Air Exchange in SI Engines

INLET AND EXHAUST VALVE TIMING

ME419

D. ABATA

Review of Introductory Material

- filling efficiency
- volumetric efficiency
- intake temperature
- intake and exhaust pressure
- altitude
- humidity

Efficiency and BMEP

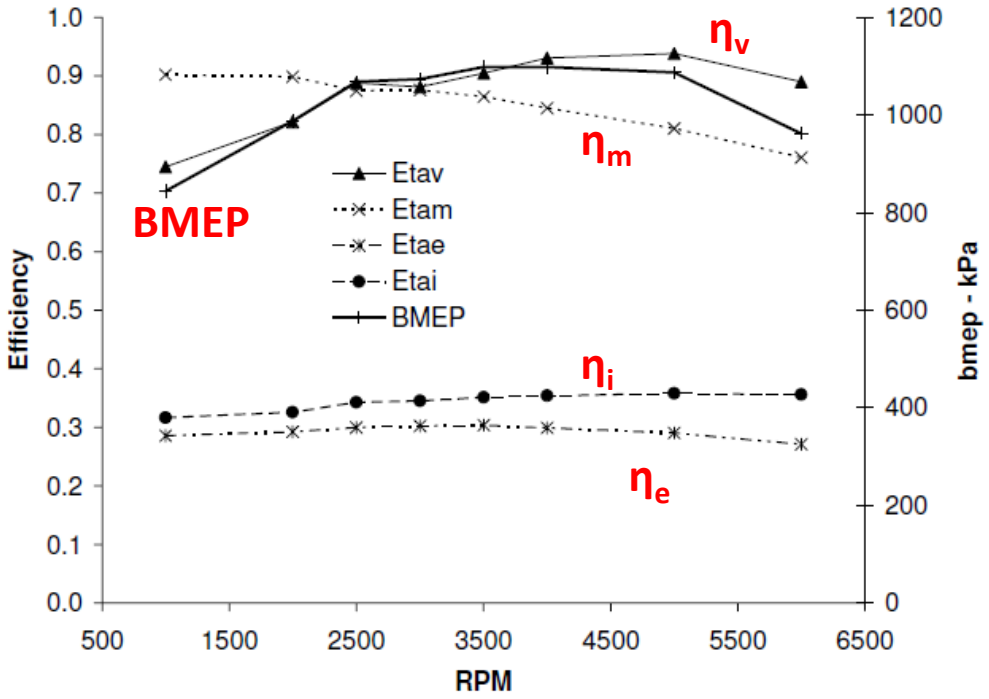


Figure 7.4: Mechanical, indicated, brake and volumetric efficiency and *bmep* as functions of engine speed at full load for a modern 1.8 liter SI engine.

