

Fuel Preferences for Marine Diesel Engine: The Advantages and Disadvantages

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INTRODUCTION

In today's fast-paced development, the use of correct and efficient fuel is truly significant to a developing nation. The study of fuel must be well investigated before any company purchase and use it. There are many factors needed to consider looking into those that can harm and those that can help boost investments. This reading focuses particularly on marine diesel fuel efficiency and performance. The two major varieties of fuels which marine diesel engine uses are the marine diesel oil (MDO) and the heavy fuel (HFO). Also mentioned in this article are fuels Low Sulfur Fuel Oil (LSFO), Natural Gas (LNG), Biodiesel and the limited Nuclear Fuel. This report distinguishes the advantages and disadvantages of the fuel used in a marine diesel engine. Diesel fuels have greatly affected our environments causing climate change. It is allegedly the major cause of sickness mostly lung diseases and sadly pointed out as the cause of many deaths of human, animals and plants. Mentioned in this study are the consequences of new rules that bring implications for the international shipping trade, the cruise industry, and ship owners and operators in particular upon their compliance to the regulations that the environmental agencies demands. Some regulations of certain countries prohibit fuels types making their paths more costly. This research intends to compare and analyze which diesel fuel type is favored for marine companies that will eventually lead them to gain more profits and which fuel is more environmental friendly.

Ships nowadays are being used vastly on seas for transporting various products and machines to different ports of a different nation. It is widely used also for national defense and monitoring. More and more modern yachts and enormous ships travel the sea for leisure and explorations. Take in mind that each unit uses one or more variety of motor engines and each one emits and produces particles on air and on the sea. It is important to control and monitor the use of engines and its fuels that are being consumed on its voyage. Diesel engines are favored in the shipping industry because of its technical characteristics. Experts say that diesel fuel is more satisfactorily than gasoline since the vapors hardly ever explode

or ignite while using it. Diesel fuel is said to be more efficient than gasoline because it has the power of 10 percent extra energy per gallon than gasoline. A diesel engine ignition does not need a spark, unlike gasoline engines. Large vessels prefer the diesel engine because it is less dangerous in traveling the high seas containing a significant amount of fuel. International shipping companies favor the use of Diesel engines known for its compression ignition. This engine makes it safer, unlike spark-ignited engines. A diesel engine uses different types of fuel on the sea. Now let us discuss which fuel is more favorable to shipping companies that use diesel engines and which is safer for our environment?

It is believed that diesel oil is very damaging to our environment and causes cancer. This fuel is known to be more efficient and advisable for diesel engines to function more years of usage. Cleaner diesel fuels were developed due to the demands of environmental organizations. In 2007, the sulfur content of diesel fuels was limited to 15 ppm (parts per million). The unclean diesel earlier was averaging the use to something like 550 ppm. This clean diesel called ULSD (ultra low sulfur diesel) is resulting from further cleansing the same high-sulfur petroleum diesel oil. (Military.com). These conflicts bring to a question if this diesel fuel better to use on seas? The fuel is a significant factor in using machines for continued development. It is prime necessity used by factories and as well as in transportations via land, air or ocean. Nevertheless, it is a must, to consider and analyze the effect of fuel emission on our environment.

Keeping our focus to the maritime industry there are numerous international controlling authorities, that guard and act as protectors of our earth, primarily the International Maritime Organization (IMO) together with many other national environmental agencies. These organizations strictly observe and examine the use of fuels that these machines and motors use. These agencies have already issued rules and regulations that radically distress maritime industry. One of the most heavy guideline being implemented is the one that the Emissions Control Areas (ECAs) particularly ECA of North American. In 2012,

ECA and the SOx Emission Control Areas (SECAs), implemented regulations on the Baltic Sea, North Sea and English Channel. These areas prohibits the ships that uses fuel with sulfur content or must possess lower nitrogen oxides (NO_x) and lesser quantity of particulate matter (PM). (Ralph McGill). These strict instructions hurt many shipping companies. It will cost the companies to buy more pricey cleaning devices in compliance to the regulations reducing sulfur emissions. Another way for the companies to comply is to use low-sulfur fuel or distillate fuel but is also a much expensive fuel. These adjustments will cost more to shipping company's earnings. Another costly alternative for ships with HFO is that ships will have to take a much more extensive route to pass over the areas of the said meticulous members of the controlled areas. (Ralph McGill)

