Production of Emulsion fuel: an eco-friendly fuel

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***Abstract*— Global issues such as the energy crisis and air pollution have prompted researchers to conduct strategic research on water-diesel and water-biodiesel fuel emulsions. Water-in-diesel emulsion is an alternative fuel that can be used with the existing engine setup without requiring any engine modifications. It has the added benefit of significantly lowering NOx, SOx, and particulate matter, along with improving combustion efficiency. Petroleum diesel or biodiesel can be blended with water to create an emulsion fuel whose performance can be evaluated. The primary aim of this research is to investigate the manufacturing process, advanced mixing technologies, and new developments in the processes, as well as their, economic feasibility.**

Keywords—water in diesel, emulsion fuel, NOx, particulate matter, combustion efficiency

I. INTRODUCTION

The ability to do work is described as energy. In other terms, energy refers to a person's, an animal's, or a physical system's (machine's) ability to function and change. Energy is now the main catalyst for all economic activity, and it plays a critical role in improving people's quality of life. In fact, everything in today's world is mostly reliant on energy. A country's energy usage is frequently used as a measure of its progress. Transportation comprises for about 24% of worldwide energy use, with 40% going to industries, 30% to domestic and commercial purposes, and the remaining 6% going to other uses. The developed and developing worlds consume vastly different amounts of energy. Roughly 2 billion people in developing world do not even have access to sufficient energy supplies. 3 billion people relies on fuel (wood, coal, kerosene, etc.), with 25% of the global population responsible for 70% of commercial energy consumption. For transportation, an American uses 100 units, a Japanese uses 30 units, and an Indian uses two units.

The following categories apply to energy sources: (i) primary and secondary energy; (ii) commercial and non-commercial energy; and (iii) renewable and non-renewable energy. Coal, timber, crude oil, natural gas, and biomass are examples of primary sources found in nature. Nuclear energy derived from radioactive chemicals, thermal energy from the earth's interior, times Secondary energy sources are created by converting primary energy sources, such as coal, oil, or gas, into steam and electricity. Commercial energy sources are sources of energy that are offered on the market for a fixed price. Electricity, coal, and petroleum products are by far the most important forms of economic energy. Energy sources which aren't now available on the commercial market. Non-commercial energy reassets consist of fuels together with firewood, farm animals dung and agricultural wastes. Renewable energy reassets are available in limitless quantity and may be renewed. They are inexhaustible. These consist of firewood, sun power, wind power, biomass, geothermal power, etc. Non-renewable sources are to be had in restricted quantity and are evolved after a protracted length of time. As a end result in their extra use, they're probably to get exhausted one day. These encompass crude oil, coal, herbal gas, nuclear power and petroleum products. Moreover, those fossil fuels have a bad effect at the environment. Thus, it's far important to limit the usage of those fuels and discover different options to them together with emulsified fuel as the use of unique ratios of water-diesel as fuel.

II. EMULSIFIED FUEL

Emulsified fuels are emulsion composed of water and a flammable liquid either oil or a fuel. Most typically used is water in diesel emulsions. Diesel engines are the foremost contributor of nitrous oxide (NO_X) and particulate matter emissions. Higher combustion temperature of the diesel engine reasons the NO_X

emission. Presently maximum of the studies paintings is sporting out for diminishing the NO_X emission.

According to literature survey, water in diesel emulsion is one of the exceptional approach for controlling NO_X emission. Due to the vaporisation of water on the combustion chamber result in lessen the height temperature. In the water in diesel emulsion technique micro-explosion procedure performs a essential role. If completely stepped forward combustion traits and decrease gaseous and stable emissions. Emulsion fuel is an unconventional fuel for diesel engines, which may be used without change with inside the engines. The advantages of an emulsion fuel consist of decreasing the emission of nitrogen oxides (NO_X) and particulate matter which might be dangerous to health and causes diesel engines to suffer. The impact of water in emulsion fuel at the emission of NO_X, particulate matter, carbon monoxide, hydrocarbon, smoke and exhaust temperature. Experimental researches show a lower in NO_X and particulate matter emissions, but the end result with growing water percent in emulsion fuels aren't steady for hydrocarbon and carbon monoxide emissions. The water content material in emulsion fuels impacts the combustion and decrease stop temperature in combustion chamber. Micro-explosion phenomena occurs and causes a growth in volatility of diesel fuels which improves the combustion efficiency.

