Modification in two Stroke Engines for Complete Combustion and Complete Exhaust

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Abstract: ***Modern race bikes use four stroke engines for racing. Two stroke engines are not used because they cause large amount of pollution due to incomplete combustion & incomplete exhaust [3]. If these two problems are over come then two stroke engines will be a better option for race bikes. This paper presents work involved in installation of specially designed exhaust manifold which will create vacuum and leads to maximum exhaust. Also the installation of twin spark plugs which will promote the complete combustion and will give more thrust on the piston. Thus overall performance of engine increased causing less pollution.***

Keywords: Modified exhaust manifold, Twin spark plugs, complete combustion, complete exhaust.

1. Introduction

There are two conventional types of engines two stroke & four stroke. In two stroke engines power is generated in one rotation of crankshaft and in four stroke engines power is generated in two rotations of crankshaft. So two stroke engines have better performance than that of four stroke engines. But despite of their advantages like high performance, low maintenance they may suffer from drawbacks like high C/CO emissions & low brake Thermal efficiency [1], incomplete combustion & exhaust. Due to incomplete combustion not only the power available at crankshaft is lowered but also the proportion of harmful contents in exhaust gases is increased[5].Due to incomplete exhaust the gases remain in cylinder dilute incoming fresh charge & reduce power producing ability of the charge. So it is essential to flush out maximum exhaust gases from cylinder [2]. In the present design of two stroke engine there is exhaust valve at top in the cylinder head operated by camshaft as shown in Fig.no.l.

The exhaust manifold has a shape of convergent-divergent nozzle. Due to this shape vacuum is created at throat of nozzle & will help to flush out maximum gases from cylinder. Also there are twin spark plugs which will help for complete combustion. During downward stroke of piston, the charge will flow through transfer port. Just before end of expansion stroke exhaust valve will be opened & exhaust gases will rush through exhaust creating partial vacuum at throat of venturi, which then will help for maximum exhaust. This engine will be a best option for performance bikes.

2. Modified Engine

The modified engine is as shown in Fig 1. The modified components are exhaust Manifold and use of twin spark plugs. Firstly when piston is at top dead centre (TDC), the fresh charge is introduced into crankcase. As the piston moves to bottom dead centre (BDC) the charge is pushed from crankcase to combustion chamber via transfer port. Then again piston will come to TDC compressing fresh charge. When spark plugs ignites the charge, piston move to bottom dead centre (BDC) producing power. Just before end of expansion stroke exhaust valve is opened & hot gases rush through it. When gases will reach the throat of convergent-divergent manifold they will create partial vacuum, which will draw more gases from combustion chamber & will help for maximum exhaust. Due to use of two spark plugs two flame fronts will be generated, they will cover maximum mixture present in cylinder and will be helpful for complete combustion of charge; also due to this more power will be extracted from the charge. The positions of spark plugs are chosen such that the flame fronts generated will not strike each other and cause any power loss. The two flame fronts will travel away from each other and cover remote areas of the cylinder.

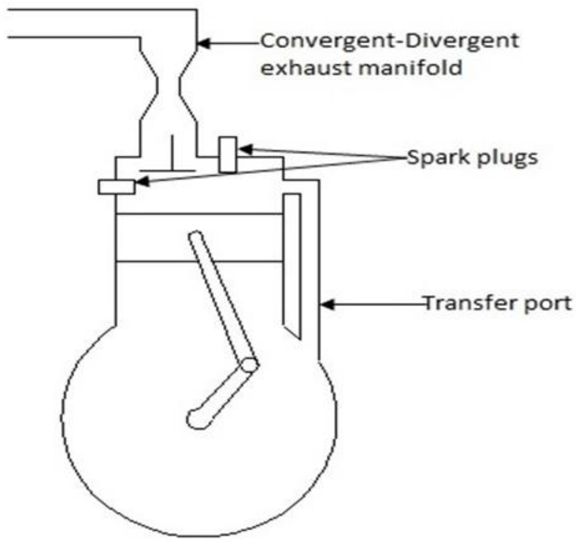

Figure 1: Modified design

3. Advantages

1. The engine has complete combustion and maximum exhaust which is not present in conventional two stroke engines.
2. Instead of exhaust port exhaust valve is used, due to this fresh charge going out with exhaust gases is also reduced causing less pollutants in exhaust.
3. Due to use of two spark plugs there is complete combustion as well as increase in power.
4. The modified exhaust manifold helps in getting maximum exhaust.

