valves are located in cylinder head and each cylinder contains 2 valves Inlet Valves and Exhaust valves that helps engine in breathing.

More number of valves per cylinder is beneficial because it helps engine to get more power and also increases fuel economy.

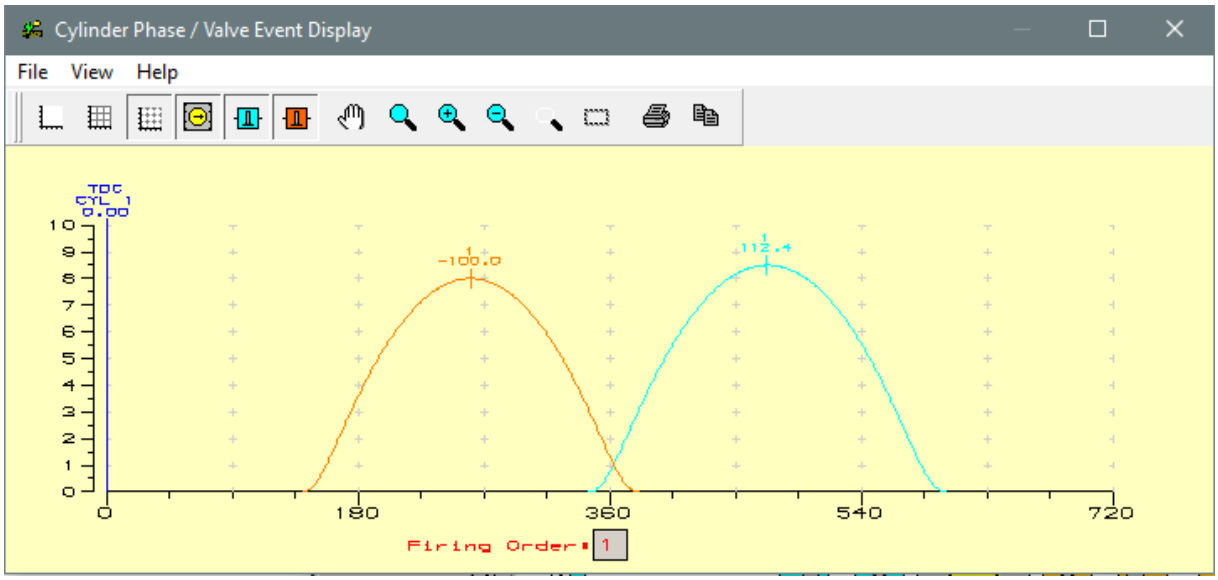
The latest engine V8 is having 8 cylinder and each cylinder contains a set of Inlet and Exhaust vales, so in total 16 valves in single engine. Trait Auto Parts is manufacturer, supplier and exporter of inlet and exhaust engine valves for all application ranging from 4 HP to 4000 HP.

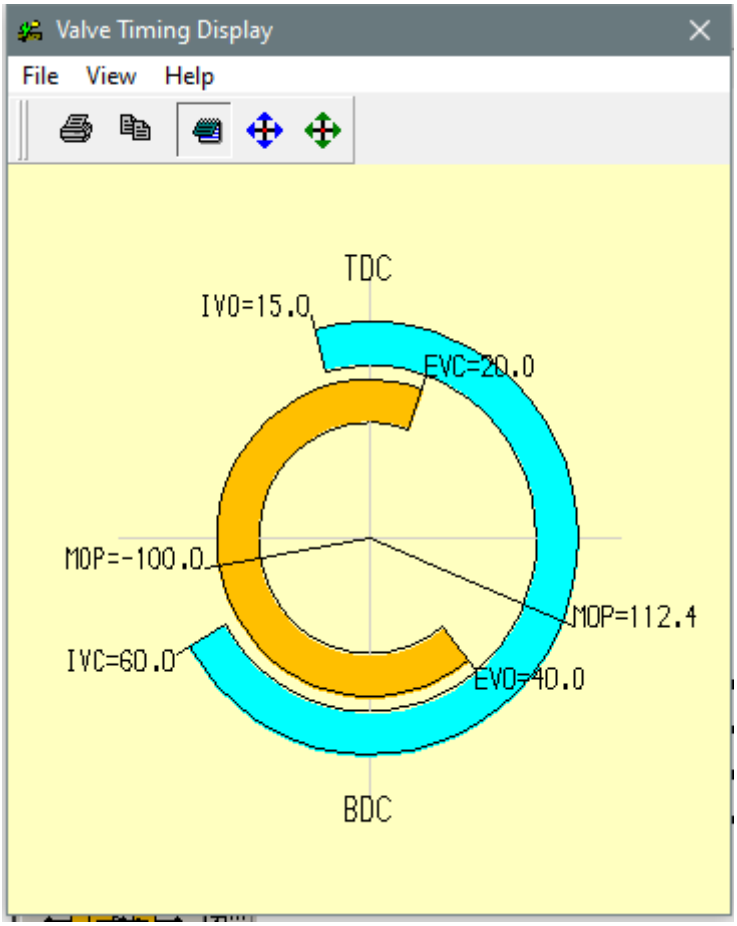
i) first give the specifications of the engine and draw the system model of the engine as in the Lotus program





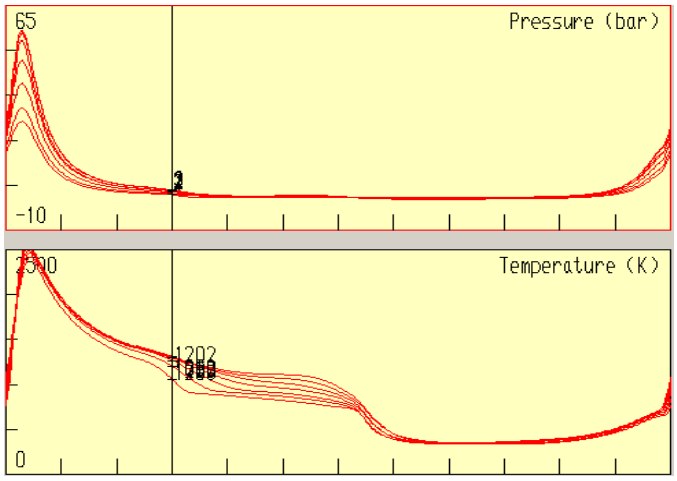
Label	default cylinder
Bore (mm)	87,0000
Stroke (mm)	84,0000
Cyl Swept Volume (l)	0,49935
Total Swept Volume (l)	0,49935
Con-rod Length (mm)	130,00
Pin Off-Set (mm)	0,00
Compression Ratio	11,00
Clearance Volume (l)	0,058747
Phase (ATDC)	0,00
Combustion Model	
Open Cycle HT	
Closed Cycle HT	
Surface Areas	
Surface Temperatures	
Scavenge-Cylinder	

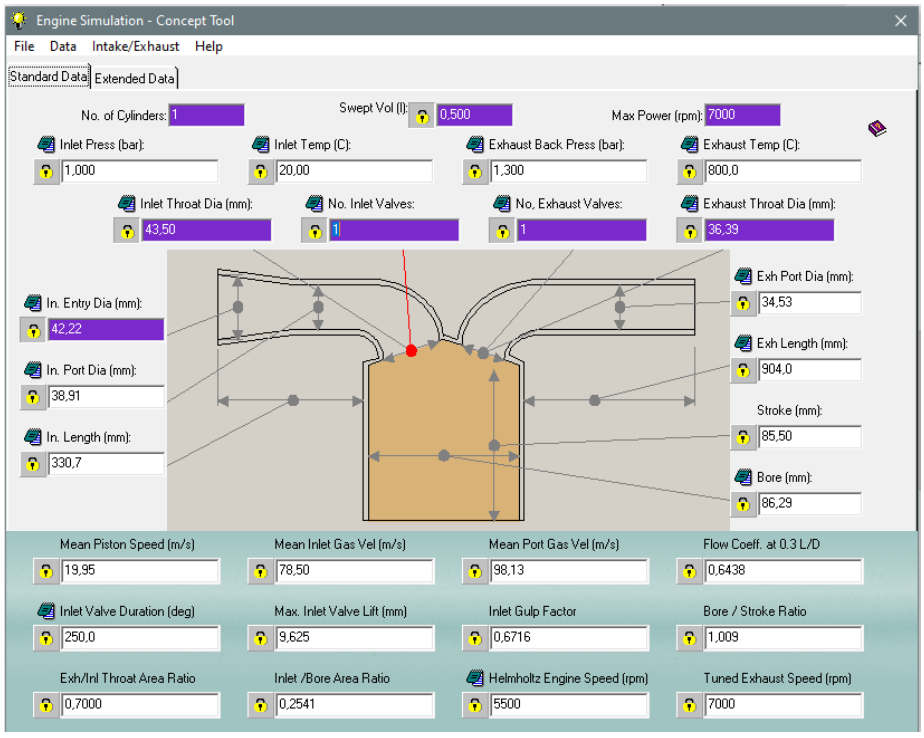

Cylinder Phase / Valve Event Display
File View Help
TDC
CYL 1
0.00
-100.0
112.4
0 180 360 540 720
Firing Order: 1

