EFFECTIVENESS OF HOMOGENIZATION EQUIPMENT ON VERY LARGE CRUDE CARRIER VESSEL

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To

Beloved parents;

Nordin Lot & Alawiah Arshad

Beloved wife & children

Noordiana, Danish, Dania, Darwish & Dhani

For all of their patience and understanding

In the past, presence and future

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ABSTRACT

The use of homogenizer in fuel treatment of heavy fuel oilonboard merchant vessel is arguable; it will reduce separation efficiency of fuel contaminants and fuel properties. Therefore this research analyses the effectiveness of homogenizer operated in Very Large Crude Carrier (VLCC) vessel, MT Bunga Kasturi Lima. The aim of this research is to compare operational effects on the application of homogenizer against those without the use of homogenizer. The common method for fuel treatment onboard the vessel is by using purifier. The separation of impurities and water from heavy fuel oil is essential for good combustion. Actual measurement was captured onboard for sludge production, fuel oil sampling for purifier efficiency and fuel properties analyses and main engine exhaust gas sampling while the vessel was sailing from Singapore to Port of Sikka, India and then to Cape Town, South Africa. The range of sludge production reduction is between 17% to 23% compared to without homogenizer in operation. Purifier efficiency gives a result between 63% to 70% reduction of Aluminum and Silicon for untreated fuel (without homogenizer) and 42% to 50% for homogenized fuel (with homogenizer). The saving calculated from the operational data such as valuable fuel oil and less handling fees for sludge disposal were used for Net Present Value (NPV) analysis. The negative NPV was obtained and showed that the installation of homogenizer did not provide economic advantages. Furthermore it could be concluded that the effect from bunker fuel type, homogenizer positioning onboard fuel treatment, vessel fuel consumption and sea state condition gave various impact on the effectiveness of homogenizer.

ABSTRAK

Penggunaan *homogenizer* dipersoalkan di dalam rawatan dan penggunaan bahan api bagi sesebuah enjin kapal dagang, dimana akan menyebabkan penurunan kecekapan dalam pemisahan bahan-bahan yang tercemar dan air yang terdapat di dalam minyak. Oleh sebab itu kajian ini bertujuan untuk menganalisis keberkesanan *homogenizer* yang beroperasi di atas kapal MT Bunga Kasturi Lima.Tujuan kajian ini adalah untuk membandingkan kesan yang terhasil dari pengunaan *homogenizer* keatas rawatan minyak dan kesannya terhadap pembakaran di dalam enjin kapal. Proses rawatan minyak di atas kapal biasanya mengunakan *purifier*. Perbandingan seperti kadar pengeluar enapcemar minyak, sampel minyak dan pengukuran kandungan ekzos gas dilakukan terhadap kesan yang sama tanpa mengunakan *homogenizer*. Pengumpulan data dan ujian itu dilakukan di atas kapal semasa dalam pelayaran dari Singapura ke Pelabuhan Sikka, India dan kemudianya ke Cape Town, Afrika Selatan. Kecekapan *purifier* memberi keputusan antara 63% hingga 70% pengurangan *Aluminium* dan *Silicon* apabila *homogenizer* tidak digunakan. Walaubagaimanapun bagi penggunaan *homogenizer* ia memberikan keputusan antara 42% hingga 50%. Seterusnya penjimatan yang diperolehi dari penggunaan *homogenizer* berdasarkan data pengoperasian seperti nilai lebih minyak yang berharga dan penjimatan dari kos pengendalian enapcemar minyak telah dikira dan seterusnya dianalisis mengunakan kaedah *NPV*. Nilai negatif *NPV* telah diperolehi dan menunjukkan bahawa pemasangan *homogenizer* tidak memberikan kelebihan dari segi keberkesanan ekonomi. Kesimpulan yang boleh dibuat ialah keberkesanan penggunaan *homogenizer* bergantung kepada jenis bahanapi, kedudukan *homogenizer* di dalam system rawatan minyak kapal, kuantiti penggunaan bahan api kapal dan juga keadaan laut.

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LIST OF ABBREVIATIONS

VLCC	-	Very Large Crude Carrier
MGO	-	Marine Gas Oil
MDO	-	Marine Diesel Oil
HFO	-	Heavy Fuel Oil
MARPOL	-	Marine Pollution
PSC	-	Port State Control
NOx	-	Nitrogen Oxide
SOx	-	Sulfur Oxide
HC	-	Hydrocarbon
CO	-	Carbon monoxide
DN	-	Do nothing
NPV	-	Net Present Value
IRR	-	Internal Rate of Return
DMCO	-	De-ratted Maximum Continuous Output
DSCO	-	De-ratted Service Continuous Output
DNVPS	-	Det Norske Veritas Petroleum Services
SFOC	-	Specific Fuel Oil Consumption
MT	-	Motor Tanker
CCAI	-	Calculated Carbon Aromaticity Index
PPM	-	Part per million
NCF	-	Net cash flow
NPV	-	Net present value
PSC	-	Port State Control
DNVPS	-	DET NORSKE VERITAS Petroleum Services

