KNOCKING IN SI ENGINE AND DIFFERENT FACTOR EFFECTING IT

Phenomena of knocking in SI Engines In a SI engine combustion is initiated between the spark plug electrodes and then spreads across the combustible mixture A definite flame front which separates the fresh mixture from the products of combustion travels from the spark plug to the other end of the combustion chamber

Heat release due to combustion increases the temperature and pressure of the burned part of the mixture above those of the unburned mixture. In order to effect pressure equalization the burned part of the mixture will expand and compress the unburned part adiabatically thereby increasing the pressure and temperature of unburned part further. If the temperature of unburned mixture exceeds the self—ignition temperature of the fuel and remains at or above this temperature during the ignition lag, spontaneous ignition (or auto— ignition) occurs at various pin—point locations. This phenomenon is called **knocking**.

The factors influencing knocking are:
1. Density factors
2. Time factors
3. Composition factors
4. Temperature factors

1. Density factors:-

Any factor which reduces the density of the charge tends to reduce knocking by providing lower energy release.

(i) Compression ratio—Increase in compression ratio increases the pressure and temperature of the gases at the end of compression stroke which decreases the ignition lag of the end gas and increases the tendency of knocking.

(ii) Mass of induced charge—An increase in mass of induced charge into the cylinder of an engine by throttling or by increasing the amount f supercharging increases both temperature and density-of the charge at the time of ignition. This increases the tendency for knocking. –

(iii) Inlet temperature of mixture—Increase in inlet temperature of mixture makes the compression temperature higher thereby, increasing the tendency of knocking.

(iv) Temperature of combustion chamber walls—Hot spots (like spark plug and exhaust valve) in combustion chamber promotes knocking.

2. Time factors:-

(i) Engine speed—An increase in engine speed increases turbulence and decreases the tendency to knock.

(ii) Flame travel distance—Shortening the time required for the flame front to traverse the combustion chamber reduces the tendency for knocking. Flame travel distance is governed by combustion chamber size and spark plug position.

(iii) Engine size—A large engine (combustion chamber size) has a greater tendency for knocking as the flame requires a longer time to travel across the combustion chamber.

(iv) Combustion chamber shape—The combustion chamber should be such which promotes turbulence to reduce knocking. Spherical shaped chambers minimizes knocking tendency,

(v) Location of spark plug—A centrally located spark plug or multiple spark plugs minimizes flame travel time and reduces kn&king.

3. Composition Factors:-

(i) Fuel—Air ratio-F/A ratio affects the reaction time or ignition delay. When the mixture is nearly 10% richer than psychometric (F/A ratio 0.08) ignition lag of the end gas is minimum and velocity of flame propagation is maximum and knocking tendency is maximum. A rich mixture is effective in decreasing the knocking tendency due to longer delay period and lower temperature of compression.

(ii) Octane rating of fuel—Higher the octane number, lesser is the tendency for knocking. Paraffin series have the maximum and aromatic series the minimum tendency to knock. The knocking characteristics of a fuel can be decreased by adding small amounts of additives called dopes.

(iii). Humidity of air—Increasing humidity of atmospheric air decrease the tendency to knock.

4. Temperature Factors:-

increasing the temperature of the unburned mixture by any factor in design oroperation will
increase the possibility of knocking in SI engine. The temper.ture of the unburned mixture is increased by the following factors:-

(i) Raising the compression ratio. For a given engine setting and fuel there will be a critical compression ratio above which knocking occurs. This compression ratio is called the highest useful compression ratio (HUCR).

(ii) Supercharging

(iii) Raising the inlet temperature.

(v) Retarding spark timing—Having the spark closer to TDC reduces knocking. However this effects the brake torque and power output of the engine.

(vi) Power output of the engine—A decrease in the output of the engine reduces the tendency
to knock.

2. Time Factors

The following factors reduce the possibility of knocking :-
Turbulence—Turbulence increase the engine speed and reduces the time available for the end charge to attain auto-ignition conditions thereby decreasing the tendency to knock.

(i) Advancing the spark timing.

(ii) Raising the coolant temperature.

(iii) Increasing the load (opening the throttle).

(iv) Raising the temperature of the cylinder and combustion chamber walls.

(v) Advancing the spark timing.

Methods for Suppressing Knocking

(i) Proper location of spark Plug—A compact combustion chamber with proper central location of the spark plug reduces the path of the flame front travel from the spark plug to the remotest part of the combustion chamber, and thereby, reduces the tendency of knocking. The same result could be obtained by multi-fuel injection system.

(ii) Proper selection of material for piston and cylinder head—The end charge cooling is much better when piston and cylinder are made of aluminium alloys as they have good thermal conductivity. A better cooling of end charge reduces the tendency for knocking.

(iii) Injecting water into the intake manifold—Injection of water in the cylinder reduces the temperature of the end gas and increases the delay period there by decreasing the tendency to knock.

(iv) Retarding the spark timings—By retarding the spark timing, the peak pressures are reached only during the power stroke and are of lower magnitude. This reduces knock.

(v) Extremely rich or lean mixture—By using extremely rich or lean mixture the flame temperature can be kept low thus eliminatng considerably the tendency of knock.

(vi) Squish recesses in combustion chamber—The provision of squish recess in combustion chamber cools the last portion of the charge and reduces the tendency of knock.

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