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International Conference and Exhibition on
Automobile Engineering
September 01-02, 2015 Valencia, Spain

VIBRATION ANALYSIS OF A DIESEL ENGINE FUELLED WITH SUNFLOWER AND CANOLA BIODIESELS

Erinç Uludamar[a], Gökhan Tüccar[b], Kadir Aydın[a], Mustafa Özcanlı[c]

a Department of Mechanical Engineering, Çukurova University, Adana, Turkey
b Department of Mechanical Engineering, Adana Science and Technology University, Adana, Turkey
c Department of Automotive Engineering, Çukurova University, Adana, Turkey

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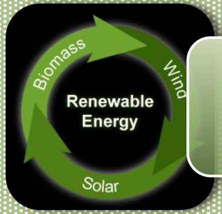
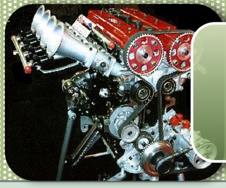
Advantages of Biodiesel



Renewable, Non-toxic, Biodegradable

Lower exhaust emissions



Can be used with little or no engine modifications

Purpose of the Study

- Biodiesel is one of the most popular alternative fuel. The usage of biodiesel is increasing day by day. Therefore, all effects of biodiesel on internal combustion engines must be known.

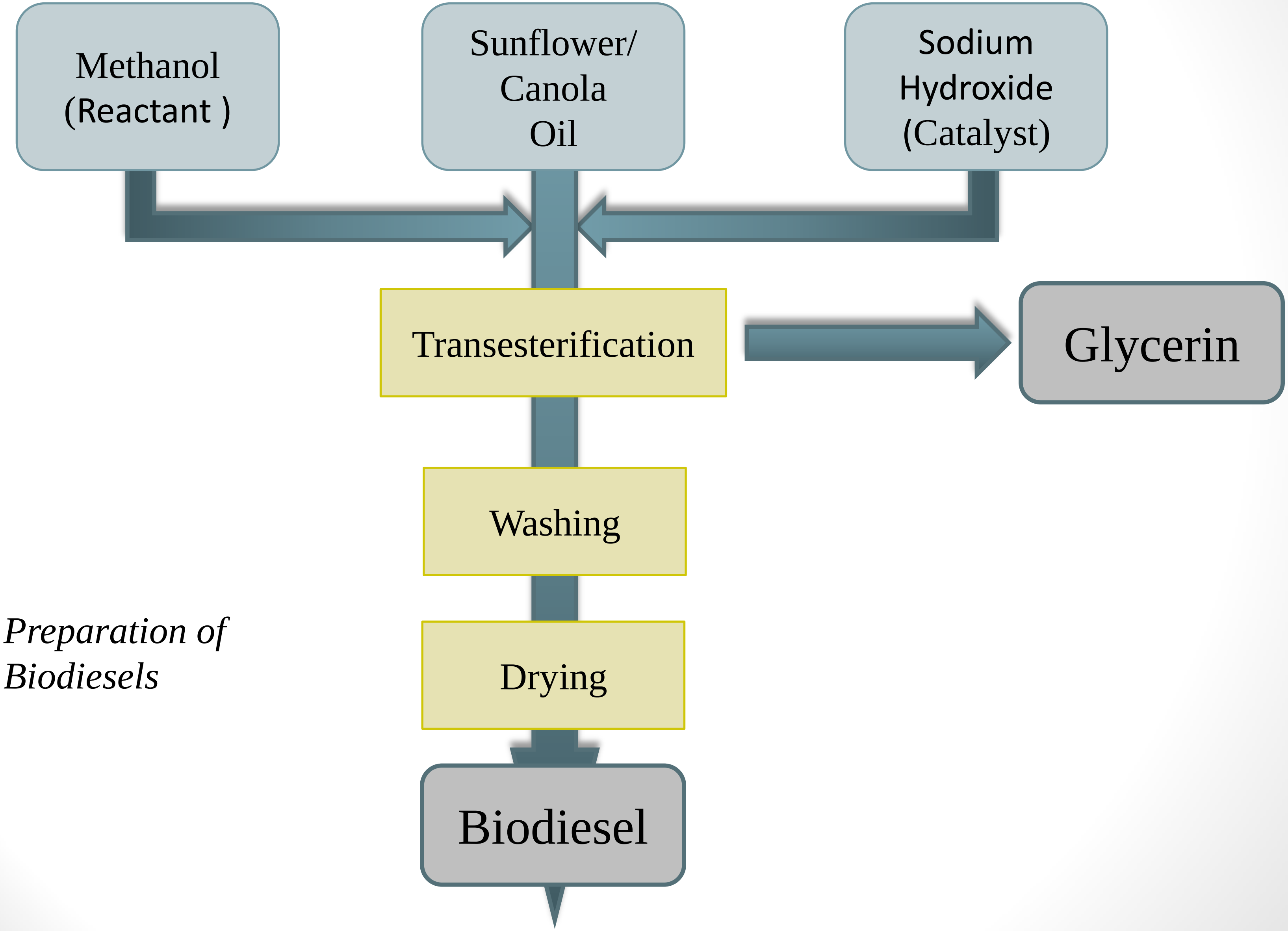
- In this study, vibration effect of canola and sunflower biodiesels at different engine speed was investigated in longitudinal, vertical and lateral axes.

Material and Method

- Experiments were conduced at 6 different engine speeds with 11 different fuels.

