ASSESSMENT OF POLLUTION CHARACTERISTICS ON 2-STROKE AND 4-STROKE ENGINES WHEN METHANOL AND GASOLINE ARE MIXED

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ABSTRACT
Everyone in the current situation is dealing with issues brought on by the rise in emissions from the IC engines utilized in all automobiles. These pollutants prove to be extremely dangerous to human life because they cause the body to produce dangerous carcinogens, which cause cancer, a disease that can be fatal. The current project, " Assessment Of Pollution Characteristics On 2-Stroke And 4-Stroke Engines When Methanol And Gasoline Are Mixed," has been taken on with the goal of lessening the harmful emissions from the engines. Since CH3OH is a common by-product of many processing businesses, including sugar factories, paper mills, etc., it has been chosen for this work since it is a renewable supply. CH3OH burns similarly characteristics as that of gasoline.

1. INTRODUCTION

It is predicted that crude oil and petroleum products would become extremely expensive to find and produce in this century. Even if engine fuel efficiency has significantly improved over the years and will likely continue to do so, the growing number of cars alone indicates that there will be a high need for gasoline in the near future. Fuels like gasoline and diesel will get more expensive and scarcer. In the upcoming decades, alternative fuel technology, accessibility, and utilization must and will increase. Concern over the emissions issues with gasoline engines is what's driving the development of alternative fuels for IC engines. Combined with other air-polluting systems, the large number of automobiles is a major contributor to the air quality problem of the world. Quite a lot of improvements have been made in reducing emissions given off by an automobile engine.

1.1. Emissions with Alternate Fuels:

The emissions are due to

1. Oxides of nitrogen (NO_x),
2. Oxides of carbon (CO_x),
3. Unburnt hydrocarbons (HC) and
4. Solid carbon particulates.

1.2 Techniques to meet Emission Norms:

To meet extremely stringent emission standards in an automotive engine, extensive researches have been carried out to explore various ways to reduce NOx and particulate emissions from petrol engines. The methods and techniques to reduce emission of pollutants from internal combustion engines usually decrease its performance. Considering the impossibility of a short term modification in the current standards of energy consumption, the most effective way for reducing environmental impacts relies on increasing the efficiency of the thermal engines. In other words, research should be carried out on development of more efficient engines or to apply means, for the current level of technology, to minimize entropy generation. Specifically, for internal combustion engines, a reasonable solution is the reduction on pollutant formation by controlling some combustion parameters in such way that engine performance is kept unaltered. An effective way for reducing nitrous oxide (NOx) emissions may be accomplished by changing the engine combustion process through the recycling of exhausted gases. This process is accomplished by adding combustion products to the fresh fuel-air mixture during the intake process. This technology is known as Exhaust Gas Recirculation (EGR) and has been applied in both spark ignition engines and compression ignition engines. The presence of inert molecules reduces the temperature and the combustion pressure inhibiting the formation of NO, by the thermal mechanism, as well as increases the detonation tolerance, (Heyhood, 1998). This method, however, while effective in reducing NOx emissions, may lead to considerable losses in engine performance.

II. LITERATURE REVIEW

- Sato et al (1997), Sousa (2000), Kohketsu (1997) (1):Several authors, They have discussed the advantages and disadvantages of the EGR technology. They have, also, proposed ways to minimize the drawbacks when applying EGR technology in different types of diesel and gas engines.
- Bortolet et al (1999) (2):Presented a fuzzy modeling method to an engine air inlet that operates on EGR. Abd-Alla and co-workers (2001), investigated the effects of diluent admissions and intake air temperature in EGR on the emissions of an indirect injection dual fuel engine. They found that diluents addition decreased NOx emissions. Even larger reduction was observed when carbon dioxide was added to the inlet gaseous fuel air charge.
- Abd-Alla et al (2002) (3):Presented a review on exhaust gas recirculation applied to internal combustion engines. The aim of the work was to review the potential of EGR to reduce exhaust emissions, mostly NOx, and to delimit the application range of the technology.
- Zheng et al (2004) (4):Reviewed the advanced and novel concepts in diesel engine exhaust gas recirculation. They claimed that EGR is effective to reduce nitrogen oxides from diesel engines while increasing particulate matter. Power losses are significant when EGR is further increased.
- Lu and coworkers (2005) (5):They conducted a fundamental study on the control of the HCCI combustion and emissions by fuel design concepts combined with controllable EGR. Cooling EGR prolonged the time for combustion. EGR had little effects on CO and HC emissions on HCCI engines.
- Heyhood (1998) (6):Despite the number of works on EGR technology, there is still a room for further investigation in SI engines when combining EGR, for pollutant reduction, and turbo charging for performance recovery. The lack of information on this specific subject has, therefore, motivated this work.Inert gases have a combined effect of reducing NOx and increase the knocking tolerance.

III. METHODOLOGY

3.1 Fuel sample preparation: Gasoline fuel is purchased from nearest petrol filling station and methanol is purchased from chemical supply stores. Various Gasoline-Methanol blends are prepared in chemical laboratory using magnetic stirrer. Gasoline-Methanol blends can be prepared by mixing gasoline and methanol in proper ratio by volume basis and then by stirring the Gasoline-Methanol mixture using magnetic stirrer without giving heat until the blend reaches proper mixture i.e. approximately 30 to 40 minutes so that the blend is stable for long time.

Table-3.1 Properties of Methanol & Gasoline

S.No	CHARACTER	METHANOL	Gasoline
1	Molecular weight	32.04 g/mol	100-105g/mol
2	Sp. Gravity	0.8	0.7-0.8
3	Density	791.8 kg/m^3	700-780 kg/m^3
4	Boiling Temp (°C)	64.5	27-255
5	Freezing point (°C)	-97.7	-57
6	Ignition Temp (°C)	464	390-420
7	Air fuel ratio	6.42:1	14.7:1
8	Octane number	111	80-99
9	Cetane number	55-60	0-10

Test Fuel Samples: Six different blends such as M10 (Methanol 10% & Gasoline 90% by vol.), M20 (Methanol 20% & Gasoline 80%), M30 (Methanol 30% & Gasoline 70%), M40 (Methanol 40% & Gasoline 60%), M50 (Methanol 50% & Gasoline 50%) and M60 (Methanol 60% Gasoline 40% by vol.) are prepared with the increment of 10% vol. of methanol to each blend. All the samples used in the work shown below.

FIG 3.1. Test Fuel Samples

FIG 3.2.Magnetic Stirrer

IV.EXPERIMENTATION

4.1 Experimental Setup:

The experimental set up consists of 2 petrol engines having 2-stroke operation and 4-stroke operation approximately nearer horse power and rated speed, a single cylinder four-stroke, air-cooled and two stroke, air-cooled, SI ignition engines are considered for this work..

