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Analysis of power tiller noise using diesel-biodiesel fuel blends

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Introduction: There are several sources of noise in an industrial and agriculture environment. Machines with rotating or reciprocating engines are sound-producing sources. Also, the audio signal can be analyzed to discover how well a machine operates. Diesel engines complex noise SPL and sound frequency content both strongly depend on fuel combustion, which produces the so-called combustion noise. Actually, the unpleasant sound signature of diesel engines is due to the harsh and irregular self-ignition of the fuel. Therefore, being able to extract combustion noise from the overall noise would be of prime interest. This would allow engineers to relate the sound quality back to the combustion parameters. The residual noise produced by various sources, is referred to as mechanical noise. Since diesel engine noise radiation is associated with the operators' and pedestrians' discomfort, more and more attention to being paid to it. The main sources of noise generation in a diesel engine are exhaust system, mechanical processes such as valve train and combustion that prevail over the other two. In the present work, experimental tests were conducted on a single cylinder diesel engine in order to investigate the combustion noise radiation during stationary state for various diesel and biodiesel fuel blends.

Materials and Methods: The engine used in the current study is an ASHTAD DF120-RA70 that is a single cylinder 4 stroke water cooled diesel engine and its nominal power is 7.5 hp at 2200 rpm. The experiment has been done at three positions (Left ear of operator, 1.5 and 7.5 meter away from exhaust) based on ISO-5131 and SAE-J1174 standards. For engine speed measurement the detector Lurton 2364 was utilized with a measurement accuracy of 0.001 rpm. To obtain the highest accuracy, contact mode of detector was used. The engine noise was measured by HT157 sound level meter and was digitalized and saved with Sound View software. HT157 uses alow impedance, capacitor microphone with a unidirectional pattern whose size, sensitivity and frequency range are 1/2", 50 mV Pa^{-1} and 10 Hz to 20 kHz with a flat extrusion, respectively. Choosing the combination of fuel was carried out according to experiments that have been done before determining engine operation parameters.

Results and Discussion: Fuel type has a direct effect on the quality of the IC engine's combustion phenomenon. One of the most important quality parameters that can be fluctuated by fuel type is engine noise. The fuel type has a direct effect on internal fuel ignition engines and affects the quality of fuel ignition. One of the effects of ignition quality is the sound of the engine that is very important in terms of both the health and evaluation of engine performance. Two-wheel tractors are of the most important tools used in agriculture. In addition to agricultural work, they have applications in rural areas as power generators. No research has been carried out so far in Iran on the sound of two-wheel tractors fuelled with diesel and biodiesel fuels. Therefore, the sound of the ignition of biodiesel and diesel mixtures in four stroke, single cylinder, two wheel diesel tractors manufactured by Ashtad Company was studied. The purpose of this study is to analyze the noise parameters of a diesel engine using B0, B5, B10, B15, B20, B25 and B30 biodiesel–diesel blends. Biodiesel was produced from waste oil and blended with net diesel fuel to evaluate the Power tiller's engine noise parameters. This study was carried out at a stationary position and at three positions such as driver's left ear position (DLEP), 1.5 meter (1.5 MAFE) and 7.5 meters (7.5 MAFE) away from the exhaust at 6 engine speeds (1200, 1400, 1600, 1800, 2000 & 2200 rpm). Statistical analysis and frequency analysis were used to analyze sound of the engine. The results showed that the sound pressure levels of the engine for B10 fuel have the least amount of noise level of the sound pressure. However, this fuel has no significant difference at 1% level with B00, B05 and B15 fuel. At the A weight level, that matches the structure of the human ear, and there is no difference between the sound pressure levels of ignition. Sound pressure level increased with increasing engine speed and the difference is significant at the 1% level. With increasing speed engine, noise levels increased up to 7.8 dB. Average sound pressure level was 83.76 dB at

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the driver's ear position (79.3 dBA), at 1.5 meters away from exhaust it was 85 dB (80.9 dBA) and at 7.5 meters away from exhaust it was 79.5 dB (72.4 dBA). The results proved that the lowest and highest sound pressure levels (SPL) of power tiller take place at B10, and B30, respectively. The SPL increased by 7.8 dB for increasing engine speed from 1200 to 2200 rpm. The test results showed that the average SPL at DLEP was 4.3 dB higher than 7.5 MAFE position.
Conclusions: B10 has minimum sound pressure level (SPL), but its difference with B00 (DIESEL FUEL), B05 and B15 is not significant in 1% error level. Considering the NOISH standard, the operator can work with a machine for 8 hours. In DLPE position, the most overcome frequency is 315 Hz for all blends that resulted from exhaustion and combustion. B10 has a minimum SPL at this peak point significantly lower than other blends. For the used engine in this experiment, by optimizing muffler design it is possible to reduce SPL of engine in this frequency peak point.

Keywords: Biodiesel, Noise, Power tiller, Sound pressure level