Low Sulphur Diesel	1300 rpm	Sunflower Biodiesel and its blends	1300 rpm	Canola Biodiesel and its blends	1300 rpm
	1600 rpm		1600 rpm		1600 rpm
	1900 rpm		1900 rpm		1900 rpm
	2200 rpm		2200 rpm		2200 rpm
	2500 rpm		2500 rpm		2500 rpm
	2800 rpm		2800 rpm		2800 rpm

Preparation of Test Fuels



Preparation of Biodiesels

Preparation of Test Fuels

TEST FUELS			
Fuel Name	**Ratio of Low Sulphur Diesel (% by volume)**	**Ratio of Biodiesel (% by volume)**	**Abbreviation**
Low Sulphur Diesel	100	-	D
Sunflower Biodiesel	80	20	S20
	60	40	S40
	40	60	S60
	20	80	S80
	-	100	S100
Canola Biodiesel	80	20	C20
	60	40	C40
	40	60	C60
	20	80	C80
	-	100	C100

Determination of Test Fuel Properties

Fuel Properties of Test Fuels				
Test Fuels	**Density (kg/l)**	**Cetane Number**	**Kinematic Viscosity at 40^{o}C (mm^2/s)**	**Gross Heating Value (kcal/kg)**
D	0,837	59,3	2,7	45857
S20	0,844	53,8	4,2	44246
S40	0,854	53,0	4,5	43430
S60	0,865	50,9	4,6	42472
S80	0,876	47,6	5,1	41388
S100	0,886	44,5	5,5	39149
C20	0,846	54,3	4,5	43413
C40	0,857	53,4	4,8	42986
C60	0,867	51,7	5	41756
C80	0,877	49	5,2	40129
C100	0,883	46	5,4	38363

Zeltex ZX 440 NIR petroleum analyzer: Cetane Number
Tanaka AKV 202 auto kinematic viscosity test: Viscosity
Kyoto electronics DA-130: Density Measurement
IKA-Werke C2000 Bomb Calorimeter: Gross Heating Value

Experimental Set-up

Brand	Mitsubishi Canter
Model	4D31
Configuration	In line 4
Type	Direct injection diesel with glow plug
Displacement	3298cc
Bore	100 mm
Stroke	105 mm
Power	91 HP @ 3500rpm
Torque	223 Nm @ 2200rpm
Oil Cooler	Water cooled

Technical Data of Measuring System	
Brand	SINUS Messtechnik GmbH Soundbook_MK2
Resolution	24 Bit
Number of Channels	4 Measuring Channels (LEMO)
Accuracy	EN 60651 and EN 60804 class 1, IEC 61672-1 class 1, group Z, percentages according to DIN 45657
Sampling rates	51.2 kHz
Transducer Supply	Polarization voltage 20 V, 63 V or 200 V and ICP (2mA, 4mA)
Time Weighting	Fast =0.125 s
	Slow =1 s
	Impulse =0.035 s
	Peak = 20µs

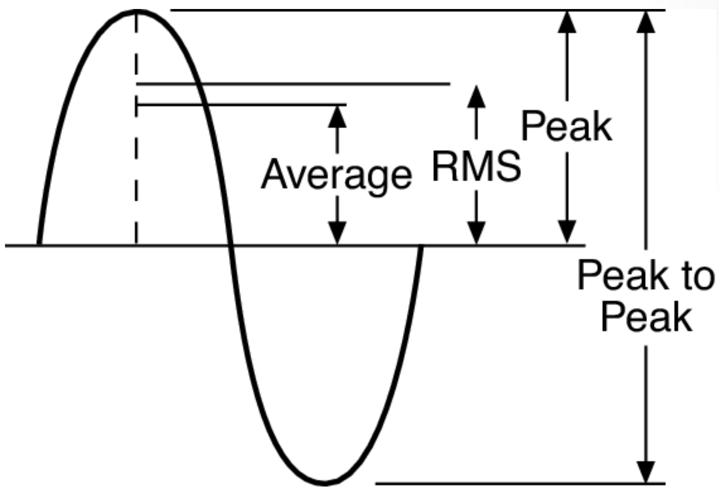
Technical Specifications of Accelerometer (PCB-356A33)	
Brand	PCB-356A33
Performance	
Sensitivity (±10 %)	1.02 mV/(m/s²)
Measurement Range	±4905 m/s² pk
Frequency Range (±5 %)	2 to 10000 Hz
Frequency Range (±5 %)	2 to 7000 Hz
Resonant Frequency	≥55 kHz
Broadband Resolution (1 to 10000 Hz)	0.04 m/s² rms
Non-Linearity	≤1 %
Transverse Sensitivity	≤5 %
Environmental	
Overload Limit (Shock)	±98100 m/s² pk
Temperature Range	-54 to +121 °C
Physical	
Sensing Element	Ceramic
Sensing Geometry	Shear
Housing Material	Titanium

Calculation of RMS value

- $a_w = \sqrt{\frac{1}{T}\int_0^T a_w^2\,(t)dt}$

a_w : weighted acceleration (m/s^2)