Arctic Countries are now discussing with IMO about the plan ban on ships that uses HFO. Even though HFO is the most inexpensive fuel it is not very advisable for use. These fuels trigger much risks to Arctic countries as HFO increasing melts the ice and bring great concern on global warming issues. According to the Clean Arctic Alliance the Bering Sea lost around half of its sea ice cover in a month. Since the 1970s, three-quarters of Arctic summer sea ice has thaw out and if not controlled, it is estimated to dissolve before 2050. (Stefanini). Therefore, many shipping companies are being discourage in using HFO because maritime protection agencies proves that it release more air pollutants such as sulfur oxide and black carbon than any other like distillate fuel and liquefied natural gas. When the black carbon from HFO settled on ice, it becomes a global warming tool, which then reflects less sunlight and melt more quickly. The physical change of the ice may vastly lead to a very noticeable climate change worldwide.

It is crucial to select the fuel because it has to do with economic and environmental concerns. It is incredibly a prime factor to know the proper fuel to be utilized to favor the development that each company wanted to achieve. Maritime companies must take concern which fuel is better to earn much profit. They must also observe characteristic of fuel performance to see if the fuels used bring damage to the environment. It is a vital factor to distinguish the quality of oil to use to prolong the best performance of the engine. Fuels must supply sufficient combustion without giving off excess contaminants that in the long run will damage the engine.

Low sulfur and ultra-low sulfur oils are permitted in these strict areas. These fuels obviously contain less percentage of sulfur and

have little or no damage to the environment. The prices of these fuels are much higher compare to HFO. But these take note that these special fuel fuels need less cleaning process. These fuels reduce the manning and maintenance of the ships which is less costly. It will also give the cruising boat more convenient passage even to particular areas where high sulfur is banned. It is why it is essential to look into the full details in choosing the correct fuel that the company will use before traveling to certain countries. Big and small companies must carefully evaluate the price and also the damage that the fuel may cause as they operate on it. Some fuel may add more harm than just looking at the purchasing price which is why the right choice is very crucial to profit and gain in the business.

In some conducted research that investigates and evaluate the strategies being used to prevent illness, that the emission of particulate matter (PM) from ship engines attribute up to 60,000 annual deaths from lung and cardiovascular disease. (Corbett JJ, Winebrake JJ, Green EH, Kasibhatla P, Eyring V, Lauer A). Another study gave undeniable evidence that pollution by airborne PM resulting from fossil fuel combustion is the reason for morbidity and premature death. (Pope CA 3rd). Frequent exposure to such PM can generate cardiovascular diseases or lung problems and perceptibly leads to cancer. There are various organizations and government agencies that protect the environmental effects of diesel emission, such as the United States Environmental Protection Agency (EPA), the International Maritime Organization (IMO) and the Marine Environment Protection Committee (MEPC) which is the association of countries and states that works together focusing on maritime safety and the prevention of pollution caused by marine industry. They have created new regulations that implement standard requirements that guarantee a cleaner emission of vessels to reduce pollution on air. (EPA.gov). These agencies examine and regulate marine diesel discharge from various pollutants.

(MDO) and the heavy fuel (HFO). Some of the fuels also mentioned in this report are the Low Sulfur Fuel Oil (LSFO), Natural Gas (LNG), Biodiesel and the limited Nuclear Fuel Advantage and Disadvantage of MDO AND HFO

MDO also was known as "Distillate Marine Diesel" (Marine Diesel Fuel Oil 2015) Most vessels of medium and high-speed diesel engines prefers the use of MDO. Although MDO contains HFO and gasoil, the volume of its gasoil is much lesser. It comprises a minimal level of sulfur. This fuel is more expensive than HFO, but the costly price is very reasonable because upon comparison to HFO this doesn't need heating system during

storage. As a ship travels to high seas, there would be times that they need to store more fuels for longer journeys and may cross cold and icy borders. During this time oil tends to get thicker and cloudier at lower temperatures forming to a gel-like characteristic and decline to flow at all. That is why heating systems need to accompany the ordinary HFO which on the other hand MDO doesn't need it all and making it less costly. MDO doesn't require detailed cleaning system which again justifies its higher price.

