NOISE REDUCTION IN TWO STROKE ENGINE BY CONTROLLING THE VELOCITY OF EXHAUST GAS

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ABSTRACT

Noise reduction in Internal Combustion Engines, specifically two stroke engines and their exhaust system modifications are being done. This particularly deals with reducing the velocity of the exhaust gases that are released from the combustion chamber to the atmosphere, thereby reducing the noise created by sudden expansion of exhaust gases. The velocity of the exhaust gases from the combustion chamber is being reduced and controlled by the effective utilization of the valve arrangement and valve mechanism through the pneumatic actuation of the valves being used in this concept of exhaust gases velocity reduction for reducing the noise created. Various types of valves used in this process are Non-Return Valves, Flow and Pressure regulating valves.

KEYWORDS: *Noise, two stroke Engines, Non-return valves, Flow and Pressure regulating valve, silencer, exhaust gas.*

I. INTRODUCTION

The undesired sound created by the two stroke engines make them prone to noise pollution and uneasiness while operation. The exhaust emissions of two stroke engines are high due to incomplete combustion and discharge of unburnt fuel along with exhaust gases. A two-stroke, or two-cycle, engine is a type of internal combustion engine which completes a power cycle with two strokes (up and down movements) of the piston during only one crankshaft revolution.

This is in contrast to a "four-stroke engine", which requires four strokes of the piston to complete a power cycle. In a two-stroke engine, the end of the combustion stroke and the beginning of the compression stroke happen simultaneously, with the intake and exhaust (or scavenging) functions occurring at the same time.

Two-stroke engines often have a high power-to-weight ratio, usually in a narrow range of rotational speeds called the "power band". Compared to four-stroke engines, two-stroke engines have a greatly reduced number of moving parts, and so can be more compact and significantly lighter.

The first commercial two-stroke engine involving in-cylinder compression is attributed to Scottish engineer Dugald Clerk, who patented his design in 1881. However, unlike later two-stroke engines, his had a separate charging cylinder. The crankcase-scavenged engine, employing the area below the piston as a charging pump, is generally credited to Englishman Joseph Day. The first truly practical two-stroke engine is attributed to Yorkshireman Alfred Angas Scott, who started producing twin-cylinder water-cooled motorcycles in 1908.

II. PROBLEM IDENTIFICATION

In the combustion phase of any 2 stroke or 4 stroke engine there is a requirement that all the mechanical, electrical and fuelling systems line up at the right time. Any of the following items that don’t correctly align to their specific requirement will have some type of ill effect on the combustion

process. One major effect is Detonation or also known as engine knock, which can be identified as marbles rattling inside your engine under heavier load conditions such as hills or hard acceleration.

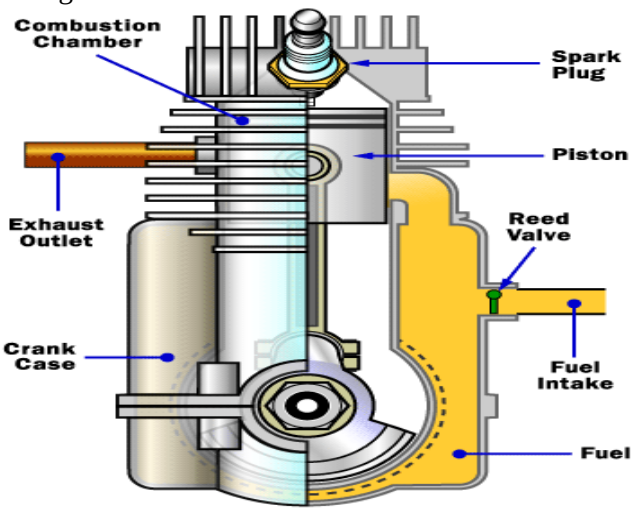

Figure 1: Two Stroke Engine Components

The following items and processes all play a part in creating this detonation phenomenon:

- **Fuel** - Incorrect octane rating or contaminated fuel in relation to the compression ratio. Incorrect fuel air ratio
- **Ignition** - Incorrectly set ignition timing or advance curve in relation to the compression ratio, fuel type, port or valve timing and manifold pressure
- **Compression** - Generally excessive in relation to ignition advance and fuel type or octane rating
- **Manifold pressure** - Excessive amounts in relation to port or valve timing abilities to burn and discharge whist under compression
- **Ambient air temperature and humidity** - Excessive induction and combustion temperature changes with fluctuating oxygen volumes

When any of the above are effecting the normal delivery of the atomised fuel charge in an adverse way causing detonation you are doing your engine harm. It is one of those must fix items, particularly on a 2 stroke. Identifying detonation in four stroke engines tends to be a little easer as the marbling sound can be heard and usually felt while throttling but the 2 stroke engine tends to hide the process within the vibration and the exhaust system noise.