The experimental setup consists of the following major equipment:

1. Single cylinder 2-stroke and 4-stroke engines,
2. Exhaust gas Analyzer,
3. Magnetic Stirrer

4.1.1. Introduction to 2-stroke and 4-stroke engines:

The 2-Stroke Engines are actually simple internal combustion engines they are even simpler than 4-Stroke Engines. As it also faced complications while understanding the mechanism of 2-stroke engines explained theoretically but it may help to study the working of 2-stroke engines in simple and easy terms. To begin with one should understand that, one thing is common between both 2-stroke and 4-stroke engines and that is both are "engines" and the job of an engine is to produce power and torque by using mixture of Air and Fuel. The Engine mainly consists of Head and Block, the Head contains the Spark plug and in case of 4-stroke engines it also consists of inlet and outlet Valves.

The 2-stroke engines are being discontinued mainly due to its polluting nature and poor mileage. The strict emission norms didn't tolerate the polluting nature of two stroke engines, as the entire combustion cycle completes in 2 strokes of piston mixing of spent gasses and the mixture of fresh fuel and air becomes inevitable making the two stroke engines not only polluting the nature but poor in fuel economy also. To complete the cycle of combustion in 4-stroke engines it takes four strokes of the piston, it means every single stroke carries out one of the four processes of the Combustion. While the piston goes down for the first time the inlet valve gets open drawing the mixture of fuel and air to the combustion chamber and then in the second stroke while the piston is coming back towards the top it Compresses the gas drawn in the first stroke and at the end of the second stroke the spark plug gets ignited and the Ignition takes place, with the force generated from the blast the piston goes down for the third stroke and finally the piston goes up with the Exhaust Valve open to expel the spent gasses out and there by completing all the four process of Combustion in 4 strokes of the piston hence the engine is called 4-stroke engine.

1. Two Stroke Engines can be identified by its distinctly loud and sharp sound, whereas 4-stroke engines have subdued sound with distinct- Purr.
2. The 2-Stroke engines are simple and light weight, where as 4-stroke engines are heavy and complex in nature.
3. The 2-stroke engines are quicker in acceleration then the 4-stroke engines as they complete the combustion cycle in almost half the time that any 4-stroke engine takes to complete.
4. Two stroke engines produce almost double the power then its same sized 4-stroke engine counterparts.
5. Two Stroke engines are cheaper to produce as there are less components used then 4-stroke engines.
6. The 2-Stroke engines are considered more vulnerable as there is no dedicated lubrication system in it hence if ignored damage to the engine is inevitable.
7. The 2-stroke engines are fast and quick in acceleration but are suicidal in long journeys with its poor lubrication system and fast engine wear and tear where as 4-stroke engines are considered as long lived engines even when used in long journeys riding continuously at very high speeds.
8. Two stroke engines are easy to maintain as compare to the 4-stroke engines.

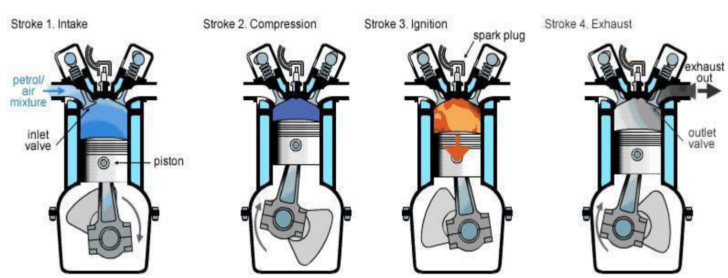

Fig.4.1. Operations in 4-stroke engine

4.2. Exhaust Gas Analyzer:

Gas analyzer as shown in Figures 4.6 & 4.7 is used to measure the CO, CO_2, HC, NOx and O_2 present in exhaust gas. This analyzer consists of four detectors namely, Non-Dispersive Infrared Detector (NDIR) which detects CO and CO_2 emission, Chemiluminiscence Detector (CLD) which detects NOx emission, Flame Ionization Detector (FID) which detects HC emission and Lambda sensor which senses the O_2. Specification of the gas analyzer is given in Table 4.3.

Fig.4.2. Exhaust Gas Analyzer

Fig.4.3. Pollution testing on 4-Stroke Engine (Hero glamour)

Table.4.1. Gas Analyzer measuring ranges

Measuring quality	**Measuring range**
CO	0…….10% vol.
CO2	0…….20% vol.
HC	0…….20000 ppm
O2	0…….22% vol.
Nox	0…….5000 ppm

Initially the engine is started with 100% petrol. It is send into the carburettor directly through a pipe. In this pollution characteristics i.e., the percentage of CO, CO_2, O_2, NO_X, HC etc., are noted from the pollution checking apparatus. The type of pollution apparatus used for the above experiment is adsorption type. In the next

step a specific amount of methanol (say 10 %) is mixed with petrol and the above process is carried out and the pollution characteristics are noted down. In the same way the remaining process is carried on with various specific proportions of methanol mixed in petrol. This is carried out until results obtained are satisfactory i.e., the percentages of CO, CO2, etc., are decreased to a certain amount. After the complete results are obtained, various graphs are plotted against the percentage of methanol blended in petrol.
The above experiment is carried out at constant speed, say 1500 rpm.
The experimentation carried with 2-stroke engine operating with different blended fuel samples and the results are compared with the results obtained when the same engine run by pure petrol. There after the 4-stroke engine considered with the same procedure. The test engines considered for this work is approximately nearer HP hence the results obtained are compared both the cases in the next chapter .

RESULTS & DISCUSSION

Experimentation was taken up to study the performance of 2-stroke petrol engine and 4-stroke petrol engine fueled with prepared fuel samples of petrol- methanol blends in various proportions at constant speed and there the emissions are measured for same petrol engines and same procedure followed to run with pure petrol for considering datum.

5.1. 2-stroke petrol engine

In case of 2-stroke engine investigations the addition of methanol gives low fuel consumption for M10, M20, M30, M40 and M50 when compared to the petrol operation that can be observed in figure 5.1. Also the methanol addition liberated emissions when compared to petrol operation can be observed in figures.5.2 – 5.5.

2-STROKE ENGINE READINGS AND GRAPHS:

Table 5.1. 2-stroke engine readings

S.No	CH_3OH % INPETROL	SPEED(RPM)	CO %vol	HC ppm	CO_2 %vol	O_2 %vol
1	0	1500	20.77	3240	1.1	15.37
2	10	1500	1.426	3020	1	21.38
3	20	1500	0.77	2930	0.3	19.41
4	30	1500	0.664	2500	0.4	20.7
5	40	1500	0.984	3080	0.7	19.9
6	50	1500	0.464	3750	1	11.67
7	60	1500	2.31	6320	4.7	0

As per the observations, when compared to pure petrol engine M0 Fuel consumption is 6%, 23%, 26%, 14%, 10% decreases for M10, M20, M30, M40 and M50 respectively as shown in Fig.5.1.

