THE INVESTIGATION ELECTRICAL POWER CONSUMPTION ON PASSENGER SHIP KM BUKIT SIGUNTANG

Sardono Sarwito[1], Semin[1], M Badrus Zaman[1]

[1]Faculty of Marine Technology
Department of Marine Engineering
InstitutTeknologiSepuluhNopember
Campus ITSSukolilo – Surabaya, Indonesia
Email :semin@its.ac.id

ABSTRACT

KM Bukit Siguntangis a passenger ship, she has specifications LOA 146.5 m, Breadth 23.4 m, total capacity passenger 2160 person. The unity of generator on ship are 4 X 1000 KVA. The aims of this research are to find out; the load factors of each electrical equipments and the effectiveness of generators. The method of this research is by to follow the journey of KM Bukit Siguntang with routes Surabaya – Makasar – BauBau – Ambon – Banda -Tual – Dobo. From those journey will find operational datas such as : operational of each equipments, lighting and from instruments measurements at ECR (Engine Control Room). The next step is to calculate the load factor of each equipments and load factors of generators (alternators).The results of this research are the load factor of each equipmentsLFe, also define the generator load factor LFgen A (base on ECR datas) <LFgen B (base on LFe calculation) <LFgen C (base on references datas). Some recommendation are suggested to improve the effectiveness and the efficiency of generator on ship. LFgen sailing, maneuvering, loading unloading are 0,68; 0,71 ;0,738, so to improve the effectiveness generator can be done by reduce the capacity each generator to be 700 KW

Keyword : load factor of equipments (LFe), load factor of generators (LFgen), passenger ship, , ECR,LFe calculation, LF ref

INTRODUCTION

Electrical consumption is an important point on the operational of ship, the electrical energy on ship are used as power supplay for equipments such as ; ship prime mover, pumps and auxiliary engines, lightings, commucations, navigations, air conditions and loading unloading system.

Electricity consumption on a ship is very large, so it takes a very careful calculation in determining the capacity and unity of the generator, it is intended that no mistakes occur. The mistake could affect on over or under capasity of electric power supplay, which will result losses in both technical and economical.

In determining the capacity and unity of generators on the vessel is done by using the table, where in the table in the form of columns such datas of all ship equipment, electricity needs, load factor of equipment, and electric power needed of equipment in some ship operating conditions (maneuvering, loading and unloading, (SardonoSarwito, 1998).

Investigation of electricity usage on ship KM Bukit Siguntang will be done through the following stages. The firstly is the data collecting of all equipment on the ship which is supplied with electricity. The secondly is tracing time operational data off all electric-powered equipment during the voyage on the three condition (maneuvering, sailing and loading unloading), during the voyage also conducted data collection on the existing MSB. The thirdly is calculated load factor of the equipment (LFe) from the secondly step, as well as will be calculated Load factor of generator LFg.

To track operational data taken on the shipping data; Surabaya - Makasar - Smell of smell - Ambon - Banda - Tual - Dobo during return trip.

The value of the load factor in each equipment will be greatly influenced by factors such as loads character, ship type, shipping route.

In determining the unity and capacity of the generator on the ship, the designer usually uses the assumed load factor of equipment (LFe) value, so that in determining the capacity and the generator unit in the vessel there will be inconsistency with the actual power needs.

By observing the passenger vessels, it is expected that the value of equipment load factor(LFe) for passenger vessels could define, it is suitable for Indonesian shipping and will be evaluated on the ship's installed generators.

The purpose of this research are:

1) Obtain the value of equipment load factor (LFe) on passenger ships for Indonesian shipping.
2) Obtain the value of the load factor generator (LFg) on the object vessel
3) Provide evaluation on the use of electric power generator and proposed suggestions for improving efficiency and effectiveness of generator operations on the vessel.

EXPERIMENT METHOD

The methodology done in completing this research with the sequence of steps as follows:

1. Search data

Collecting technical specifications and real operational data of equipment equipment on ships (pumps, lamps, lifting equipment, generators etc.) by following the voyage on the vessel.

2. Data processing

- Calculates the real load factor of all equipment and load factor of the real generator when the ship is operating.
- Reconstruct the calculation of power requirement of the generator and its unit with real equipment load factor data and the ship's built-in generator so that it will get the load factor generator result of processed load factor of real equipment.
- Reconstruct the calculation of power requirements of generators and units with existing equipment data on the ship and generator installed using data load factor equipment references from textbook.

