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Some technical methods for emission reduction from diesel engines

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Abstract: Air pollution is the result of modern life activities such as increased energy consumption, the development of cutting-edge industries such as metallurgy, chemicals, aviation, and so on pollution is sourced from three main sources: natural sources (plants, soil), fixed sources (home heating, power generation, industry), and transportation. In the transportation, diesel engines are one of the largest emission engines. The use of a number of technical measures to reduce diesel emissions has been presented in this paper. The result of the article contributes to the application of advanced equipment in the reduction of toxic emissions of diesel engines.

Keywords: diesel engine, emission, technical method

1. Introduction

At present, marine pollution sources in maritime, aquaculture, tourism, oil and gas, etc., are related to the diverse and complicated use of marine resources. This pollution condition is due to the oil being used as fuel, lubricant, hydraulic for the ship, to the cargo oil shipped; Dangerous goods such as explosives, radioactive substances, combustible substances, toxins ... transported by ship; Waste, sewage, antifouling paint used for the hull. Hazardous materials used for shipbuilding are asbestos, heavy metals, chemicals. Pollution caused by the movement of aquatic species through ballast water; Communicable diseases spread through the maritime route; Operation of old ships demolition, and exploitation of oil and gas on the sea. Ship operations (including fishing vessels and cargo ships) are one of the artificial sources that contribute significantly to air pollution. The quality of Vietnamese ships is not high, many vehicles are too old, obsolete, low fuel burning efficiency and no exhaust gas treatment system ... so they emit more toxic gases such as: SO_2, CO_2 , CO, NO_2, C_xH_y ...

Currently, Vietnam has over 1,700 transport vessels, with the number of fishing vessels of about 130,000, corresponding to the amount of gasoline fuel consumed about 4 million tons per year. It can be said that this is the source of pollution to the sea, coastal areas and many places, seriously affecting the marine ecosystem, destroying marine resources, endangering human health. Environmental experts say that vessels are a major source of pollution to the environment. Especially in port cities and coastal areas because of their use of poor quality bituminous fuels, which have high levels of emissions such as nitrogen oxides (NO), sulfur dioxide (SO2). In addition, these wastes also produce acid rain and tiny particles of soot in the air.

According to US government statistics, ships are responsible for two-thirds of SO2 emissions in the transport sector in 2002, with a lack of control measures that could lead to up to 98% In addition, the US and Canadian governments also set new emission standards for large vessels. Accordingly, from 2015, new ships will have to reduce 96% SO_2 compared to today. Similarly, ships built after 2016 will have to cut 80% of their NO emissions. The European Union's report on the impact of ship emissions on the health of the European Union shows that toxic emissions from ships are killing about 39,000 people each year in Europe, of which He suffered the most heavy losses.

The EU is currently planning to establish the first low-emissions areas, minimizing the pollution from thousands of cargo ships moving through the seas each year. The EU will accept that governments support maritime companies to meet strict SO_2 standards. In support of EU solutions, the International Maritime Organization (IMO) agrees to limit the SO_2 content of marine fuels for ships that pass through areas with effective emission control by 2015. Meanwhile, shipping companies will face the potential to meet lower SO_2 emissions and cleaner fuel costs, which have raised shipping rates. The EU accepted IMO's proposal to reduce the sulfur content of marine fuels, with the sulfur limits for all ships cutting to 0.5% by 2020 (currently at 3.5%). The limits for all ships in the Baltic and North Sea (known as control area emissions), will be cut to 0.1% from 0.5% by 2015. Instead of using fuel Marine operators can also use alternative treatment technologies to clean the emissions of ships to minimize pollution. In order to control properly the emissions of ships in maritime activities, Vietnam should have policies, legal documents, regulations, and state regulations for fishing vessels and transports. Reduce emission of emissions, especially greenhouse gas emissions, ship science and technology, ship engines, waste gas collectors.

2. Emissions source from diesel engines

Nowadays, airborne pollutants have been identified, most of which are present in the exhaust gas of internal combustion engines. Table 1 below shows the ominous concentration increase of some pollutants in the atmosphere:

Table 1. The increase of pollutants in the air

Pollutants	*Pre-industrial*	*Currently*	*Increase rate (%/year)*
CO_2	270	340	.4
N_2O	0.28	0.30	0.25
CO	0.05	0.13	3
SO_2	0.001	0.002	2

Depending on the energy policy of each country, the distribution of pollution rates of different sources is not the most. In the last years of the twentieth century and early XXI century, the country has developed rapidly in the national economy; the transportation industry has also rapidly developed in both road and waterway. Despite the rapid development, our economy is still a underdeveloped economy, the re-use of old engines in water transport means is still widespread, the problem of pollution The emissions generated by these engines are a major concern. The problem of reducing the level of exhaust gas due to diesel engines is posing extremely urgent. All internal combustion engines and diesel engines in particular cause noise and environmental pollution, especially due to their exhaust gas. The environmental hazardous ingredients contained in engine exhaust include: CO, CO_2, NO_x, C_nH_m, SO_2 ...

