Analysis of Transient Response and Harmonic Disturbances on the Tanker's Electrical System Based on Simulation

Sardono Sarwito[1], Eddy Setyo Koenhardono [2], Kirana Putri Taradipa Martha[3]

Abstract— **Basically a ship has a variety of conditions, namely cargo handling, anchoring, maneuvering, and sailing its requires large electricity consumption. The quality of the voltage is not good will cause damage to electrical equipment on board. Disturbances that occur in electrical system of MT. X may result in a decrease in the performance of existing electrical equipment on the vessel and affect a certain condition as in loading-unloading conditions the time required for loading and unloading becomes longer due to interference with the electrical system. The MT.X tanker system has 5 (five) main busbars: BUS 1, FEEDER PANEL, DSB 2, DSB 3 & 4, and DSB 6. The MT tanker. X has a generator of 3 units with a power of 680 kw each, a frequency of 60 hz and a voltage of 450 V. Transient disturbance analysis under loading-unloading condition occurs transient response due to starting ballast pump where the voltage rises and then drops within 0.5 seconds with the highest value of 100.44% at 4.01 seconds and the lowest value is 99.50% to 4.81 can then reach steady state conditions at 99.9%, which does not exceed the IEEE standard limits. In harmonic disturbances under loading-unloading conditions, in the feeder panel connecting the harmonic source with load at the 5th order, the value of VIHD is 8.77%, which exceeds the IEEE standard of 5%. While the value of VTHD in loading and unloading conditions also exceeded the predefined standard limits. After installation of the filter, it can be seen that the value of VIHD at the 5th order in loading-unloading condition decreased to 3.6% after the installation of filter on feeder panel, or equal to decrease as much as 5.17%. The decline in the value of VIHD has fulfilled the IEEE 519-2014 standard of 5% on each individual order. Meanwhile, VTHD value in loading-unloading condition also decreased, from 11.18% to 7.02%.**
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Keywords— Transient Response, Harmonics, Electrical System

I. INTRODUCTION

In essence the ship has a variety of conditions including loading and unloading (handling of cargo), lego anchors (retaining), maneuvering (maneuvering), and sailing (sailing) which requires large electricity consumption[1]. Poor quality of the voltage will cause damage to electrical equipment on board [1]–[3]. The development of power systems in both the generator and the load will produce new problems concerning the stability system. In the use of two or more generators that work freely, the amount may change if the amount of power is unstable[3], [4]. A system will achieve stability when the mechanical power in the main generator drive with electrical power is channeled to the load.

Poor quality voltages can cause damage to electrical equipment on board [3], [5]. Causes of disturbance originating from within the system include abnormal voltages and currents, poor mounting, overloading, and material damage such as broken wire, broken insulators or insulated defects cords [4], [6]. When viewed in terms of the length of time the disturbance, it can be grouped

into two temporary disturbances, which can be lost by itself or by deciding momentarily disturbed parts of the voltage source. The second is permanent disruption, where to free it necessary corrective action and / or get rid of the cause of the disorder. There are various kinds of disturbances that exist in an electrical system that is, transient response, harmonic, etc[6], [7].

Transient response is a performance that shows the speed of the system response in units of time at the transition phenomenon[6]. Harmonics is a disturbance that occurs in power distribution system due to the distortion of current wave and voltage[8], [9]. Basically, harmonics is a symptom of the formation of waves with different frequencies which are the multiplication of integers with their fundamental frequency. This is called the harmonic frequency that arises on the original waveform while the integer frequency multiplier is called the harmonic sequence number. In this study transient responses and harmonics related or influenced one another. At the time of incoming load, the network flow will automatically increase as well, the high current will affect the magnetization on the generator, which generator rotation will also decrease or in other words the rotation frequency decreases. Related to the problem, it will be done how to detect and improve transient response and harmonics.