LIST OF SYMBOLS

V1	-	sludge tank capacity
K1	-	1% clause of sludge
C	-	Daily fuel oil consumption
D	-	Period of voyage
np	-	payback period
P	-	Initial investment
P	-	Principal of investment
I	-	Cash flow
r	-	discount rate/inflation rate
t	-	Number of year
kW	-	Kilowatt
v (%)	-	Purifier efficiency
vo	-	Amount contaminant outlet flow
vi	-	Amount contaminant incoming flow
V_1	-	Theoretical value
V_2	-	Maker's expectation
V_a	-	Actual sludge production
Gr_o	-	Specific gravity (15/4°C),
Pe	-	Engine power obtain by Main Engine operating data
C_o	-	Fuel consumption for one (1) hour by Flow Meter
t_1	-	Inlet temperature at Flow meter
SI	-	saving generates from valuable burnable fuel oil in t year
OS	-	Operator reduction cost (Less sludge handling) in t year
SV	-	Resale value in t year
OC	-	Operating cost in t year
MC	-	Maintenance cost in t year
FO	-	Fuel oil

m^3	-	cubic meter
mt	-	metric ton
E_P	-	Electric motor and feed pump power consumption
G_P	-	Total power consumption at normal sea going,
G_{fo}	-	Fuel oil consumption for Generator engine,
Dt	-	depreciation charge for year t
B	-	First cost
S	-	Estimated salvage value
N	-	Recovery period
D	-	Depreciation rate 1/n
R	-	Without Homogenizer / Untreated fuel
H1+H2	-	With homogenizer / Homogenized fuel
M/E	-	Main engine
Kt	-	knots
Kg/m3	-	kilogram per cubic meter
mm/s2	-	millimeter per second
cSt	-	centistokes
% v/v	-	percentage of volume
% m/m	-	percentage of content
Mg/kg	-	Milligram per kilogram
° C	-	Degree Celsius
MJ/kg	-	Mega joule per kilogram

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CHAPTER 1

INTRODUCTION

1.1 Background

Today the world's fleet includes approximately 55% slow speed diesel, 40% medium speed diesel and 5% other engine types (Rischmann, 2005). Prior to 1970 marine fuel quality was fairly predictable and did not seem to be a major cause for concern. Residual fuels were purchased for boiler and slow speed diesel engine consumption both for marine and shore installations, where they were a viable alternative to solid fuels or gas. At that time residual fuels may found under the titles or short names as 'Burner Fuel', 'Heavy Oil', 'Boiler Oil', and 'Bunker C' which still exist.

Today the efficiency of the oil refinery processes is good and now the residual fuel is produced using different refinery processes. The heavy fuel oil use for Marine fuel oil is expensive due to high light crude oil prices (Rischmann, 2005). Marine fuel oil quality is influenced by the worldwide refinery mix, the variation in crude oil quality available, and the demand patterns for middle distillate and residual fuels (American Bureau Shipping, 1984). Implementation of good fuel oil treatment is essential in order to operate vessel without problems.

If new homogenizer system is positioned in the right place of fuel treatment system, the homogenizer can help to solve operational problems, which may occur during the use of heavy fuel oil onboard of the vessels.

The research will be based on the installation of Homogenizer onboard VLCC Bunga Kasturi Lima and to investigate the effectiveness of the homogenizer equipment onboard fuel oil system.

1.2 Problem Statement

The use of homogenizers in pre-treatment of heavy fuels is controversial, the major manufacturers of fuel purifier advocate against installation of homogenizer upstream separators, arguing that it will strongly reduce separation efficiency (Lien and Kolle, 2002). Previous researcher found that there no significant changes in separation efficiency between untreated and homogenized fuel could be detected (Lien and Kolle, 2002).

It is important to investigate to what extent the fuel oil homogenizer system affects the purifier efficiency, fuel oil consumption, sludge performance and equipments maintenance.

In MISC Berhad context, the installation of fuel oil homogenizer will be significant in order to reduce and recover Fuel oil sludge as valuable operative fuel oil. This research compares the advantages and disadvantages of using homogenizer and the cost involved. The results are certainly useful to major shipping companies in term of significant effect, environmental effect and cost to the overall vessel operation.

1.3 Objective of the Research

i. To compare the operational effects on the application of Homogenizer equipment onboard vessel against without the use of homogenizer
ii. To determine the effectiveness of homogenizer equipment installed on Very Large Crude Carrier (VLCC) vessel.

1.4 Scope of Research

The scope of the research covers the application of Homogenizer equipment onboard M.T Bunga Kasturi Lima. The target route of vessel sailing is from Singapore to Fujairah. Fuel bunkering will be expected in Singapore. Operating condition such as vessel's speed, Main Engine output and fuel consumption, will be monitored.

This study will concentrate on the comparative study with and without the use of homogenizer on the operational effect for following;

i. Purifier Efficiency η_p
ii. Sludge Reduction ν_r
iii. Fuel oil properties F_p
iv. Specific fuel oil consumption
v. Exhaust Gas Analysis

The above operational data will be used for economic analysis by using Net Present Value.

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