

PAPER 115 – THE DESIGN OF ENGINE WITH REDUCED EMITTED POLLUTANTS ON THE ENVIRONMENT

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ABSTRACT

Two major emitted gases from the combustion engines which pollute the environment are nitrogen oxide (NO_x) and Carbon iv oxide (CO₂). In this study, a redesign engine is presented which extract nitrogen from the air before combustion and Carbon iv after combustion. The components of the redesign engine include the nitrogen extractor chamber, the combustion chamber, the cyclone and the carbon iv oxide absorption chamber will be modeled in order to obtained the relationship between the input and output parameters in each section. These parameters which will be the basis for designing the model include the airflow rate, pressure, temperature, as well as the chemical combustion of the gases at each stage. For the absorption of nitrogen Al₂SiO₅ was use while KOH was used at the exhaust end to absorb the carbon iv oxides. For the four stroke petrol engine used for the experiment, the exhaust temperature at normal working condition using oxidant containing nitrogen was 200°C, but when the air was bubbled through Al₂SiO₅ at a concentration of 40g/dm³ the exhaust temperature increased to 300°C which is about 50% increase. At the exhaust the CO₂ produced was 6.66 but upon passing the exhaust gas through KOH after using the redesign engine, the percentage reduction at 67% KOH was 64%.

KEYWORDS: Pollution, gases, combustion, re- design engine.

1. INTRODUCTION

The issue of global warming is a result of burning of fossil fuel as carbon iv oxide and nitrogen oxide are continuously being released into the atmosphere. The nitrogen oxide that is emitted, the effluent eat up the ozone layer thereby exposing the earth to more radiation from the sun. On the other hand, if carbon iv oxide that is released, due to ongoing deforestation there are fewer plants now available to convert carbon iv oxide to oxygen and as a result of this the temperature of the environment rises. Using electrical cars cannot be a solution to this as the battery being used are produced through combustion (Derek, 2017). Charging the battery is another problem which has to be done by means of electricity produced by combustion. It is in this circumstance that this study is centred on how to remove nitrogen before combustion from the air and carbon iv oxide has to be absorbed from product of combustion before being disposed into the atmosphere .however the issue of chemistry of combustion will be avoided in this presentation (Libin and Sajunla, 2018).

The same space the engine is to occupy within the vehicle is to remain. The retrofitted engine is to have the nitrogen absorbing device before combustion and carbon iv oxide absorbing reagent after combustion. Provision will be made

to ensure the elimination of nitrogen as a moderant is taken care of by cooling (by adding dopant to the coolant). (Baskar et al, 2021) investigated the effect of oxygen enriched combustion on pollution performance characteristics of spark ignition engine and reported a high value of nitrogen oxide emission with increasing oxygen concentration as a drawback of the technology.

(Zhou et al, 2020) carried out research on combustion, performance and emission analysis of an oxygen controlling downsize spark ignition engine and found that increasing the oxygen percentage in the air and decreasing the equivalent ratio, lower fuel consumption.