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II. METHOD

A. Transient Response

Transient response is a performance that shows the speed of the system response in units of time at the transition phenomenon. Transient or transitional symptoms are the change of current or voltage values even both instantaneously or within a certain time period (in micro order seconds) in steady state. The cause is that can be from external factors and internal factors. Transient symptoms occur in circuits containing components or elements capable of storing energy such as inductors and / or capacitors. This symptom arises because the energy received or released by the component can not change instantaneously (current on the inductor and voltage on the capacitor).

The cause of the transient response is the determinant parameters, which usually occur due to open circuit, short circuit (short circuit), or switching, in source operation, etc. Transients are the looping of voltage and current variables that take place during the transition from one stable state to another. Changes in current, voltage during indirect is required and require better time to complete in milliseconds or even microseconds.

This rapid change can not, however, happen instantly or instantaneously because the transient process is obtained through energy exchange, which is usually stored in the magnetic field of the inductance or electric field of capacitance. The change of energy can not occur suddenly or suddenly because it will produce unlimited power (power is a derivative of energy ($P = dW / dt$), which will not occur in real circumstances All changes of parameters when transient response then disappears, and will appear in a new steady state

In this case, the transient response can be regarded as the behavior of the circuit between two steady states, the old steady state (before the change) and the new steady state. The causes of transient response include: (a) Load switching (Load switching); (b) Switching capacitor (c) Recovery voltage
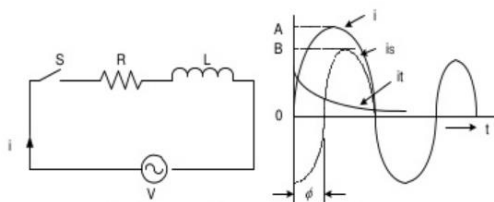

Figure 1 (a) Equivalent Circuit R-L and (b) Flow Shape For R-L Circuits In the current waveform for the obtained R-L circuit [6]

i = initial current (ampere)
V = voltage (Volt)
R = resistance (Ohm)
L = induction (Henri)
is = steady state state current (Ampere)
it = transient current (Ampere)
t = time (seconds)
so:
it = transient current (Ampere)
A = constant
R = resistance (Ohm)
L = inductance (Henri)

Specifications Transient Response is a specification of the observed system response from the moment of change of input signal / interference / load until incoming response in steady state. The benchmarks used to measure the quality of this transient response include:

- Time constan (T) = Measurement time that states response speed, measured from t = 0 s / d response reaches 63.2% of the steady state response.
- Rise time (TR) = Measures of time indicating the presence of a response, measured from a 5% to 95% response of the steady state response.
- Settling time (Ts) = Size of time that states response has entered ± 0.5%, ± 2%, or ± 5% of steady state response
- Delay time (TD) = Size time indicating delay factor of output response to input, measured starting t = 0 s / d response reach 50% from steady state response.
- Overshoot = The relative value that represents the ratio of the maximum response price that exceeds the steady state price compared to the steady state value.

The Steady State Response Specification is a system response specification observed from the moment the response enters the steady state state indefinitely (in practice the observation time is made during Ts ≤ t ≤ 5Ts). The benchmarks used to measure the quality of the steady state response are, among others; steady state error
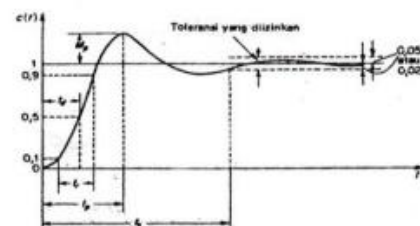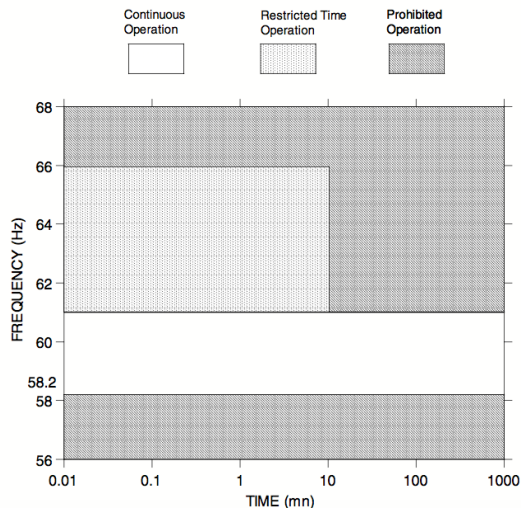

