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Total Cost of Ownership Modeling for Dynamic Equipment

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Abstract

Since the end of 2014, the price of crude oil has decreased by over 60%. This decrease in price has forced the main oil and gas companies to increasingly apply cost reduction strategies. One of these strategies is called Total Cost of Ownership (TCO) when applied to equipment acquisition procedures as an evaluation metric. This cost reduction method includes evaluating direct and indirect costs with the scope of objectively comparing potential equipment purchases throughout the entire operational period. The article describes a procedure for selection and analysis intended to be used in the company OMV Petrom, accompanied by a numerical example in the case of a compression process.

Key words: *total cost of ownership, cost reduction*

Introduction

Total Cost of Ownership (TCO) is an analysis meant to uncover all the lifetime costs that follow form owning certain kinds of assets. For this reason, TCO is sometimes called *life cycle cost*. Ownership at acquisition represents different cost categories like: initial cost, maintenance cost, operating cost, environmental cost [1-7]. Also, every cost categories brings many others cost element:

- Initial Cost - Purchase cost, Initial Training, Installation, Approvals, and other;
- Maintenance Cost - Corrective Maintenance, Preventive Maintenance;
- Operating Cost - Energy Consumption, Cooling System, Downtime;
- Environmental - CO_2 emissions, Decommissioning, Decontamination;

Modeling

Cost model categories for the gas compressors were chosen to represent cost areas that need careful planning and management during the 10 year period in view. Once the scenario cash flow estimates are made, the model's structures can now be exploited to show cost dynamics that may not be so easy to see in the cash flow statements. Examples for hidden cost are: energy consumption and preventive maintenance. The elements of Total Cost of Ownership (TCO) method are represented in Figure 1. Using the TSO method first we determine what type compressor we need depending on the scenario (suction pressure, discharge pressure, nominal

flow, and gas composition) [8]. Once compressor type and size are determined, we can examine the compressors 10 year operating cost.

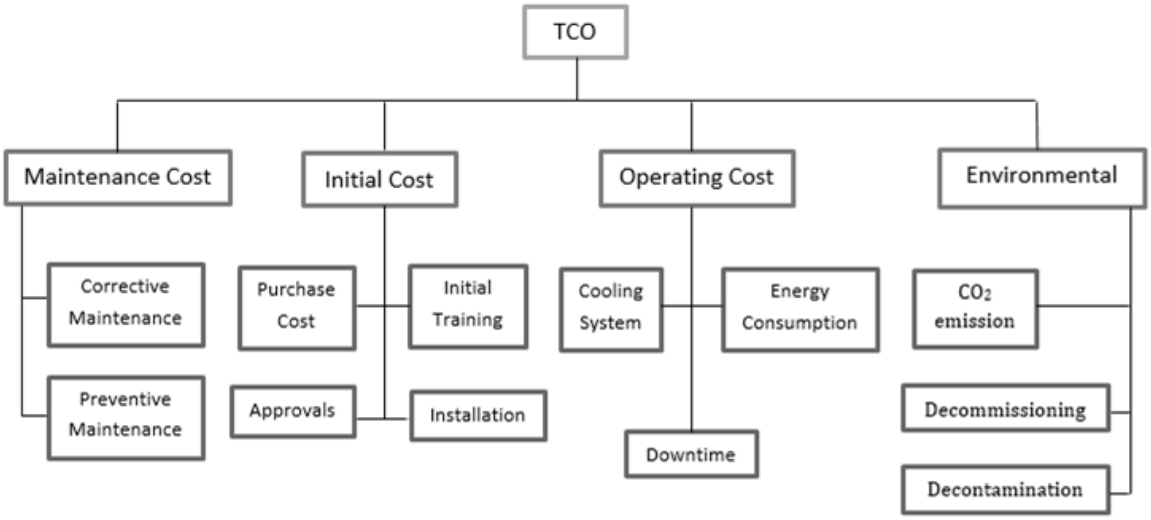

Fig. 1. The structure of Total Cost of Ownership (TCO) method.