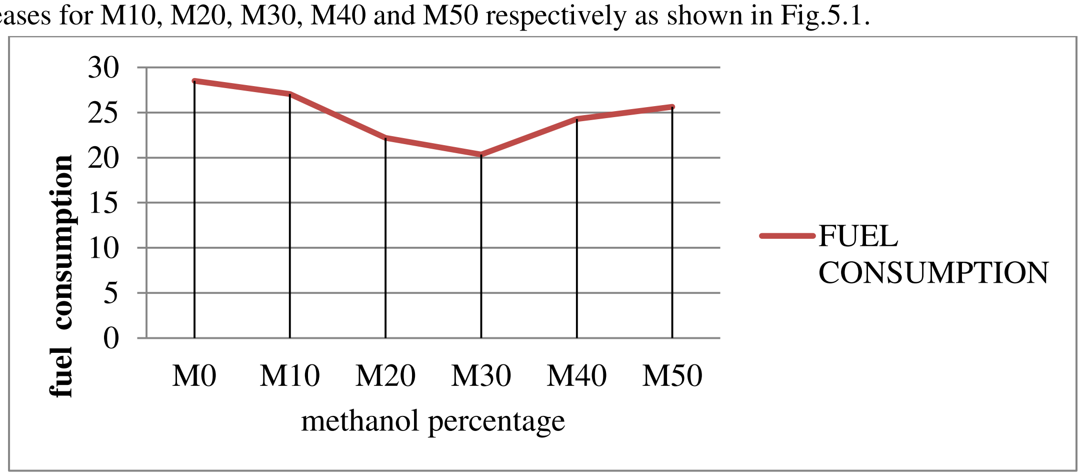

Fig.5.1. Fuel consumption for all blends (2-Stroke)

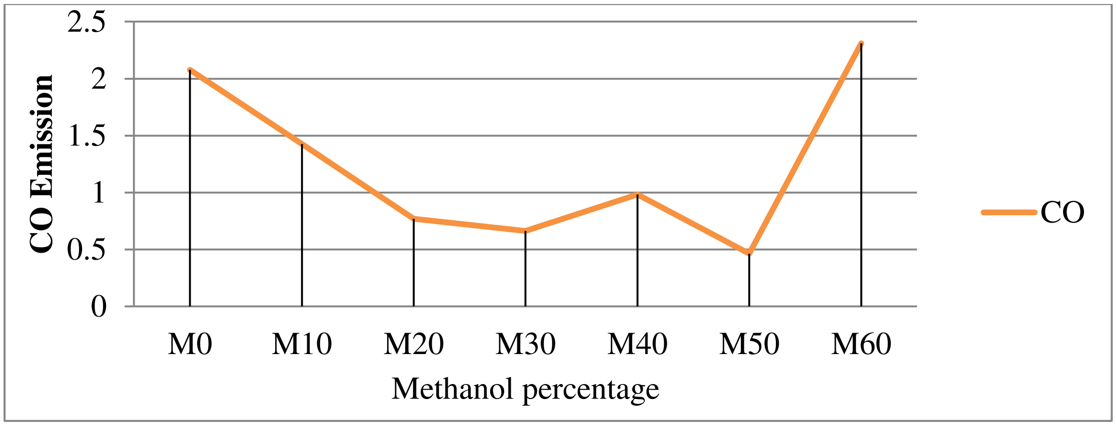

Fig.5.2. CO Emissions for blended fuels (2-Stroke)

Fig.5.2. indicates CO emission reduction in 2-stroke engine operated with blended fuels except M60 as compared with pure petrol operation. 32% of CO is decreased for M10, 63% of CO is decreased for M20, 69% of CO is decreased for M30, 53% of CO is decreased for M40, 78% of CO is decreased for M50 and 12% of CO is increased for M60 compared to M0.

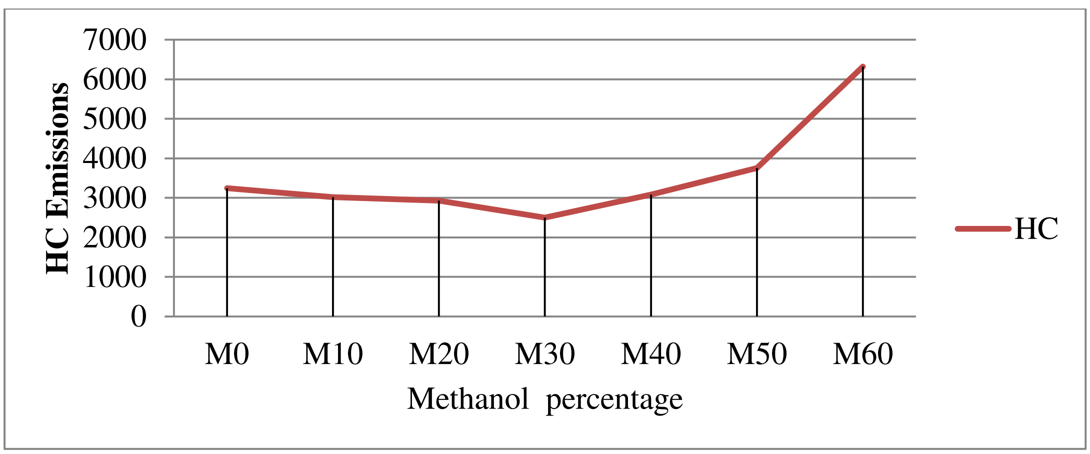

Fig.5.3. HC Emissions for all blended fuels (2-Stroke)

Fig.5.3. indicates HC emission reduction in 2-stroke engine operated with blended fuels except for M50 and M60 as compared with pure petrol operation. 7% of HC is decreased for M10, 10% of HC is decreased for M20, 23% of HC is decreased for M30, 5% of HC is decreased for M40, 16% of HC is increased for M50 and 96% of HC is increased for M60 compared to M0. The same and similar observations can be found for CO_2 emissions for blended fuels as shown in fig.5.4.