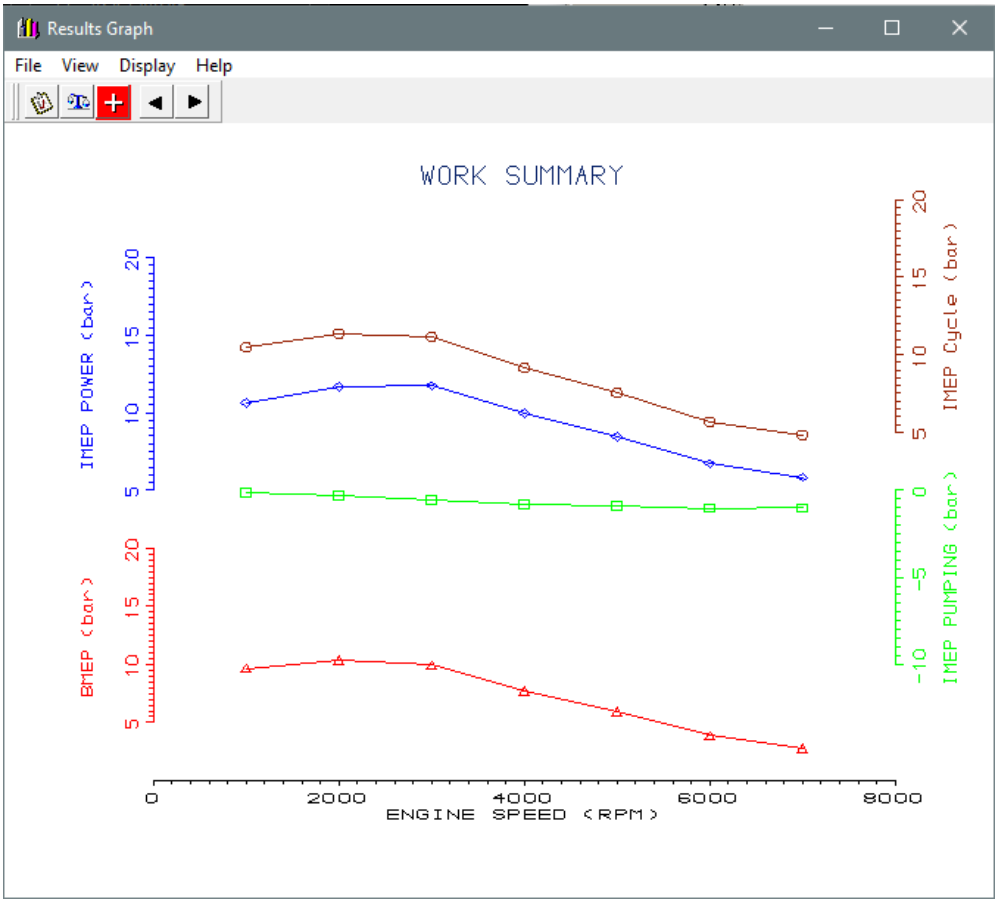

Valve Timing Display
File View Help
TDC
IVO=15.0
EVC=20.0
MOP=-100.0
MOP=112.4
IVC=60.0
EVO=40.0
BDC

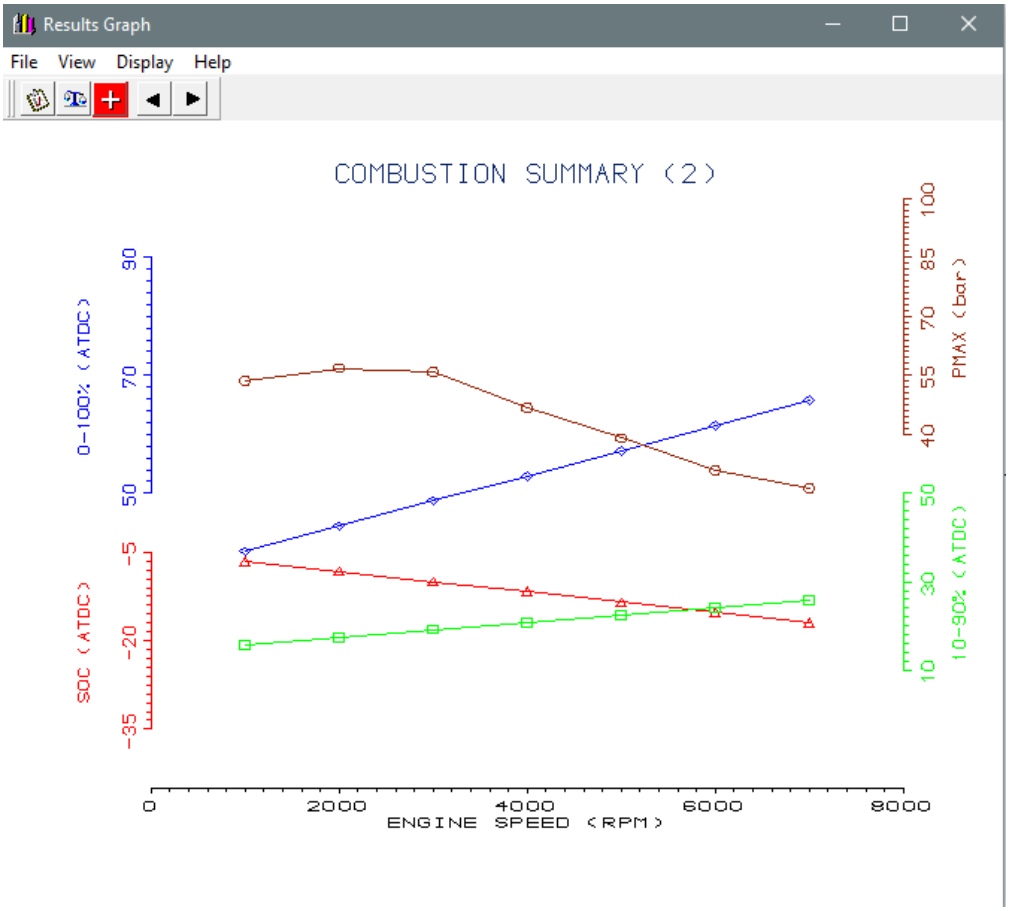
VALVE 1

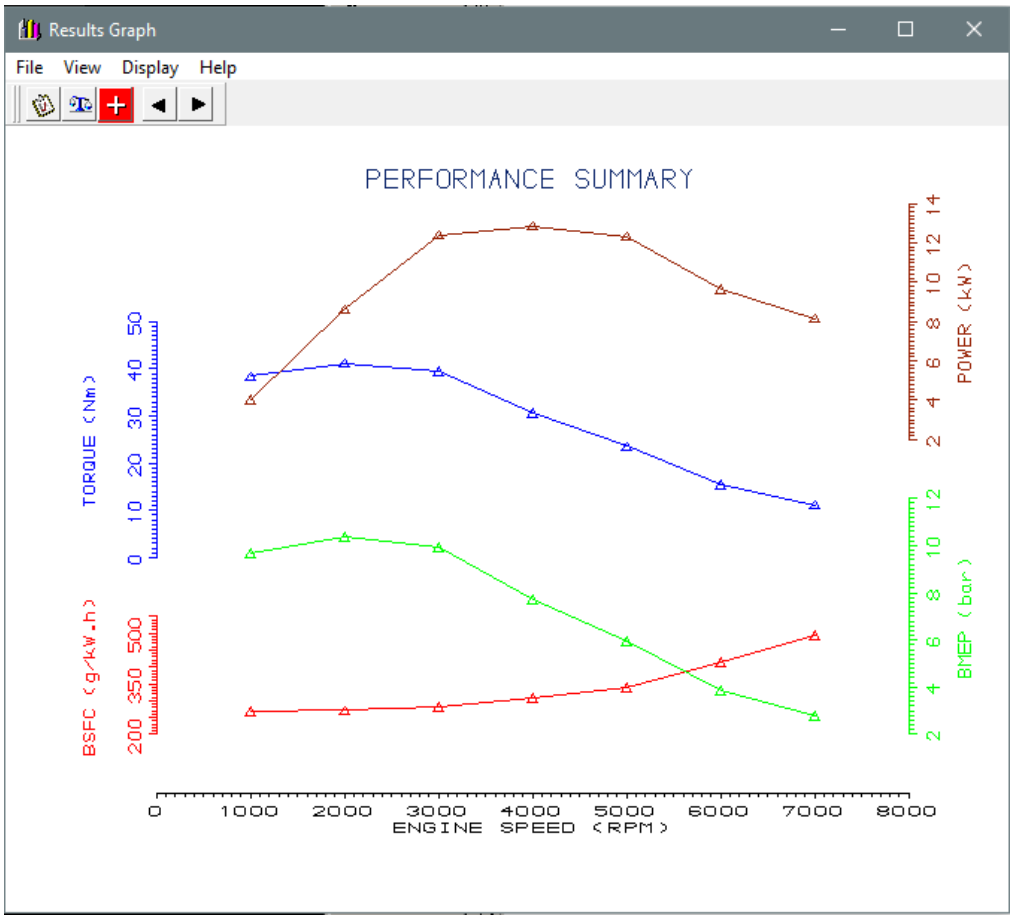
P-theta, T-theta, p-V diagrams and performance curves

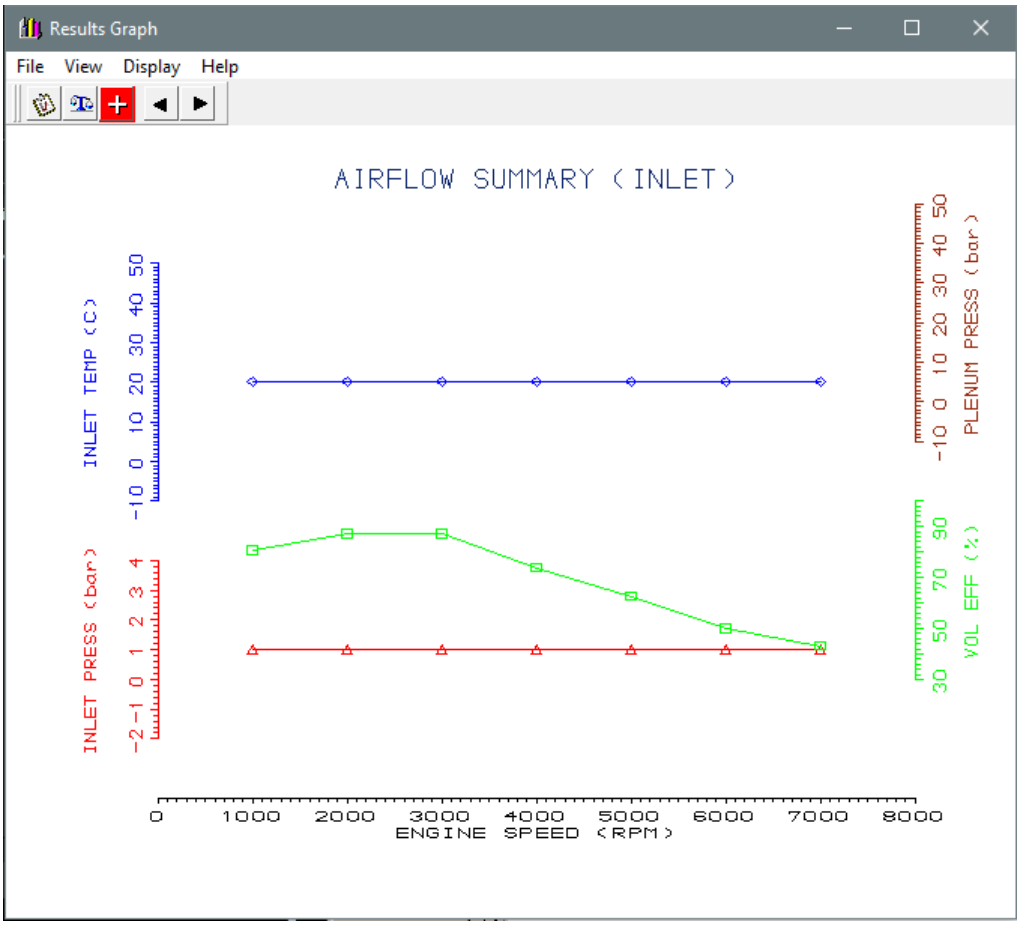





Results Graph
File View Display Help
WORK SUMMARY
IMEP POWER (bar)
BMEP (bar)
IMEP Cycle (bar)
IMEP PUMPING (bar)
0
2000
4000
6000
8000
ENGINE SPEED (RPM)