Heavy fuel oils have large percentages of heavy molecules such as long-chain hydrocarbons and aromatics with long-branched side chains. (Bomin) Almost all medium and low-speed marine diesel engines are considerably used for heavy fuel oil. Compare to MDO, HFO Requires treatments to clean impurities, requires a heating system to lower the viscosity which dramatically affects the combustions of fuel. The fact it needs heating and treatment system automatically requires more weight and space to a vessel. It is why it is not very practical for smaller vessels. HFO emissions are proven to be very harmful. Many countries do not advise the use of this oil.

Liquefied natural gas or LNG is becoming popularly used because it has a clean-burning characteristic. It is very favorable to environmental agencies because it has less carbon dioxide than other fossil fuel. It is odorless, colorless, non-toxic and non-corrosive. (Wikipedia) It also contains less particulate matter than liquid fuels. LNG must be stored as a liquid under pressure and then warmed to gas before combustion.

Nuclear fuel is definitely not for consumers. It is used for military vessels and is very restricted. Nevertheless, it is mentioned in this report to inform its existence. It is also used for ice breaking. Apparently, it has many disadvantages because it is very expensive, it needs specialized manning. It is complicated in handling and has a very critical process of disposing of its waste materials.

Biodiesel is the clean-burning fuel. It is similar to diesel, but it has no petroleum product. It I created through a chemical process called transesterification which separates glycerin from fat and set down as methyl esters or biodiesel. It can be used in compression type engine with little modifications. It is the most Environmental friendly fuel. Biodiesel fuel is a mixture of organic matter that acts as a substitute for petroleum. New diesel engines have been shown to function effectively with biodiesel blends.

ULSD ultra low sulfur diesel is a diesel fuel with substantially lowered sulfur content. It allows the use of advanced technologies to reduce harmful pollutants, and it eliminates nitrogen oxide

(NOx) and particulate matter (PM) emissions. This fuel will encourage more ships to use diesel engines utilizing ULSD resulting in more diesel fuel on the rise. ULSD fuel is designed to facilitate cleaner engine vehicles with advanced emission control strategy, resulting in notably improved air specification and lesser pollution.

It is verified that the diesel fuel (DF) or marine diesel oil (MDO) has a lower content of toxic compounds, than the unrefined fuel HFO. Nevertheless, MDO is still being questioned whether it is safer because of its higher filth content. But the diesel soot, which is they said to be a carcinogen and responsible for air pollution should still need to be further examined and probe. It is advised to use modern and active filtration devices and technique to reduce the formation of what is said to be carcinogen soot in the ships (PLoS One). Due to the enthusiastic monitoring of environmental agencies and authorities, new and better fuel types namely Biodiesel and ULSD were produce and being utilized. It could be pricey, but the benefits and the fewer expenses for maintenance is justifiable. The maritime regulators make sure that the marine ecosystem is safe from harmful particles exhausted from funnels of these large vessels.

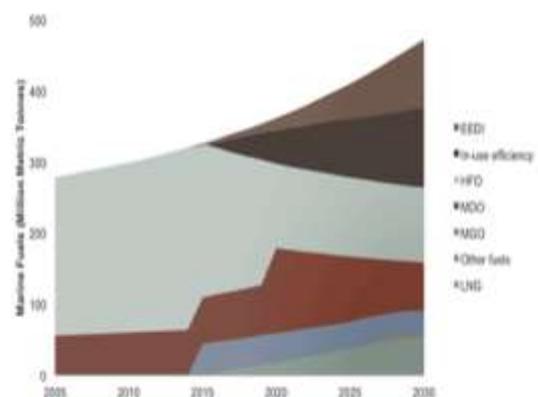
This table shows the carbon content of some fuels

Table 1. The Carbon content per fuel type.

Type of fuel	Reference	Carbon Content	CF (H-CO ₂)/Fuel)
Diesel / Gas Oil	ISO 8217 Grades DMX through DMC	0.875	3.296000
Light Fuel Oil (LFO)	ISO 8217 Grades RMA through RMD	0.86	3.151040
Heavy Fuel Oil (HFO)	ISO 8217 Grades RME through RMX	0.85	3.144000
Liquefied Petroleum Gas (LPG)	Propane:	0.819	3.060000
	Butane:	0.827	3.030000
Liquefied Natural Gas (LNG)		0.75	2.750000

(Acomia)

This graph shows the consumptions of different fuel



types (Wang)

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