BMEP and BSFC

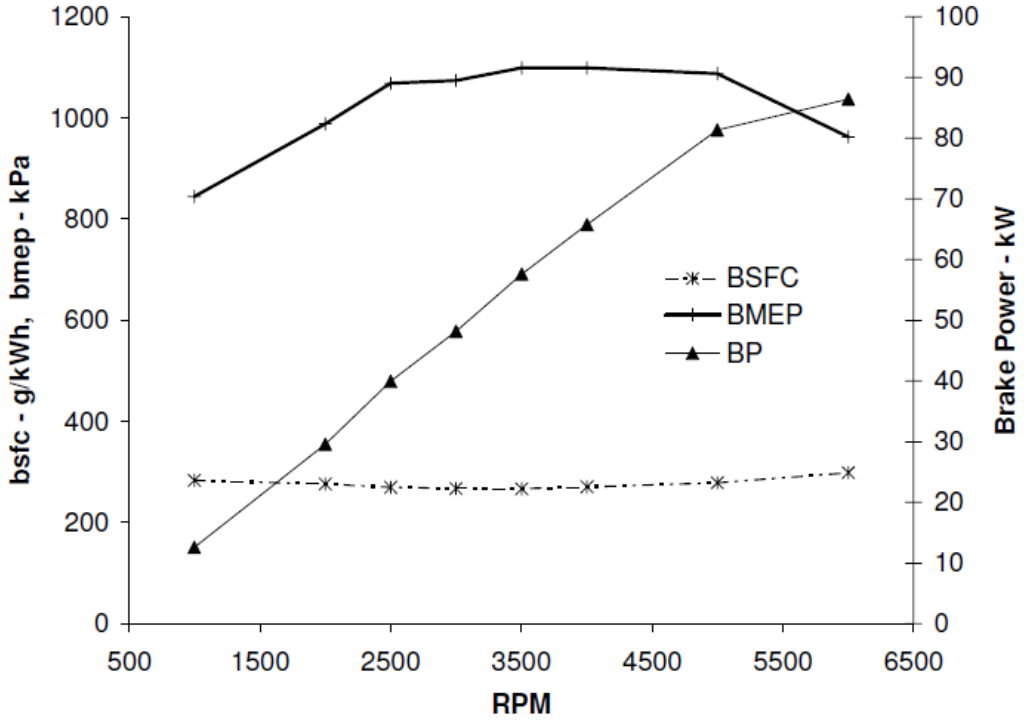


Figure 7.5: Brake power, mean effective pressure and specific fuel consumption as a function of engine speed at full load for a modern 1.8 liter SI engine.

Valve Lift Profiles

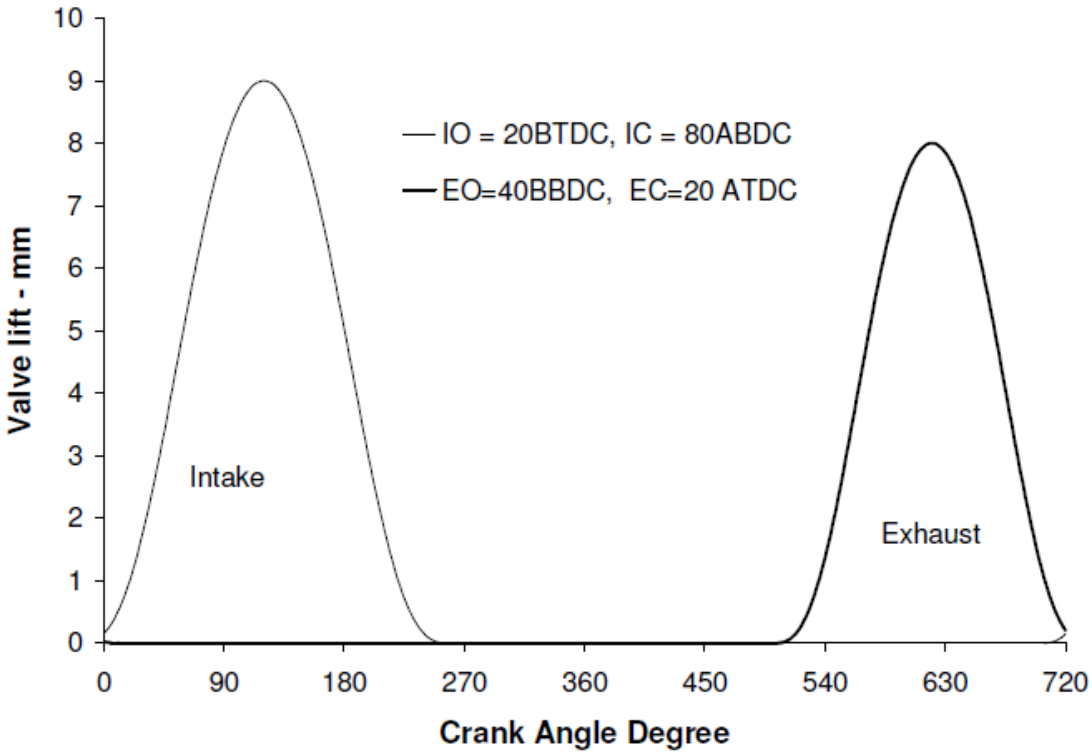


Figure 7.6: An example of valve profiles for a spark ignition engine with a bore of 80 mm.