Figure 2 Ladder Response Curves [7]

B. IEEE Standard

According to the IEEE standard 106-2003 the ability of the generator to withstand under / over frequency phenomena is described in Figure 2.3 below

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Figure 3 IEEE standard

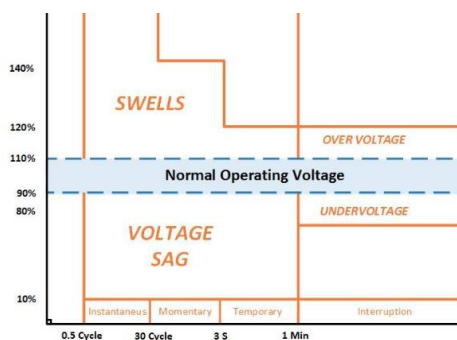From the picture above can be taken explanation as follows:

- Under frequency is permitted up to 58.2 Hz
- Over frequency is allowed up to 61 Hz

For systems with a frequency of 50 Hz, it is necessary to change the unit to% form in order to find the data. Then for frequency 50 Hz,

- (58.2 / 60) x 100% = 97%
- (61/60) x 100% = 101.67%

Then the frequency is not expected to touch the above value when steady state for system stability is maintained.

According to IEEE standard 1195, transient disturbance that can occur is voltage dip, voltage swell, over voltage and under voltage. The standard of the Voltage Dip can be seen in Figure 4 below:

Figure 4 Voltage dips standard

From the picture 4 can be taken some explanation as follows:

- Normal operating voltage ranges from 90% - 110% of nominal voltage.
- Voltage sag / dip is a temporary drop in voltage up to the range of 10% -90% nominal voltage.
- Voltage swells are temporary rises of voltage up to 110% -180% of rated voltage.
- Duration of the dip voltage is divided into 3 categories: instantaneous (0.5 cycle – 30 cycle), momentary (30 cycle – 3 seconds), and temporary (3 seconds – 1 minute)
- Undervoltage and overvoltage are sustained interruption categories

- Voltage Dip are only allowed at 10% below and above nominal voltage values.

C. Harmonic

Harmonics is a disturbance that occurs in power distribution system due to the distortion of current wave and voltage[8], [9]. The cause of the occurrence of harmonics is the use of equipment that has non-linear characteristics. The existence of harmonic current in electric power system can not be eliminated. One way to decrease the harmonic current content is by a single passive frequency filter. Harmonics is a phenomenon arising from the operation of non-linear electrical loads so that the formation of high frequency waves which is a multiple of the fundamental frequency so that the shape is not sinusoidal. The relationship between harmonic and fundamental frequencies can be written as follows,

$$F_h = nf_i$$

Fh = harmonic frequency
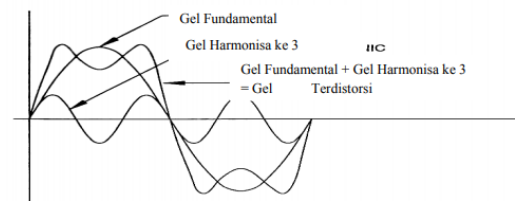n = wave multiplier (integer)
fi = fundamental frequency.