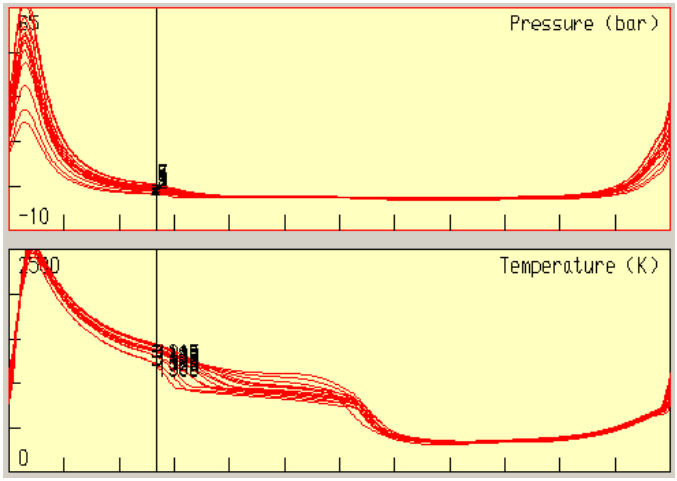

Results Graph
File View Display Help
COMBUSTION SUMMARY (2)
0-100% (ATDC)
SOC (ATDC)
PMAX (bar)
10-90% (ATDC)
0
2000
4000
6000
8000
ENGINE SPEED (RPM)

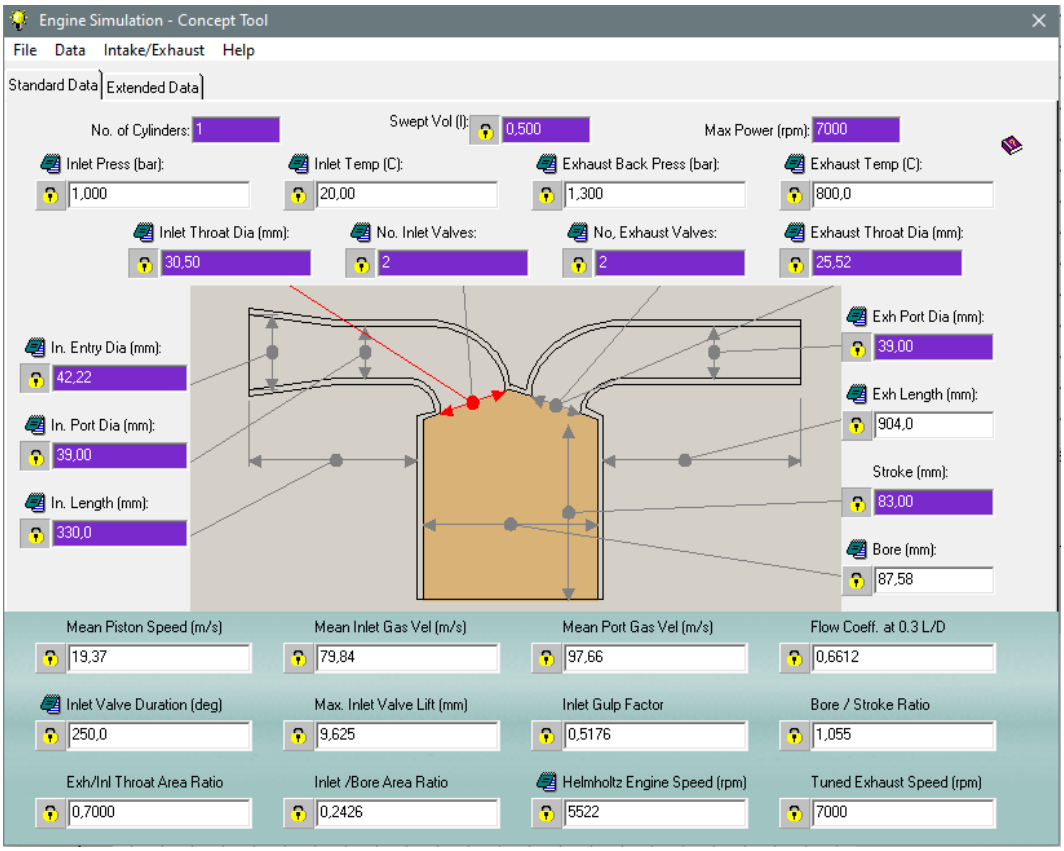

Results Graph
File View Display Help
PERFORMANCE SUMMARY
TORQUE (Nm)
0 10 20 30 40 50
BSFC (g/kW.h)
200 350 500
POWER (kW)
2 4 6 8 10 12 14
BMEP (bar)
2 4 6 8 10 12
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

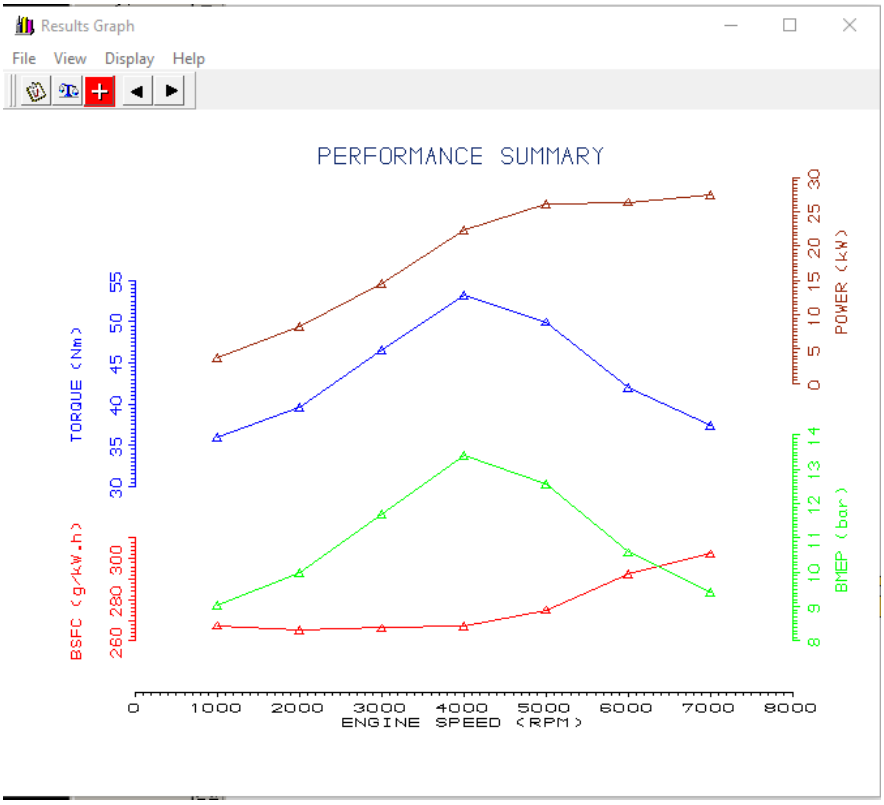

Results Graph
File View Display Help
AIRFLOW SUMMARY (INLET)
INLET TEMP (C)
-10 0 10 20 30 40 50
INLET PRESS (bar)
-2 -1 0 1 2 3 4
PLENUM PRESS (bar)
-10 0 10 20 30 40 50
VOL EFF (%)
30 50 70 90
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