Volume, Valve Lift, Piston Speed

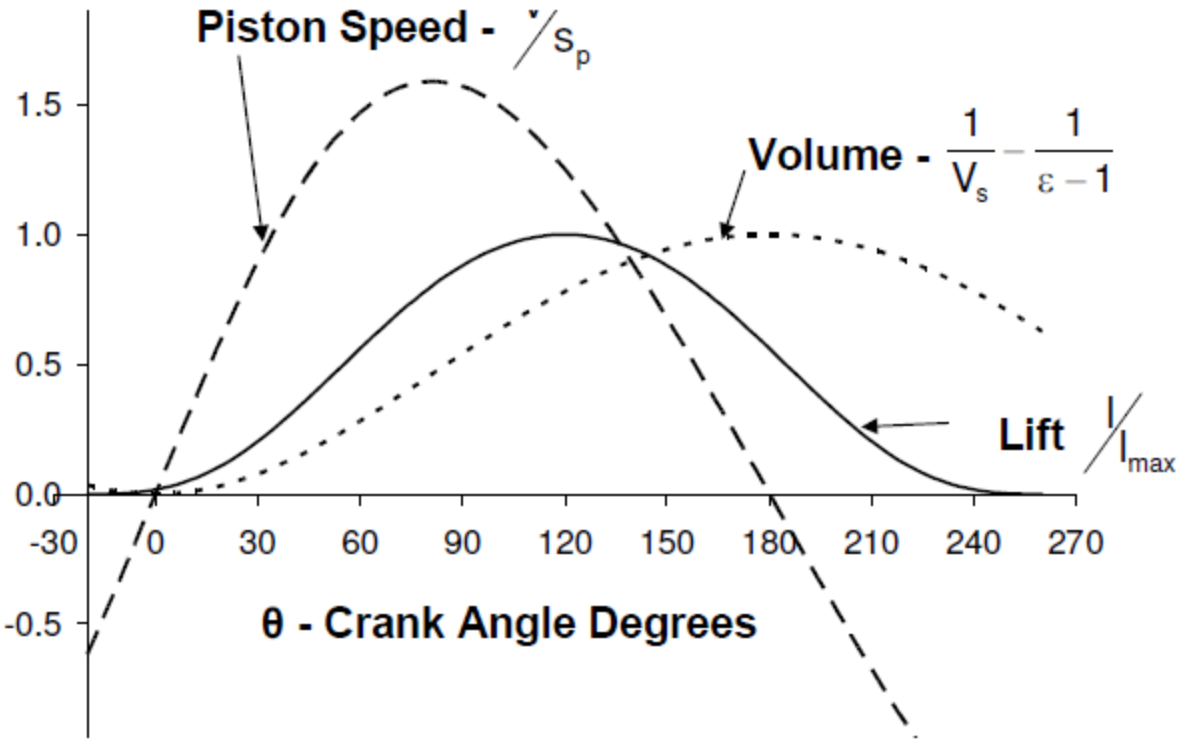


Figure 7.7: Normalized cylinder volume, intake valve lift and instantaneous piston speed as a function of crank angle for the camshaft of Figure 7.6.