Thus, human activities make up the majority of the toxic emissions to the environment. According to the statistics, the waterway and railway transportation has a toxic content of approximately 10% in the transport sector with a capacity of 70000 cv diesel engine and the amount of toxins produced is about 2 - 8 kg/s, 10 15 times higher than allowed. The combustion process in diesel exhaust always contains a significant amount of NO_x (NO, NO_2, N_2O, collectively called NO_x), carbon oxide (CO), unburned hydrocarbons (HC) And solid particles, especially soot. The concentration of pollutants in the exhaust depends on the type of engine and operating mode. In diesel engines, CO concentrations are very small, accounting for negligible proportions; HC concentration is equal to about 20% of the HC concentration of the gasoline engine while the NOx concentration of the two types of engines is equivalent. In contrast, soot is an important pollutant in Diesel exhaust gas, but its content is negligible in the exhaust gas of a gasoline engine. The impurity, especially sulfur and additives in the fuel, also affect the composition of pollutants in the combustion product. Generally, commercial gasoline contains about 600ppm of sulfur. Sulfur content may be up to 0.5% for diesel. During combustion, sulfur is oxidized to SO_2, then a portion of SO_2 is further oxidized to SO_3, which can combine with water to produce H_2SO_4. Maximum temperature of combustion is also an important factor affecting the composition of pollutants as it strongly affects reactive kinetics, especially NOx and soot formation reactions. In real life, due to the amount of toxic substances in the combustion gases of the internal combustion engine, the user is less concerned about the dangers it causes. However, the analysis of data on air change in recent years has shown a very significant increase in pollutants. Without measures to limit this increase in a timely fashion, future generations will face a very harsh living environment. Environmental protection is not just a requirement of each country or region that makes sense on a global scale. Depending on the conditions of each country, the rules and standards of environmental pollution apply at different times and places. Environmental pollution caused by engines has been of interest to scientists since the beginning of the 20th century and it began to become law in some countries in the 1950s. In Vietnam, environmental protection law is effective from day On January 10, 1994, the Government issued Decree No.175/CP of October 18, 1994, guiding the implementation of the Law on Environmental Protection.

3. Solution of emission reduction of diesel engine

3.1. Exhaust gas emission of diesel engine

The exhaust gas composition includes non-combustible substances, complete and incomplete combustion of fuels, excess oxygen, nitrogen oxide, etc. The volume of exhaust gas by volumetric statistics as follows:

Table 2: Exhaust gas component of diesel engine

Exhaust gas component	**Rate (%)**
NOx (%)	0.002 ÷ 0.5
SO_2 (%)	0.003 ÷ 0.1
C_nH_m (%)	0.009 ÷ 0.05

CO_2 (%)	2 ÷ 14
CO (%)	0.01 ÷ 0.5
N_2 (%)	76 ÷ 78
H_2O (%)	0.5 ÷ 6
O_2 (%)	2 ÷ 15
PM (mg/m^3)	10 ÷ 1100
Fuel (mg/m^3)	0 ÷ 0.01

According to Loyds statistics on toxins in the exhaust gas of marine diesel engines, the marine diesel engine emission is givn in Table 3.

Table 3: Toxins in exhaust gases of marine diesel engine (LOYDS statistics)

Exhaust gas component	Low speed engine (kg/tons of fuel)	Medium speed engine (kg/tons of fuel)
NOx	84	59
CO	9	8
CO2	3165	3265
HmCn	2.5	2.7
S	-	6

3.2. Solution for emission reduction of diesel engine

Prior to the urgent need to reduce the pollution caused by diesel exhaust, people have been studying to find ways to reduce toxins while discharging diesel engines. Almost all measures are aimed at improving the quality of combustion in the engine to reduce the amount of toxins generated by fires.
Cars are a useful vehicle but also one of the main sources of pollution. Reducing pollutant emissions is the basic task of any automaker. As early as the 1970s, many automakers researched and fabricated parts to reduce emissions.

a. Emissions Gas Recirculation (EGR)

The EGR system was invented to control the car's environmental pollution levels in the early 1970s, about two years earlier than catalytic neutralizing systems. The EGR system reduces the NOx concentration by re-circulating the exhaust gas back into the engine's load system under load conditions.