Figure 5 Distorted Waves, Fundamentals, Third Harmonics

D. Effect of Harmonic Disturbance

Harmonic disturbance leads to heat generation of cables and transformers, loss of loss and reduced efficiency of motor work. In addition there are some consequences that occur due to harmonics in the electrical system that is the emergence of mechanical vibrations in electrical panels, harmonics can cause additional torque at KWH meter, consequently rotation of the plate will occur more quickly or error occurs in KWH meter because the induction disk is designed only on basic frequency.

Voltage or current harmonics cause additional rugirugi on stator windings and rotor circuits, and laminate on the rotor and stator. These losses are greater than losses due to DC resistance due to Eddy current and skin effect. The harmonic current arising on the stator of the AC machine produces a motor action (positive harmonic slip, Sn). This action produces a torque shaft in the same direction as the harmonic field speed so that all positive sequential harmonics help the torque shaft rotation while the negative sequential harmonics is the opposite.

E. How to Reduce Harmonic Disturbance

When a power system experiences harmonic distortion problems, there are several basic ways to overcome them:

1. Reduce harmonic current generated by load
2. Add a filter to divert the current entering the system, or localize the harmonic current
3. Change the frequency response by using filters, inductors, and capacitors.

F. IEEE Standard 519-2014

Recommended harmonic voltage limit:

1. Daily 2nd percentile value is very short (3 seconds) should be less than 1.5 times the value given in Table 1.
2. The value of the 95th percentile (10 minutes) percentile should be smaller than the value given in Table 1.

At PCC, the system owner or operator must limit the harmonic line-to-neutral voltage in the following table 1:

Table 1 Recommended Harmonic Voltage Limit

Bus voltage *V* at PCC	Individual harmonic (%)	Total harmonic distortion THD (%)
V ≤ 1.0 kV	5.0	8.0
1 kV < *V* ≤ 69 kV	3.0	5.0
69 kV < *V* ≤ 161 kV	1.5	2.5
161 kV < *V*	1.0	1.5[a]

Based on Table 2.1 above, the recommended harmonic voltage limit for VIHD or voltage individual harmonic distortion is 5%, while the harmonic voltage limit for VTHD or voltage total harmonic distortion is 8%.

G.   Ship Electrial System

The ship's electrical system is a system that operates within a ship's electrical installation. It can be clarified that the ship's electrical installation is one of the ship's working systems that deliver electrical energy for its use for the sustainability of the performance of a ship's operations. Without an electrical system on board, the ship will not be able to operate for operational activities. Because in essence electricity is the main requirement in carrying out operational activities on board. Without the electricity of course components such as motors, pumps, electronic devices, navigation equipment, and other components that require electricity, will not be able to operate. Electrical systems on ships can be started from a power generator unit that is a diesel generator which will then pass through various components of the distribution system for power supply[1], [3].

On the electrical system in the ship generally use at least 2 diesel generator. Because in operation in full load state can be used all generator available. However, when under normal load conditions then the use of generators can be done alternately so that the reliability of the generator can be maintained properly. The number of generators can be determined by calculating the number of power requirements of all the electrical components onboard. To determine the amount or amount of power required (determining the power of the generator) on the vessel, it must first be determined the power to be used by lamps for lighting, and electrical equipment (electric motors) (Sarwito, 1995). From the calculation tesebut obtained how many generators are needed with the power in accordance with the needs of power on the ship.

H. Generator

The generator is a large dynamo that functions as a power plant. The function of the generator is to convert mechanical energy into electrical energy. There are two main components in the electrical generator, the stator (the silent part) and the rotor parts that move. Based on the type of electric current generated, the electric generator is divided into 2 kinds, namely AC generator and DC generator. The alternating current generator (AC) is known as the alternator. The generator is expected to supply electricity during interruption, in which the supply is used for priority loads. While the generator set (generator set) is part of the generator.

