LONG-TERM FSO/FPSO CHARTER RATE ESTIMATION

Hesty A Kurniawati[1], Wasis D Aryawan[1], Achmad Baidowi

[1] Department of Naval Architecture, Faculty Of Marine Technology, Sepuluh November Institut of Technology, Indonesia

Email: tita@na.its.ac.id

Abstract

Most of the charter rate data provided in the market is for the short-term and it is based on freight rate for cargo ships. This paper offers a method to estimate long-term charter rate for special ships such as FSO and other supporting vessels. The method is utilizing engineering economy such as IRR and goal seek facility provided in spreadsheet. The IRR is iterated 2% above the basic saving interest rate to find more attractive charter rate and the sensitivity analysis provides flexibility for the owner in order to anticipate the volatility of economic condition

Keywords: FSO/FPSO, Charter Rate, IRR

1.   INTRODUCTION

The World demand of energy is increasing day by day.The crude oil growth of demand is around 43% in a span of 20 years (1990 – 2010), in order to meet this heavy demand world offshore production has risen three times to 53 million barrels per day in a span of 10 years[1], meanwhile the world natural gas consumption grew by 2.2% below the historical average 2.7%. But for the southeast natural gas market, there is a huge gap between the supply and demand, the gap is around 9 bcf/d[2] as shown in Fig.1
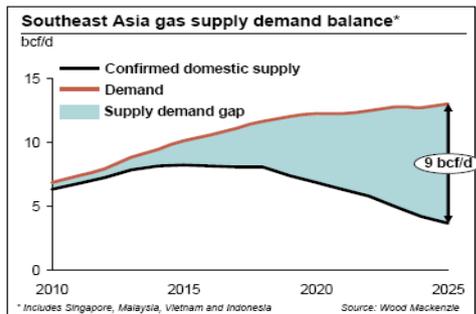
Fig.1 Southeast Asia gas supply and demand

One of production facilitywhich has been widely used in offshore oil or gas production are Floating Production Storage and Offloading (FPSO) or Floating Storage and Offloading (FSO). In fact, the largest population of FPSO is in Asia region, there are 42 FPSO in Asia region and it represents 23.2% FPSO population all over the world as shown in Table.1

Table.1 FPSO per region

Region	Number
Asia/Far east	42
West Africa	41
South America	39
Europe	25
Australia/New Zealand	13
Mediterranean/Black Sea	5
US Gulf Mexico	3
Canada	2
Indian Ocean	1
Idle	10
Total	181

Most of the FPSOs in the world are leased FPSOs for 15 years or more. The growth of FPSO usage in the world is 81% marked by the number of FPSO has increased from 90 to 180 from 2004 to 2013 units as shown in Fig.2. This indicates the necessity of charter or lease rate estimation is very important.
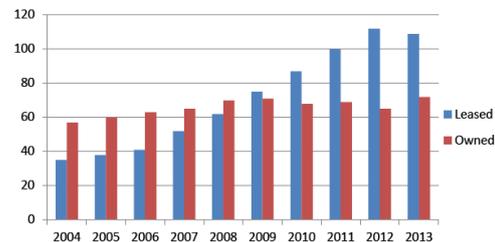
Fig. 2 . Number Of FPSO from 2004 to 2013

Most of the charter rate estimations are defined based on spot rate of voyage charter provided in the future market. Spot market provides historical data of charter rate and it is volatile, Seasonality has an important implication for market participants4. There are 4 main groups of freight market, dry bulk, Tanker, Container and other types of ships1, the special ships

charter rate such as FSO/FPSO is difficult to find in the market data, most of the market data and economic model of charter rate is for short term.

Based on backgrounds mentioned previously, this paper proposes a method to estimates the charter rate based on engineering economy principles, in this case based on NPV and IRR.

2. METHOD

2.1. Revenue
Revenue is generated by the charter rate fee paid by the charterer, the operating days will be vary depend to the maintenance schedule.

2.2. Capital Cost
The investment cost is representing the total amount of assets or money which must spent by the owner to gain in order to finance the investment.