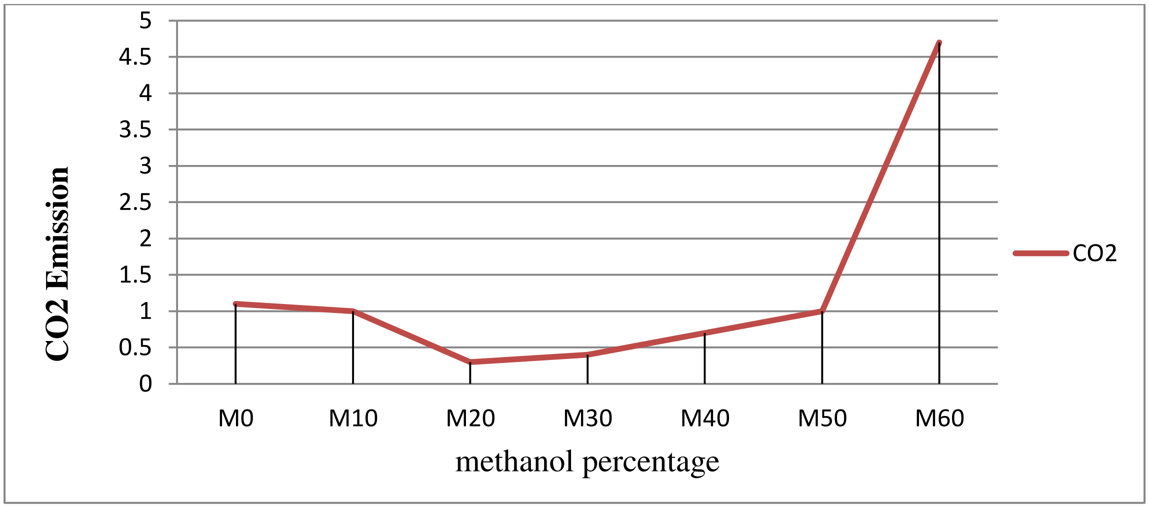

Fig.5.4. CO_2 Emissions for all blended fuels (2-Stroke)

Fig.5.4. indicates the CO_2 emissions of all fuel samples compared with pure petrol operation and observations are decreasing 10% of CO_2 for M10, 73% of CO_2 for M20, 63% for M30, 36% for M40 and 10% for M50 and increasing 328% of CO_2 for M60 compared to M0. Obviously it can be observed increment in O_2 liberation in Fig.5.5.

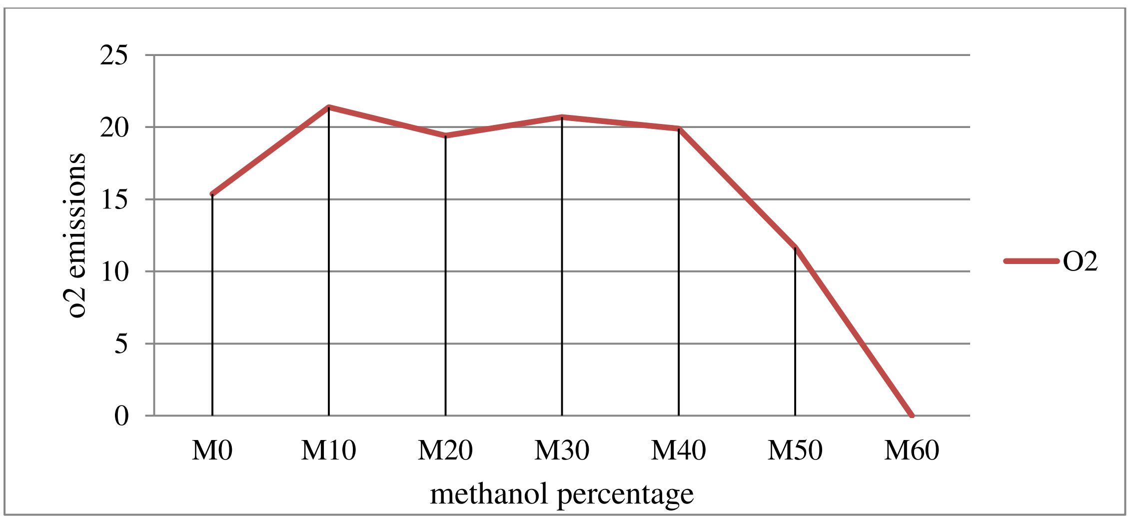

Fig.5.5. O_2 Emissions for all blended fuels (2-Stroke)

Fig.5.5. indicates the O_2 emissions of all fuel samples compared with pure petrol operation and observations are increasing 40% of O_2 for M10, 27% of O_2 for M20, 35% for M30, 30% for M40 and decreasing 25% for M50 100% of O_2 for M60 compared to M0. And there are no emissions of NO_X for the fuel samples in two stroke engine.

5.2. 4-Stroke petrol engine:

In case of 4-stroke engine investigations the addition of methanol gives low fuel consumption for M10, M20, M30, M40 and M50 when compared to the petrol operation that can be observed in figure 5.6. Also the methanol addition liberates emission when compared to petrol operation it can be observed in figures.5.7 – 5.11.

4-STROKE ENGINE READINGS AND GRAPHS:

Table 5.2. 4-stroke engine readings

S.No	CH_3OH % in petrol	SPEED(RPM)	CO %vol	HC ppm	CO_2 %vol	O_2 %vol	NO_X ppm
1	0	1500	3.25	443	3.9	6.07	0
2	10	1500	1.85	573	2.5	5.4	0
3	20	1500	1.34	213	2	19.44	0
4	30	1500	1.095	224	1.6	10.27	1
5	40	1500	2.579	170	4.2	10.95	0
6	50	1500	0.06	823	1.6	14.68	0
7	60	1500	0.295	428	3.8	8.22	0

As per observations when compared to pure petrol engine M0 Fuel consumption for 4-Stroke engine is 9%, 28%, 33%, 20%, 2.05% decreases for M10, M20, M30, M40 and M50 respectively as shown in Fig.5.6.

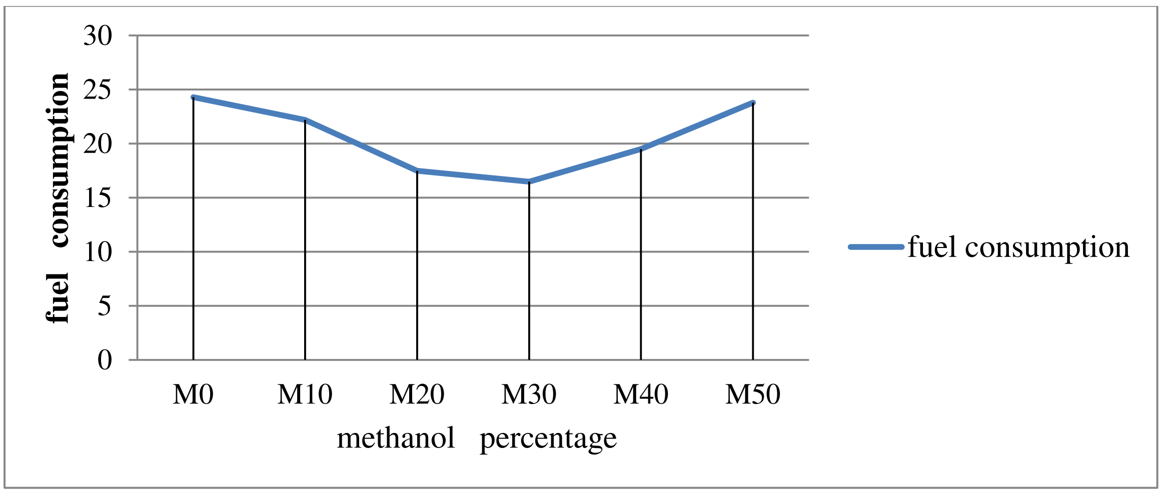

Fig.5.6. Fuel consumption for all blends (4-Stroke)