I. Induction Motor

An induction motor or so-called asynchronous motor is an electric motor that converts electrical energy into mechanics. In principle is also affected by the rotating field, the rotation of the induction motor is caused by the rotating field (rotating flux) produced by the field coil on the stator. It is said to be an induction motor because the new motor can work when the rotor conductor is induced by the magnetic rotating field on the stator. This asynchronous motor works based on the difference between stator field rotation (Ns) and rotation of rotor (Nr). It says motor slip because the motor rotates when Ns> Nr[10], [11].

J. Ship Condition

Grouping based on ship activity above aims to facilitate in determining the load factor of each equipment, because not all electrical equipment on the ship is operated continuously. So according to Sarwito (1995) in the calculation of the determination of the generator has several views to determine the operational conditions of ships such as:

- Two Conditions: sail and berthing.
- Four conditions: sailing, leaving port, loading and unloading, and at harbor.
- Eight conditions: sailing, leaving the harbor, loading and unloading, and at harbors all in day and night conditions.

The maximum electrical load requirement is also important to know to determine the generator capacity required for generators to supply the maximum power requirements on the ship. While the minimum requirement is used to determine the configuration of the appropriate power system and to determine when the generator is in operation. Sarwito (1995) says there are three groups of load on the ship that must be served by the generator based on their respective functions:

- Load on the gastric deck (hull part
- Load in the form of electric motors of power planes in ship machinery systems (machinery parts)
- Load in the form of electronics, lighting, communication equipment, and navigation systems that support the ship's electrical system (electrical load)

K. Overvoltage

Overvoltage (Voltage over) is an increase in effective value of voltage to exceed 110 percent of the nominal voltage when it exceeds one minute. Overvoltage can be caused by load switching operations such as switching off at large loads, energizing capacitor banks.

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L. Undervoltage

Undervoltage is a decrease in the effective value of the voltage to exceed 90 percent of the nominal voltage when it exceeds one minute. Undervoltage can be caused by load switching operations such as switching on loads, bank switching capacitors.

III. RESULTS AND DISCUSSION

In this final project, the analysis is done by making simulation to know the transient response and harmonics disruption at 4 condition of the ship that is loading-unloading, sailing, anchoring, and maneuvering. To know the disturbance that exist in 4 condition, need to be simulated by using single line diagram data arranged in software simulation. After the compilation of single line data on software, do load flow analysis to determine whether single line diagram is connected with busbar. after doing load flow, then that is doing transient analysis and harmonics. (Table 2- 4)

Table 2 Data used for loading-unloading condition

Nama Peralatan	kW	A	V	Hz
Ballast Pump	200	315	450	60
Ballast Pump	200	315	450	60
Boiler Fan 1	55	59	450	60
Boiler Fan 1	55	59	450	60
Inert Gas Fan	75	117	450	60
Inert Gas Fan	75	117	450	60
Hydr Oil Pump	100	165	450	60
Hydr Oil Pump	100	165	450	60
Low Press Pump	11	19.8	450	60
Compressor	55	128	450	60
Hydr Pump Crane	100	165	450	60
Ecr Ac	3.75	7	450	60
Workshop Cooler	3.75	7	450	60
Turning Gear	3.7	7.2	450	60
Overhead Crane	5	10	450	60
Fo Purifier	5.5	9.1	450	60
M/E Lo Purifier	5.5	9.1	450	60
G/E Lo Purifier	3.7	6.5	450	60
Fo Shifter Pump	3.7	7	450	60
Cargo Oil Turbine Lo	1	2	450	60
Ejector Pump	5.5	9.9	450	60
Distilate Pump	1.5	2.8	450	60
Hyd Oil Pump For Valve	1.5	3.4	450	60
Hyd Oil Pump For Valve	1.5	3.4	450	60
3.5 Ton Prov Crane				
Hoisting	7.5	13.2	450	60
Slewing	2.2	4.2	450	60
Galley Ac	3	5.89	450	60
Prov Ref Comp 1	3.7	12.5	450	60
Meat	0.08	1.4	450	60
Vege	0.08	1.4	450	60
Disposer Galley	0.9	1.9	450	60
Galley Exh Fan	1.5	3.3	450	60
Sanitary Exh Fan 1	1.5	3.3	450	60
0.9 Ton Prov Crane				
Hoisting	2.2	4.2	450	60
Slewing	0.75	1.6	450	60