III. WHAT IS NOISE?

A popular definition of noise is „an undesirable sound". To what extent a sound can be characterized as noise is, of course, a personal evaluation. However, if the sound level is so high as to be damaging to health, it will normally be considered by one and all as undesirable and, therefore, as noise. Sound is the result of mechanical vibrations occurring in an elastic medium, e.g. air. When the air starts to pulsate, the variations in air pressure will spread from the source through the transfer of energy from molecule to molecule. The more energy transferred, the higher the sound level.

The International Standards Organization (ISO) has determined the following reference values for acoustics.

Reference for sound intensity:

$Io = 10{-}12\ W/m^2$

Reference for sound pressure:

$Po = 2 \times 10{-}5\ Pa$

Reference for vibration velocity:

$Uo = 2 \times 10{-}9\ m/s$

The above-mentioned intensity and pressure reference values represent sound intensity and sound pressure at the lowest levels perceptible to the human ear. As the ear is not particularly sensitive and

is just able to discern that a sound has doubled in intensity, a linear division of the intensity would be impractical. For this reason, decibel (dB) has been introduced as a unit for measuring sound. This unit is logarithmic and is defined as 10 times the logarithmic relationship between the actual intensity of the sound and the reference value:

Sound intensity level (dB):

Ls= 10 x Log10 (I/Io) (1)

Reference, Io = 10−12 W/m^2.

As sound pressure squared corresponds to the intensity of the sound, the following corresponding values are valid when we use sound pressure as a basis

Sound pressure level (dB):

Lp = 20 x Log10 (p/po) (2)

Reference Po = 2 x 10−5 Pa

IV. PROPOSED DESIGN

The main objective of this project is to design and fabricate a component, an attachment which serves as a part of the two stroke engine, whose function is to reduce the velocity, control the flow of exhaust gases thereby reducing the noise produced by sudden expansion of the exhaust gases.

The so proposed invention aims to overcome these problems by suitably using various technologies and the design of a component to reduce the velocity of exhaust gases. In two stroke engines one of the major reasons for noise is the sudden expansion of exhaust gases from combustion chamber pressure to atmospheric pressure (you can relate this phenomenon to "clapping your hands" the sound while clapping is created just because of the compression and sudden expansion of air that is trapped inside your palms). The so proposed invention makes use of the principle of controlled expansion and flow of exhaust gases to reduce undesired sound created while operating two stroke engines.

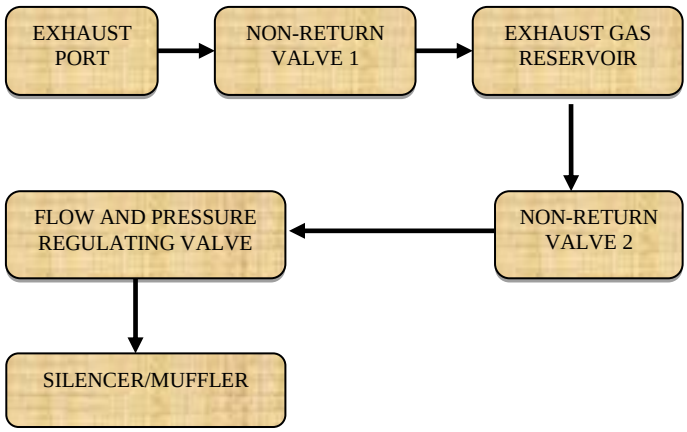

Figure 2: Diagrammatic Representation of the Process

Note: Valves used here are pneumatic valves of suitable size and configuration

V. TECHNICAL DESCRIPTION:

This invention particularly deals with reducing the velocity with which the exhaust gases are released from the combustion chamber to the atmosphere, thereby reducing the noise created by sudden expansion of exhaust gases.

The time for which the exhaust port remains open is around 135 degrees of the crank angle. At this stage of 135 degrees of crank angle the exhaust gases are forced out of the combustion chamber into the atmosphere creating sudden expansion of gases. The so proposed invention uses the rest of the time (i.e. the remaining 225 degrees of the crank angle) in addition to the available 135 degrees to control, regulate the exhaust gases flow. This is done with the help of an 'exhaust gas reservoir' and a series of 'valve arrangement' to control, regulate the flow of the exhaust gases.