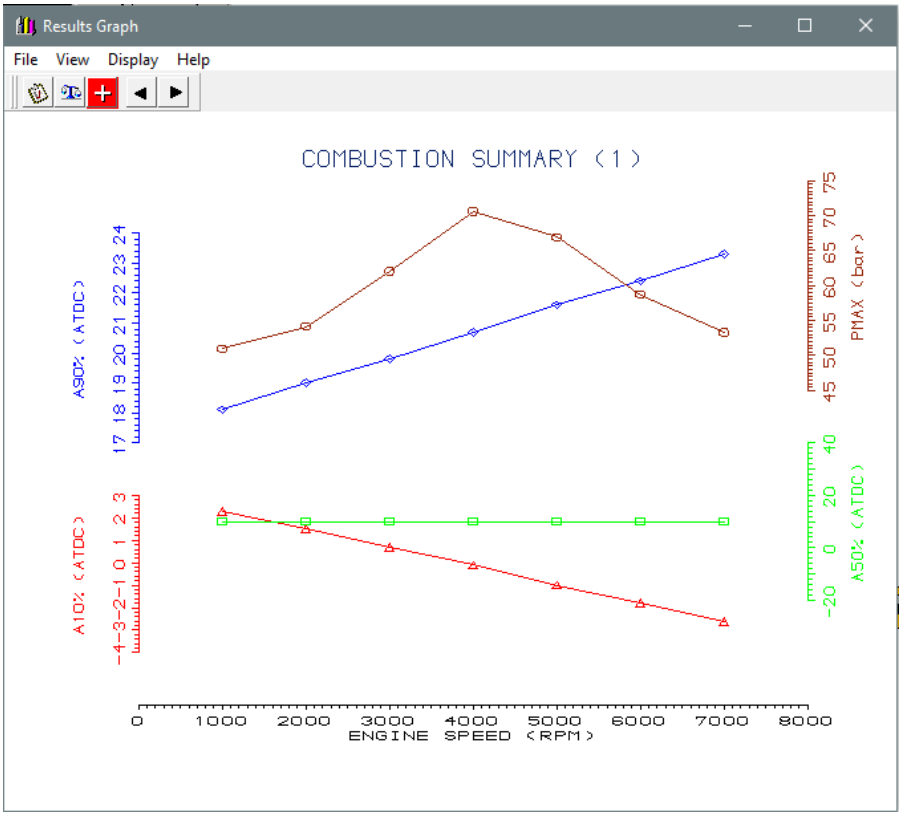
VALVE 2

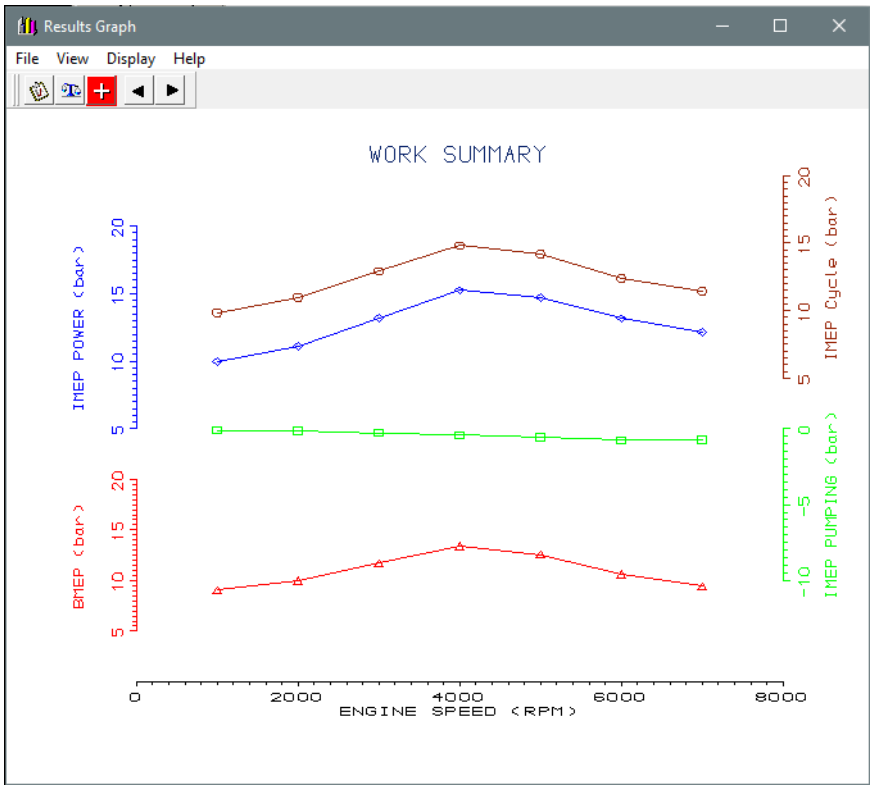
P-theta, T-theta, p-V diagrams and performance curves

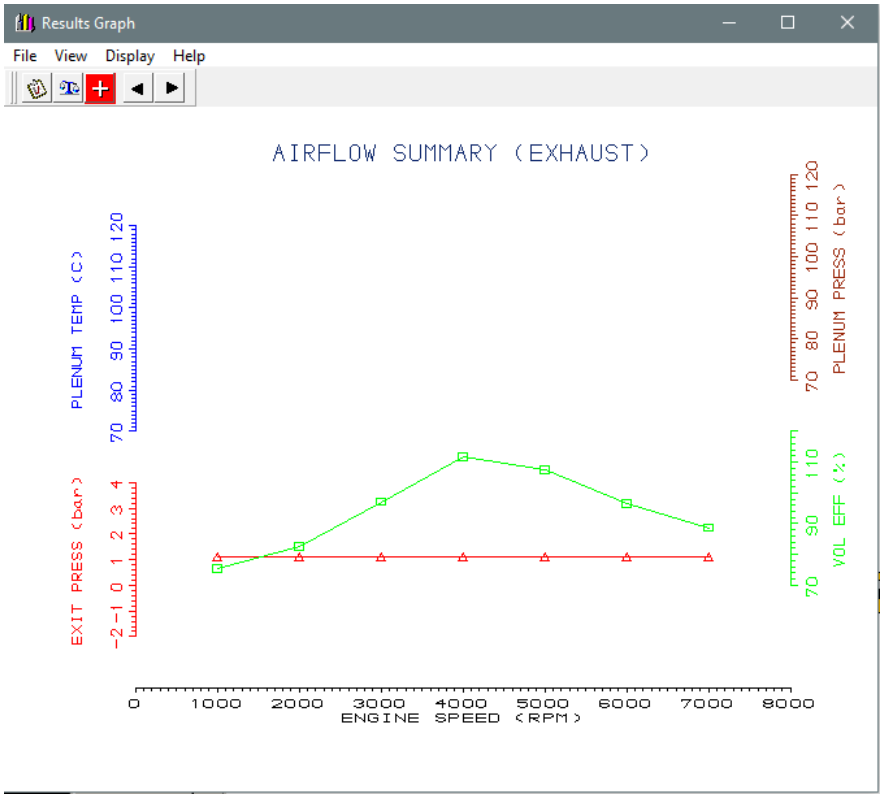





Results Graph
File View Display Help
PERFORMANCE SUMMARY
TORQUE (Nm)
30 35 40 45 50 55
BSFC (g/kW.h)
260 280 300
POWER (kW)
0 5 10 15 20 25 30
BMEP (bar)
8 9 10 11 12 13 14
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)


Results Graph
File View Display Help
COMBUSTION SUMMARY (1)
A90% (ATDC)
17 18 19 20 21 22 23 24
A10% (ATDC)
-4 -3 -2 -1 0 1 2 3
PMAX (bar)
45 50 55 60 65 70 75
A50% (ATDC)
-20 0 20 40
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

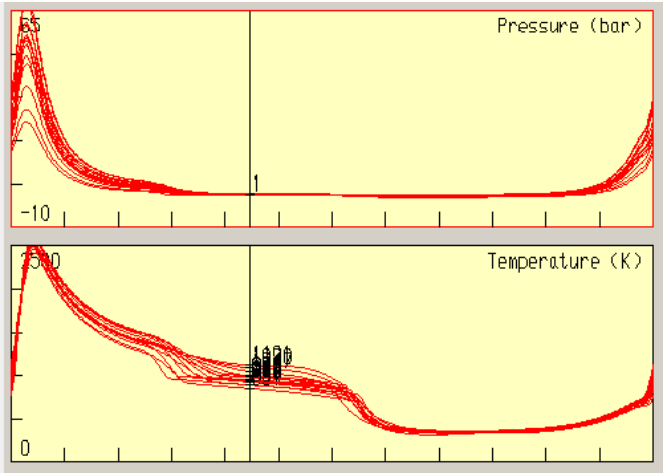

Results Graph
File View Display Help
WORK SUMMARY
IMEP POWER (bar)
BMEP (bar)
IMEP Cycle (bar)
IMEP PUMPING (bar)
ENGINE SPEED (RPM)

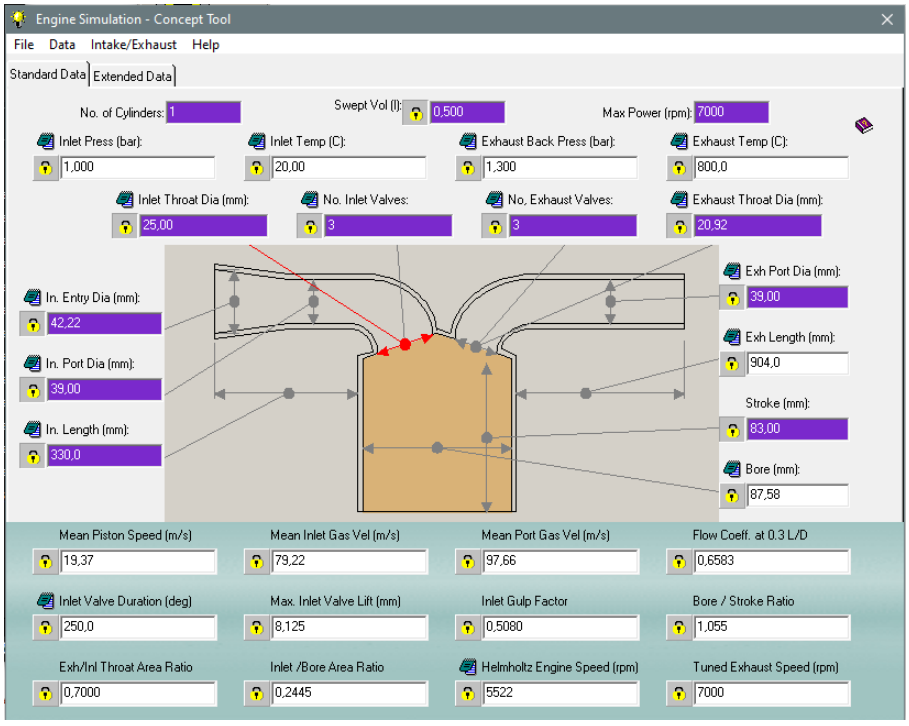

Results Graph
File View Display Help
AIRFLOW SUMMARY (EXHAUST)
PLENUM TEMP (C)
EXIT PRESS (bar)
PLENUM PRESS (bar)
VOL EFF (%)
ENGINE SPEED (RPM)