2. MATERIALS AND METHODS/METHODOLOGY/EXPERIMENTAL PROCEDURE

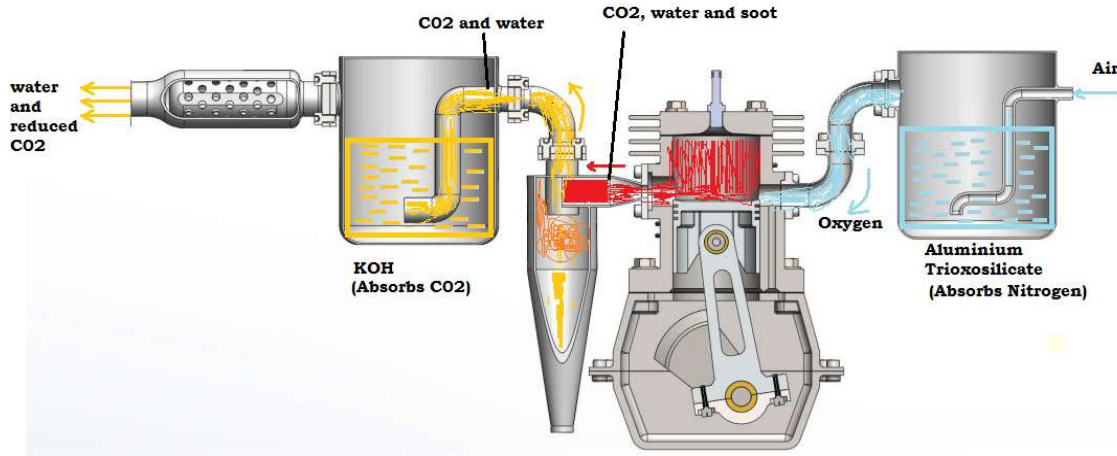


Fig 1: Design Engine with Three combustion Chamber.

A four stroke, single cylinder gasoline engine is used Yamaha 125. The materials for the redesign engine with reduced pollutant emitted to the environment are: Engine type 125 Yamaha engine four stroke one cylinder, displacement 29.87dm³, stroke 155.5mm, bore 174.5mm, power 860kw, rated torque 11.88Nm at 6500rpm others are compression ratio 17.5, specific fuel consumption 235kg/h and the reagents are potassium hydroxide (KOH) and Aluminium silicate (Al₂SiO₅).The nitrogen absorbed consist of Aluminium silicate and carbon iv oxide absorbed consist of potassium hydroxide, other accessory are thermocouple, measuring cylinder and gas analyzer. The nitrogen extractor is attached

at the entrance of the air and the carbon iv oxide absorbed at the exhaust pipe. A drill was made to accommodate the thermocouple within the engine. The exhaust gas analyzer is placed at the exit of the exhaust pipe.

The experimental setup mainly consist of four stroke one cylinder spark ignition engine, exhaust gas analyser, flow meter and thermometers. It is an already existing engine which is restructured to consist of three combustion chambers and a post combustion chamber. The pre- combustion chamber is to accommodate nitrogen extracting substance. The engine used in this research has 174.5mm, stroke 155.5mm and rated power of 860Kw at 6500rpm. The engine was coupled with exhaust gas analyser and a thermocouple. The gasoline used in this work was obtained from a petrol station. The experiment was carried out with 10g/dm³, 20g/dm³, 30g/dm³, 50g/dm³ Of Aluminium silicate (Al₂SiO₅) and potassium hydroxide (KOH).The engine experiment was conducted under constant spark timing and compression ratio (17.5:1). During the experiments, all data were taken after steady-state condition were reached and all measurements were repeated at least four times at each test point and the average value were used to minimize systematic errors. Exhaust gas emission such as nitrogen oxide (NO_x), carbon iv oxide (CO₂) and hydrocarbon (HC) were measured using the exhaust gas analyzer. Technical specification such as measurement ranges and accuracy of the exhaust gas analyzer are taken.

3. RESULTS AND DISCUSSION

Table 1: Technical specification of exhaust gas analyzer

	Emission	Measuring range	Accuracy
1	CO ₂	0- 20%	0.01%
2	NO _x	0- 40%	1ppm
3	HC	0- 40ppm	1ppm