Valve Lift and Piston Speed

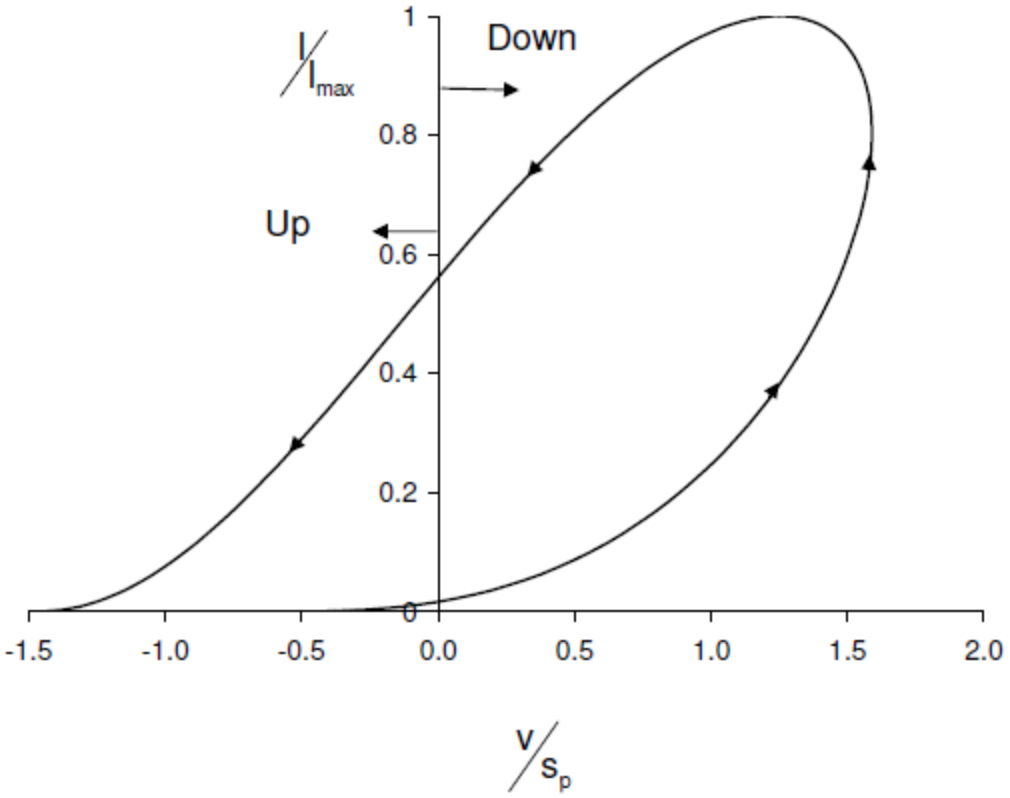


Figure 7.8: Normalized valve lift as a function of normalized instantaneous piston speed for the intake valve of the camshaft of Figure 7.6.

Example Engine Specifications

Table 7.1: Engine parameters for valve timing effects simulation.

Bore - mm	73.96
Stroke - mm	75.48
Cylinders -	1
Displacement - liter	0.324
Connecting Rod Length - mm	150.0
Intake Valve diameter - mm	31.5
Exhaust Valve diameter - mm	31.5
Intake Valve lift - mm	9.0
Exhaust Valve lift - mm	8.0
Compression Ratio	9.3
Intake Manifold Pressure - kPa	101.6
Exhaust Manifold Pressure - kPa	102.1

Effect of Intake Valve Opening

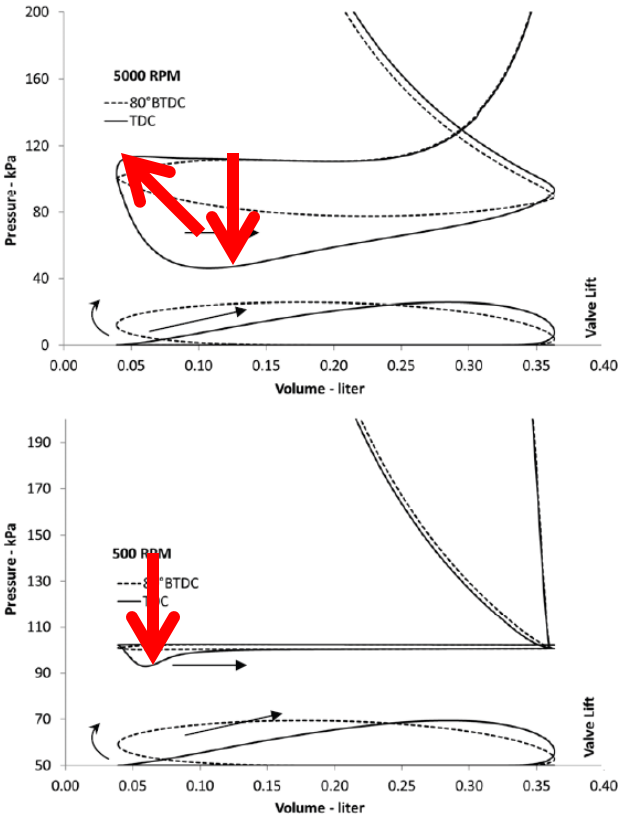


Figure 7.9: The effect of intake valve opening on air exchange processes at 500 and 5000 rpm for intake valve openings of Top Dead Center and 80° BTDC.