3. Analysis
   - To test the load factor generator.
   - At this stage, the comparison between the result of the real operating generator load factor, load factor generator with processed data load factor of real operational equipment and load factor generator with processed data load factor refferensi text book. This is done to test the feasibility of load factor value of equipment and load factor generator of calculation result.
   - Analyze the use of generators mounted on research vessels that include:
     - Optimal generator operation
     - Possible replacement of more efficient generators
4. Conclusion

Drawing conclusions based on the results of the analysis and calculations obtained related to the purpose of research.

1. Determination Method of Electrical power needed on Ship

To determine the needed of electrical power on ship, it is necessary to record the overall specifications of all equipment (lighting, pump pumps and all lift machines) on board. Further calculations are made to determine the needs of capacity and unity of the generator, this is do by the table anticipated power balance on ship. Some terms in generator calculations need to be understood:

a. Load factor of equipment (LFe)

Load factor equipment is a factor derived from the division of electrical power used by a device divided by maximum power if the equipment is operated continuously in a ship operation.

LFe = (electrical power of equipment x time operation) / (electrical power of equipment x total time ship operation) (1)

For example, a pump with 2 KW of power at sailing operation at the total time of use is 10 hours while sailing time 24 hours then calculation of equipment load factor is as follows:

LFe pump = (2kw x 10 hours) / (2 kw x 24 hours)
So obtained LFe pump = 0.416

b. Diversity Factor

Diversity factor is defined as the ratio of the total power of the equipment operating with the total power of all equipment, the diversity factor is applied only to intermittent operating equipment. The value of this factor diversity is explained in the rule of BKI vol IV chapter I D.1.c as follows:

Factor diversity should be determined by including the highest load considerations expected to occur at the same time, if proper determination is not possible, the factor diversity used should not be less than 0.5. (BKI vol IV, 1978)

c. Intermitten load.

Intermitten loads are loads that operate discontinuously broken and unscheduled. Such as bilga pump, lubrication pump etc.

d. Continuous load

Continuous loads are loads that operate continuously or on scheduled. Such as AC blower etc.

e. Load Factor of Generator (LFg)

Load factor of generator is a factor derived from the division of total electrical power used on ship divided by maximum power of generators which is operated in a ship operation.

LFg = total electric power used/(unit generator operated x capasity of generator) (2)

For example, total electrical power used on ship at sailing operation 90 KWat the total generator operated have nominal capasity 2 x 75 KW, load factor of generator is as follows:

LFg = (90 kw x) / (2 kw x 75 KW)

So obtained LFg = 0.67 = 67 %

Furthermore, in the rule of BKI mention that to anticipate the existence of start current that arise in machine of electric machine hence at least there must be power remaining of 15% of electric power needed at the time of operation to anticipate the current start. (BKI vol IV, 1978)

Because it is very important and a requirement in the calculation of generator capacity in the vessel then for example if the total requirement of electric power required for 100 Kw then due to rules about the start current is the available generator capacity of at least 115 Kw or if stated in the load factor generator(LFg) is by 86%, this is the max value of LFg. (SardonoSarwito, 1998).

2. Determination of Capacity and Ship Generator Units

a. Determination of capacity and generator unit in ship will go through the following stages:

a. Calculation of total power demand for each ship operation operation

In determining the capacity and the unit of electric generator that is installed on the ship, calculation is done by using the table table calculation on some operational conditions of the ship are: sailing, maneuvering, loading and unloading, where in each condition there is a load factor ship equipment (LFe). (Sardono, 1998) Analyze the electrical load in the form of a table which is called as calculation of electric power balance. In this table contains of columns of the type of equipment and specifications, incoming and outgoing power, number of equipment, type of operation, number of equipment operated, load factor of equipment, intermittent or continuous load category and required electrical input power. (Harington Roy, 1971) In grouping the loads there are three groups of electrical load on the ship are: (Sardono, 1998).

-Electrically loads (lighting, communication, instrumentation and navigation)
-Hull Machinery Loads (loads on the deck of the ship).
-Auxiliary machinery load loading load.