2.3. Operating Cost
Operating costs, which constitute the expenses involved in the day-to-day running of the ship—essentially those costs such as crew, stores and maintenance that will be incurred whatever trade the ship is engaged in[8], The common components of operating cost are:
- Crew Cost
- Maintenance and Repairs
- Administration and general charges
- Lubrication Oil
- Insurance
- Provisions and stores
- Voyage Cost

The total annual operating cost strongly influenced by the maintenance schedule, the operating cost must be covered for all the economic lifetime of the ship, a ship must follows maintenance and survey schedule, ideally the survey requires the ship to be docked, so the annual cost will be increases due to the docking.

2.4. Capital Budgeting in Engineering Economy

Estimation method of long term charter rate for special ships such as FSO, are still relatively rare, this paper proposes a method to estimate the long-term charter rate of an FSO based on engineering economy analysis. Engineering economy is an approach of design to meet maximum effectiveness in the use of scarce resources: man-power, materials (including fuel), machinery and spare money[5]. This method utilizes capital budgeting principles to assess the feasibility of an investment. There are several known criteria of capital budgeting such Net Present Value (NPV), Internal Rate of Return (IRR), Cost and Benefit Ration(C/B ratio). In this study IRR and NPV in this case FSO/FPSO charter rate, the project must fulfill at least two criteria, first, is the Net Present Value(NPV). The net present values (NPV) of income and expenditure are calculated over the assumed life time of the ship (N) years, the final sum should be positive for the investment to be profitable at the assumed discount rate – or where alternatives are being compared it should be the larger sum.

$$NPV = \sum_{t=0}^{N} \frac{\bar{CF_t}}{(1+r)^t}$$

Where :
r is the cost of capital
t is time of project
CF is Cash Flow

The second requirement is the Internal Rate of Return (IRR), this method requires that the rate of return is at least equal or higher than the saving interest rate offered by commercial Bank[6].

$$NPV = \sum_{t=0}^{N} \frac{\bar{CF_t}}{(1+IRR)^t} = 0$$

The financial performances and investment strategy of the project must be able to make the ship owner survive in the shipping market, there are three key variables which ship-owners have to work with [7], and those variables are:
- The revenue received from chartering/operating the ship;
- The cost of running the ship;
- The method of financing the business

The decomposition of those three variables has been conducted based on general structure of the cost and revenue structure.

2.5. Net Cash Flow

The component of cash flow consist of :
- Revenue
- Total Cost
- Earnings before tax
- Tax
- Net cash flow
- Cumulative cash flow

Based on the cumulative cash flow the Break Even Point of the investment can be determined, A break even is achieved when the value of the cumulative cash flow is positive or even to all investment cost.

3. CHARTER RATE OF FPSO/FSO

Based on the method proposed in the previous section. A case study based on the charter requirements as given in Table 2. The assumptions is the FSO will be chartered for 20 years in time charter scenario. The time charter assumes that maintenance cost, docking, lubrication, fuel oil, crew cost is the owner responsibility. But the scenario still adjustable based on the agreement between ship-owner and charterer.

Table 2 Assumptions and parameters of the FSO

Economic Life time of the ship	20	years
Capital Cost	50,000,000	US$
LOA	261 m	m
Breadth	39	m
Depth	23.1	m
Draft	15.25	m
Salvage value of ship	5,000,000	US$
Contract period	20	Years

3.1. Charter Revenue

It is assumed the operating days is 365 days when there is no docking schedule,and assumed 345 when there is a schedule for the ship needs to be docked,the charter rate will be calculated per day,the first 10 years of the rate assumed flat or in the same amount due the contract is for 10 years,the next 5 years decreases 50% from the first year,and the last 10 years assumed 30% from the first year rate,this assumption is based on the decreasing performance of the ship due to the depreciation.The decreasing rate must be adjusted to the condition.

3.2. Capital Cost

This paper assumed that the owner uses loan from a bank to finance 75% of the total capital cost. The rest of the capital (25%) came from the owner. The maturity of loan assumed is 5 years, The interest rate is 10%, payment per year is once a year.

The total payment per year which consist of principal payment and the interest payment is US$ 9,892,405.53. The detail of the annual payment for 5 years described in Table 3.