Effect of Intake Valve Closing

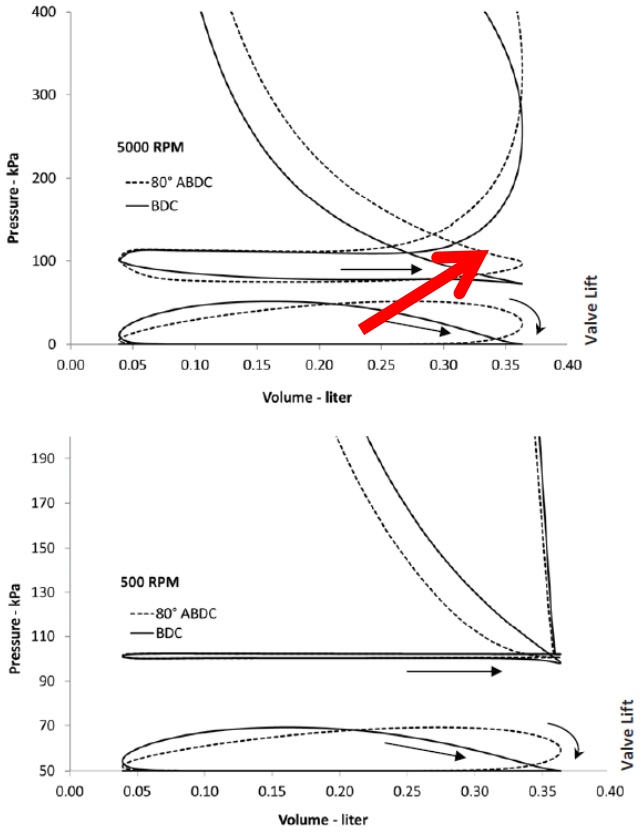


Figure 7.10: The effect of intake valve closing on air exchange processes at 500 and 5000 rpm for intake valve closings of Bottom Dead Center and 80° ABDC.

