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THE USE OF HYDROGEN IN INTERNAL COMBUSTION ENGINES AND IT IS IMPACT ON CARBON AND NITROGEN OXIDE EMISSIONS

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Abstract-

To study the effect of adding hydrogen to diesel fuel on carbon and nitrogen oxide emissions, as well as reducing fuel consumption and improving engine performance, we used the ANSYS simulation program, which is considered one of the most powerful engineering simulation programs. You can use it to analyze the effect of hydrogen in diesel fuel on carbon and nitrogen oxide emissions, as well as to reduce fuel consumption and improve engine performance. The fuel type (diesel + hydrogen) was defined and fuel properties were determined, such as the hydrogen ratio, fuel density, combustion coefficient, adjusting the air-to-fuel ratio, and the effect of mixing - with diesel. After running the program, you will notice that when the hydrogen ratio increases, carbon dioxide emissions decrease and nitrogen oxide emissions increase due to the high combustion temperature and an improvement in fuel efficiency if the ratios are adjusted correctly.

Keywords- hydrogen, diesel fuel, on carbon and nitrogen oxide emissions, fuel consumption

I. INTRODUCTION

With the growing need for clean and sustainable energy sources, hydrogen is a promising solution to replace traditional fossil fuels. Hydrogen produces no carbon emissions when burned, making it an ideal choice for reducing environmental pollution. This research aims to explore the potential of hydrogen in internal combustion engines, along with strategies for improving fuel efficiency [1] . Adding hydrogen to internal combustion engines is a promising technology for improving fuel efficiency and reducing harmful emissions, but it requires technical improvements to ensure safe and efficient operation. With advances in storage and injection technologies, hydrogen could be a sustainable solution for the future of transportation systems and vehicles. [2-3]

II. PROPERTIES OF HYDROGEN AS FUEL

Hydrogen is a very light element and has a high combustion energy compared to conventional fuels such as gasoline and diesel. Among its most important properties are::

- High energy density (approximately 120 megajoules per kilogram).
- Produces only water vapor upon combustion, limiting environmental pollution.
- High combustion rate, leading to increased engine efficiency.

2.1- Application of hydrogen in internal combustion engines

Hydrogen can be used in internal combustion engines in several ways.:

1. Direct Combustion: Hydrogen is injected directly into the combustion chamber, similar to what happens in conventional gasoline engines.
2. Coupled Combustion: Hydrogen can be blended with conventional fuels to improve combustion efficiency and reduce harmful emissions.
3. Full Conversion0: Completely replacing conventional fuels with hydrogen, requiring modifications to the engine design to ensure efficient operation.

2.2- Improve efficiency and fuel economy

1. Improving the air-fuel ratio: Precise control of the air-fuel ratio increases combustion efficiency and reduces fuel consumption.
2. Using direct injection systems: Direct hydrogen injection helps improve the combustion of the mixture inside the cylinder.
3. Exhaust recirculation: Exhaust heat can be used to heat the incoming air, reducing thermal energy loss.
4. Reducing vehicle weight: Reducing weight leads to reduced fuel consumption and improved overall performance.

III. COMPUTER PROGRAM

To prepare ANSYS to simulate the effect of hydrogen fuel percentage increase on COx and NOx emissions, as well as its effect on fuel consumption and engine performance efficiency, follow the following steps: Design the 3D geometry of the combustion chamber and engine using ANSYS Design Modeler. Use ANSYS Meshing to create a mesh of appropriate resolution, paying special attention to the combustion region to ensure accurate results. Define the Combustion and Transport Equations Use an appropriate combustion model to simulate the combustion reactions. Use Species Transport equations to determine the chemical reactions between hydrogen, air, and fossil fuels. Add a nitrogen oxides (NOx) emissions model. [4-6] Adjust parameters such as temperature, oxygen concentration, and fuel quantity to assess the effect of hydrogen. Then, Define a fuel

mixture containing a different percentage of hydrogen alongside the base fuel (such as diesel). combustion libraries to enter the hydrogen combustion reactions. Input the air and fuel flow at the combustion chamber inlet, and then define the temperature and pressure in the various regions of the engine. Run the simulation, ensuring that the equations are mathematically convergent. Use Residual Monitors to monitor the accuracy of the solutions. After the simulation is complete, analyze the results. Monitor the temperature and pressure distribution inside the combustion chamber. Analyze the composition of the combustion products using graphs and contour plots. Compare NOx and COx emissions at different hydrogen ratios. Evaluate the impact of hydrogen on fuel consumption and thermal efficiency. Experiment with different hydrogen ratios in the fuel mixture (5%, 10%, 20%, etc.).Test the effects of changing operating conditions such as pressure and temperature. [7] Use more complex combustion models to improve the accuracy of your results. The carbon dioxide Figure 1 shows a decrease in emissions with an increase in the percentage of hydrogen, as the combustion of clean hydrogen leads to a reduction in carbon emissions. Figure 2 shows an increase in emissions with a higher hydrogen content because the high temperatures resulting from hydrogen combustion may lead to more nitrogen oxides. Figure 3 shows the effect of hydrogen on fuel consumption, where figure 4 shows The effect of hydrogen ratio on engine efficiency noted that Engine efficiency improves when hydrogen is blended with conventional fuel. [8-12]