Table 3 Annual Payment for 5 years

		0	1	2	3	4	5
SALVAGE VALUE	US$	5,000,000.00	47,631,578.95	45,263,157.89	42,894,736.84	40,526,315.79	
DEPRECIATION	US$		(2,368,421.05)	(2,368,421.05)	(2,368,421.05)	(2,368,421.05)	(2,368,421.05)
BEGINNING BALANCE	US$	37,500,000.00	31,357,594.47	24,600,948.39	17,168,637.70	8,993,095.94	
INTEREST PAYMENT	US$		(3,750,000.00)	(940,727.83)	(738,028.45)	(515,059.13)	(269,792.88)
PRINCIPAL REPAYMENT	US$		(1,842,721.66)	(1,842,721.66)	(1,842,721.66)	(1,842,721.66)	(1,842,721.66)
ENDING BALANCE	US$	31,357,594.47	24,600,948.39	17,168,637.70	8,993,095.94	0.00	
TOTAL PAYMENTS	US$		(9,892,405.53)	(9,892,405.53)	(9,892,405.53)	(9,892,405.53)	(9,892,405.53)

3.3. Operating Cost

This paper considers two type of survey or docking as part of the operating cost. The intermediate survey and special survey. The intermediate survey cost is US$75,000 and the special survey docking is US$100,000 while the regular maintenance cost is US$50,000.
The detail of operating cost is shown in Table 4.

Table 4. Total Operating cost

	Annual	Intermediate survey	Special Survey
Crew	201,196	201,196	201,196
Maintenance & Repairs	50,000	75,000	100,000
Admin and charges	25,000	25,000	25,000
Lub Oil	6,000	6,000	6,000
Insurance	600,000	600,000	600,000
Provisions and stores	50,000	50,000	50,000
Total Annual Cost	932,196	957,196	982,196
Total Operating Cost	**932,196**	**957,196**	**982,196**

There are several basic assumptions used in this calculation which can be shown in **Appendix 1**

3.4. Charter Rate and Sensitivity Analysis

The charter rate is calculated based on IRR. In order to make the investment is feasible, the charter rate must provide higher IRR compared to the bank saving interest rate.

In this paper the value of IRR is simulated between 10% -20%. Table 5 shows the scenario of IRR, profit and Charter rae from 10% up to – 20%. The scenario is required to obtain sensitivity of charter rate against targeted IRR.

Table 5. Variation of Charter rate

IRR	PROFIT	CHARTER RATE (US$)
10%	0%	24,380
12%	2%	26,021
14%	4%	27,617
16%	6%	29,181
18%	8%	30,713
20%	10%	32,214
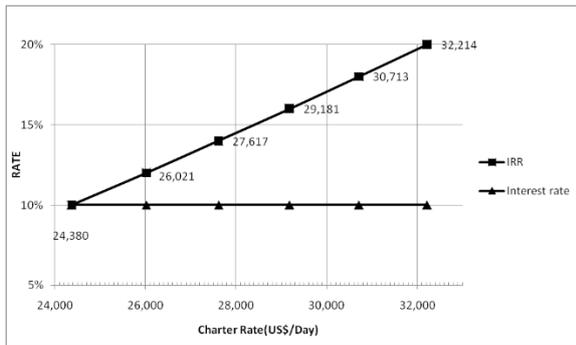
Fig. 3. Variation of charter rate and IRR

It is can be found from Fig. 3. That the minimum charter rate is US$24,380 per day, this value is defined based on the bank saving interest rate 10%.

Table 6. NPV values based on variation of IRR

IRR	PROFIT	NPV (US$)
10%	0%	$ -
12%	2%	$ 2,937,075
14%	4%	$ 5,793,763
16%	6%	$ 8,593,280
18%	8%	$ 11,335,502
20%	10%	$ 14,072,381

Beside sensitivity analysis IRR and charter rate, it is also required to conduct sensitivity analysis of IRR and NPV as shown in Table 6.
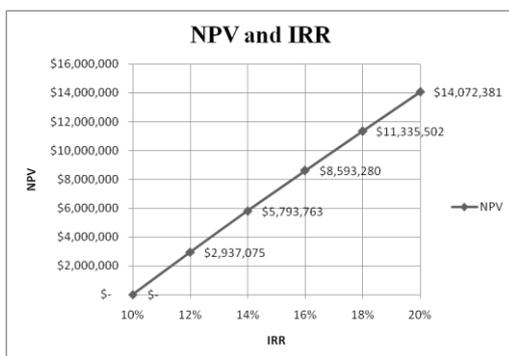
Fig. 4. Iteration of NPV and IRR