Tuning

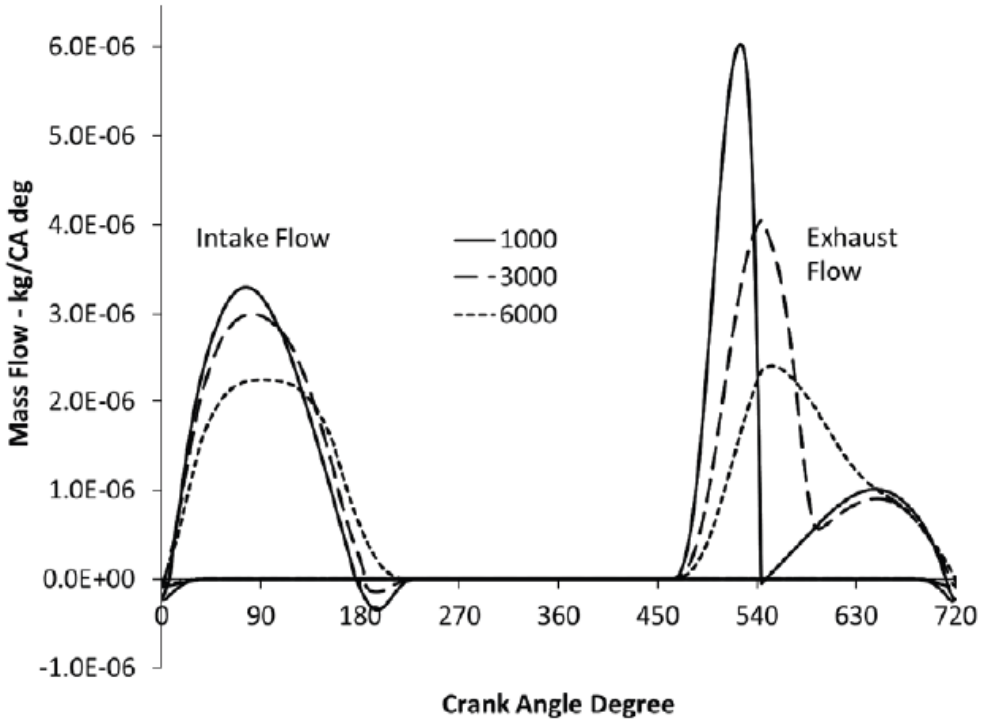
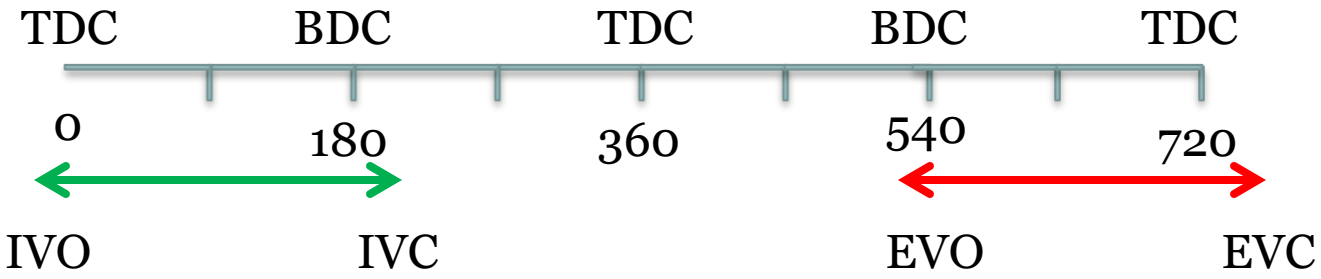
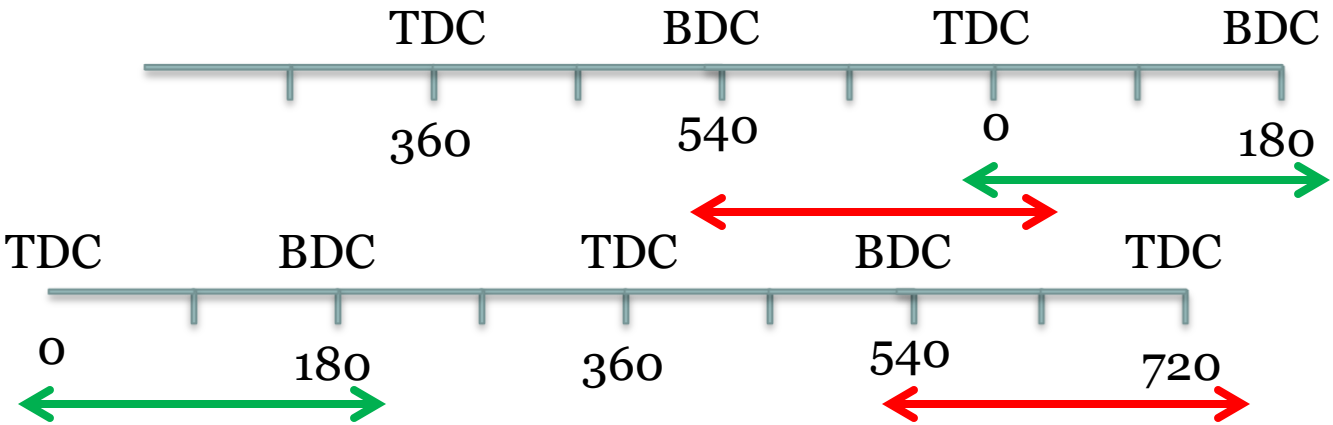


Figure 7.14: Simulated intake and exhaust flows for the reference engine of Table 7.1 at 3 operating speeds.