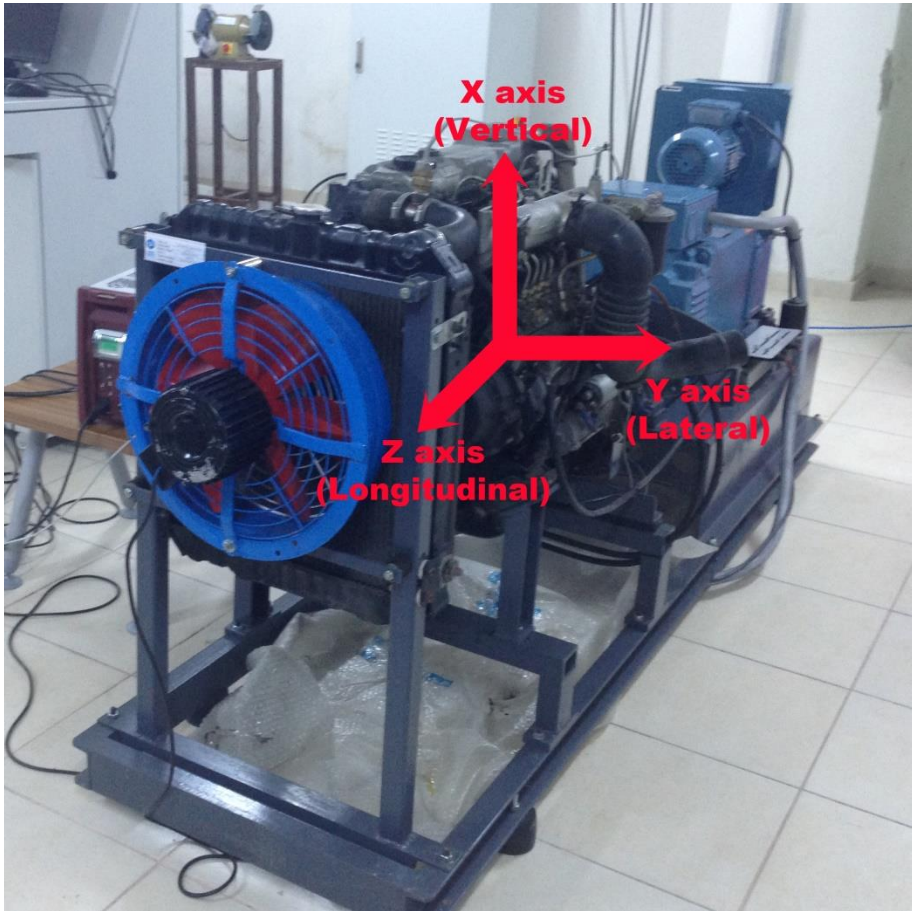
T: measurement time



- $a_{total} = \sqrt{a_{vertical}^2 + a_{lateral}^2 + a_{longitudinal}^2}$

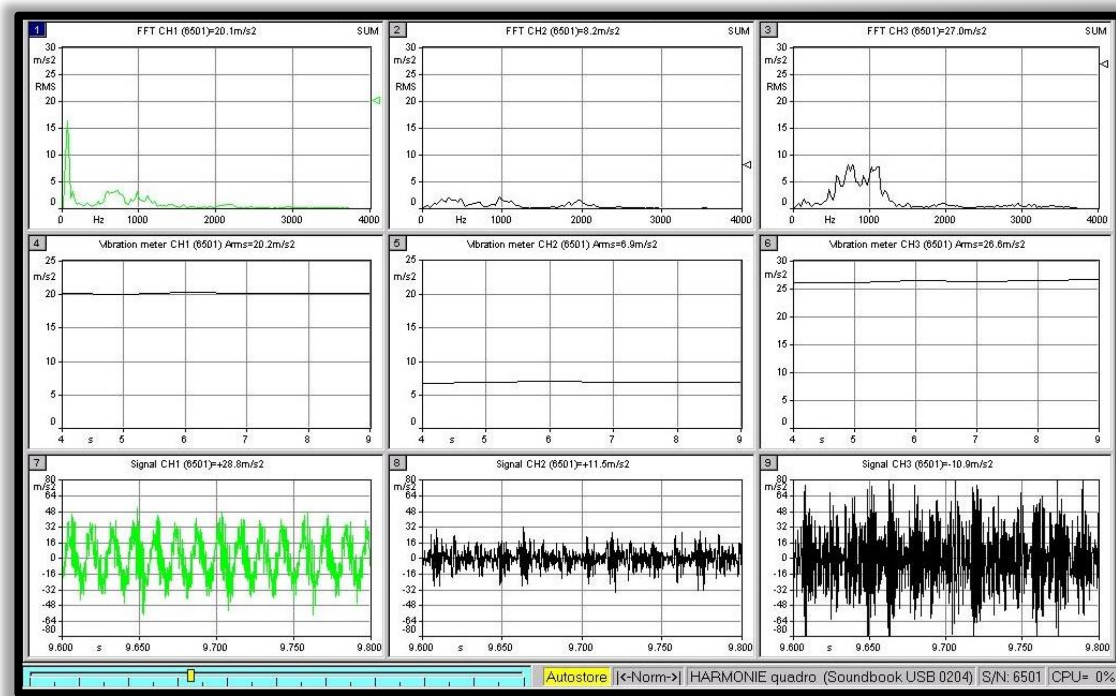
a_{total}: combined acceleration of three axes