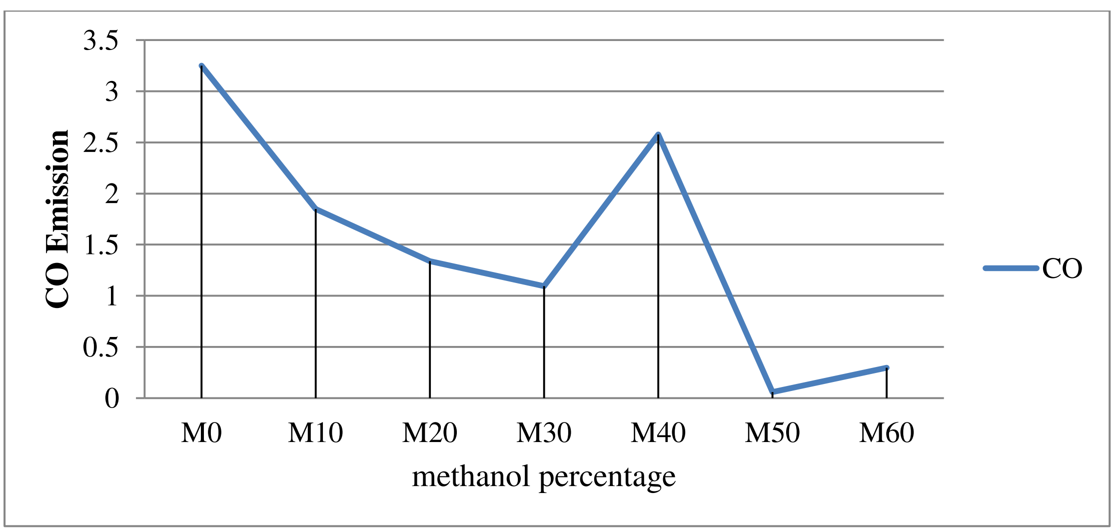

Fig.5.7. CO Emissions for blended fuels (4-Stroke)

Fig.5.7. indicates CO emission reduction in 4-stroke engine operated with blended fuels as compared with pure petrol operation. 44% of CO is decreased for M10, 59% of CO is decreased for M20, 67% of CO is decreased for M30, 21% of CO is decreased for M40, 98% of CO is decreased for M50 and 91% of CO is decreased for M60 compared to M0. The same and similar observations can be found for HC emissions for blended fuels as shown in fig.5.8.

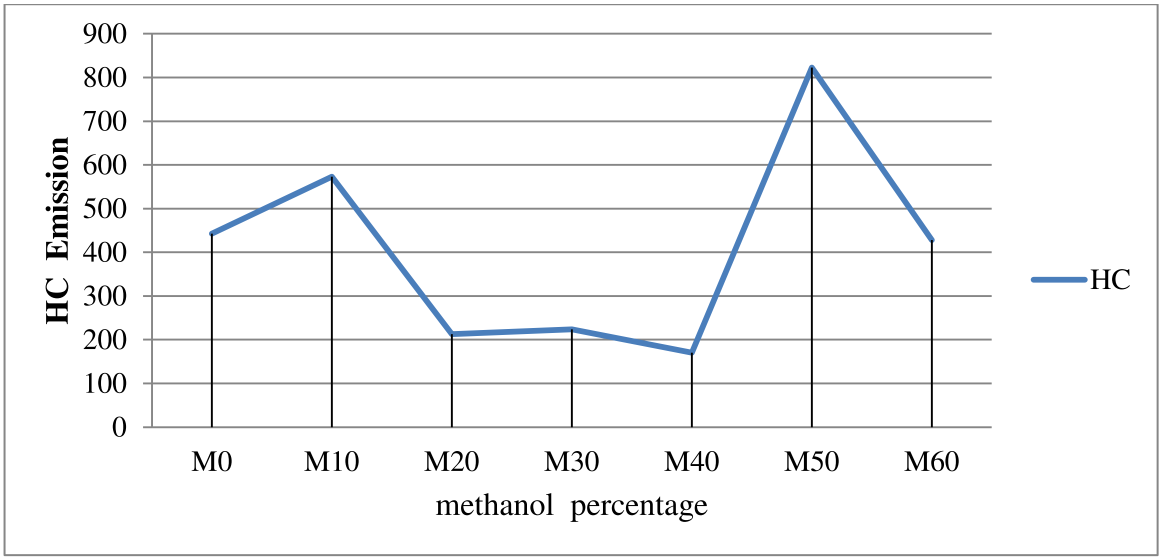

Fig.5.8. HC Emissions for all blended fuels (4-Stroke)

Fig.5.8. indicates HC emission reduction in 4-stroke engine operated with blended fuels except for M10 and M50 as compared with pure petrol operation. 30% of HC is increased for M10, 52% of HC is decreased for M20, 50% of HC is decreased for M30, 62% of HC is decreased for M40, 85% of HC is increased for M50 and 4% of HC is decreased for M60 compared to M0. The same and similar observations can be found for CO_2 emissions for blended fuels as shown in fig.5.9.

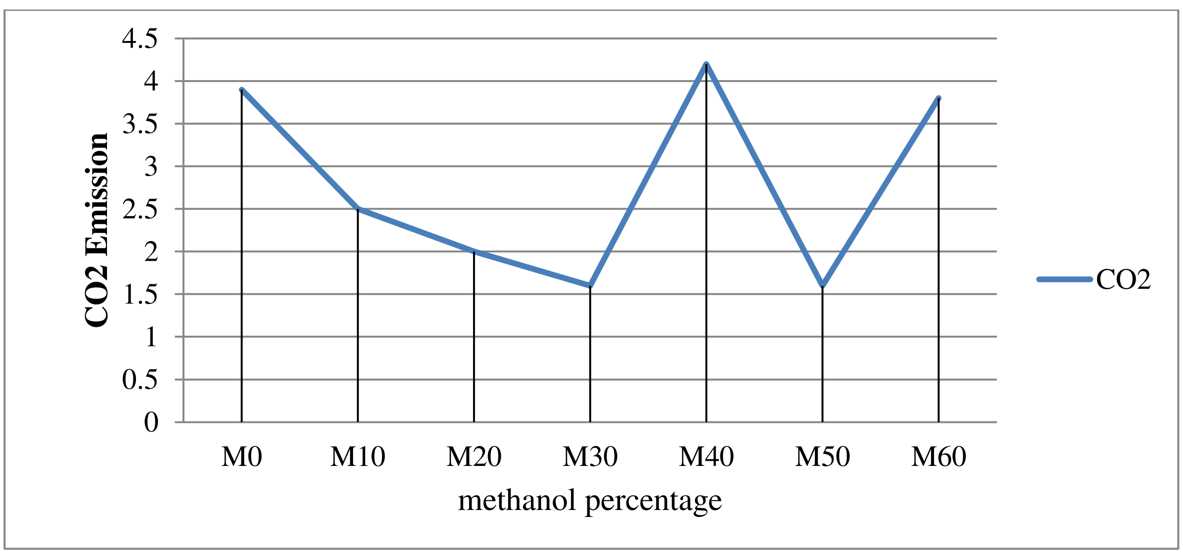

Fig.5.9. CO_2 Emissions for all blended fuels (4-Stroke)