Table 1 Comparison of properties between diesel and petrol

III. MICRO EXPLOSION PHENEOMENA

Characteristic (Unit)	Diesel	Petrol
Density at 15ºC gm/cm^3	0.8116	0.715-0.8
Flash Point, ºC	52	-46
Kinematic viscosity, mm^2/sec	2.734	4.29*10^-5
Dynamic viscosity, at 15ºC mPa.s	3.7997	2.9*10^-4
Pour Point, ºC	-2	-18
Freezing Point, ºC	-11	-38
Aniline Point, ºC	70	70
Diesel Index	30	80-91
Enthalpy of Combustion, MJ/Kg	42-46	43-47
Auto ignition Temperature, ºC	350-625	280-486

The micro explosion occurred because of the presence of water droplets that exploded in the course of the combustion techniquein the combustion chamber. Water droplets dispersed in diesel gasoline will explode, forming small droplets of diesel fuel. This tiny fuel grain experienced a second explosion, called a micro explosion. Because diesel fuel (which consists of hydrocarbons) already had a completely small droplet, the combustion that came about might be perfect with accelerated combustion efficiency, in order that hydrocarbon emissions could lower. The micro-explosion phenomenon has additionally impacted particulate count. One of the reasons of particulate count lower is because of puffing behaviour. Puffing has triggered an increase in the combination of gasoline with air and flame distortion, consequently decreasing particulate count. Adding water to the fuel has decreased combustion temperatures. It has triggered an boom in OH radicals, that's beneficial for oxidation of soot precursors in order that soot has been decreased.

Source; Recent progress on mixing technology for water-emulsion fuel: A reviewAgus Sartomoa,b, Budi Santosoa,, Ubaidillaha, Oki Murazac,

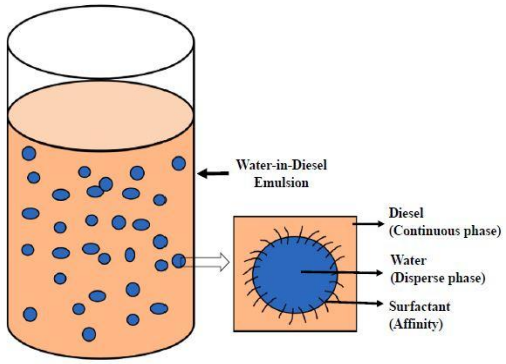

Figure 1. Schematic diagram of water in diesel dispersion emulsion

IV. MECHANISM OF WATER IN DIESEL EMULSION

Fuel composition, combustion chamber temperature, combustion process, and compression ratio have stimulated the engine's performance and exhaust emissions. In terms of fuel composition, water emulsion gas reduces NOx emissions and particulate matter. Water emulsion fuel additionally impacted adjustments in combustion chamber temperature and combustion processes, which in turn encouraged the reduction of both emissions. The purpose of that is a

phenomenon that happened during water-gas emulsion within side the combustion chamber. Two crucial phenomena happened within side the combustion chamber, specifically the reduced combustion temperature and the phenomenon of micro-explosion

V. PARAMETERS RELATED TO WATER EMULSIONS

Temperature parameter effect: Highest the emulsion temperature smaller is the density. In other words stability decreases as the water emulsion fuel temperature increases.

Mixing speed parameter effect: Water emulsion fuel is a combination of fossil fuels and water, wherein two drinks are not able to combine permanently. The blending procedure have become a large thing in blending the two liquids for acquiring a high stability blending equipment in order that a aggregate of emulsion gas could be produced with water of a droplet size in accordance to what's desired

*Effect of mixing time:*Mixing time is one of the elements that have an impact on the homogeneous mixture formation. Homogeneous combinations have smaller water particle size than non-homogeneous combinations. The small particle size influences the balance of the mixture. In the case of water emulsion fuels, water changed into a substance dispersed with the aid of using fuel. If the emulsion mixture had a high homogeneity and fashioneda completely small water droplet, then its balance changed into accelerated and it changed into stable for a longer time, which ends up in good quality emulsion fuel

*Role of Surfactant:*Surfactant, usually referred to as emulsifier, is a material that plays an important positionin the water diesel fuel emulsion blending process. Surfactants have a feature to reduce surface tension from water and additionally to lessen interface anxiety in water and diesel fuel. With surfactants, emulsions are combined properly and feature excessive balance. Hydrophilic-lipophilic balance (HLB) value and molecular structure are the major factors in the emulsion fue lstability formation. Water-in-oil emulsions are suitable for low HLB values; oil-in-water emulsions are suitable for high HLB values.