Table 3 Data used for sailing condition

Nama Peralatan	kW	A	V	Hz
Steering Gear	50	82	450	60
Boiler Fan	55	59	450	60
Boiler Fan	55	59	450	60
Hydraulic Oil Pump	100	165	450	60
Hydraulic Oil Pump	100	165	450	60
Compressor	55	128	450	60
Ecr Ac	3.75	7	450	60
Lathe	1.5	3.2	450	60
Drill Machine	0.4	1.25	450	60
Grinder	0.75	1.57	450	60
Turning Gear	3.7	7.2	450	60
Sewage Treatment	1.5	3	450	60
Fo Purifier	5.5	9.1	450	60
M/E Lo Purifier	5.5	9.1	450	60
G/E Lo Purifier	3.7	6.5	450	60
Fo Shifter Pump	3.7	7	450	60
Ejector Pump	5.5	9.9	450	60
Distilate Pump	1.5	2.8	450	60
Hyd Oil Pump For Valve Control Sys 1	1.5	3.4	450	60
Hyd Oil Pump For Valve Control Sys 2	1.5	3.4	450	60
Life&Rescue Boat Winch Sb Side	18	33	450	60
Life Boat Winch Port Side	3.7	7.3	450	60
Galley Ac	0.4	1	450	60
Galley Ac	3	5.89	450	60
Prov Ref Comp 1	3.7	12.5	450	60
Prov Ref Comp 2	3.7	12.5	450	60
Meat	0.08	1.4	450	60
Vege	0.08	1.4	450	60
Disposer Galley	0.9	1.9	450	60
GALLEY EXH FAN	1.5	3.3	450	60
Galley Exh Fan	1.5	3.3	450	60
Sanitary Exh Fan 1	1.5	3.3	450	60
Sanitary Exh Fan 1	1.5	3.3	450	60
Hot Water Circ Pump	0.4	1	450	60

Table 4 Data used for anchoring condition

Nama Peralatan	kW	A	V	Hz
Compressor	55	128	450	60
Hydraulic Oil Pump	100	165	450	60
Hydraulic Oil Pump 2	100	165	450	60
Ecr Ac	3.75	7	450	60
Workshop Cooler	3.75	7	450	60
Fo Purifier	5.5	9.1	450	60
M/E Lo Purifier	5.5	9.1	450	60
G/E Lo Purifier	3.7	6.5	450	60
Fo Shifter Pump	3.7	7	450	60
Ejector Pump	5.5	9.9	450	60
Distilate Pump	1.5	2.8	450	60
Galley Ac	3	5.89	450	60
Prov Ref Comp 1	3.7	12.5	450	60
Meat	0.08	1.4	450	60
Vege	0.08	1.4	450	60
Disposer Galley	0.9	1.9	450	60
Galley Exh Fan	1.5	3.3	450	60
Sanitary Exh Fan 1	1.5	3.3	450	60

Table 5 Data used for loading-unloading condition

Nama Peralatan	k	A	V	Hz
Steering Gear	50	82	450	60
Boiler Fan	55	59	450	60
Compressor	55	59	450	60
Hydraulic Oil Pump	100	165	450	60
Hydraulic Oil Pump	100	165	450	60
Ecr Ac	3.75	7	450	60
Workshop Cooler	3.75	7	450	60
Fo Purifier	5.5	9.1	450	60
M/E Lo Purifier	5.5	9.1	450	60
G/E Lo Purifier	5.5	9.1	450	60
Fo Shifter Pump	3.7	6.5	450	60
Galley Ac	3.7	7	450	60
Prov Ref Comp	3.7	12.5	450	60
Meat & Vege	0.16	2.8	450	60
Disposer Galley	0.9	1.9	450	60
Galley Exh Fan	1.5	3.3	450	60
Sanitary Exh Fan 1	1.5	3.3	450	60

A. Transient Response simulation

In this transient response simulation, the authors used four ship conditions: loading-unloading, sailing, anchoring, and maneuvering as case study scenarios in the simulation.