Fig.5.9. indicates the CO_2 emissions of all fuel samples compared with pure petrol operation and observations are decreasing 36% of CO_2 for M10, 49% of CO_2 for M20, 59% for M30, 59% for M50 and increasing 8% for M40 and increasing 3% of CO_2 for M60 compared to M0. Obviously it can be observed increment in O_2 liberation in Fig.5.10

Fig.5.10. indicates the O_2 emissions of all fuel samples compared with pure petrol operation and observations are decreasing 12% of O_2 for M10, increasing 23% of O_2 for M20, 70% of O_2 for M30, 81% for M40, 141% for M50 and 36% for M60 compared to M0.

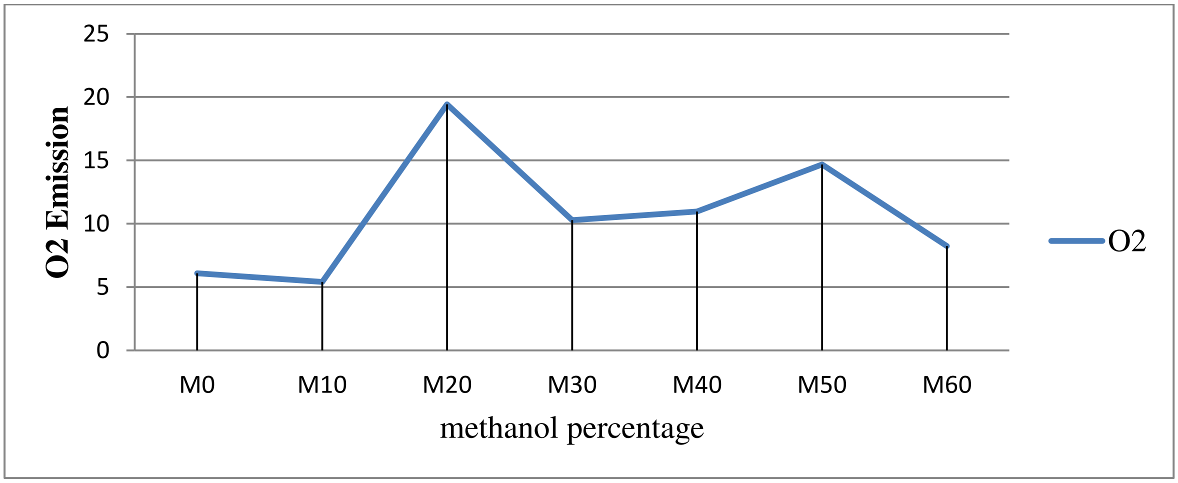

Fig.5.10. O_2 Emissions for all blended fuels (4-Stroke)

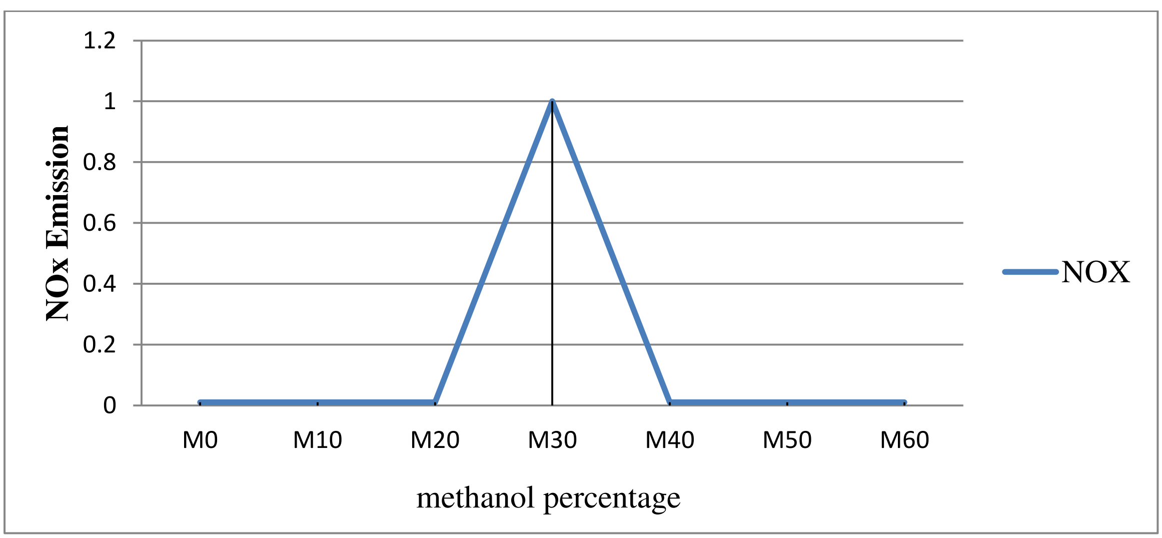

Fig.5.11. NOx Emissions for all blended fuels (4-Stroke)

5.3. Comparative Study between 2-stroke and 4-stroke engines:

As we compare all the emissions from the blended fuels on both 2-Stroke and 4-Stroke engines, the following figures from 5.12 – 5.18 shows the difference.

