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VARIOUS DESIGNS OF THE TWO-STROKE ENGINE HEADS WITH THE VALVE FLUSHED SYSTEM

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Abstract

The two-stroke engines have never acquired the popularity of the four-stroke engines due to their inherent performance limitations. The tasks of many engineering teams were to find the basic causes, which resulted in the inferior performance of these engines. Today's task is to build a two-stroke engine whose performance could match that of a four-stroke engine in areas of common use. The most typical performance problems of a two-stroke engine are high petrol consumption caused by low efficiency, toxic by-products of combustion being emitted into the atmosphere (caused by oil present in the petrol), and uneven and loud engine noise. The greatest challenge is to achieve a good chamber purge during one stroke in which the fresh fuel mixture flows through the piston-controlled inlet port while at the same time the fumes are being exhausted through the outlet port. This in contrast with the four-stroke engines where the intake and exhaust are each done with two separate strokes. From the energy point of view, the two-stroke engine is not efficient because a certain amount of fresh fuel is being wasted in the exhaust fumes. We propose to replace the piston-controlled cam with the valve-flushed system, which will cause the combustion process to become more efficient. The purpose of this paper is to present various designs of the engine heads and analyse their performance. The goal of this proposal is to choose the best combination of these engine heads in order to achieve the optimum overall engine performance.

Keywords: *engine, two-stroke, internal combustion, valve flushed system, piston-controlled cam, high petrol consumption, oil in the petrol, toxic by-products, loud noise, uneven running, low efficiency*

1. Introduction

At the present time, there is little interest in the two-stroke engines in the automotive industry. These engines are almost completely displaced by the four-stroke engines due to their inherent limitations in common use. The designs and operation of these engines has not changed in the last 50 years. Lack of technical advances especially in the areas of engine efficiency, toxic by-products of combustion as well as engine noise, were compounded by Poland's entry into the European Union and the need to follow new standards. Comparison of performance of the two and four-stroke engines as well as market needs for them could lead to the conclusion that it makes no sense in continuing research and development of the two-stroke engines by the engine manufacturing companies. Despite a general lack of interest in the two-stroke engines, there exist applications in which the use of these engines is indicated. These engines are generally smaller in size and because of that are being used in motorcycles despite their deficiencies. Some researchers, such as prof. Jerzy Kusmidrowicz at the Wroclaw University of Technology, have been doing research on two-stroke engine performance and efficiency. According to prof. Kusmidrowicz, the key to improved operation and efficiency of the two-stroke engines, lies in improved purging of the chamber during the combustion cycle. Prof. Kusmidrowicz tested and evaluated several designs on engines mounted on test stands. Instead of standard design piston controlled flush systems, he evaluated valve controlled flush systems similar to the flush systems used in the four-stroke

engines. That approach required some specific modifications of the engines. A few problems needed to be researched:

1. Proper purge of the cylinder in view of the decreased area of the purging ports of the inlet and exhaust valves which in addition are at some moments open simultaneously,
2. There was a need to control and direct the purging gas

Moreover, the short period of time during which both valves are open required an additional air compressor, which would provide purging air for short period. The short distance between the intake and exhaust valves and the need to direct the purging gas from beneath the piston and toward the exhaust valve, required an improved control of the purging system.

2. Designs of the engine heads

In early designs, the purging gas was directed from under the piston towards the exhaust valve while not performing proper cylinder purging. In the first design modifications, the inlet valve was fitted with some kind of a screen, which was also used with the four-stroke self-ignition diesel engines. This arrangement caused the injection gas flow to assume a spiral shape. This solution however had two significant flaws. First, the unwanted rotation had to be eliminated by blocking the valve at an exact, fixed position. Second, the area between the valve and the socket was reduced by 30 to 50% [1, 2].

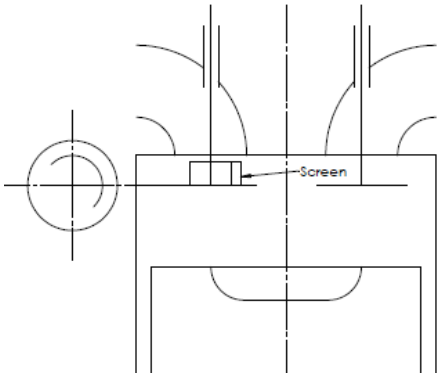

Fig. 1. The inlet valve with the screen [1]

The second modification of the two-stroke engine was one with a chalice shaped chamber. The purpose was to direct the purging air stream as well as combustion under the valve. Calculations were made for the air velocity distribution. The final results for this design showed an inferior performance when compared to the piston-controlled cam [1, 2].

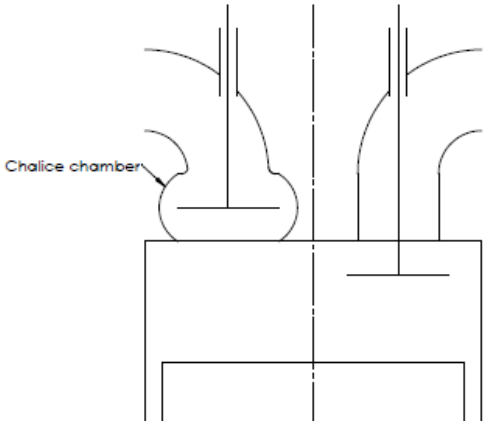

Fig. 2 The inlet channel with the chalice chamber [1]

The third modification was a system with a double inlet valves connected with each other and a pit, which forms a chamber. The net effect was an increase in the cross-section for the gas flow with the concurrent reduction in the air flow resistance [1, 2].