In the first scenario the loading-unloading condition, where the largest load on the condition that is on the ballast pump of 200kW. In loading unloading conditions, the ballast pump used is 2 units. The simulation is done to get the stability value of transient response when the largest load is done starting.
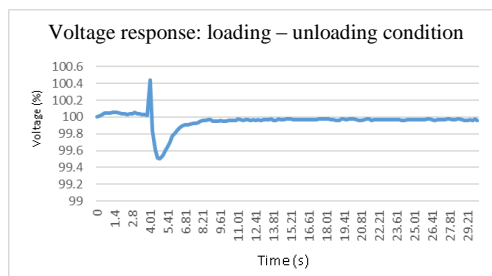

Figure 6. Voltage response: loading – unloading condition

In loading-unloading conditions, transient response occurs due to starting ballast pump where the voltage rises and then drops within 0.5 seconds with the highest value of 100.44% at 4.01 seconds and the lowest value is 99.50% in the 4th second , 81 can then reach steady state conditions at 99.9%. Under loading-unloading conditions the transient response conditions still meet the standards and can be classified as stable.
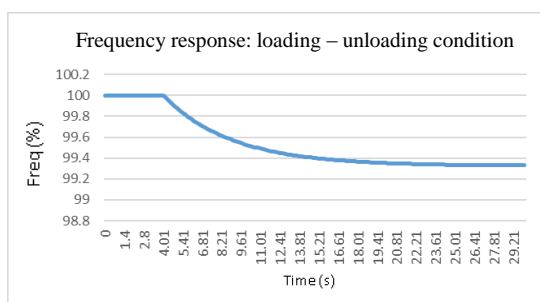

Figure 7. Frequency response: loading – unloading condition

Graph above shows the frequency response in the simulation of loading-unloading conditions, indicating a transient response due to the starting of the ballast pump where the frequency decreases up to 99.3% and is instantly stable at that value. The value still meets the standards and the system is still allowed to operate.

B. Harmonics Simulation

After the electrical system has been compiled on the software, then the load flow analysis must be simulated to get the value of harmonics and where the location of harmonics on the electrical system it happens. Simulation results will appear if there is a harmonic value that exceeds the specified standard limit.

Here is the VTHD value obtained from the simulation of harmonics with simulation software under loading-unloading conditions without using passive harmonic filters found in the table

Table 6. Voltage total harmonic distorsion

VTHD (VOLTAGE TOTAL HARMONIC DISTORTION)			
Report - No Filter - Loading Unloading			
BUSBAR	kV	Fund. %	THD %
BUS 1	0.450	100.00	11.18
DSB 2	0.450	100.00	11.18
DSB 3&4	0.450	100.00	11.18
DSB 6	0.450	100.00	11.18
FEEDER PANEL	0.450	100.00	11.18
Cable76~	0.450	99.90	11.28
Cable78~	0.450	99.90	11.28
Cable80~	0.450	99.74	11.32
Cable82~	0.450	99.89	11.28

In this loading-unloading condition, THD value is 11.18%, 11.28%, 11.32% which means that it has exceeded the maximum THD% ie 8%.