Fig.4 shows that to obtain profit 0% to 10% from the bank saving interest, the NPV shall be from US$2,937,075 to US$14,072,381. The complete calculation of charter rate at 16% of IRR presented by **Appendix 2**

4. CONCLUSION

Long-term charter rate of an FSO/FPSO can be defined by using capital budgeting principle where the evaluation criteria are the NPV and IRR. By conducting IRR iteration gradually 2% above the basic IRR or basic saving interest rate will provides ship owner sensitivity against the volatility of the saving interest rate.

For this case the mean value or the moderate charter rate value is at US$8,757 at 16% IRR (6% higher than saving interest rate).This Method provides flexibility both for owner and charterer to estimate the long term charter rate in the volatile or uncertain condition.

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Appendix 1. Basic assumptions of charter rate

1.	CAPITAL COST SUMMARY		
1.1	Capital Cost(conversion and ship price)	US$	50,000,000

2.	OPERATING COST SUMMARY			
2.1	Crew	US$	201,196	/year
2.2	Maintenance & Repairs	US$	50,000	/year
2.3	Administration & general charges	US$	25,000	/year
2.4	Lub oil	US$	6,000	/year
2.5	Insurance	US$	600,000	/year
2.6	Provisions and stores	US$	50,000	/year
2.7	Total Operating Cost	US$	882,196	/year

3.	VOYAGE COST SUMMARY			
3.1	Bunkers	US$	-	/year

4.	FINANCIAL SUMMARY			
4.1	Maturity of loan		5	year
4.2	Payment per year		1	
4.3	Equity	US$	12,500,000	25%
4.4	Debt	US$	37,500,000	75%
4.5	Interest rate/year	%	10.0%	
4.6	Loan Repayment / Year (Flat)	US$	9,892,406	
4.7	NPV	US$	8,670,383	
4.8	Economic Lifetime of ship	Year	25	
4.9	Salvage Value	US$	5,000,000	

5.	CHARTER RATE FOR VARIOUS IRR				
	IRR	Margin	RATE/DAY	BEP(year)	Remarks
5.1	10%	0%	24,380 US$/day	9	Basic Charter Rate
5.2	12%	2%	26,021 US$/day	9	
5.3	14%	4%	27,617 US$/day	8	
5.4	16%	6%	29,181 US$/day	8	
5.5	18%	8%	30,713 US$/day	7	
5.6	20%	10%	32,214 US$/day	7	
	Note:	Margin= IRR - Interest Rate = IRR - 10%			

Appendix 2. Charter Rate Spreadsheet

		Year	0	1	2	3	4	5	6	7	8	9
Revenue	RATE/DAY (No Profit)	US$		29,224	29,224	29,224	29,224	29,224	29,224	29,224	29,224	29,224
	OPERATING DAYS	US$		365	365	345	365	345	365	365	345	365
	TOTAL REVENUE/YEAR	US$		10,666,867	10,666,867	10,082,381	10,666,867	10,082,381	10,666,867	10,666,867	10,082,381	10,666,867
Ship Financing	SALVAGE VALUE	US$		50,000,000	47,631,579	45,263,158	42,894,737	40,526,316	38,157,895	35,789,474	33,421,053	31,052,632
	DEPRECIATION	US$		(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)
	BEGINNING BALANCE	US$		37,500,000	31,357,594	24,600,948	17,168,638	8,993,096	0	0	0	0
	INTEREST PAYMENT	US$		(3,750,000)	(3,135,759)	(2,460,095)	(1,716,864)	(899,310)	-	-	-	-
	PRINCIPAL REPAYMENT	US$		(6,142,406)	(6,756,646)	(7,432,311)	(8,175,542)	(8,993,096)	-	-	-	-
	ENDING BALANCE	US$		31,357,594	24,600,948	17,168,638	8,993,096	0	0	0	0	0
	TOTAL PAYMENTS	US$		(9,892,406)	(9,892,406)	(9,892,406)	(9,892,406)	(9,892,406)	-	-	-	-
Cost	OPERATING COST:											
	Crew	US$		201,196	201,196	201,196	201,196	201,196	201,196	201,196	201,196	201,196
	Maintenance & Repairs	US$		50,000	50,000	75,000	50,000	100,000	50,000	50,000	75,000	50,000
	Administration and general charges	US$		25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
	Lube Oil	US$		6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
	Insurance	US$		600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000
	Provisions and stores	US$		50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
	Total Variable Cost	US$		932,196	932,196	957,196	932,196	982,196	932,196	932,196	957,196	932,196
	VOYAGE COST:											
	Bunkers	US$		-	-	-	-	-	-	-	-	-
	Total Voyage Cost	US$		-	-	-	-	-	-	-	-	-
	TOTAL COST	US$		10,824,601	10,824,601	10,849,601	10,824,601	10,874,601	932,196	932,196	957,196	932,196