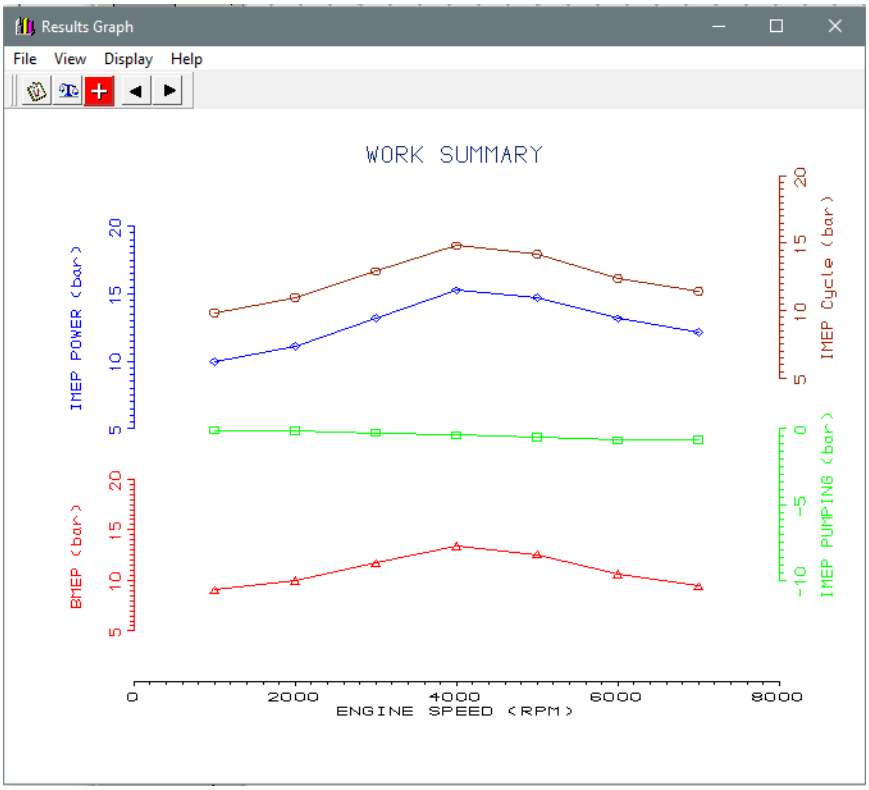
VALVE 3

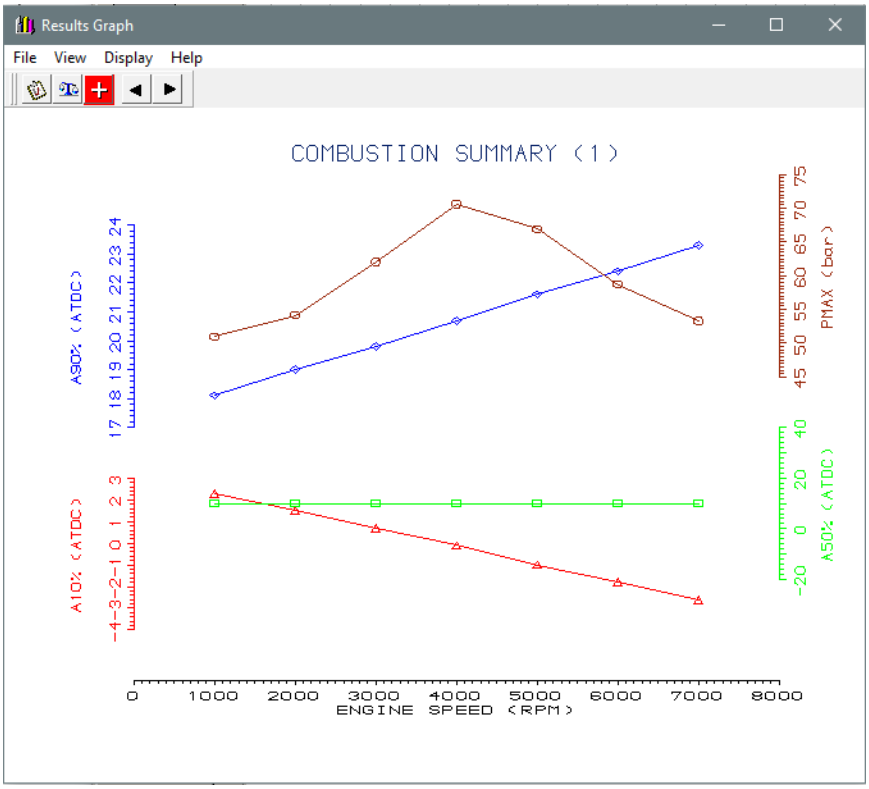
P-theta, T-theta, p-V diagrams and performance curves

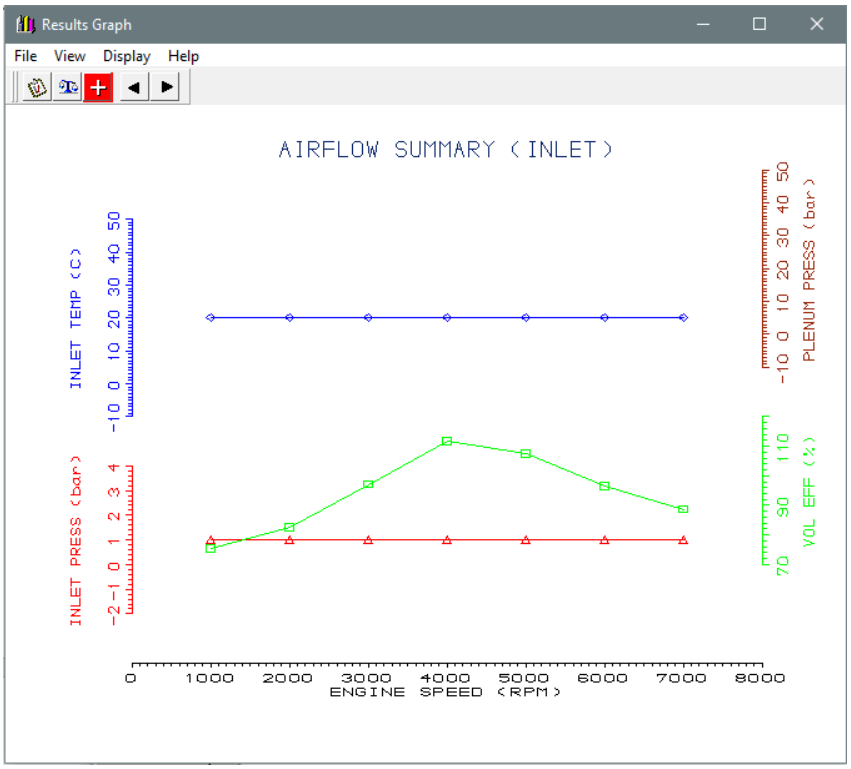
This has a single large exhaust valve and two smaller intake valves. A three-valve layout allows better breathing than a two-valve head, but the large exhaust valve results in an RPM limit no higher than a two-valve head. The manufacturing cost for this design can be lower than for a four-valve design. The three-valve design was common in the late 1980s and early 1990s; and from 2004 the main valve arrangement used in Ford F-Series trucks, and Ford SUVs. The Ducati ST3 V-twin had 3-valve heads.

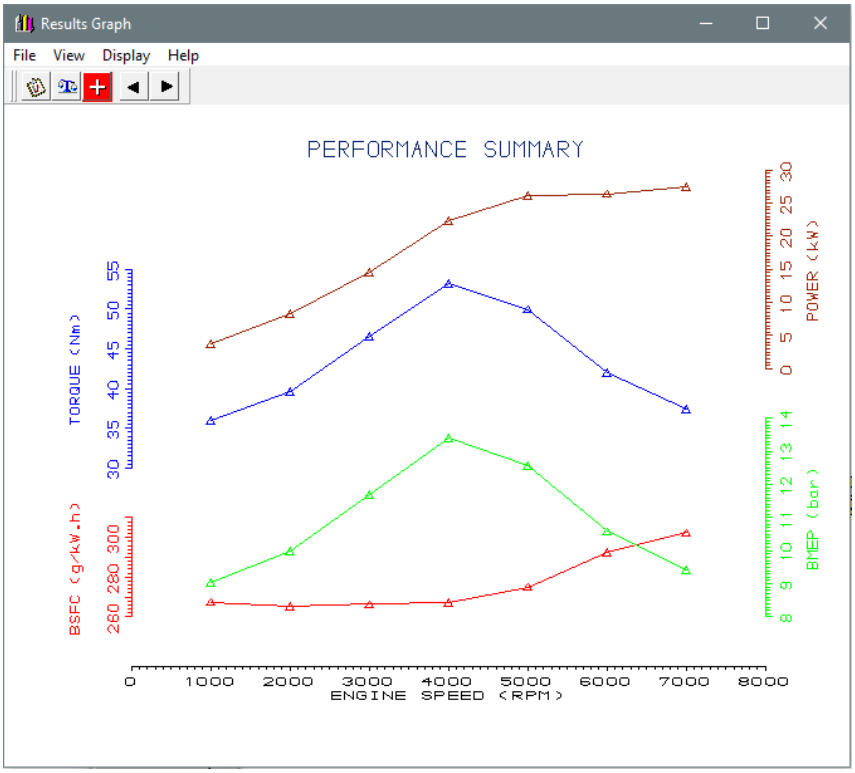





Results Graph
File View Display Help
WORK SUMMARY
IMEP POWER (bar)
BMEP (bar)
IMEP Cycle (bar)
IMEP PUMPING (bar)
ENGINE SPEED (RPM)


Results Graph
File View Display Help
COMBUSTION SUMMARY (1)
A90% (ATDC)
A10% (ATDC)
PMAX (bar)
A50% (ATDC)
ENGINE SPEED (RPM)

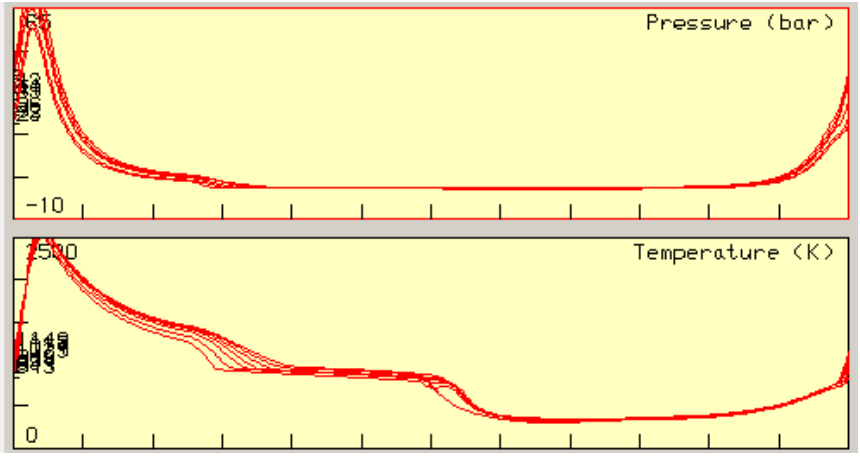

Results Graph
File View Display Help
AIRFLOW SUMMARY (INLET)
INLET TEMP (C)
-10 0 10 20 30 40 50
PLENUM PRESS (bar)
-10 0 10 20 30 40 50
INLET PRESS (bar)
-2 -1 0 1 2 3 4
VOL EFF (%)
70 90 110
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