Valve Timing





Valve Timing and Engine Torque

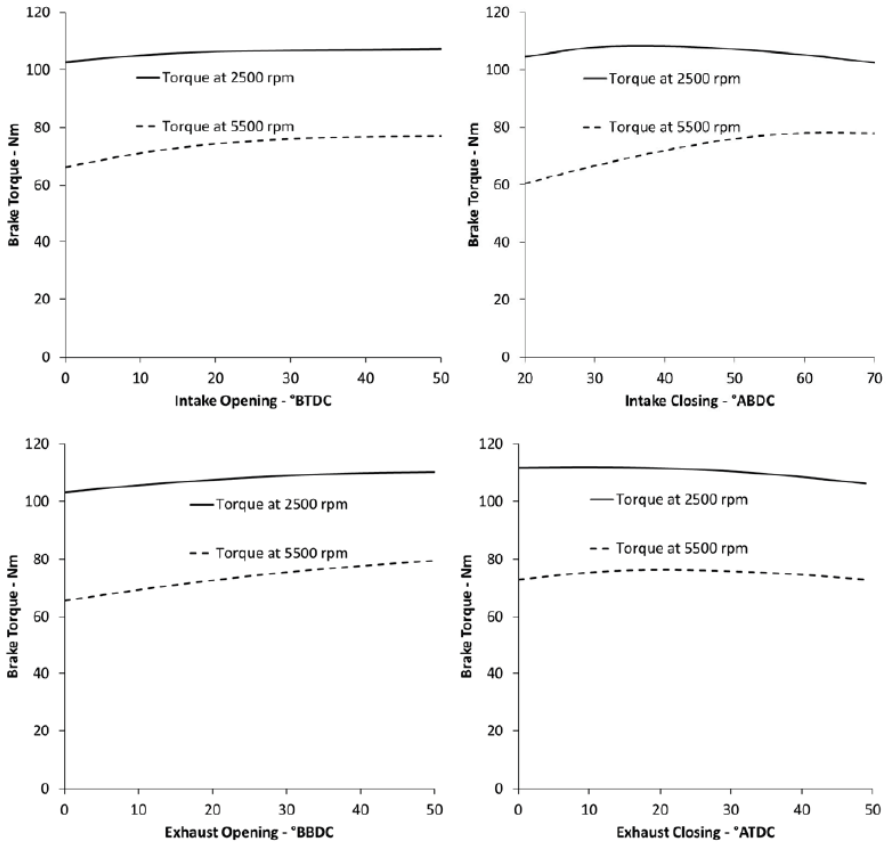


Figure 7.15: Effect of valve timings on engine torque at two engine speeds, for the reference engine of Table 7.1.

Valve Timing and Power

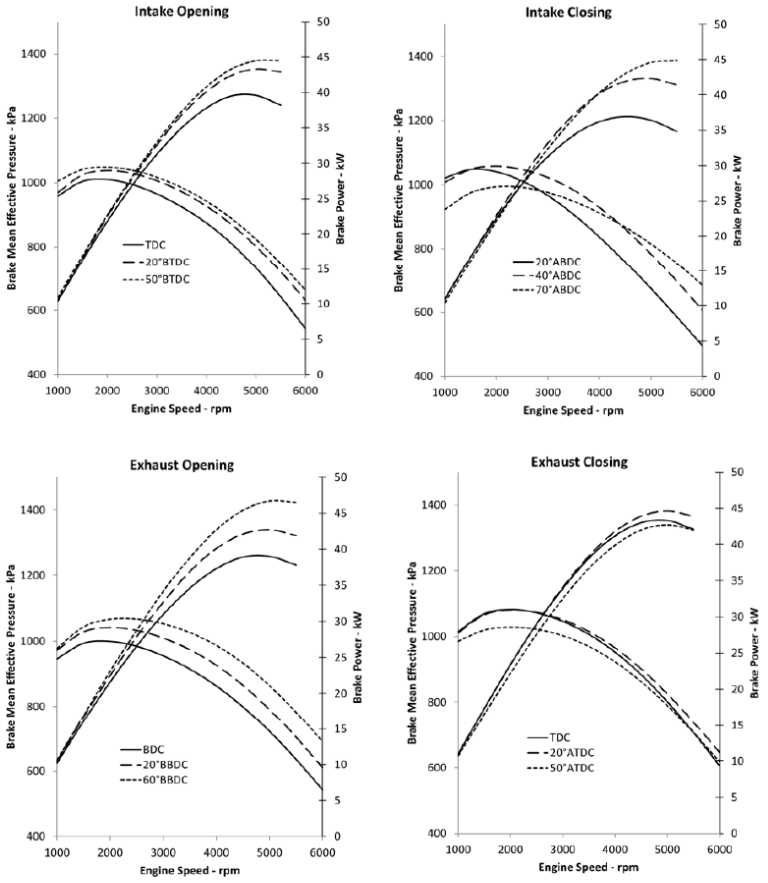


Figure 7.16: Effect of valve timings on engine power and *bmep* for the reference engine of Table 7.1.