	Year	0	1	2	3	4	5	6	7	8	9
Earning Before Tax			(157,735)	(157,735)	(767,221)	(157,735)	(792,221)	9,734,671	9,734,671	9,125,185	9,734,671
Tax			(47,320)	(47,320)	(230,166)	(47,320)	(237,666)	2,920,401	2,920,401	2,737,555	2,920,401
Net Cash Flows = Earning Aft. Tax		(12,500,000)	(110,414)	(110,414)	(537,054)	(110,414)	(554,554)	6,814,270	6,814,270	6,387,629	6,814,270
Cum. Cash		(12,500,000)	(12,610,414)	(12,720,829)	(13,257,883)	(13,368,297)	(13,922,852)	(7,108,582)	(294,313)	6,093,317	12,907,586
Control BEP			-		-		-		-	BEP	-

Evaluation Criteria		Value	Criteria	Min	Remarks
Present Worth (PW or NPV) at 20 th year	US$	8,670,383		0	Positive Incr. Wealth
Present Worth Index (NPVI)	kali	0.17	Ok	0	Null
IRR	%	16%	Ok	10.00%	MARR
IRR Index (IRRI = IRR/ MARR)	kali	1.61	Ok	0	Null
BEP from year -		8	Ok	1	Construction Period
Accum Cash on BEP	US$	6,093,317	Ok	0	Positive Accum Cash

10	11	12	13	14	15	16	17	18	19	20
29,224	14,612	14,612	14,612	14,612	14,612	8,767	8,767	8,767	8,767	8,767
345	365	365	345	365	345	365	365	345	365	345
10,082,381	5,333,433	5,333,433	5,041,190	5,333,433	5,041,190	3,200,060	3,200,060	3,024,714	3,200,060	3,024,714
28,684,211	26,315,789	23,947,368	21,578,947	19,210,526	16,842,105	14,473,684	12,105,263	9,736,842	7,368,421	5,000,000
(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)	(2,368,421)
0	0	0	0	0	0	0	0	0	0	0
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	0	0	0
-	-	-	-	-	-	-	-	-	-	-
201,196	201,196	201,196	201,196	201,196	201,196	201,196	201,196	201,196	201,196	201,196
100,000	50,000	50,000	75,000	50,000	100,000	50,000	50,000	75,000	50,000	100,000
25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000
50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
982,196	932,196	932,196	957,196	932,196	982,196	932,196	932,196	957,196	932,196	982,196
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
1,964,392										
982,196	932,196	932,196	957,196	932,196	982,196	932,196	932,196	957,196	932,196	982,196

10	11	12	13	14	15	16	17	18	19	20
9,100,185	4,401,237	4,401,237	4,083,994	4,401,237	4,058,994	2,267,864	2,267,864	2,067,518	2,267,864	2,042,518
2,730,055	1,320,371	1,320,371	1,225,198	1,320,371	1,217,698	680,359	680,359	620,255	680,359	612,755
6,370,129	3,080,866	3,080,866	2,858,796	3,080,866	2,841,296	1,587,505	1,587,505	1,447,263	1,587,505	6,429,763
19,277,715	22,358,582	25,439,448	28,298,244	31,379,110	34,220,406	35,807,911	37,395,416	38,842,679	40,430,184	46,859,946
-		-		-		-		-		-