

The Acoustic Spectrums of the combustion Process in the IC-Engines

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The burning of the fuel-air mixture inside the engine proceeds in special conditions of a closed volume. The flame is an effective generator of acoustic noise, so spectral analysis of the sound has much potential for yielding information about the dynamics of the combustion. In the present work, an experimental study of the acoustic spectrums of the burning in the internal combustion engines is performed.

The measurements were carried out on engines of various cars (Hyundai i40, 2.0 L, 150 hp; Hyundai Accent, 1.6 L., 105 hp; Chevrolet Cruze 1.6 L, 109 hp; Peugeot 4007, 2.4 L, 170 hp; Opel Astra 1.6 L, 115 hp). The acoustic signals were recorded using a voice recorder installed under the car's hood near the engine cylinders (in the frequency range 200-7000 Hz, signal-to-noise ratio 37 dB). The engine speed set to the fixed values from 900 to 3000 rpm. The raw data were collected at a sampling frequency of 16 kHz with 16-bits per sample. The frame length was 2048, each frame was 25% overlapped. Frames were windowed with Hamming window and 2048 points FFT was applied to each frame.

The energy spectrums have complex structure. The main energy of the acoustic noise is concentrated in the band 600 - 1600 Hz, the frequency of the maximum does not depend on the engine speed. The cylinder volume and the engine speed determine the width and structure of the spectrum.

Based on the flame propagation velocity in piston engines in the absence of detonation of 40-80 m/s, and the characteristic size of the combustion chamber 0.1 m (cylinder diameter), a lower frequency of combustion noise of 400-800 Hz can be estimated. The result is consistent with observations.

In the high-frequency part of the spectrum (above 4000 Hz), an increased level of energy is noticeable, which can be explained by the presence of detonation combustion waves.

Experimental records of engine acoustic noises contain a variety of information about the dynamics of the combustion. Determination of the dependence of the combustion parameters on the cylinder's geometric dimensions and fuel quality is of great practical importance for the development of internal combustion engines.