Axes of the Test Engine

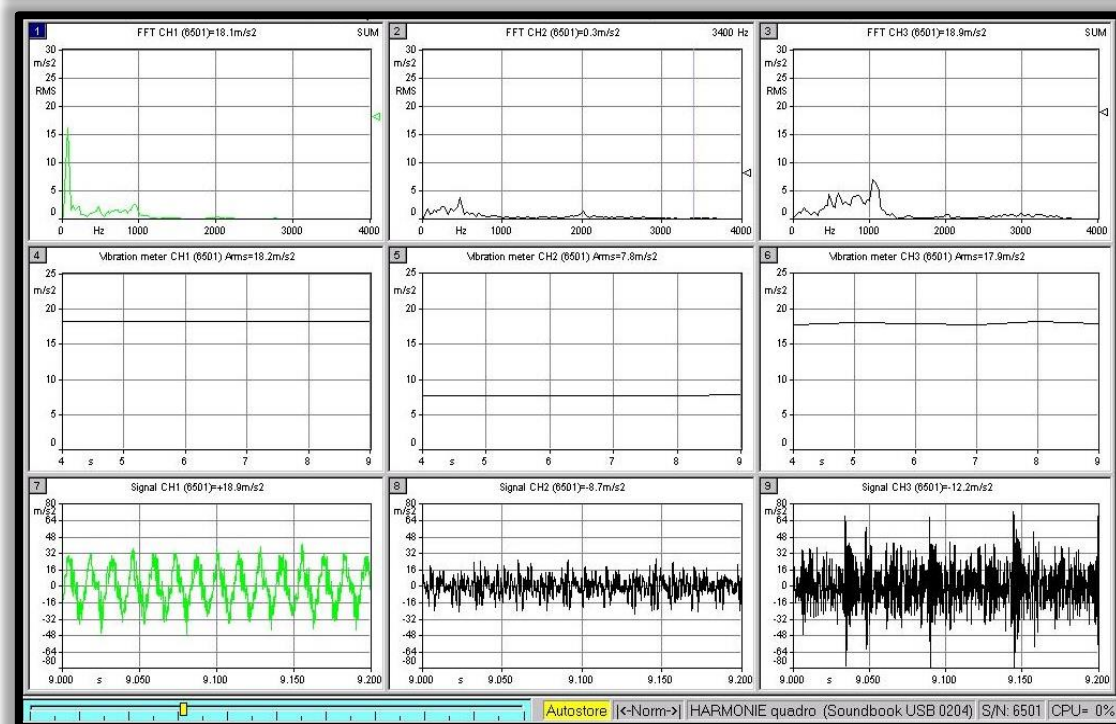


Comparison of Different Fuels

D@2200 rpm

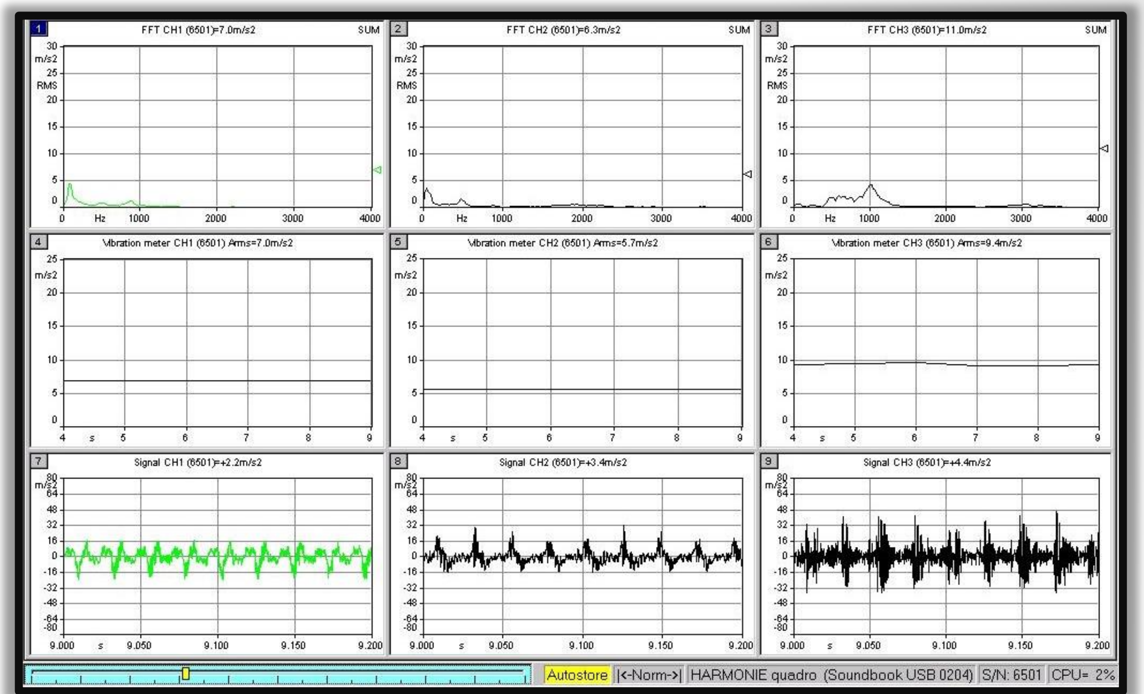


C60@2200 rpm

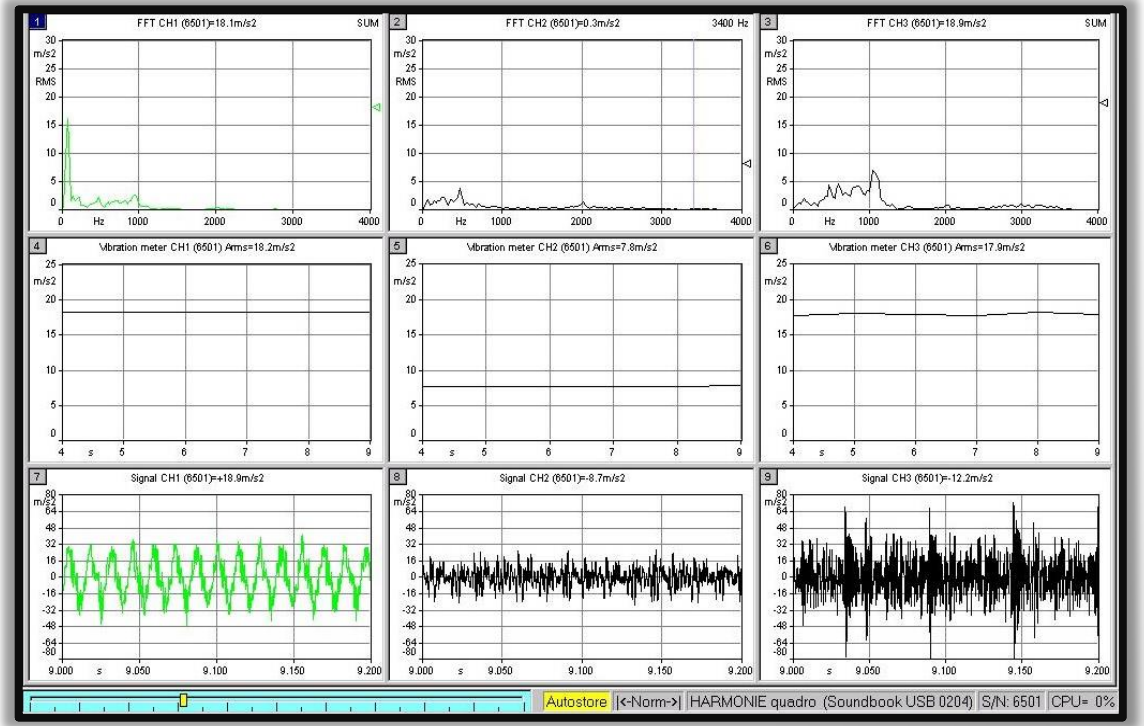


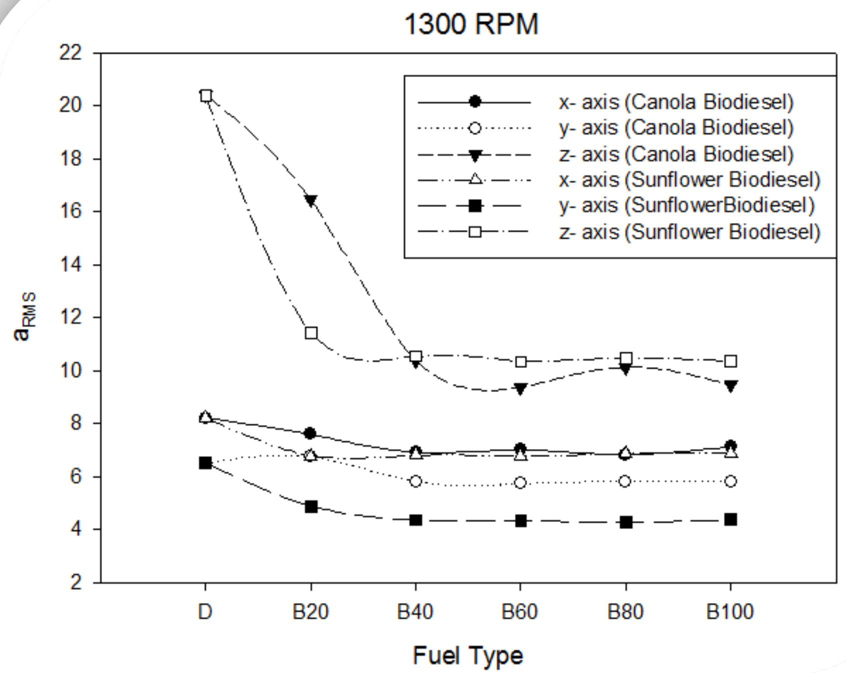