From calculation using table hence will be known the needed of electric power at every operation of ship (sailing, loading and unloading, maneuvering and dock) at each type of load (intermitten and continuous), then by entering factor diversity hence will be known the total electric power needed of each ship operations (sailing, loading and unloading, maneuvering and docking)

b. Selection of capacity and unity generator on board

In determining the capacity of the generator and the unity it is done by using a table containing columns as follows: generator specifications, number of sets, load factor generators in each ship operation (sailing, loading and unloading, maneuvering, docking) and number of generator sets operated on each respectively ship operations. Furthermore, in determining the choice of generator to be installed it needs to be considered many things, including the longest ship operation considerations and the highest load factor generator. Next will be obtained the capacity of generators and unity that will be installed on the ship

RESULT AND DISCUSSION

1. Load Factor Equipment (LFe)

By using the theory of calculating the existing load factor of the equipment, the load factor equipment for each device in each condition is as follows:

Table 1. .Comparison of refference load factor with load factor calculated from shipping

no	Equipments	manuver		sailing		Loading unloading	
		reffer	calculation	reffer	calculation	reffer	calculation
	a) Main engine						
1	Gear oil pump	0,7	1		1	0,85	0
2	Lips hydrolic pump	0,7	1	0,85	1	0,85	0
3	F W cooling pump	0,85	1	0,85	1	0,85	0
4	Sea cooling water pump	0,85	1	0,85	1	0,85	0
5	ST by LO pump M engine	0,65	1	0,65		0,85	0
6	MDO buster pump	0,65	1		1	0,85	0
7	Mo. rail trolley Eng casing	0				0	0
8	Preheater pump ME*					0,5	0,13
9	Chain host bunker station*					0,66	0,13
	b) Aux diesel engine						
1	Sea cooling water pump	0,65	1	0,85	1	0,6	1
	c) Air compressor						
1	For starting air compressor*	0,85	1	0,8	0,188	0,85	0,26
	d) Air conditioning						
1	Compressor AC plant	0,85	1	0,8	1	0,85	1
2	SWC pump AC	0,85	1	0,8	1	0,85	1
3	Chilled water pump AC	0,85	1	0,8	1	0,85	1
4	Compressor prov. plant	0,85	1	0,8	1	0,85	1
5	FW cooling pump AC ECR*	0,85	1	0,8	1	0,85	1
6	SW pump provision plant	0,85	1	0,8	1		1
	e) incinerator						
1	Oil burner*			0,65	0,282		0
2	Sludge oil pump*			0,65	0,282		0
3	Electr motor mixer oil tank*			0,65	0,282		0
4	Electrmotr primary fan*			0,65	0,282		0
	f) boiler plant						
1	Oil burner*	0,65	1	0,65	0,5	0,85	0,13
2	Feed water pump*	0,85	1	0,85	0,5	0,85	0,13
	g) purifier						
1	FO/LO sparator	0,65	1	0,65	1	0,65	0
2	FO/LO feed sparator	0,65	1	0,65	1	0,65	0
	h) FW generator						
1	H W jacket cooling pump			0,85	1	0,85	
2	SW ejector pump			0,85	1	0,85	
3	FW distillation pump			0,85	1	0,85	
	i) Sewage plant						
1	Sewage pump*	0,85	1	0,85	0,31		
2	Sewage cruising pump	0,85	1	0,85	1		
3	Aeration blower	0,8	1	0,85	1		
4	Sewage metering pump	0,85	1	0,85	1		
	j) Deck machinery						
1	Typhon horn	0,8	0,8				
2	Steering gear	0,2	1	0,2	1		
3	Bow thruster	0,8	0,1157				
4	EM hydr pump comb anc& MO winch	0,4	1				
5	EM Hyd for MO winch Oto	0,4	1				