In addition to getting VTHD values, from this simulation also get the value of VIHD which is the value of Individual Harmonic Distortion on each order of harmonics. on the feeder panel connected to the source of harmonics has a value of VIHD at the 5th order of 8.77%.
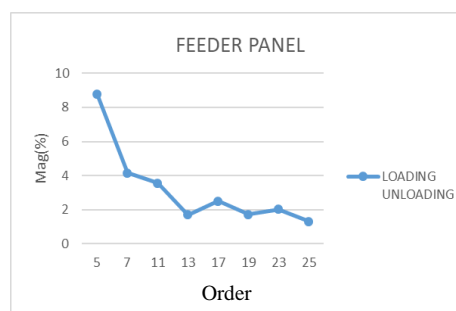

Figure 8. Voltage Drop: loading – unloading condition

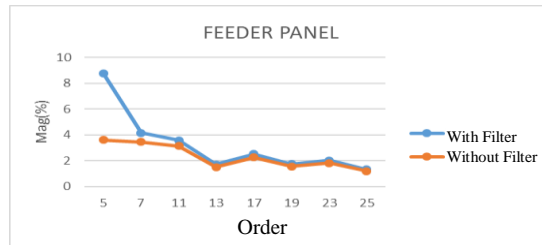After the installation of passive filters on the feeder panel in loading-unloading conditions (Figure 9)

Figure 9. Voltage Drop with and without filter per order

From the Figure 9 it can be seen that the value of VIHD at the 5th order in loading-unloading conditions decreased to 3.6% after the installation of filters on the feeder panel, or equal to decreased by 5.17%. The decline in the value of VIHD has fulfilled the IEEE 519-2014 standard of 5% on each individual order. Meanwhile, VTHD value in loading-unloading condition also decreased, from 11.18% to 7.02%. The decrease in VTHD values can be seen in the Figure 10.
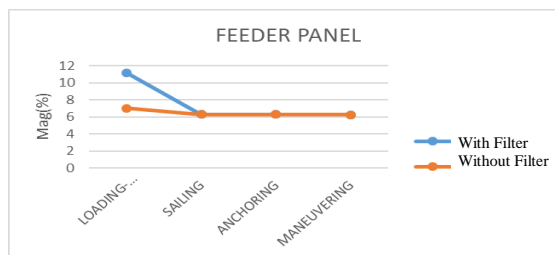

Figure 10. Voltage Drop with and without filter per condition

After installing passive filters on the feeder panel in loading-unloading conditions, the VTHD value decreased by 4.16% to 7.02% which the VTHD value has complied with IEEE 519-2014 standard of 8%.

IV. CONCLUSION

After performing the analysis using ETAP 12.6.0 simulation on MT tanker electrical system. X, it can be concluded that is: (1) In transient response and harmonic disturbance analysis performed by ETAP 12.6.0 simulation yield the following value In loading-unloading conditions, transient response occurs due to starting ballast pump where the voltage rises and then drops within 0.5 seconds with the highest value of 100.44% at 4.01 seconds and the lowest value is 99.50% in the 4th second , 81 can then reach steady state conditions at 99.9%. Under loading-unloading conditions the transient response conditions still meet the standards and can be classified as stable. frequency response in the simulation loading-unloading conditions, indicating a transient response due to the starting of the ballast pump where the frequency decreases up to 99.3% and is directly stable at that value. The value still meets the standards and the system is still allowed to operate. In this loading-unloading condition, THD value is 11.18%, 11.28%, 11.32% which means that it has exceeded the maximum THD% ie 8%. In addition to getting VTHD values, from this simulation also get the value of VIHD which is the value of Individual Harmonic Distortion on each order of harmonics. on the feeder panel connected

to the source of harmonics has a value of VIHD at the 5th order of 8.77%. Graph 4.9 below explains the value of harmonics in each order under loading-unloading conditions. While in 3 other conditions there is no harmonic disturbance that exceeds the standard. Analysis on transient disturbance already meet the standard so no repair is needed. Conversely, the harmonic analysis in loading-unloading conditions has not met the standard so that it is done by using a passive filter. Installation of the passive filter affects the other 3 conditions so that the harmonics value on the condition of sailing, anchoring and maneuvering participate experienced the decrease.

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