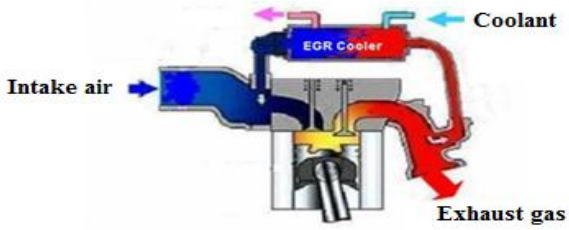

Figure 1. Diagram of exhaust gas recirculation

The effect of this system is to reduce the combustion temperature or decrease the oxygen concentration in the diesel engine. In addition, recirculation gas also increases the specific heat of the flue gas so the fire temperature decreases. The goal of lowering these parameters is to stop NOx production, reducing the concentration of the substance in the exhaust gas.

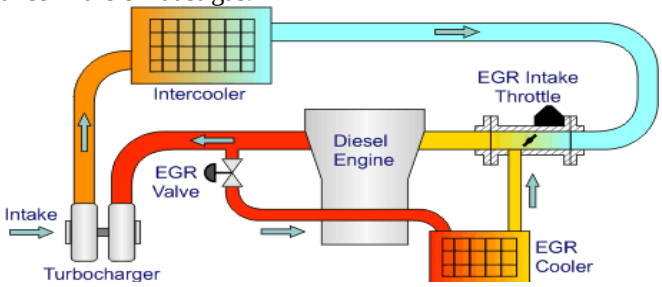

Figure 2. Principle diagram of diesel engine exhaust gas recirculation system

In fact, the higher the temperature, the more NOx is produced (nitrogen is in the air). In addition to temperature, many factors affect NOx formation such as combustion chamber pressure, combustion time, fuel mixture, inlet temperature or refrigerant temperature. For example, reducing the compression ratio and reducing the injection angle or slow ignition (gasoline engine) will reduce the amount of NOx produced, however, this will reduce the maximum power and engine performance.

EGR systems using pipelines connecting the discharging unit to the collector are called external exhaust gas recirculation. A control valve will be responsible for regulating the number of openings and airflow control. The exhaust gas circulates before being mixed with the intake air cooled by otherwise it increases the intake air temperature, affecting the engine power.

Modern diesel engines are EGR cooled by a heat exchanger to increase the amount of recycle gas. Unlike gasoline engines, on diesel models engineers do not limit the rate of recirculation gas. For example, there are engines that use up to 50% of the exhaust to feed. The main effect of circulating gas emissions on diesel engines is the increased specific heat of the mixture, which reduces the combustion temperature and improves efficiency and reduces fuel consumption.

b. Heat treatment method

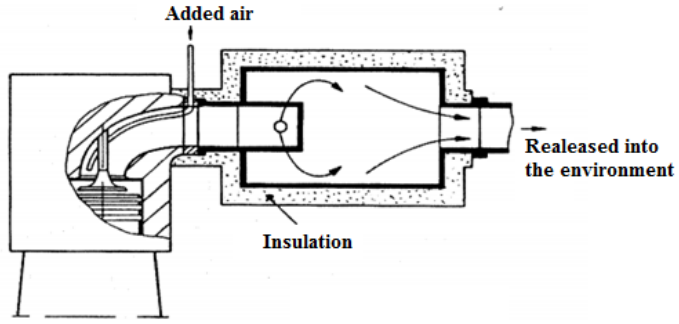

Figure 3. Heat treatment method for exhaust gas

The basic principle of this approach is that both the filter and the engine exhaust will be heated to a minimum temperature necessary to start the combustion process of the solid. To raise the temperature of the filter, one can use one of the following:

- Use electrical energy for micro-ondes, by using a filter made of semiconductor materials or by installing a heat-resistant ceramique filter.

It is possible to heat the filter with a brule with an automatic two-layer filter system: the exhaust gas is fed through the first filter, while the second filled with solid particles is recycled simultaneously with bruleur.

c. Using castalyst

Non-catalysts using SNCR only use urea or NH3 without catalyst so the cost is low. The reactions occur within certain temperature ranges and the high temperature range for SNCR operation is very narrow, the optimum temperature for effective SNCR is about 900 ÷ 11000C so it should be applied to the exhaust stream having High temperature, stable operation and reasonable SNCR regulator.