Comparison at Different Engine Speeds

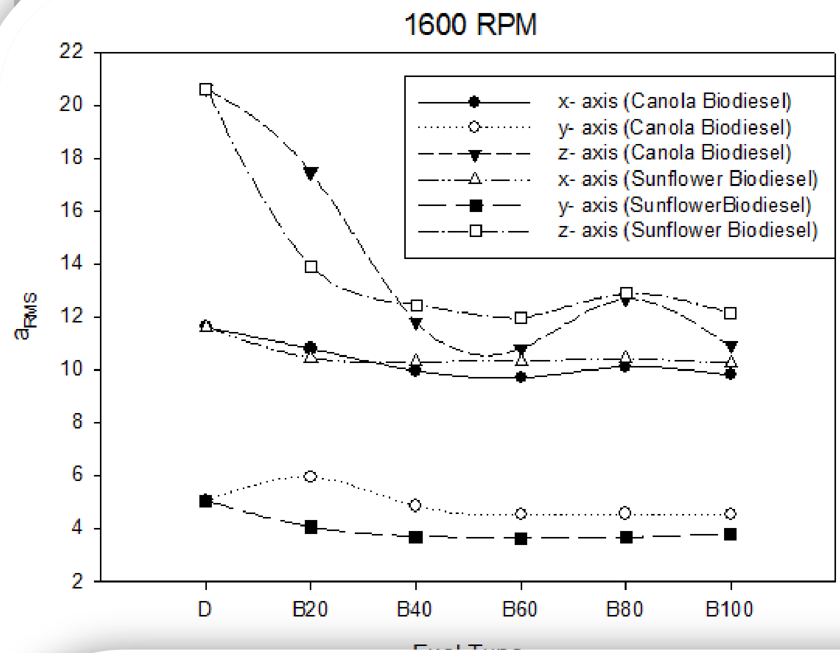
C60@1300 rpm

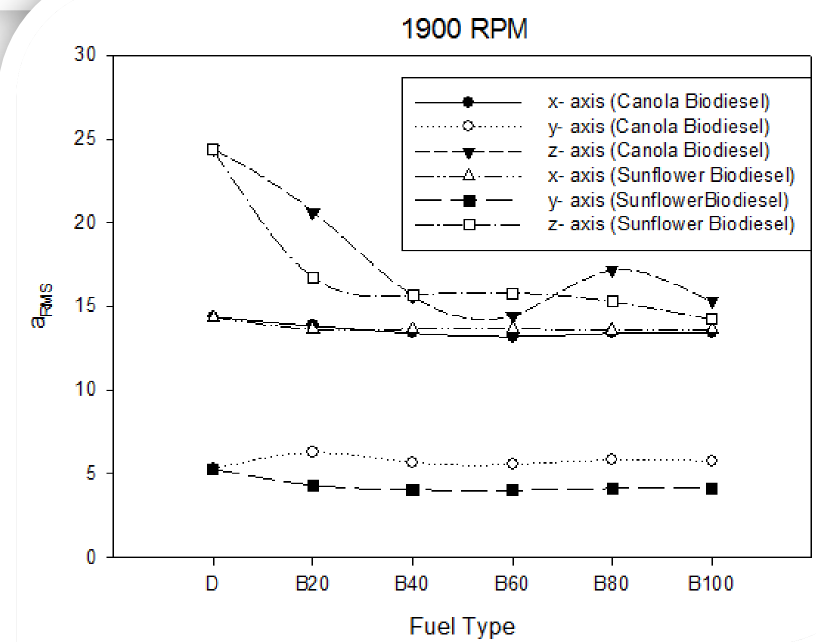


C60@2200 rpm



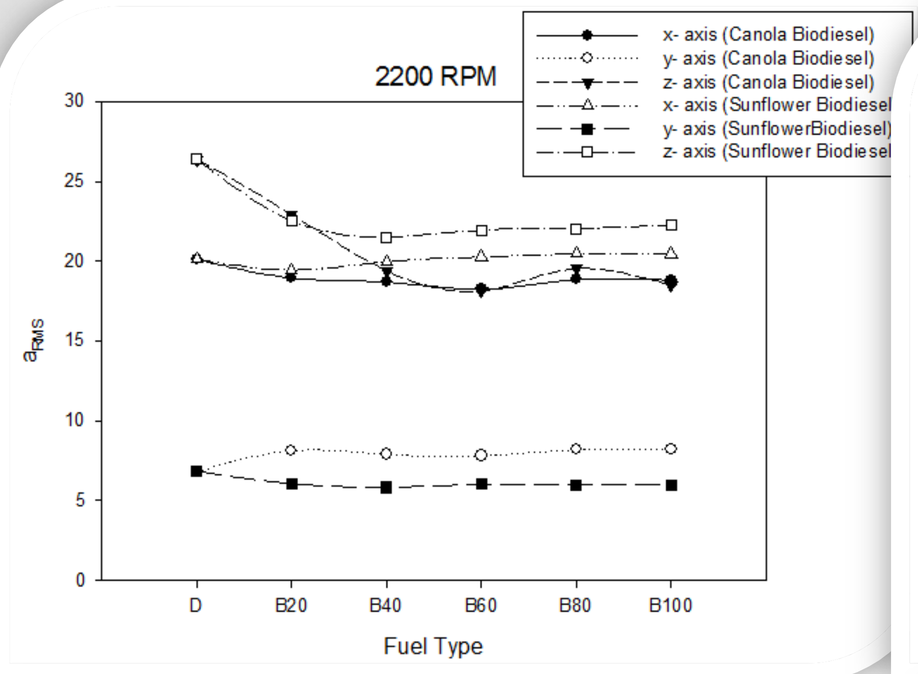


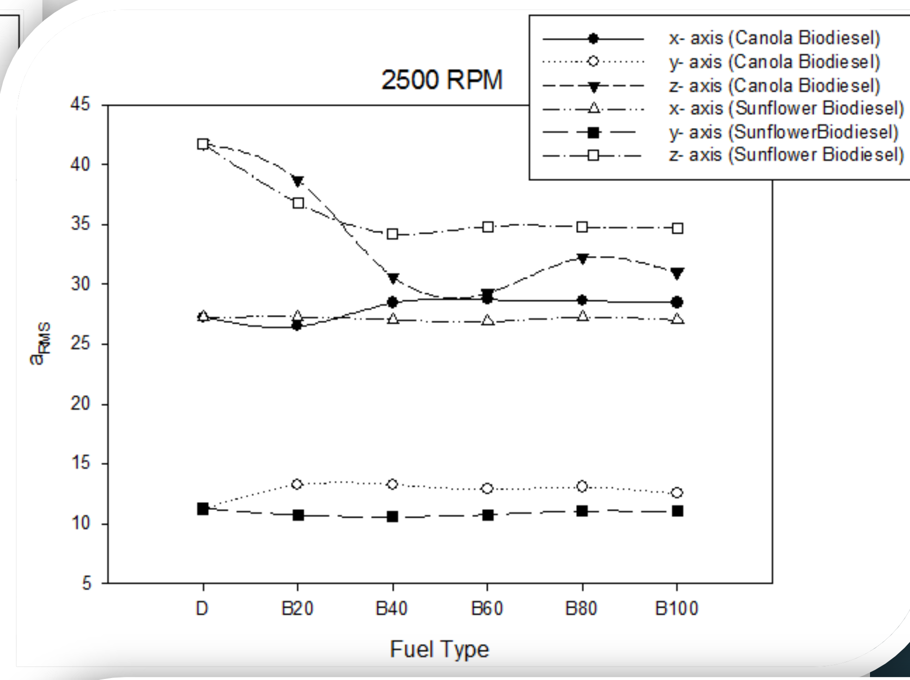