no	Equipments	manuver		sailing		Loading unloading	
		reffer	calculation	reffer	calculation	reffer	calculation
6	EM oil cooler deck crane*					0,8	0,78
7	EM accommodation ladder deck*					0,9	0,78
8	Deck crane*					0,9	0,78
	k) pumps						
1	Pump for bilge separator*			0,85	0,39		
2	Bilge and ballast pump*			0,85	0,31		
3	Vacuum priming*			0,8	0,39		
4	MDO transfer*	0,85	1	0,8	0,26	0,8	0,13
5	Dirty oil*	0,85	1	0,65	0,2	0,6	0,13
6	LO transfer*	0,65	1	0,65	0,2	0,8	0,13
7	SW hydropore	0,85	1	0,85	1	0,8	1
8	FW hydropore	0,85	1	0,85	1	0,8	1
9	Circulating warm water	0,8		0,85	1	0,8	1
10	Laundry water pump*	0,8		0,4	0,26	0,6	0,13
	l) Galley & Pantry eq						
1	Frying pan*	0,4		0,4	0,26	0,6	0,52
2	Galley range*	0,5		0,5	0,21	0,45	0,26
3	Galley range cook plate*	0,5		0,5	0,16	0,45	0,52
4	Galley range oven*	0,5		0,5	0,21	0,45	0,26
5	Dish washer*	0,4		0,4	0,21	0,45	0,52
6	Water boiler*	0,4		0,4	0,37	0,6	0,52
7	Ice flakers	0,45	1	0,6	1	0,6	1
8	refrigerator	0,45	1	0,6	1	0,6	1
9	Small cargo lift*	0,4		0,4	0,21	0,6	0,26
	m) L.dry equipment						
1	Washing machine*	0,4		0,4	0,26	0,8	0,52
2	hydro extractor*	0,4		0,4	0,26	0,8	0,52
3	Ironing machine*	0,6		0,4	0,26	0,8	0,52
	n) Blower's ven.tor						
1	Axial vent supply/exh	0,85	1	0,85	1	0,85	1
2	Radial vent supply			0,85		0,85	0
3	Air condition	0,85	1	0,8	1	0,85	1
4	Vent unit	0,85	1	0,85	1	0,85	1
	o) Workshop						
1	Lathe machine*				0,05	0,6	
2	Grinding machine*				0,05	0,6	
3	Drilling machine*				0,05	0,6	
4	Electr welder*				0,1	0,6	
5	Valve grinding macine*					0,6	
	p) Life boats						
1	Boat david						

*Intermitten load

From the calculation result table load factor equipment (LFe calculation) compared with the refference load factor (LFereff) above then seen:

• For continuous loads, the refference load factor lower than the load factor of calculation result

• For intermitten loads, the refferensi load factor higher than the load factor of calculation results

• For workshops equipments, the refferensi load factor wrong in determining the appropriate position, which is written in loading conditions unloading in reality on sailing condition.

This difference (items 1 & 2) is due to behavioral habits of humans or crew operating the ship, while for item 3 there is an error that needs to be fixed in the refference table

2. Calculation of load factor generator (LFgen) on passenger ship

The load factor generator (LF gen) calculation will include 3 calculations:

• Calculations based on observations on the ECR.

• Calculation using the equipment load factor calculated above

• Calculation using refference load factor

The next will be grouped in each of the ship operating condition with the results as shown in the following table :

Table 2.load factor of generator on sailing operation

Method of calculation	rute	A/E (unit x KW)	Power (KW)	LFg
A. Base on ECR indicator (LFg A)	Sby - Mksr	2 x800	1060	0,663
	Mksr – Baubau	2 x800	1010	0,631
	Baubau - Ambon	2 x800	1050	0,656
	Ambon - Banda	2 x800	1000	0,625
	Banda - Tual	2 x800	1040	0,65
	Tual - Dobo	2 x800	1020	0,636
	Mean			0,643
	Lowest - highest			0,631 – 0,663
B. Base on LFe calculation (LFg B)	Sby - Mksr	2 x800	1254	0,784
	Mksr – Baubau	2 x800	1248	0,78
	Baubau - Ambon	2 x800	1257	0,786
	Ambon - Banda	2 x800	1244	0,778
	Banda - Tual	2 x800	1250	0,782
	Tual - Dobo	2 x800	1246	0,779
	Mean			0,781
	Lowest - highest			0,778 - 786
C. Base on LFe of refferences (LFg C)		2 x 800	1093,75	0,68

From table 2 it is seen that the three generator load factor (LFg) has the following sequence; LFg A (ECR Observation)<LFg B (equipment load factor from refference) <LFg C (load factor observed equipment)