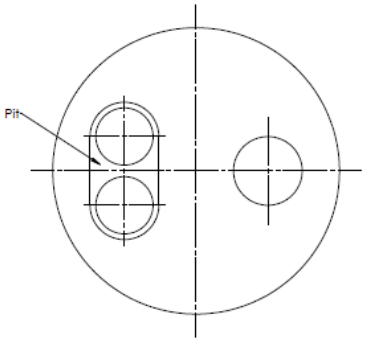

Fig. 3. Double inlet valve system [1]

Another modification was one in which an in-fixed bushing is being used to place the inlet valve in a vertical position. This scheme allows shaping of the walls of the chamber to control the purging air flow. The problem with this approach is its complicated design [1, 2].

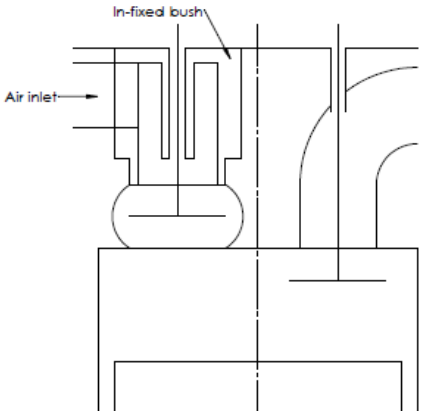

Fig. 4. The inlet valve in the in-fixed bush [1]

The last modification used a system with a gas deflector. When the valve is flush with the cam, the deflector dampens the airstream flowing into the cylinder and directs it towards the bottom of the piston, then, on return it pushes the fumes out [1, 2].

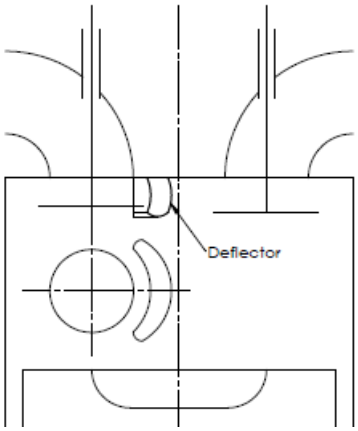

Fig. 5. The deflector placed in the cylinder [1]

In my Master's thesis written under the supervision of prof. Andrzej Kazmierczak at the Wroclaw University of Technology, I proposed a design that improved on the idea of a deflector as well as improvements in the combustion and purging efficiencies of the two-stroke engine. In addition, I have modified the design of the head. In addition, the deflector, which I designed, is not part of the head and is manufactured as a separate element. This allows it to be built into different shapes as well as using different materials of construction. Such approach to the manufacture of the deflector also simplifies its servicing when removed from the engine, thus reducing the costs of service or maintenance. The deflector is attached by a screw and placed into a special pit assuring its exact position as well as immobility under the pressure of the flowing gases. Along the axis of symmetry, I have placed the location for the spark plug. This construction allows the gas to be directed at the spark plug thus assuring a more complete combustion process [3].

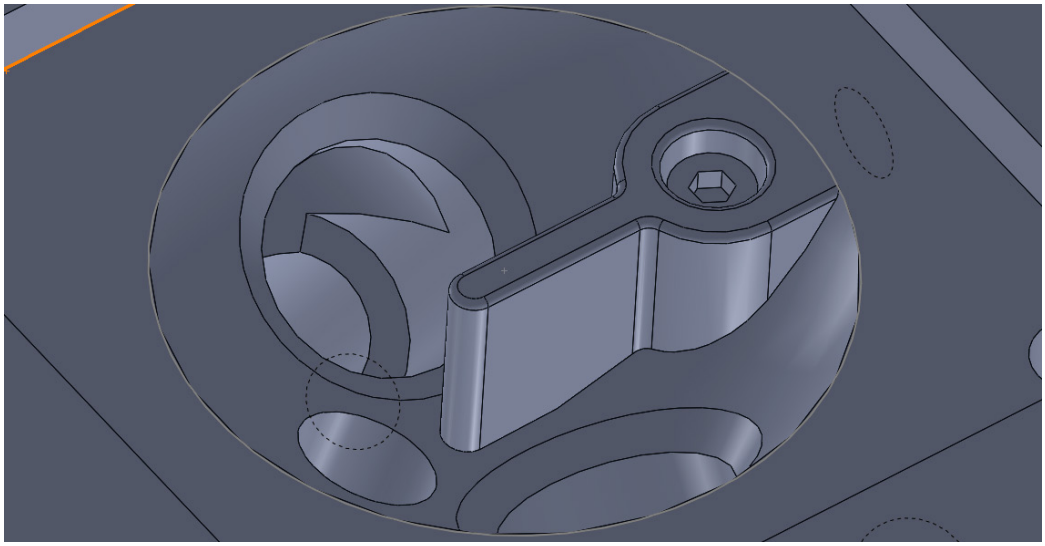

Fig. 6. Custom deflector in the combustion chamber [3]

I believe that there exist opportunities to improve the construction and performance of the two-stroke engines as is shown by the experiments described above. I strongly believe that my suggestion of a modified deflector will result in an engine that is more efficient in fuel usage and more effective in the purging cycle. I am convinced that this will lead to a greater acceptance of the two-stroke engines in a larger variety of equipment.

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