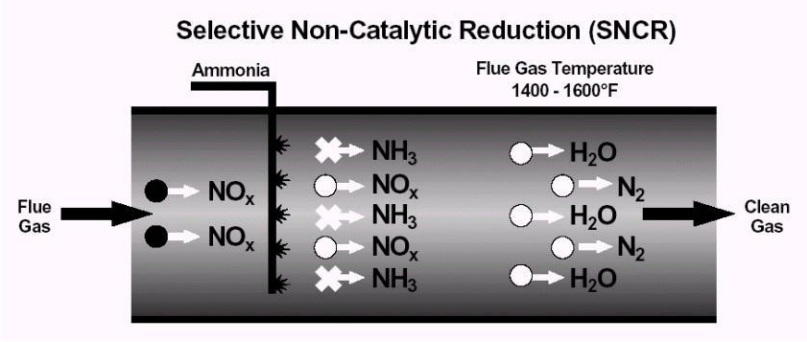

Figure 4. SNCR diagram

The advantage of this type is the low cost, easy to install but operate in the narrow temperature range. The reactions are the same as the SCR but only at the right temperature range, so the range of activity of the SNCR is very narrow, the NOx reduction effect is lower than the SCR but the price is much cheaper because it is not equipped with catalysts. The SNCR system reduces 30-60% of NOx, minimizes the operation of the

machine, easy to install, the fact that SNCR is less used than SCR, SNCR mainly applies to boilers where the agent is sprayed directly into Boiler chamber at very high temperature in accordance with SNCR reaction.
Chemical methods have the advantage that they can be applied to older engines without affecting the structure of the engine, the engine only needs to be equipped with this device in the exhaust line. But the process has not been completed because either NOx or NH3 (Ure) is redundant, resulting in difficulty adjusting the flow. Some NH3 slides out of the catalyst and high temperature NH3 is no longer neutral but oxidized to pollutants, and NH3 is very toxic, so it should be reasonable, temperature range Appropriate, now tend to use ure due to safety, less toxic.

d. Using TiO_2 nanostructure

TiO_2 is a durable, non-toxic, cheap, white powder that has been used for hundreds of years in building materials, as a pigment for paints, in chemical, pharmaceutical and cosmetic industries. . The application of photocatalytic effects of TiO_2 nanoparticles to the decomposition of airborne pollutants is considered as an important solution to clean the environment. The TiO_2 nanoparticle treatment method is superior to traditional adsorption methods; Low investment and operating costs (just sunshine, oxygen and humidity in the air); Oxidation is carried out under normal temperature and pressure conditions; Most organic toxins can be oxidized to the final carbon dioxide and water. TiO_2 crystalline anatase crystals, when exposed to ultraviolet (UVC) UVA rays, will have a very photocatalytic activity. Compared with other substances. Recently, scientists in the country have successfully researched and applied TiO_2 nanocomposite catalysts for cleaning the air. The effect of photosynthetic catalyst material - nano TiO_2, Removal of bacteria, mold in the house, prevention, Deodorization in the office: smell of cigarettes, food smell, incense ... Inorganic, biodegradable, toxic such as VOCs, SOx, NOx ..

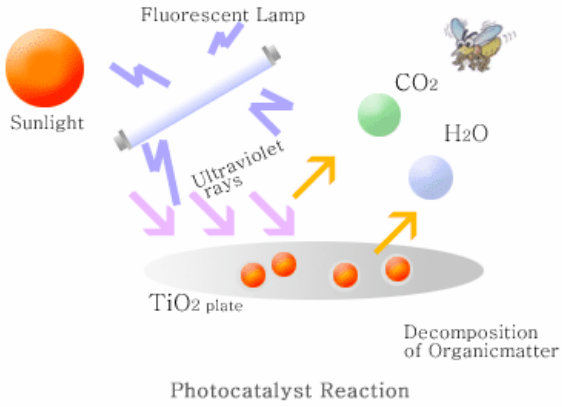

Figure 5. Exhaust gas treatment by nanostructure material

4. Conclusion

The paper presents some technical solutions to reduce the emissions from diesel engines. However, for diesel engines, soot emissions are more concerned and using soot filters is superior. At present, soot filtration has been ongoing research to reduce the pollution level of diesel exhaust. However, this technique is widely applicable in the future whether or not it depends on advances related to the development of the filter element, the layout of the filter system on the diesel engine

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