Table 3. Load factor of generator on maneuvering operation

Method of calculation	Port	A/E (unit x KW)	Power (KW)	LFg
A. Base on ECR indicator (LFg A)	Sby	3x800	1450	0,604
	Mksr	3 x800	1550	0,646
	Baubau	3 x800	1550	0,646
	Ambon	3 x800	1500	0,625
	Banda	3 x800	1550	0,646
	Tual	3 x800	1580	0,66
	dobo	3 x800	1550	0,646
	Mean			0,639
	Lowest - highest			0,604 – 0,66
B. Base on LFe calculation (LFg B)	Sby	3 x800	1506	0,626
	Mksr	3 x800	1659	0,69
	Baubau	3 x800	1638	0,683
	Ambon	3 x800	1611	0,67
	Banda	3 x800	1594	0,664
	Tual	3 x800	1777	0,74
	dobo	3 x800	1608	0,67
	Mean			0,677
	Lowest - highest			0,626 – 0,74
C. Base on LFe of refferences (LFg C)		3 x 800	1709,39	0,71

From table 3 it is seen that the three generator load factor (LFg) has the following sequence; LFg A (ECR Observation) <LFg B (load factor observed equipment) <LFg C (equipment load factor from refference)

Table 4.load factor of generator on loading unloading operation

Method of calculation	Port	A/E (unit x KW)	Power (KW)	LFg
A. Base on ECR indicator (LFg A)	Sby	2x800	960	0,60
	Mksr	2 x800	900	0,56
	Baubau	2 x800	900	0,56
	Ambon	2 x800	940	0,59
	Banda	2 x800	880	0,53
	Tual	2 x800	900	0,56
	dobo	2 x800	900	0,56
	mean			0,56
	Lowest - highest			0,53 – 0,6
B. Base on LFe calculation (LFg B)	Sby	2 x800	1171	0,73
	Mksr	2 x800	1095	0,68
	Baubau	2 x800	1130	0,71
	Ambon	2 x800	1151	0,72
	Banda	2 x800	1088	0,68
	Tual	2 x800	1088	0,68
	dobo	2 x800	1108	0,69
	Mean			0,69
	Lowest - highest			0,68 – 0,73
C. Base on LFe of refferences (LFg C)		2 x 800	1182	0,738

From table 4. it is seen that the three generator load factor (LFg) has the following sequence; LFgen A (ECR Observation) <LFg B (load factor observed equipment) <LFg C (equipment load factor from refference). From the third table load factor generator (sailing, maneuvering, loading unloading) above it can be concluded:

- From LFg C when sailing, maneuvering, loading and unloading (0.68, 0.71, 0.738) look high enough and still possible to increase LFg by decreasing the value of generator capacity of 700 KW per unit
- From load factor generator based on observation data of ECR (LFg A) when sailing, maneuvering, loading and unloading (0,663; 0,66,06) look high enough number and still there is possibility to be increased LFg by decreasing value of generator capacity equal to 600 KW per unit .
- Load factor generator of processed load factor of equipment (LFg B) shows the above results from the value of load factor of observation result of ECR (LFg A) shows that the data load factor of the equipment (LFe) is valid to be used as refference data for next passenger ship design.

CONCLUSION

From the discussion results obtained the following conclusions:

1. Load factor of equipment as written in table 1,could be applied on ship design of shipping passenger in Indonesia, with note when using load factor of equipment from table refferensi need to be revised at workshop load should be changed in from condition of sailing to be loading unloading condition.
2. The value of the generator load factor on the ship is as follows: LFgen A (ECR Observation) <LFgen B (load factor observed equipment) <LFgen C (equipment load factor of refference).
3. Referring to the result of refference load factor when sailing, maneuvering, loading and unloading (0,68, 0,71,7,738) it is possible to decrease the generator capacity to 700 KW per unit.

REFERENCES

Harrington Roy L. 1971. *Marine Engineering,*

SardonoSarwito, Ir.MSc. 1998 .“ Perhitungan*Kapasitas Generator di Kapal*“., JurnalTeknologiKelautan,

BKI.RancangandankonstruksiInstalasiPembangkitPeraturanklasifikasidanKonstruksiKapalLautJilid IV, 1978.PeraturanInstalasiListrik

Theraja BL. 1980.*Fundamental of Electrical and Electronics*, Nirja Construction & Development Co Ltd Ram Nagar New Delhi,