FACTORS WHICH AFFECT VOLUMETRIC EFFICIENCY

1. Induction and exhaust system flow friction:

Due to flow friction, pressure drops occur in the inlet across the air filter, carburetor/injector, throttle, and manifold. Pressure drops also occur in the exhaust across the exhaust valve, port, manifold, catalyst, muffler and pipe.

2. Induction system heat transfer:

Heat transfer to the inlet mixture in the inlet manifold and port decreases its density. Fuel heating and vaporization as well as air heating are involved.

3. Valve timing effects:

(a) At low engine speed, a significant amount of mixture which entered the cylinder during the intake stroke is pushed back into the intake by the moving piston during the compression stroke prior to inlet valve closing.

(b) At high engine speed, the high momentum of the air in the intake manifold towards the cylinder set up during the intake stroke forces additional air into the cylinder while the intake valve remains open after BC.

(c) During the valve overlap period between inlet valve opening and exhaust valve closing, both valves are open. The amount of overlap, and engine speed, affect the residual fraction which has an effect on volumetric efficiency.

4. Valve flow friction:

The inlet valve and port are the largest flow resistance in the inlet system. There is a pressure drop across the port and valve due to flow friction.

5. Choking in the inlet valve and port:

At very high piston speeds, the velocity at the point where the flow area in the port and valve is a minimum can become sonic. This phenomenon, called choking, additionally limits the mass flow rate through a restriction. (Note, initially, choking will only occur during a portion of the inlet process.)

6. In-cylinder heat transfer:

The incoming air is cooler than the combustion chamber walls. Heat transfer from these walls to the fresh charge within the cylinder decreases its density.

7. Intake (and exhaust) tuning:

By suitable design of intake (and exhaust system)–length of runners, pipe cross-sections--advantage can be taken of wave phenomena to increase the inlet port pressure at the end of the intake process, and to decrease the exhaust port pressure at the end of the exhaust process. Such tuning benefits can be realized within specific speed ranges.