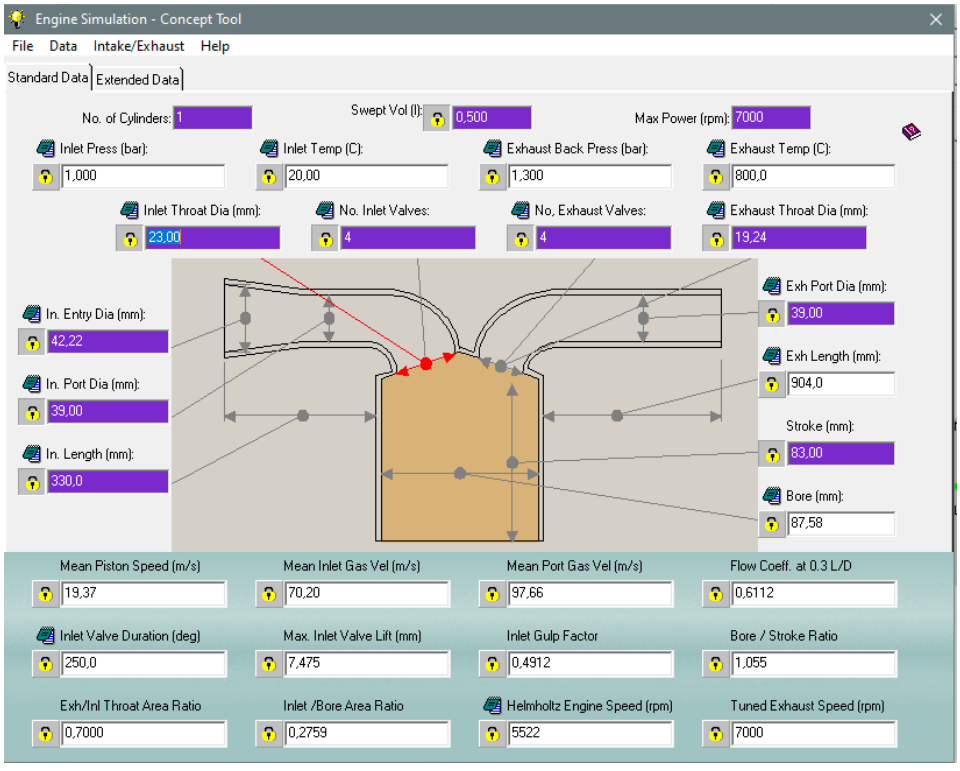

Results Graph
File View Display Help
PERFORMANCE SUMMARY
TORQUE (Nm)
30 35 40 45 50 55
POWER (kW)
0 5 10 15 20 25 30
BSFC (g/kW.h)
260 280 300
BMEP (bar)
8 9 10 11 12 13 14
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

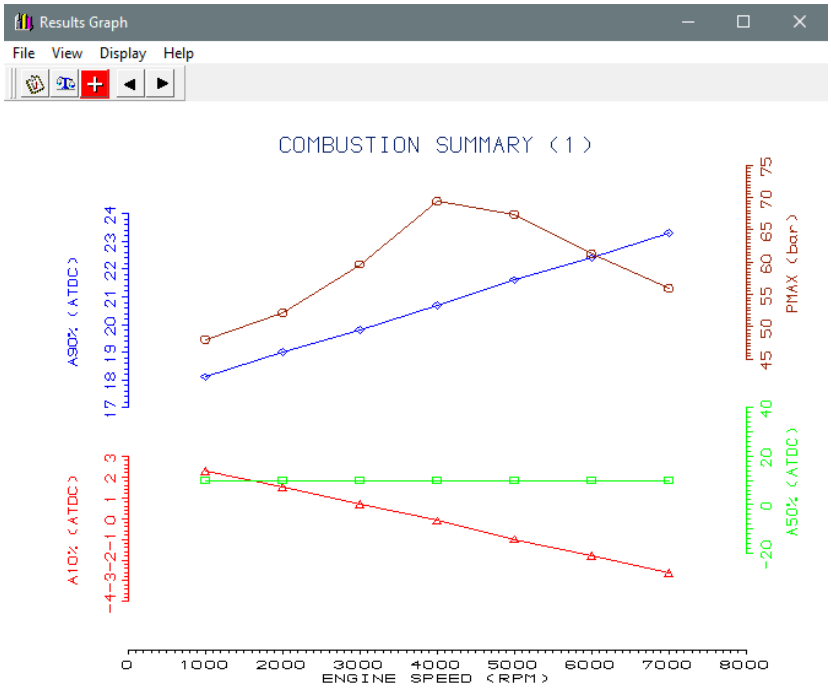
VALVE4

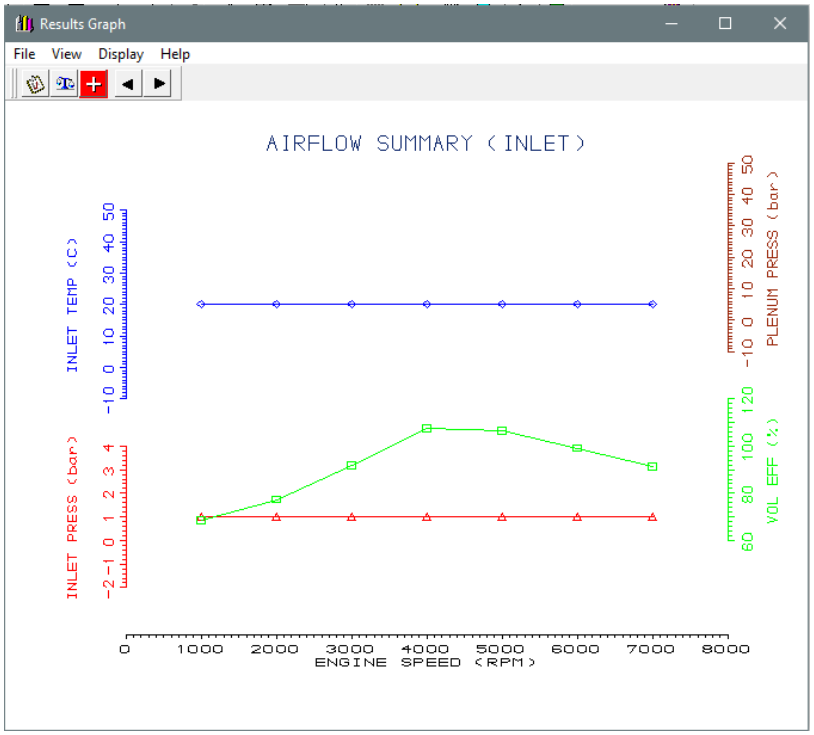
P-theta, T-theta, p-V diagrams and performance curves

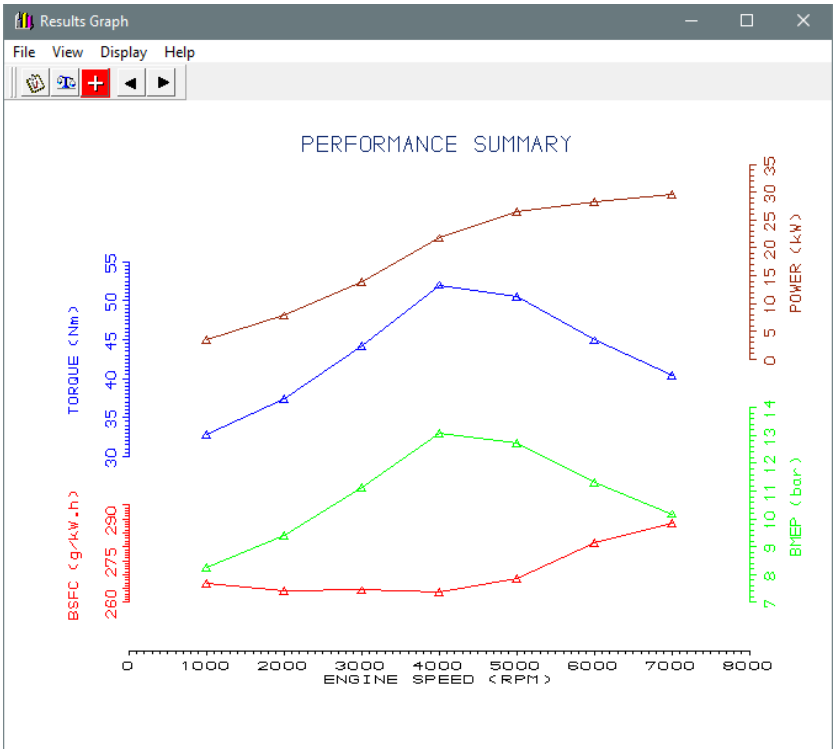
This is the most common type of multi-valve head, with two exhaust valves and two similar (or slightly larger) inlet valves. This design allows similar breathing as compared to a three-valve head, and as the small exhaust valves allow high RPM, this design is very suitable for high power outputs.