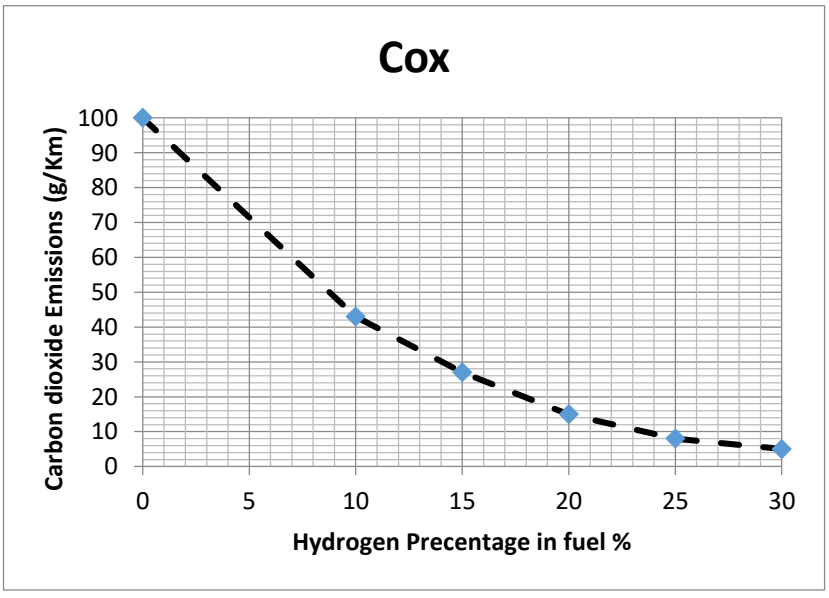

Fig. 1 Effect of hydrogen on carbon dioxide emissions

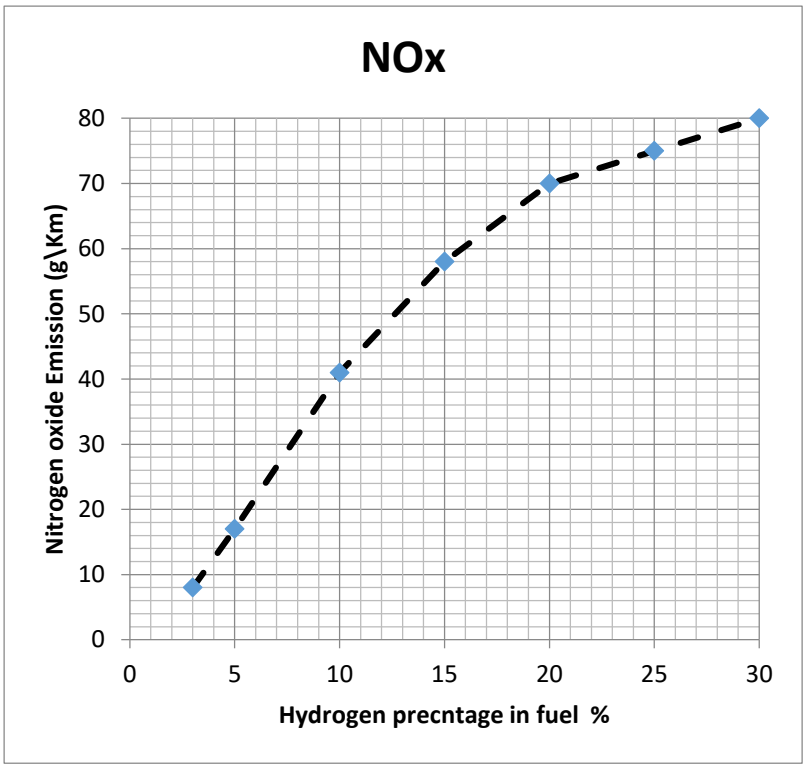

Fig. 2 Effect of hydrogen on nitrogen dioxide emissions

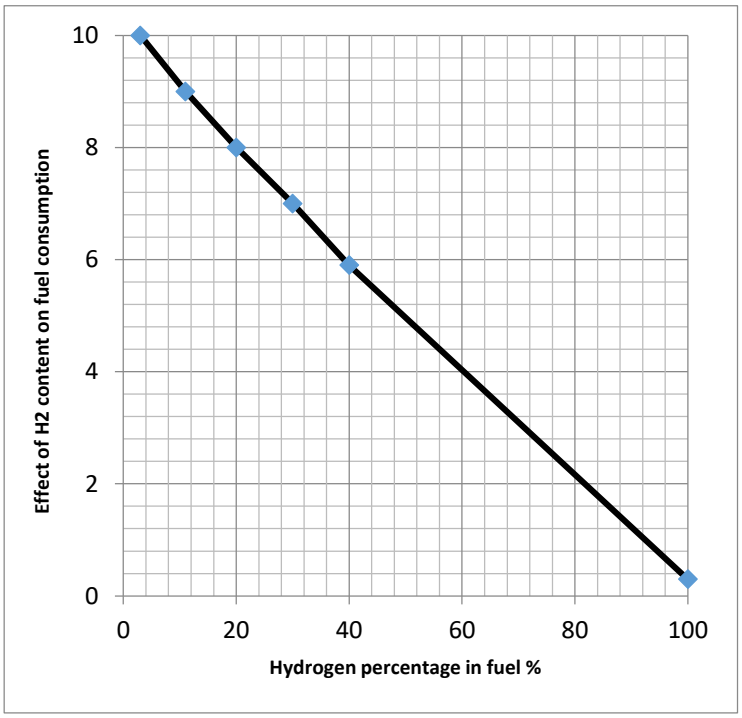

Fig. 3 effect of hydrogen on fuel consumption

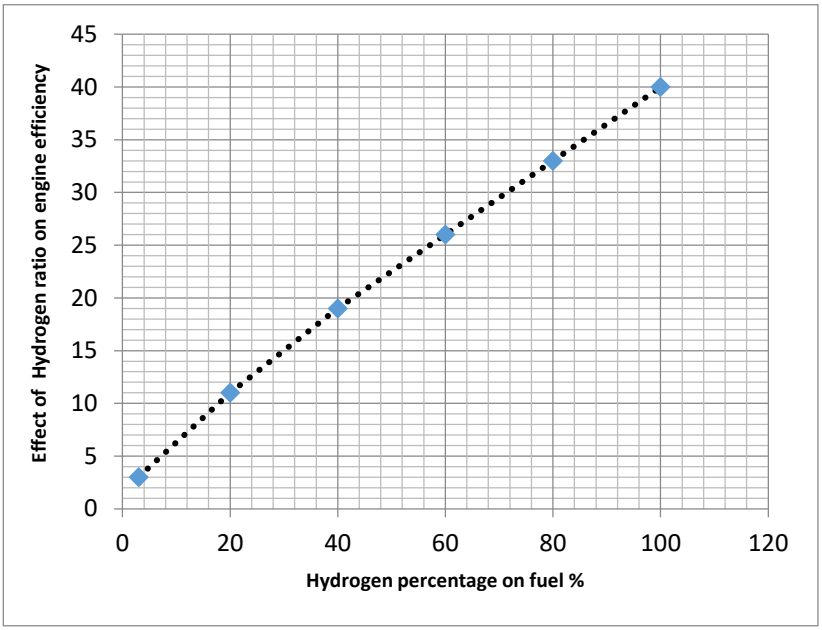

Fig. 4 The effect of hydrogen ratio on engine efficiency

IV. CONLUSION

The use of hydrogen in internal combustion engines is an important step toward achieving a cleaner environment and reducing dependence on fossil fuels. Despite some technical challenges, such as hydrogen storage and production costs, ongoing developments in this field make hydrogen a promising option for the future of sustainable transportation. Conclusion. This method will help you understand the impact of adding hydrogen to fuel on engine efficiency and emissions. You can use the results to improve combustion chamber design or adjust injection systems to achieve optimal performance with lower emissions. One of the most important observations when increasing the proportion of hydrogen to fuel is:

1. Hydrogen has a high combustion rate and a wide ignition range, which increases combustion efficiency and reduces pollutants.
2. The main challenge in using hydrogen is storage and transportation, due to its light weight and easy ignition.
3. Some gasoline engines can be modified to use hydrogen, but this may require significant modifications to the fuel and ignition system.

4. The hydrogen ratio effects on engine efficiency, efficiency increasing as the hydrogen ratio increases.
5. Hydrogen has a high combustion rate, which enhances combustion efficiency and reduces thermal energy loss.
6. When hydrogen is added to diesel, the proportion of fossil fuel burned is reduced, resulting in a lower amount of carbon dioxide emitted.
7. Variable impact on nitrogen oxides (NO_x): In some cases, hydrogen combustion leads to increased combustion temperatures, which can increase the formation of nitrogen oxides. However, adjusting the mixing ratio and controlling the injection timing can reduce this increase.
8. The amount of diesel fuel required to produce the same horsepower can be reduced, resulting in fuel savings and increased fuel economy.
9. Hydrogen does not contain carbon dioxide (CO_2), so its use does not produce any. This makes it an excellent option for reducing greenhouse gas emissions.
10. Thermal efficiency is often higher than gasoline engines, due to hydrogen's combustion rate and physical properties.

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