4. Calculations for Manifold Design

The size of convergent-divergent nozzle in manifold is calculated as follows:-
The characteristic velocity of the exhaust gases is calculated using the following equation:

$$C^* = \sqrt{\frac{R*T_c}{\gamma} * \left(\frac{\gamma+1}{2}\right) * \left[\frac{\gamma+1}{2}\right]^{\frac{\gamma+1}{2*[\gamma-1]}}} \quad (1)$$

Condition of nozzle at throat can be calculated as

$$T_{th} = T_c \left(\frac{2}{\gamma+1}\right) \quad (2)$$

$$P_{th} = P_c * \left[\frac{2}{\gamma+1}\right]^{\frac{\gamma}{\gamma+1}} \quad (3)$$

$$\rho_{th} = \frac{P_{th}}{R*T_{th}} \quad (4)$$

$$u_{th} = \sqrt{\gamma R T_{th}} \quad (5)$$

Exit conditions

$$M_e = \sqrt{\frac{2}{\gamma-1} * \left[\frac{P_c}{P_e}\right]^{\frac{\gamma-1}{\gamma}} - 1} \quad (6)$$

$$T_e = \frac{T_c}{1+\frac{\gamma-1}{2}*M_e^2} \quad (7)$$

$$\rho_e = \frac{P_e}{R*T_e} \quad (8)$$

$$u_e = M_e \sqrt{\gamma R T_e} \quad (9)$$

Nozzle expansion ratio

$$\varepsilon = \frac{1}{M_e} * \left[\frac{2}{\gamma+1} * \left(1 + \frac{\gamma-1}{2} * M_e^2\right)^{\frac{\gamma+1}{2*(r-1)}} + \varepsilon * \frac{P_{e-}P_a}{P_c} \quad (10)$$

Nozzle thrust coefficient

$$C_f = \gamma \sqrt{\left[\frac{2}{\gamma+1}\right]^{\frac{\gamma+1}{\gamma-1}} * \frac{2}{\gamma-1} * \left[1 - \frac{P_e}{P_c}\right]^{\frac{\gamma-1}{\gamma}}} \quad (11)$$

By calculating thrust coefficient, nozzle dimensions can be estimated as follows:

$$A_e = A_{th} * \varepsilon \quad (12)$$

$$D_e = 2 * \sqrt{\frac{A_e}{\pi}} \quad (13)$$

Throat and exit diameters, assuming divergent angle, the length of divergent part of nozzle can be calculated as

$$L_{div} = \frac{D_{ex} - D_{th}}{2*\tan\phi_2} \quad (14)$$

Length of convergent part of nozzle

$$L_{conv} = \frac{D_c - D_{th}}{2\ \tan\phi_1} \quad (15)$$

Total length of nozzle

$$L_{nozzle} = L_{conv} + L_{div} \quad (16)$$

5. Notations

C^*= Characteristic gas velocity in m/s

γ= Ratio of specific heats

T_{th} = Temperature at throat of convergent-divergent nozzle in Kelvin.

ρ_{th} = Density of exhaust gases at throat in kg/m^3.

$^M{}_e$= Mass flow rate at exit m^3/s.

T_e= Exit temperature in Kelvin.

ρ_e= Density of exhaust gases at exit in kg/m^3.

ε = Nozzle expansion ratio.

C_f = Nozzle thrust coefficient.

A_e = Area at exit of nozzle in m^2.

D_e = Diameter at exit of nozzle in m.

A_{th} = Area at throat of nozzle in m$^{2.}$

D_e= Exit diameter of nozzle in m.

D_{th} = Diameter at throar of nozzle in m.

P_c = Pressure in convergent part of nozzle in N/m^2.

P_e = Pressure in divergent part of nozzle in N/m^2.

6. Conclusion

The racing bikes need high pickup and it is to be maintained with the due course of time. The complete burning of fuel is always required in two stroke at same time the wastage of fresh charge with the exhaust is to be prevented. This modification will lead to prevent the loss of fresh charge. The complete combustion is also promoted by improving the combustion process by applying twin spark plugs. The modified engine combustion is efficient than that in ordinary two stroke engine. The basic two stoke cycle is remain unchanged but the work done as output will increase hence cycle efficiency will improve.

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Author Profile

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