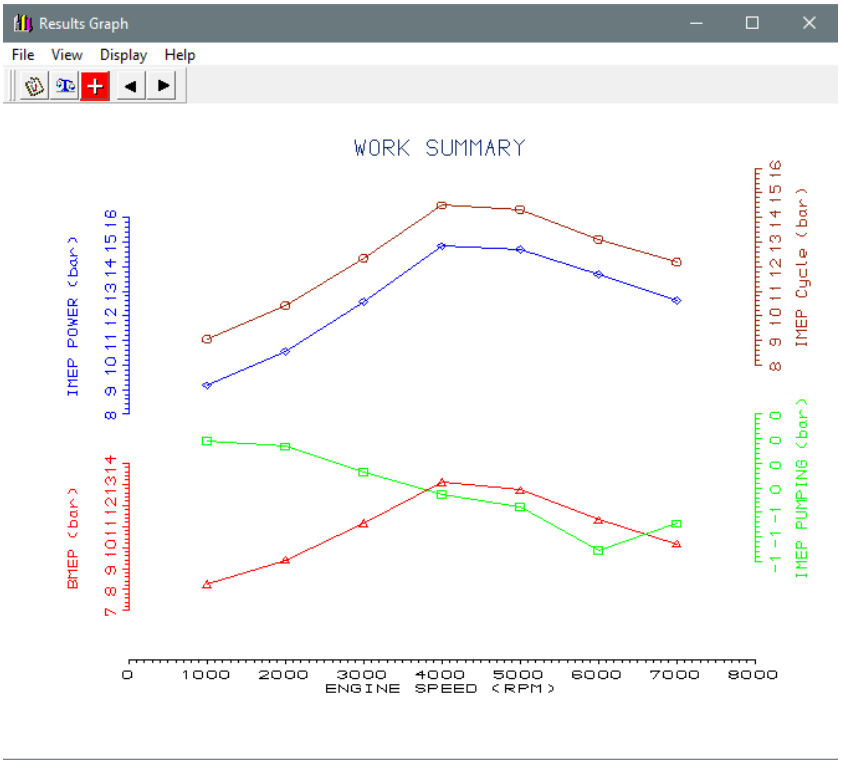





Results Graph
File View Display Help
COMBUSTION SUMMARY (1)
A90% (ATDC)
17 18 19 20 21 22 23 24
A10% (ATDC)
-4 -3 -2 -1 0 1 2 3
PMAX (bar)
45 50 55 60 65 70 75
A50% (ATDC)
-20 0 20 40
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

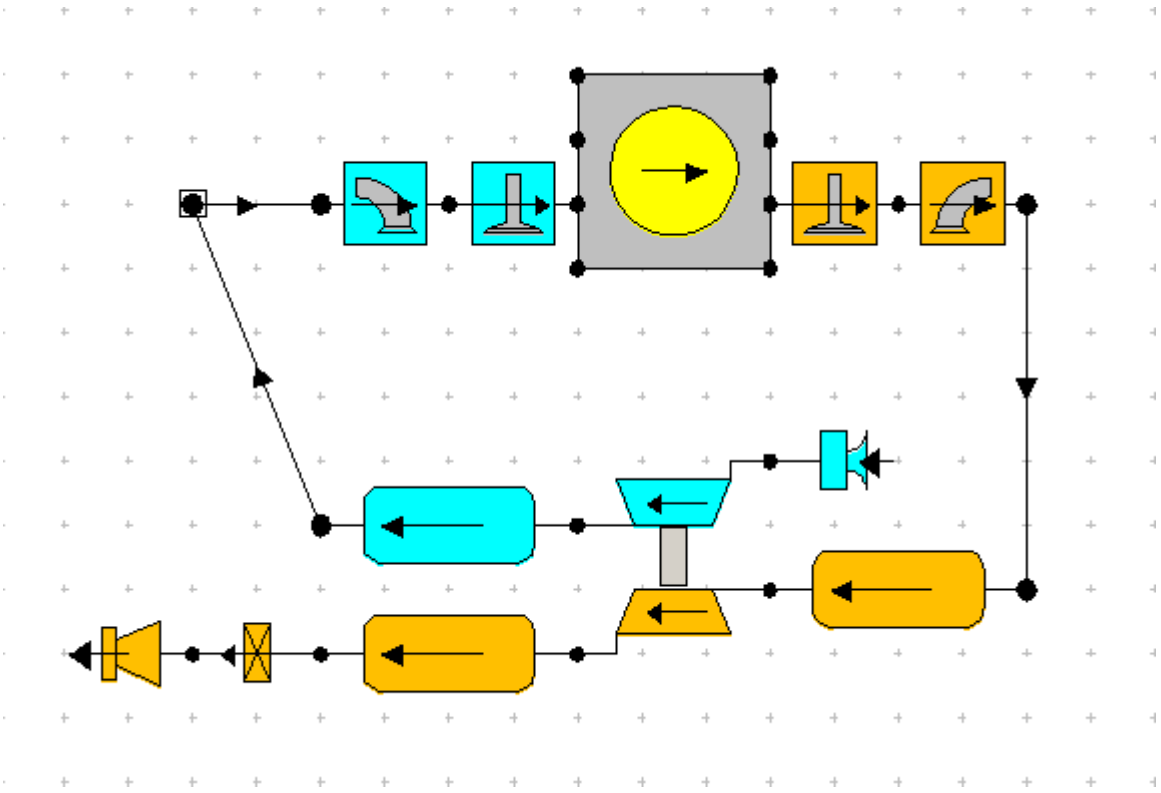

Results Graph
File View Display Help
AIRFLOW SUMMARY (INLET)
INLET TEMP (C)
-10 0 10 20 30 40 50
INLET PRESS (bar)
-2 -1 0 1 2 3 4
PLENUM PRESS (bar)
-10 0 10 20 30 40 50
VOL EFF (%)
60 80 100 120
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

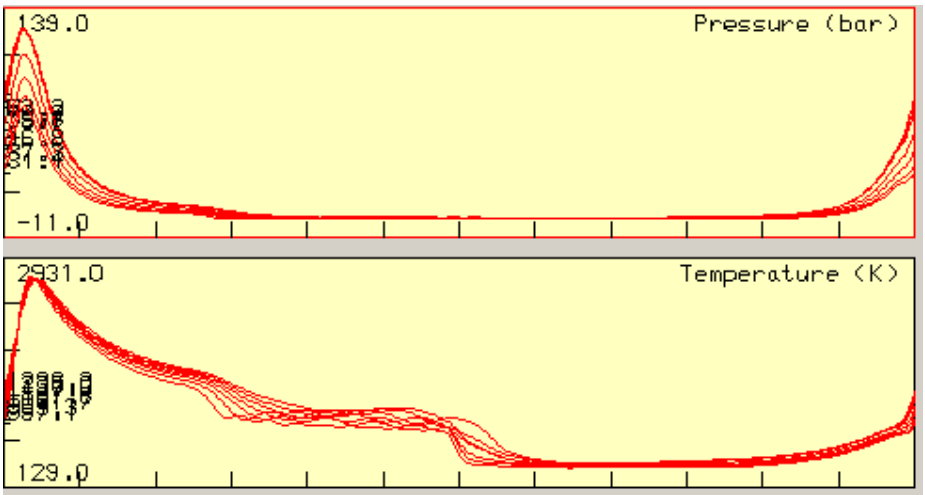

Results Graph
File View Display Help
PERFORMANCE SUMMARY
TORQUE (Nm)
30 35 40 45 50 55
BSFC (g/kW.h)
260 275 290
POWER (kW)
0 5 10 15 20 25 30 35
BMEP (bar)
7 8 9 10 11 12 13 14
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

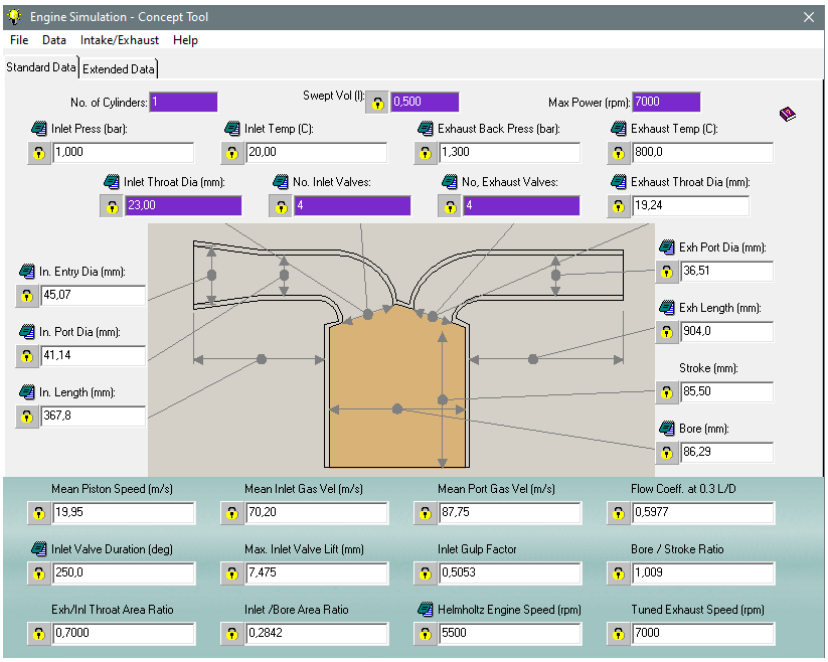

Results Graph
File View Display Help
WORK SUMMARY
IMEP POWER (bar)
8 9 10 11 12 13 14 15 16
BMEP (bar)
7 8 9 10 11 12 13 14
IMEP Cycle (bar)
8 9 10 11 12 13 14 15 16
IMEP PUMPING (bar)
-1 -1 -1 0 0 0 0
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

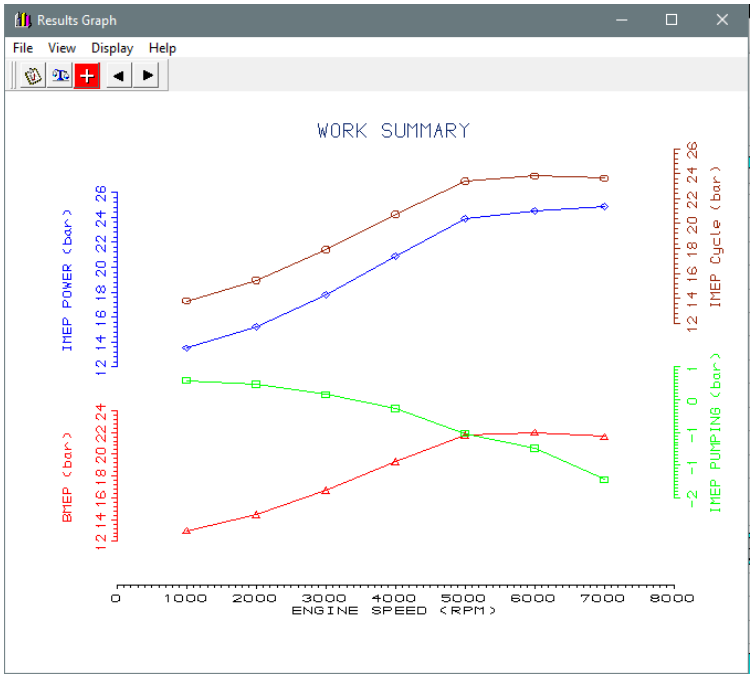
VALVE4+

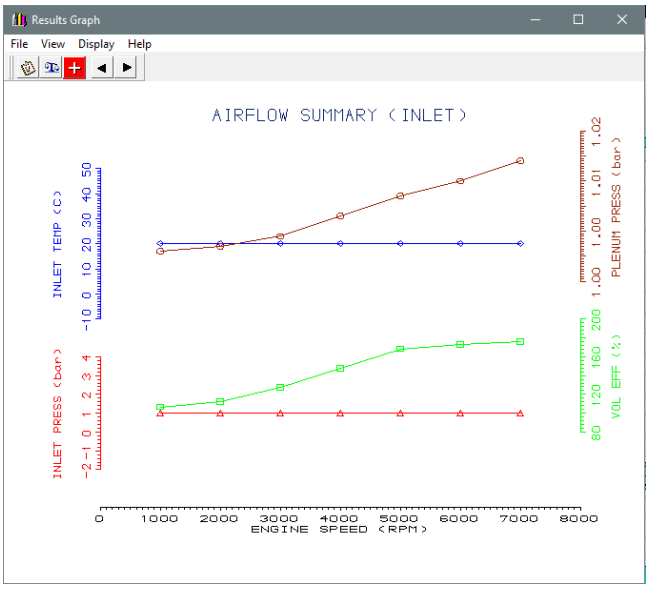
P-theta, T-theta, p-V diagrams and performance curves