Table 5.3. 2-Stroke and 4-stroke engine readings

S.No	CH_3OH % in petrol	SPEED(RPM)	CO %vol		HC ppm		CO_2 %vol		O_2 %vol		NO_X ppm	
			2 Stro-ke	4 Stro-ke	2 Stro-ke	4 Stro-ke	2 St-oke	4 Str-oke	2 Str-oke	4 Str-oke	2 Str-oke	4 Str-oke
1	0	1500	20.7	3.25	3240	443	1.1	3.9	15.7	6.07	0	0
2	10	1500	1.42	1.85	3020	573	1	2.5	21.8	5.4	0	0
3	20	1500	0.77	1.34	2930	213	0.3	2	19.1	19.4	0	0
4	30	1500	0.66	1.09	2500	224	0.4	1.6	20.7	10.7	0	1
5	40	1500	0.98	2.57	3080	170	0.7	4.2	19.9	10.5	0	0
6	50	1500	0.46	0.06	3750	823	1	1.6	11.7	14.8	0	0
7	60	1500	2.31	0.29	6320	428	4.7	3.8	0	8.22	0	0

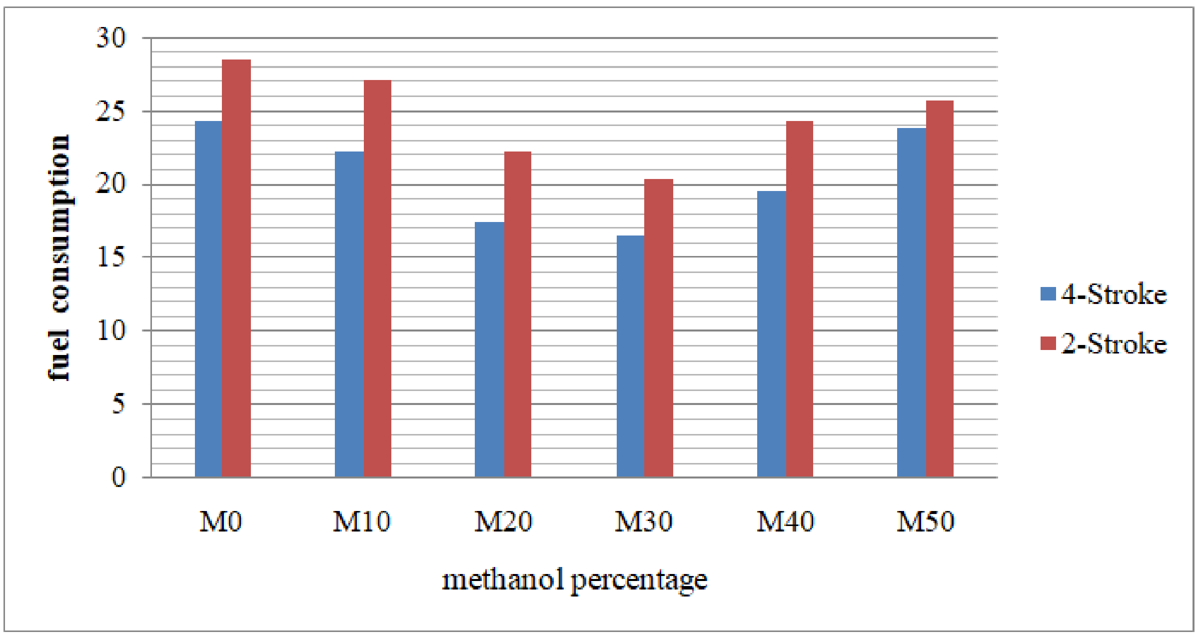

Fig.5.12. Fuel consumption for blended fuels

The causes of fuel consumption of the use of methanol fuel is higher than gasoline is due to volumetric energy content of methanol is lower than gasoline, thus causing more a mixture of methanol-gasoline needed to produce the same power compared to using gasoline.

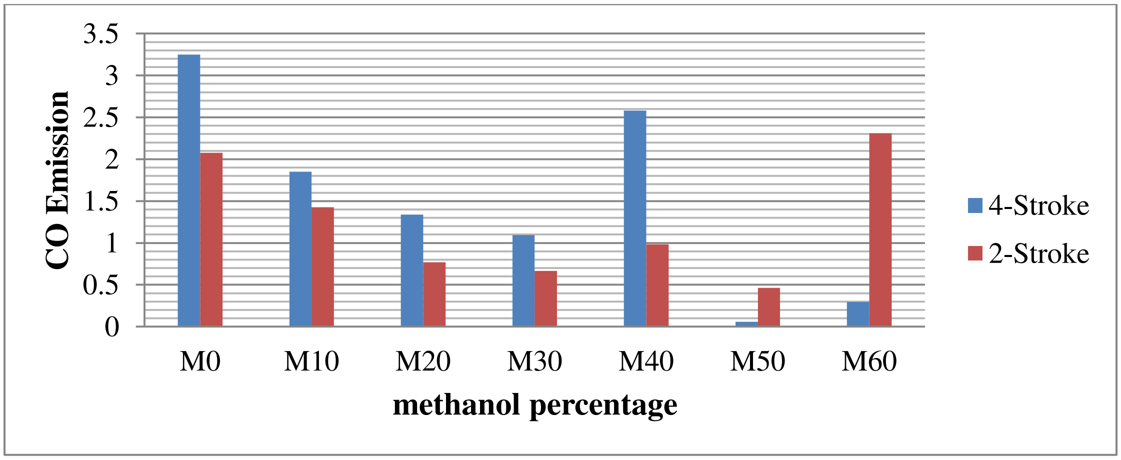

Fig.5.13. CO Emissions

The graph showed that when methanol percentage increases, the concentration of CO emission is decreases. This can explained by the oxygen content owing of methanol, in which an increase in of oxygen content of fuel will increase the further oxidation of CO during the engine exhaust process. Another significant reason of this reduction is that methanol (CH3OH) has less carbon than gasoline (C8H18).