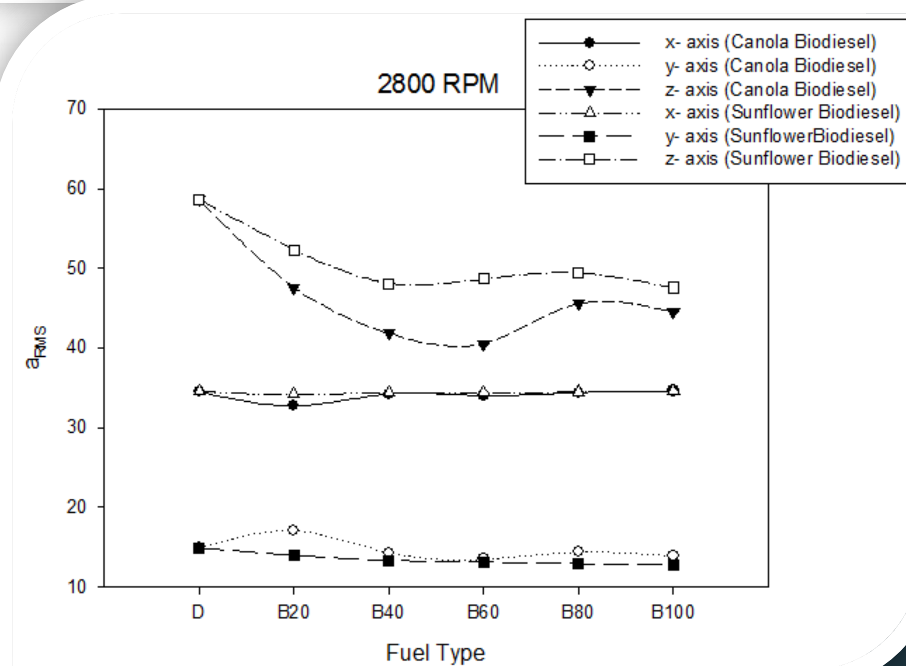


D : Low Sulphur Diesel
B20 : 20% biodiesel ratio into D (by volume)
B40 : 40% biodiesel ratio into D (by volume)
B60 : 60% biodiesel ratio into D (by volume)
B80 : 80% biodiesel ratio into D (by volume)
B100: Biodiesel