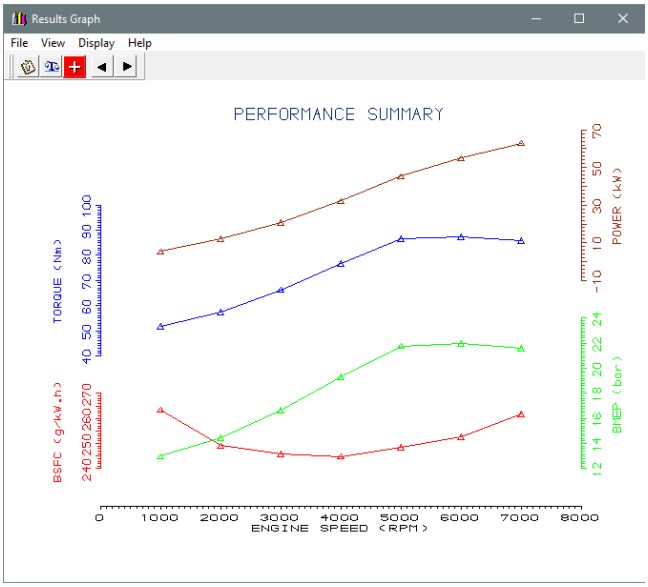


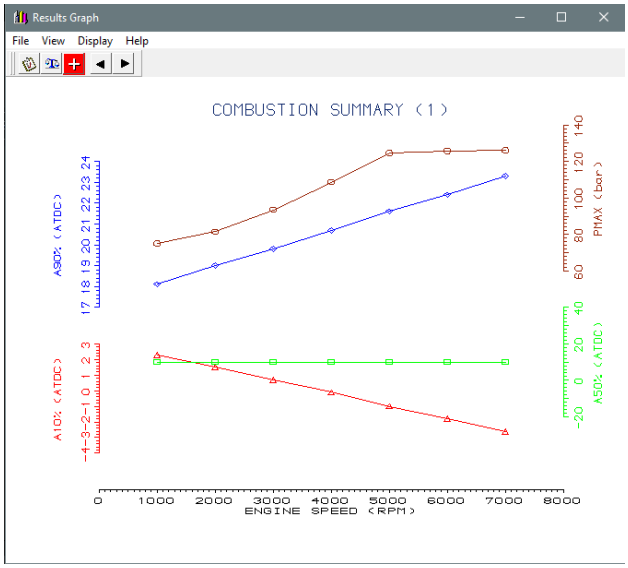



Engine Simulation - Concept Tool
File Data Intake/Exhaust Help
Standard Data Extended Data
No. of Cylinders: 1
Swept Vol (l): 0,500
Max Power (rpm): 7000
Inlet Press (bar): 1,000
Inlet Temp (C): 20,00
Exhaust Back Press (bar): 1,300
Exhaust Temp (C): 800,0
Inlet Throat Dia (mm): 23,00
No. Inlet Valves: 4
No. Exhaust Valves: 4
Exhaust Throat Dia (mm): 19,24
In. Entry Dia (mm): 45,07
In. Port Dia (mm): 41,14
In. Length (mm): 367,8
Exh Port Dia (mm): 36,51
Exh Length (mm): 904,0
Stroke (mm): 85,50
Bore (mm): 86,29
Mean Piston Speed (m/s): 19,95
Mean Inlet Gas Vel (m/s): 70,20
Mean Port Gas Vel (m/s): 87,75
Flow Coeff. at 0.3 L/D: 0,5977
Inlet Valve Duration (deg): 250,0
Max. Inlet Valve Lift (mm): 7,475
Inlet Gulp Factor: 0,5053
Bore / Stroke Ratio: 1,009
Exh/Inl Throat Area Ratio: 0,7000
Inlet /Bore Area Ratio: 0,2842
Helmholtz Engine Speed (rpm): 5500
Tuned Exhaust Speed (rpm): 7000


Results Graph
File View Display Help
WORK SUMMARY
IMEP POWER (bar)
BMEP (bar)
IMEP Cycle (bar)
IMEP PUMPING (bar)
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)


Results Graph
File View Display Help
AIRFLOW SUMMARY (INLET)
INLET TEMP (C)
-10 0 10 20 30 40 50
INLET PRESS (bar)
-2 -1 0 1 2 3 4
PLENUM PRESS (bar)
1.00 1.00 1.01 1.02
VOL EFF (%)
80 120 160 200
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)


Results Graph
File View Display Help
PERFORMANCE SUMMARY
TORQUE (Nm)
40 50 60 70 80 90 100
BSFC (g/kW.h)
240 250 260 270
POWER (kW)
-10 10 30 50 70
BMEP (bar)
12 14 16 18 20 22 24
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

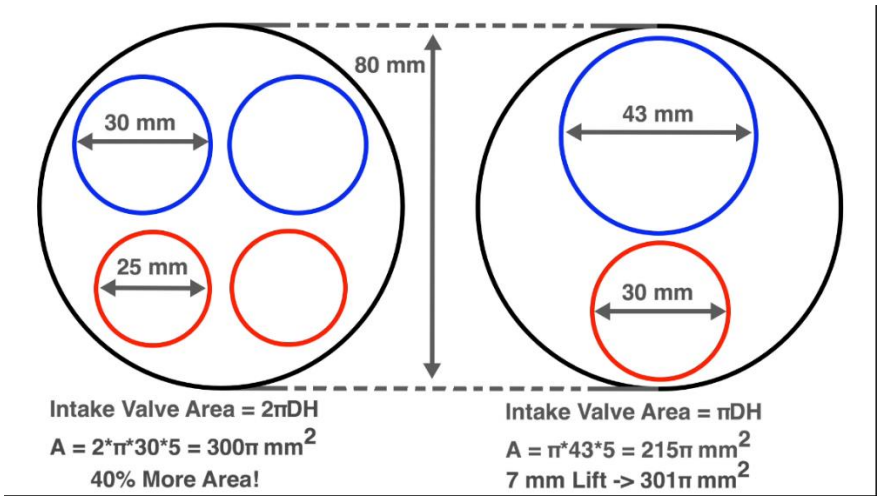

Results Graph
File View Display Help
COMBUSTION SUMMARY (1)
A90% (ATDC)
17 18 19 20 21 22 23 24
A10% (ATDC)
-4 -3 -2 -1 0 1 2 3
PMAX (bar)
60 80 100 120 140
A50% (ATDC)
-20 0 20 40
0 1000 2000 3000 4000 5000 6000 7000 8000
ENGINE SPEED (RPM)

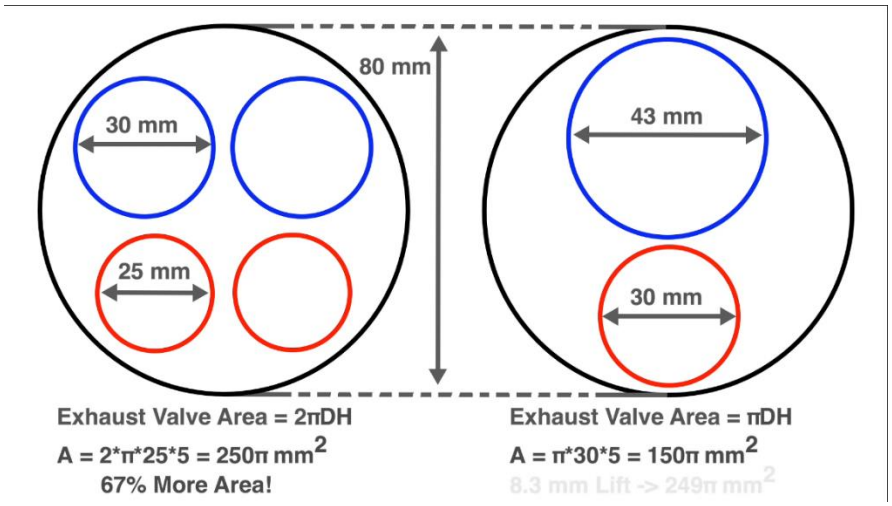
Conclusion

Number of valves in cylinder is a trade-off between engine aspiration and the complexity of the valvetrain.

The absolute minimum is two per cylinder, one intake one exhaust. Theoretical area of 2 valves inside the combustion chamber is 50% (not taking into account HEMI heads etc.).

Adding another intake valve would net you a maximum of 64% of the cylinder bore area and allow for more complex and efficient designs in terms of air fuel mixture. The downside is the valvetrain now contains more parts, making it less reliable and somewhat more expensive to produce.





Also, with a 4-valve setup the valves are smaller and lighter causing less valve float at higher rpm, allowing for higher rpms than a 2-valve setup

Source

https://lotusproactive.files.wordpress.com/2013/08/getting-started-with-lotus-engine-simulation.pdf

https://www.quora.com/Whats-the-difference-in-the-number-of-valves-in-an-engine