Scavenging in a Stratified, Charged Two-Stroke Engine

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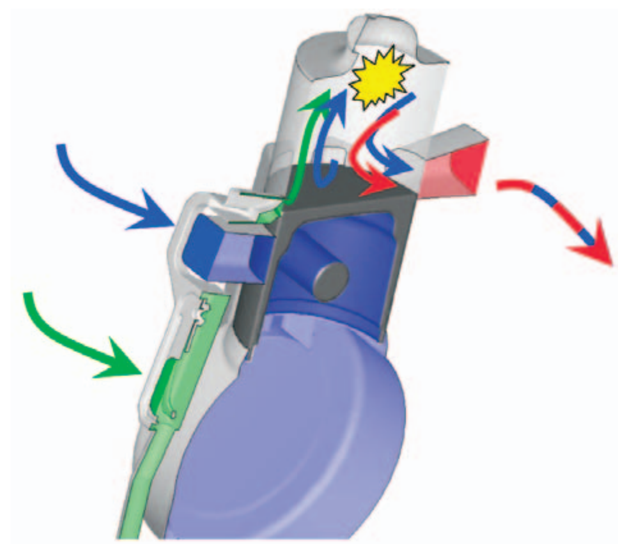
TWO-STROKE GAS ENGINES are commonly used in hand-held machines, such as chain saws and grass trimmers. These engines have a tendency to cause pollution as a result of unburned hydrocarbons being released along with the exhaust. At SOLO Kleinmotoren, a new by-pass system has been developed that allows the combustion chamber to be flushed with either a lean fuel mixture or pure air early in the engine cycle. Fuel is injected as a rich mixture later in the cycle when the outlet port is closed. The by-pass system prevents the fuel from escaping from the combustion chamber before combustion is complete.

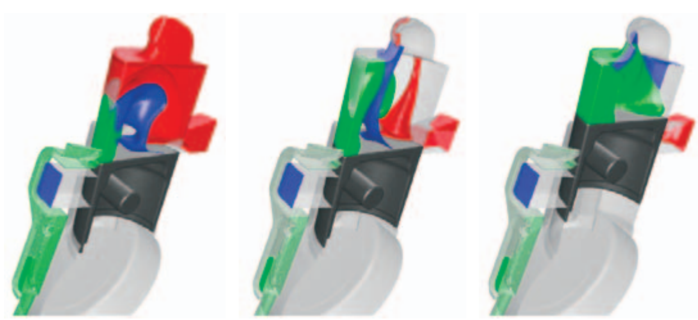
A numerical investigation of the by-pass system has been carried out using the dynamic mesh model in FLUENT. Throughout several engine cycles, the mass fractions of pure air, a rich fuel mixture, and a mixture of exhaust gases were tracked. Combustion was approximated by resetting the pressure, temperature, and components of the three gaseous species each time the piston was in the top dead center (TDC) position.

The operation of the engine is illustrated at right. During the suction phase, clean air is drawn into the crank case (blue arrow) and a fresh mixture of fuel and air is drawn into the by-pass channel (green arrow). As the crank case compresses, the clean air enters the combustion chamber through transfer ports, while the fuel mixture is pressed into the chamber through an injection port. Due to fluid dynamic constraints dictated by the local flow, the fresh air in the chamber prevents the fuel mixture from leaving the combustion chamber directly through the outlet port. Only exhaust gases (red) and pure air can be released into the environment.



A schematic of the engine with the by-pass system: pure air (blue) and fuel (green) enter through ports on the left; following combustion, pure air and exhaust gases leave through the outlet port on the right

The distributions for the three gaseous species at three different piston positions illustrate the success of the by-pass system. The blue surface corresponds to fresh air, the green surface to the fuel mixture, and the red surface to the exhaust gas mixture. At bottom dead center (BDC), the positions of the surfaces indicate that the fresh air forms a fluid shield between the fuel mixture and the outlet port. When the piston has advanced 50° beyond BDC, the fluid shield is not perfect, so a small portion of the fuel mixture can leak past the shield near the cylinder walls. When the piston has advanced 100° after BDC, the outlet port is closed by the rising piston, just before the fuel mixture has a chance to escape.



Surfaces of fresh air (blue), fuel (green), and exhaust (red) at three piston positions: a) bottom dead center (BDC), where the air forms a fluid shield to block the fuel, b) 50° beyond BDC, where some fuel leaks past the air shield near the cylinder wall, and c) 100° beyond BDC, at which time the rising piston has closed the outlet port

The results of the simulation show the ability of the new engine to reduce environmental pollution by limiting the release of unburned hydrocarbons. The results also suggest that there is potential to improve the fluid dynamics of the fuel injection as well as the flushing of the combustion chamber to further enhance the performance of the new by-pass system. ■