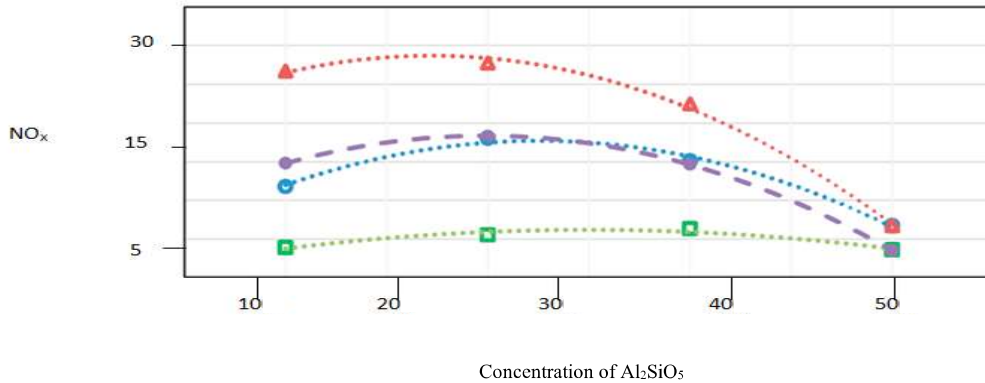


Fig 2: Variation of NO_x with Al₂SiO₅

The effect of NO_x as pollutant emission of the test engine was investigated. There was a significant decrease in NO_x emission at 20g/dm³ of aluminum silicate. This is a promising result since nitrogen oxide is a greenhouse gas and that is why we reduced NO_x emission level. In the case of 30g/dm³, NO_x emissions were reduced by 10.3% and 11.2% respectively.

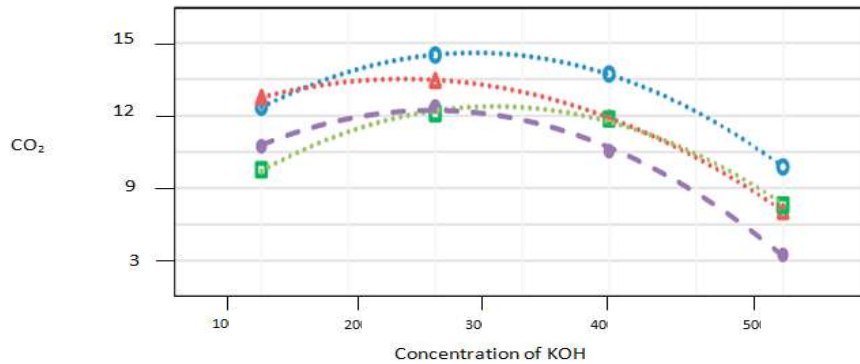
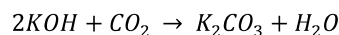


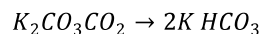
Fig 3: Variation of CO₂ being absorbed by KOH

The results obtained shows that there was maximum absorption of carbon iv oxide by potassium hydroxide at 30g/dm³ and 40g/dm³. Therefore the possible reason for the maximum absorption at 40g/dm³ is due to increase in combustion temperature.

The absorption process was analysed using a reagent tank in which the exhaust gas was bubbled through. In the column, an aqueous solution of KOH will react with CO₂ in the exhaust gas. The absorption reaction of KOH and CO₂ usually leads to the production K₂CO₃ according to the stoichiometric equation



In the case of excess of concentration of KOH, it leads to the increased production K₂CO₃ over a long period of time but if the advert of complete usage of KOH and CO₂ become in excess, an undesirable product is formed



Therefore, obtaining the right percentage to absorb the CO₂ adequately over a long period of time is the aim of the phase of the experiment.

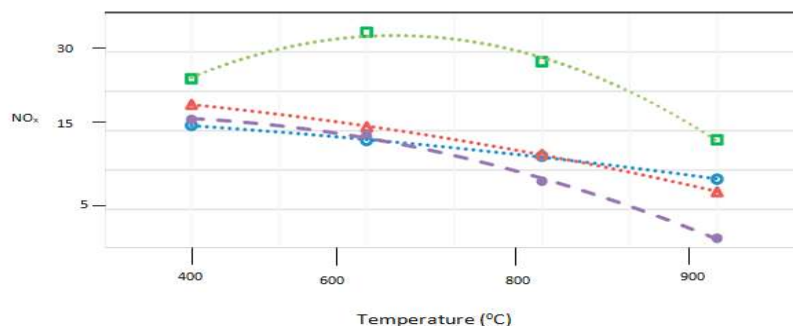


Fig 4: Effect of combustion temperature on the engine

The extraction of nitrogen from the oxidant increases the temperature. Maximum temperature is obtained at $50\text{g}/\text{dm}^3$, but the metrological temperature of the engine is not exceeded. Dopant was added to reduce the temperature of the engine.