Comparison of different fuels at x- y- z axes







D : Low Sulphur Diesel
B20 : 20% biodiesel ratio into D (by volume)
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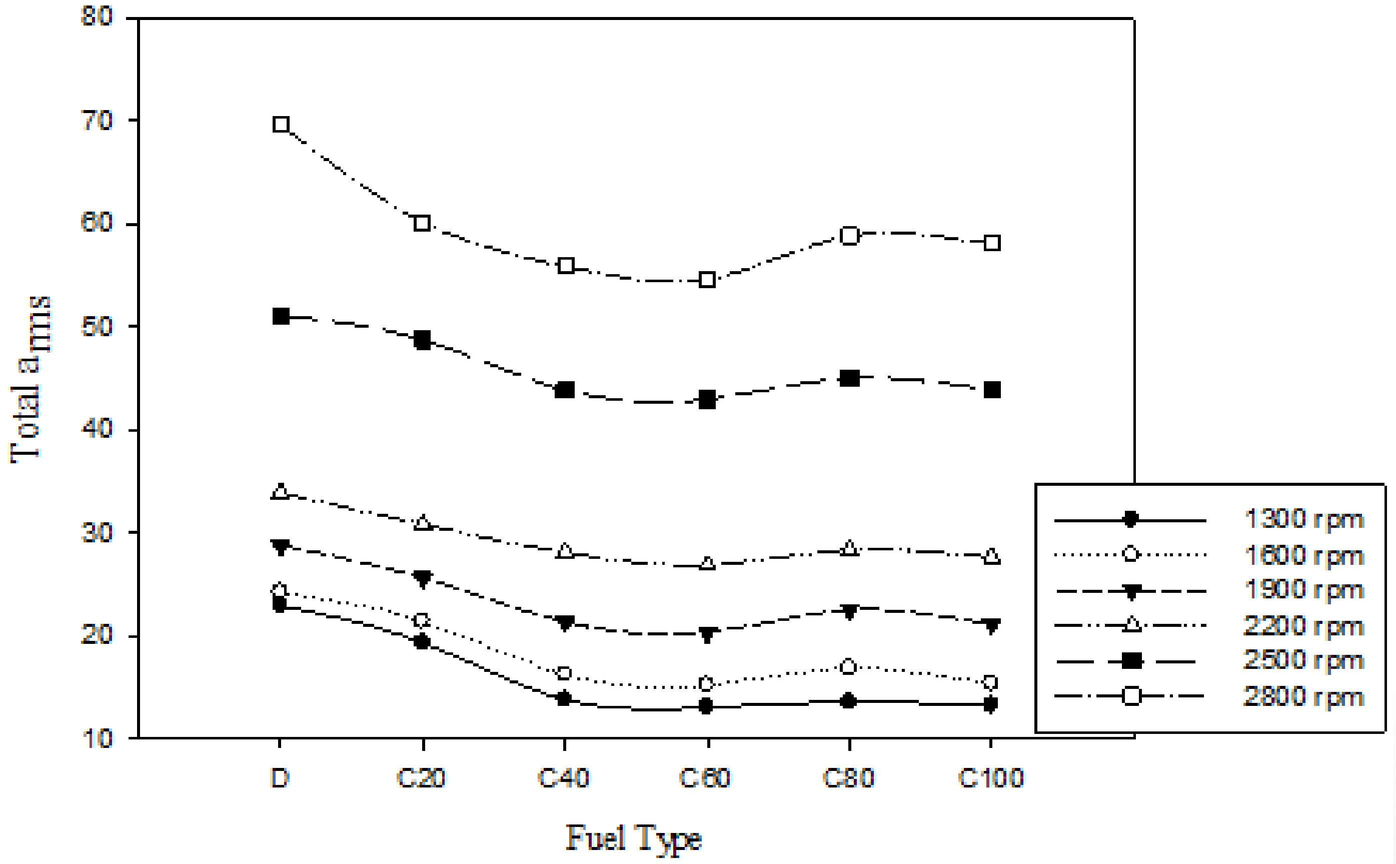
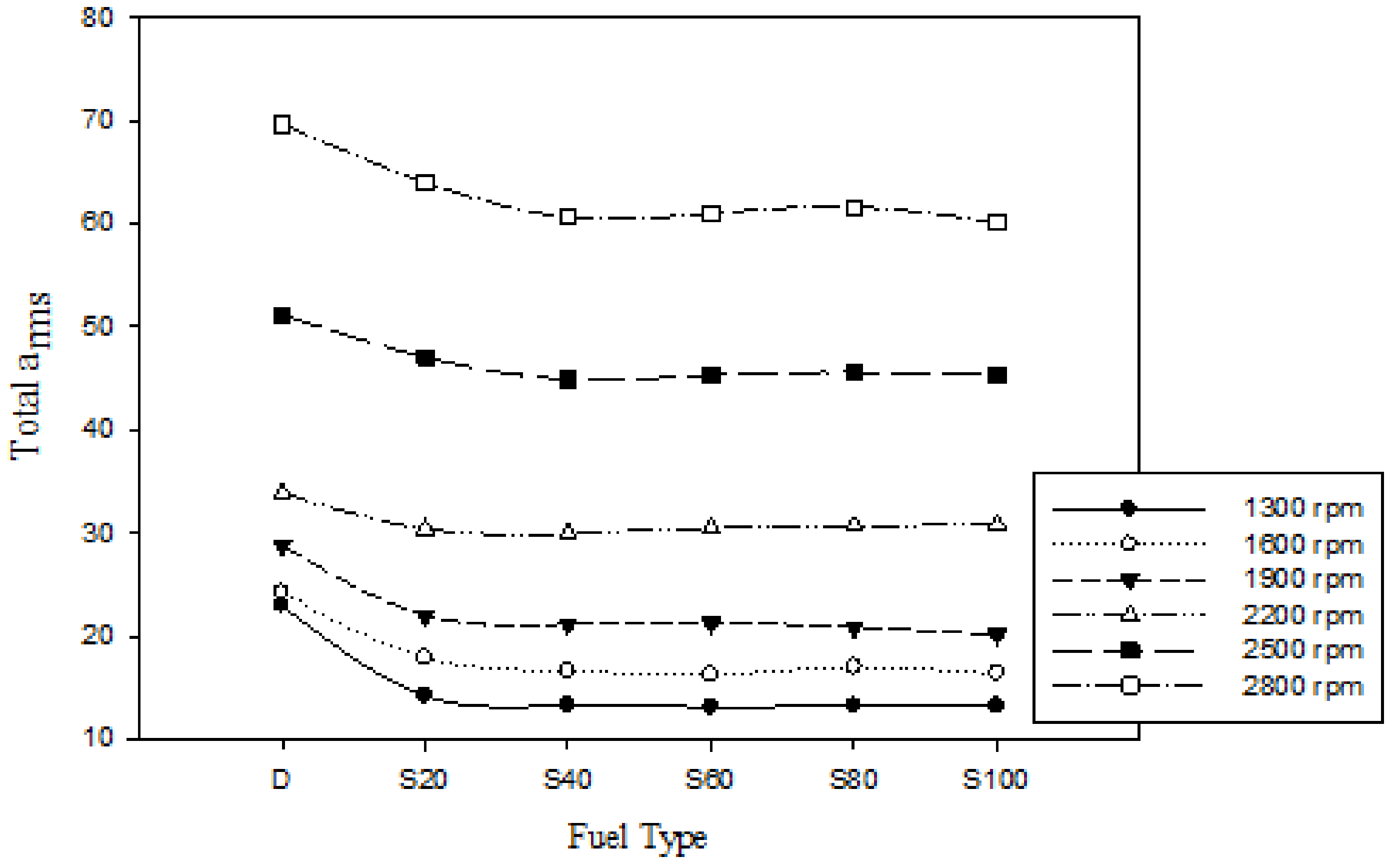
B60 : 60% biodiesel ratio into D (by volume)
B80 : 80% biodiesel ratio into D (by volume)
B100: Biodiesel

Comparison of different fuels at x- y- z axes

Total a_{rms} Values of Canola Biodiesel



Total a_{rms} Values of Sunflower Biodiesel



CONCLUSIONS

- Vibration amplitude increased with engine speed.
- Canola and sunflower biodiesel addition into the low sulphur diesel fuel decreased the vibration acceleration of the diesel engine. Sunflower biodiesel was improved the vibration amplitude more than canola biodiesel.
- Up to 40% biodiesel blend of canola and sunflower biodiesels with low sulphur diesel fuel, vibration values significantly improved, and the least value observed with 60% biodiesel blend for most of the test fuel.
- The results also showed that, even though total a_{rms} of all frequencies were highest at longitude axis, at all engine speeds; the maximum vibration amplitude occurred in vertical axis due to upward and downward piston movement.

Acknowledgements

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Thank you for your attention!

Erinç ULUDAMAR
Research Assistant
Çukurova University
Department of Mechanical Engineering
Automotive Division