VI. MIXING TECHNOLOGY WITH SURFACTANT

In the mixing technique with surfactants, three substances (gasoline, water, and surfactant) are mixed the use of a mixer in a blending chamber for a selected duration. The parameters need to be considered in the mixing process: the mixing technology used, the effect of mixing speed, and the mixing time. The three parameters will have an effect on the first-rate of the resulting water droplet emulsion fuel. As the size of the water droplets is kept smaller the more is the stability of the emulsion fuel. The surfactant (surface active agent) makes the mixture of water dispersed in oil in a greater strong manner. If water is polar and oil is nonpolar, the surfactant should be a substance whose molecules have both polar and non-polar properties. Such substances have combining forces that can produce excessive balance in an aggregate of oil and water. The concentration of those properties may have unique values. If the attention of the polar molecule is higher, it's far greater like water and is called “hydrophilic”. If the non-polar attention is higher, then it is more like oil and is called “lipophilic”. The surfactant’s molecular concentration stage is commonly expressed in HLB units. Scale stages from zero to 20, zero way the materials are non-polar/lipophilic; 20 way the materials are polar/hydrophilic. The popularly used surfactant kinds are Span eighty and Tween 20 surfactants. Span eighty already has an HLB value of 4.3, appropriate for making water-in-oil emulsions; Tween 20 has an HLB value of 16.7, appropriate for making oil in- water emulsions. This is the principle cause why researchers are the usage of surfactants as emulsifiers of diesel gasoline and water. Another cause for the usage of surfactants is that emulsion fuels may be made in phases and three phases (water in oil or oil in water), and surfactants help produce smaller water droplet sizes (macro emulsion, micro emulsion, and Nano emulsion).

Table 2. Physical Properties of Water in Diesel Samples using Mechanical Stirrer				
Sample	density at 20 °C (kg/m3)	Surface tension at 20 °C (mN/m)	average size of dispersed water particle (μm)	Average volume of suspended droplet (mL)
95:5	847.85	25.01	33.42	0.013
90:10	857.81	22.82	32.43	
80:20	870.41	19.01	30.7	

Source: Experimental Investigation of Micro explosion Occurrence in Water in Diesel Emulsion Droplets during the Leidenfrost Effect Mohammed Yahaya Khan, Z. A. Abdul Karim, A. Rashid A. Aziz, and Isa M. Tan

Table 3. Physical Properties of Water in Diesel Samples using Homogenizer				
Sample	density at 20 °C (kg/m3)	Surface tension at 20 °C (mN/m)	average size of dispersed water particle (μm)	Average volume of suspended droplet (mL)
95:5	849.76	25.23	1-2	0.010
90:10	854.44	25.75		
80:20	870.17	25.51		

VII. CONCLUSION

The recent advances in Water in Diesel emulsion fuel studies that are gathered and reviewed include areas of surfactant, emulsion fuel stability, types of emulsion fuel, emulsion fuel's impact on the performance and emission of diesel engines, and, finally, the micro-explosion phenomenon.

From the reviews that were made, it can be concluded that:

1. Thermal efficiency is increased by using the Water in Diesel emulsion fuel compared to neat diesel fuel. Various studies have agreed that the improvement of the combustion efficiency is mainly due to the increase of ignition delay and the micro-explosion phenomena.

2. It is agreed by most of the studies that Water in Diesel does result in improvements in brake power, torque and specific fuel consumption measurements when the total amount of diesel fuel in the emulsion is compared with that of the neat diesel fuel.

3. NOx and Particulate matter emissions are greatly reduced by using the Water in Diesel emulsion fuel. The reduction of NOx is due to the lower peak temperature of the flame during the combustion. The particulate matter is reduced to the micro-explosion phenomena which increases the combustion efficiency.

4. Unburnt hydrocarbons and Carbon Monoxide exhaust emission is found to be increased by using the Water in Diesel emulsion fuel. The reason being reported is due to the reduction of combustion efficiency. However, this is in contrast with most experimental results reported that show that the combustion efficiency is increased by using Water in Diesel emulsion.

Source: An overview of utilizing water-in-diesel emulsion fuel in diesel engineand its potential research study Ahmad Muhsin Ithnin , Hirofumi Noge , Hasannuddin Abdul Kadir , Wira Jazair

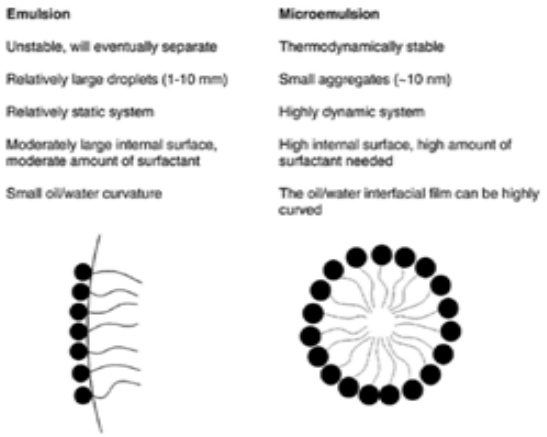

Figure 2 Difference between Emulsion and Micro emulsion

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