4. CONCLUSIONS

The redesign engine developed works by reducing the nitrogen content in the air which enters the inlet manifold of the engine thereby increasing the percentage of oxygen available in a given air fuel ratio and reducing the percentage of NO_x produced at the exhaust at elevated temperatures. The results indicated that extracting nitrogen from the oxidant with aluminum silicate at $20\text{g}/\text{dm}^3$ to $40\text{g}/\text{dm}^3$ shows reduction of NO_x at the effluent. Carbon iv oxide emission was also absorbed using potassium hydroxide. Maximum absorption occur at $40\text{g}/\text{dm}^3$. The reduction of NO_x and CO_2 were tested with exhaust gas analyzer. It is concluded that aluminum silicate is used to extract nitrogen from air which lead to reduction in nitrogen oxide emission while carbon iv oxide absorbed by potassium hydroxide which enable us to reduce global warming. The work will make available a system to reduce the depletion of the ozone layer which shields the earth from harmful ultra- violet radiation of the sun. Determination of the time with which the nitrogen absorption reagent becomes saturated and cannot further absorb the nitrogen and the effect of the volume and temperature on the absorption decay time. For the exhaust system, the temperature has the tendency of boiling up the KOH and at higher temperatures it may even completely evaporate, so there is need to either look for a medium to increase the operating temperature of KOH, or check for the effectiveness of using solid state of KOH as the reagent. Also, there would be a need to determine the time for complete saturation of the KOH at the selected optimal state.

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REFERENCES

- Baskar, J.; Robert,W. and Zhijum.W. (2021). Carbon capture for Automobiles using internal Combustion Rankine cycle engine, Journal of engineering for gas turbine and power, 3:35 -41
- Bosch,M.; Serras,F. and Bagguna.J. (2015). Synthesis of new oxadiazole derivatives as Inflammatory analgesic and antimicrobial agents, International Journal on medical chemistry 4: 16- 22
- Derek, M.S.(2017 September 7). Carbondioxide Removal Option: A Literature Review Identifying Carbon Removal Potentials and Cost, Master's Thesis at the University of Michigan.

- Hitesh, B.P. and Suple, Y.R. (2018). Experimental investigation of exhaust emission of four stroke spark ignition engine by using direct injection of LPG and its analysis, *International journal of modern engineering research*, 3: 2600- 2605.
- Krishnamoorthy, G. and Sami, M. (2017). Radiating Modelling in Oxy- Fuel Combustion Scenarios, *America society of Mechanical Engineers, Power Division Publication*, 7: 615-621
- Libin, P and Sajunulai, F. (2014), A Comparison of emission of SI and CI engine in a low nitrogen oxy-combustor environment, *International Journal of advance research in science and Engineering*, 7:78-85.
- Longwell, J.P; Frost, E.E. and Weiss, M.A. (2013) Flame Stability in Bluff – Body Recirculation Zones, *Journal of Industrial and Engineering Chemistry*, 45: 29 -33.
- Maher, A.R and Baghdadi, S.A. (2013). Performance study of a four stroke spark ignition engine working with hydrogen and ethanol as supplementary fuel, *International Journal of Hydrogen energy* 3: 1005- 1009.
- P.S. Micheal, and Fusoil, P.U. (2013). Development of a Combustion Chamber Design Methodology and Automation of the Design Process, *International Journal of Aeronautical Sciences*, 4: 5- 10
- Prasad, T, Yassodam, S and Latha, P. (2010). Effects of Nanoscale zinc oxide particles on the Germinating, growth and yield of Peanuts, *A Journal of Agricultural chemistry* 9: 2-6.
- Yinghui, G; Canbing, L. and Yijia, C. (2016) Cost Analysis of air Capture driven by Wind Energy Under Different Scenarios, *Journal of Modern Power System and clean energy*, 4: 275- 281.
- Zhou, S; L. Yin, F.D and Qianqian Jia, G.A, (2020), Computational study of a vertical plunging still water, *A Journal of chemical science engineering* 1 : 72- 79.