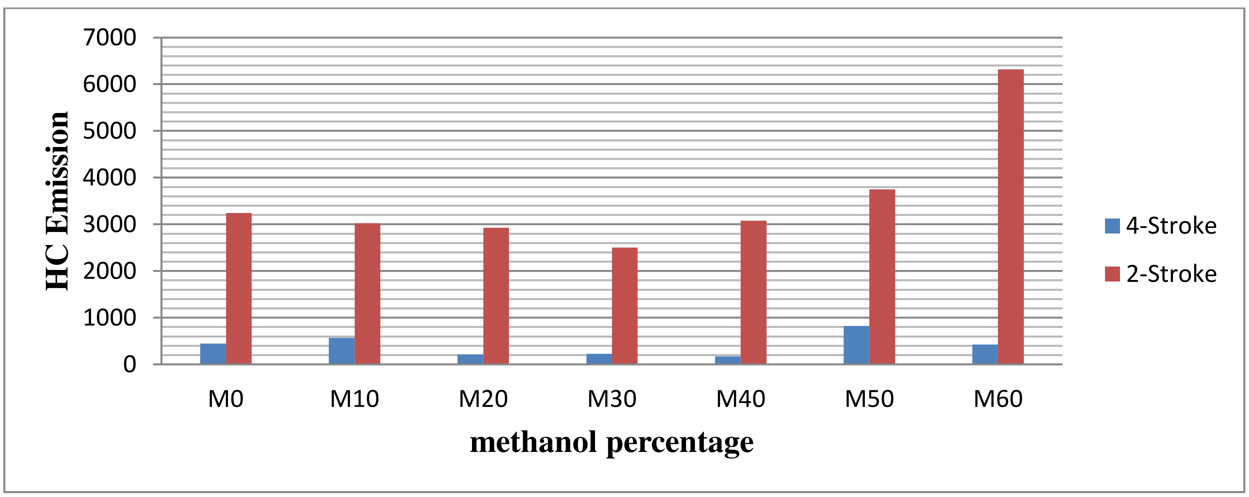

Fig.5.1.4.HC Emissions

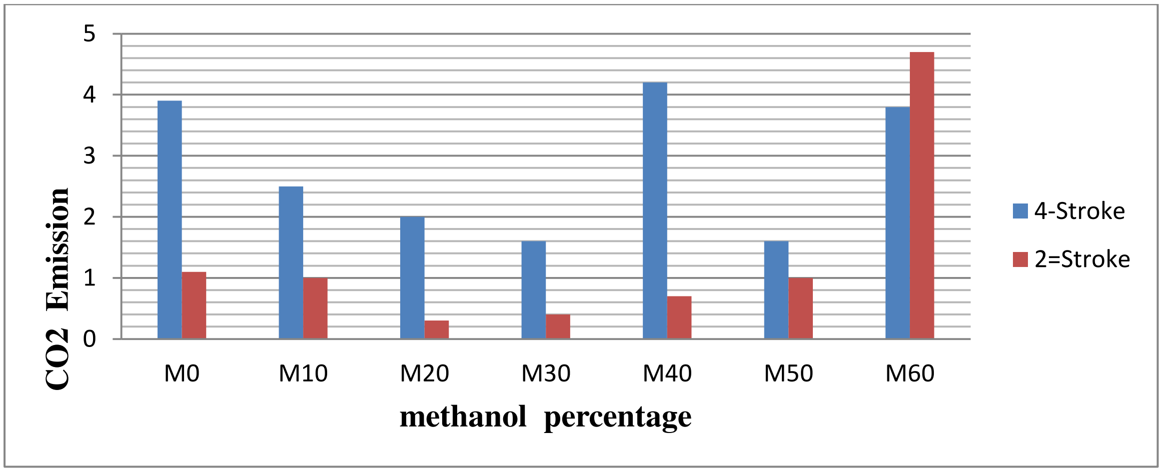

Fig.5.15. CO_2 Emissions

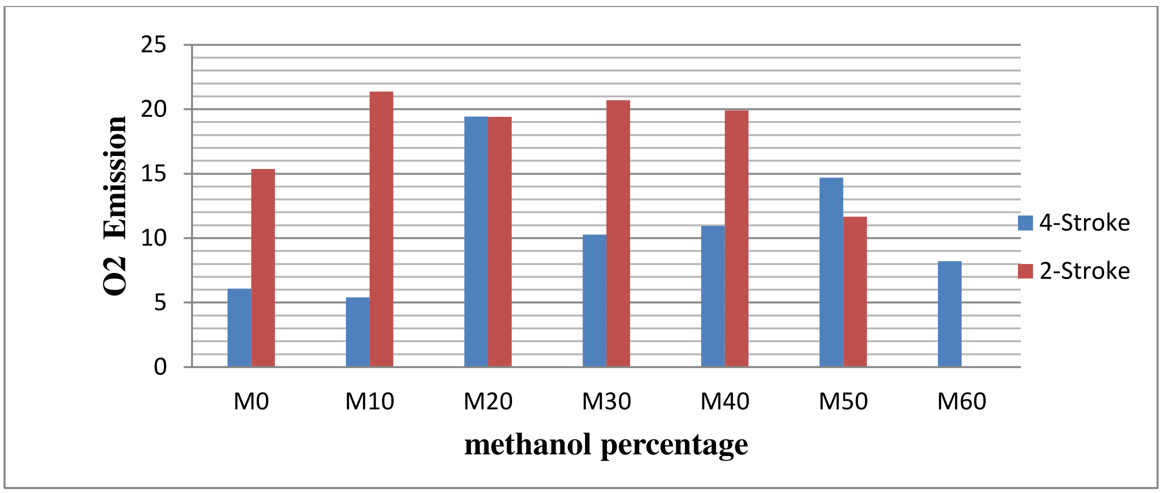

Fig.5.16. O_2 Emissions

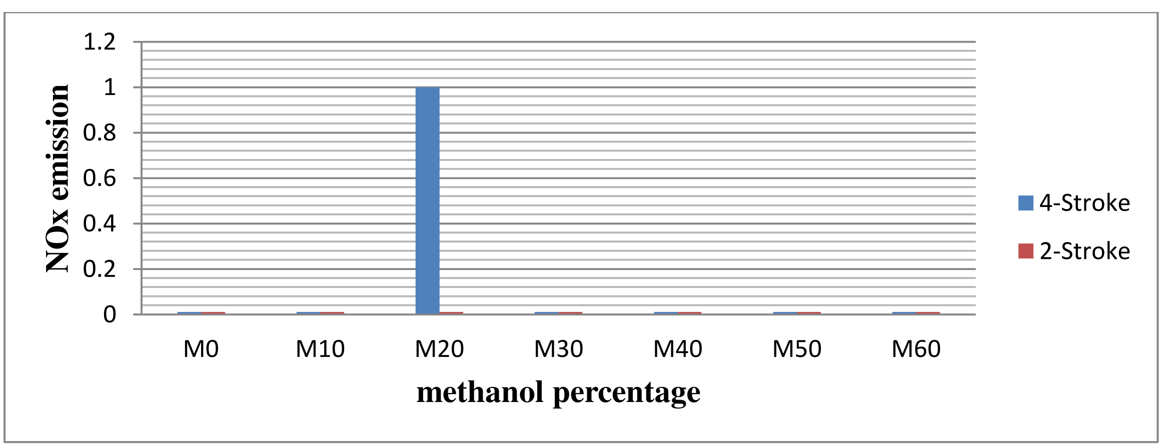

Fig.5.17. NOx Emissions

CONCLUSION

After comparing 2-stroke and 4-stroke engines, conclusions were reached based on experimental findings and research. Due to the length of the combustion cycle and the time available for scavenging, 4-stroke engines' CO emissions are significantly decreased. The lower cycle peak temperature in 4-stroke engines ultimately results in lower NOx emissions. In comparison to regular gasoline or petrol, methanol blend has a lower effective specific heat and calorific value. The cycle peak temperature decreases as a result. By using ethanol blends, gasoline consumption might be reduced by up to 50%, saving money for the future. It is evident that alcohol-gasoline blend fuels can significantly reduce pollutant emissions without requiring significant changes to engine architecture. Among the all combined fuel samples M30 (Methanol 30% and Gasoline 70% in vol. Basis) is selected as the best composition from the obtained readings on 2-Stroke and 4-Stroke engine.

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