Referring to port timing diagram of a common two stroke engine

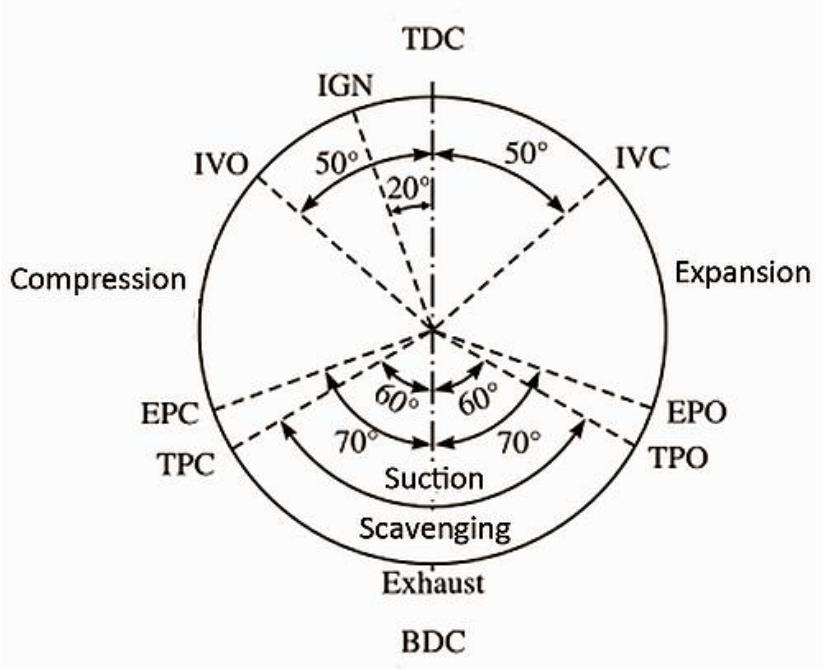

Figure 3: Port Timing Diagram of Two Stroke Engines

The above mentioned 'exhaust gas reservoir' is simply a chamber of suitable shape and volume that exactly holds the amount of exhaust gases produced at a single opening of exhaust port(provided with necessary allowances). Roughly speaking the 'exhaust gas reservoir' is used to trap the exhaust gases produced at a single open of exhaust port, store it for a temporary period.
The purpose of valve arrangement is to prevent the back flow of the exhaust gases, regulate its pressure flow. The back pressure will occur which is overcome by using an increased diameter of exhaust pipe.

VI. WORKING

As represented in the above diagram the exhaust gases are received from the exhaust port when the port opens, the 'non-return valve-1' is placed to prevent the back flow of exhaust gases into the combustion chamber due to any pressure changes that occur inside the engine cylinder. The exhaust gases are instantly stored inside the exhaust gas reservoir simultaneously the exhaust gases are sent out through the pressure regulating and flow valves so that the exhaust gases are sent out in a regulated manner. A non-return valve-2 is provided to prevent the back flow of exhaust gases into the reservoir.
The pressure regulating and flow control valves are configured in such a way that it utilizes all the time available (i.e. the exhaust port opens 135 degrees and the remaining 225 degrees) to send the exhaust gases in a regulated, controlled fashion. On a rough calculation it is expected to get an additional 45.7% of time. So this time is utilized to send the exhaust gases in a reduced velocity, by the use of valve arrangements. Thereby reducing the undesired sound created during the operation of engine.

VII. FUTURE ENHANCEMENT

Further research is expected to be done on what kind of pressure regulating and flow control valve to be used and their configuration, if a situation to open/close the valve arises, then it should be done with a help of timing gear, chain or cam arrangement that is driven by crankshaft itself, to make the process self-sustainable

Intercooling at exhaust gas reservoir may be provided either by extended surfaces (fins) or oil cooling to further increase the efficiency of the process.

VIII. CONCLUSION

Thus the undesired sound created during the operation of two stroke engines is expected to be reduced and also this component requires no external power source for its operation.
It is expected to be fabricated in a compact manner so that it can be fitted into the engine with simple mounts and also it can be applied to any two stroke engine by proper configuration of valves and designing of components. It increases the complexity of the engine. "Exhaust gas reservoir" should be fabricated in such a way that it is airtight and allows no leakage of gases**.**

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