We used the next formulas into the algorithm of evaluation. The formula used to calculate the price of energy consumption C_e[Eur/year] is:

$$C_e = \frac{P \cdot E_p \cdot T_o}{\eta_h \cdot \eta_m \cdot \eta_v}, \tag{1}$$

where P is power of the compressor [kW]; E_p price of energy – we supposed an increase of the price 2 % annually [Eur/kWh]; T_o time of operation - it has been assumed 0.75 of the total hours during a calendaristic year [hours/year]; η_h, η_m and η_v are hydraulic, mechanical and volumetric efficiencies respectively. The total cost of exploitation C_t [Eur/year], including cost of operation C_o , cost of maintenance C_m and cost of energy C_e is:

$$C_t = C_o + C_m + C_e. \tag{2}$$

The income obtained annually R is:

$$R = V_g \cdot P_t, \tag{3}$$

where V_g is the volume of gaz compresed [m^3_N/year]; P_t price of compression [Eur/m^3_N] – it was used a price of 0.1 Eur/m^3_N. The net income N is the difference between annually income and total cost of exploitation [Eur/year]:

$$N = R - C_t. \tag{4}$$

The updated value of money MV_iinto the year i is:

$$MV_i = \frac{MV_0}{(1+r)^i}, \tag{5}$$

where MV_0 is the money value at the initiantion of the project; r is the update rate including risk and inflation – it was presumed 5 % each year. Three cases have been modelled, Table 1, using : a reciprocating compressor; a centrifugal compressor and a screw compressor. The last column represent the cost of energy calculated with relation (1).

The maintenance cost has been evaluated using the producer's values. The procedure obliges the potential bidders to complete the Tables 2-4 with their maintenance program. It is recommended to create a template for the preventive maintenance program [2, 9]. Each case has an acquisition

price, Table 6. Maintenance and operational costs depend on the compressor type, Table 5. Here we used data from the petroleum companies, obtained by personal connections of the authors and references [9, 10]. The values are updated with relation (5). Annually the company which execute the gas compression has a profit, Table 5 last column, and a total revenue in 10 years. In Figure 2 we can see a great difference between the three cases. The centrifugal compressor has a lower hydraulic efficiency and it counts in the prince of energy; this aspect increase over time; in 6 years the operation is in loss. The total revenues are compared with the acquisition cost of the compressor difference highlighting the best option. In our example this is the variant with the screw compressor, Table 6.

Table 1. The analysed cases

Case	Power, kW	Operational time, [hours/year]	Flow, [m^3_N/h]	Pressure, bar	Energy price, [Eur/kWh]	Volumetric Efficiency[1]	Hydraulic Efficiency[1]	Mechanical Efficiency[1]	Energy cost, [Eur/ year]
Reciprocating compressor	240	6570	634.52	16	0.12	0.90	0.8	0.85	309176
Centrifugal compressor	240	6570	587.86	16	0.12	0.90	0.70	0.90	333714
Screw compressor	240	6570	643.85	16	0.12	0.90	0.75	0.92	304695

1) from [8].

Table 2. Preventive maintenance data

Crt. No.	Description	Preventive Maintenance (Services + Spare Parts)					Maintenance Total Cost
		V	RT	RC1	RC2	RK	
1	Contractor 1						
2	Contractor 2						
3	Contractor 3						

Table 3. Preventive maintenance data, details

Crt. No.	Preventive Maintenance	Services Value	Spare parts Value	Total Value
Contractor 1				
1	V			
2	RT			
3	RC1			
4	RC2			
5	RK			

Table 4. Preventive maintenance services

Crt. No.	Operation Description	Duration [hours]	Unit Price	Total Price
1				
2				
…				
Total value for Preventive Maintenance Services				

Table 5. Reciprocating compressor analysis

Year	Purchase cost, [Eur/year]	Maintenance cost [Eur/year]	Maintenance cost updated [eur/year]	Operational cost [Eur/year]	Operational cost updated [Eur/year]	Energy cost [Eur/year]	Energy cost updated [Eur/year]	Income [Eur/year]	Income updated [Eur/year]	Profit [Eur/ year]
t	300000									
1		20000	19048	8000	7619	309176	294454	416881	397029	75909
2		20800	18866	8160	7401	315360	286041	416881	378123	65815
3		21632	18687	8323	7190	321667	277868	416881	360117	56373
4		22497	18509	8490	6984	328101	269929	416881	342969	47547
5		23397	18332	8659	6785	334663	262217	416881	326637	39303
6		24333	18158	8833	6591	341356	254725	416881	311083	31609
7		25306	17985	9009	6403	348183	247447	416881	296269	24435
8		26319	17813	9189	6220	355147	240377	416881	282161	17751
9		27371	17644	9373	6042	362250	233509	416881	268725	11530
10		28466	17476	9561	5869	369495	226838	416881	255929	5746
Total revenue during ten years interval [Eur]										376016

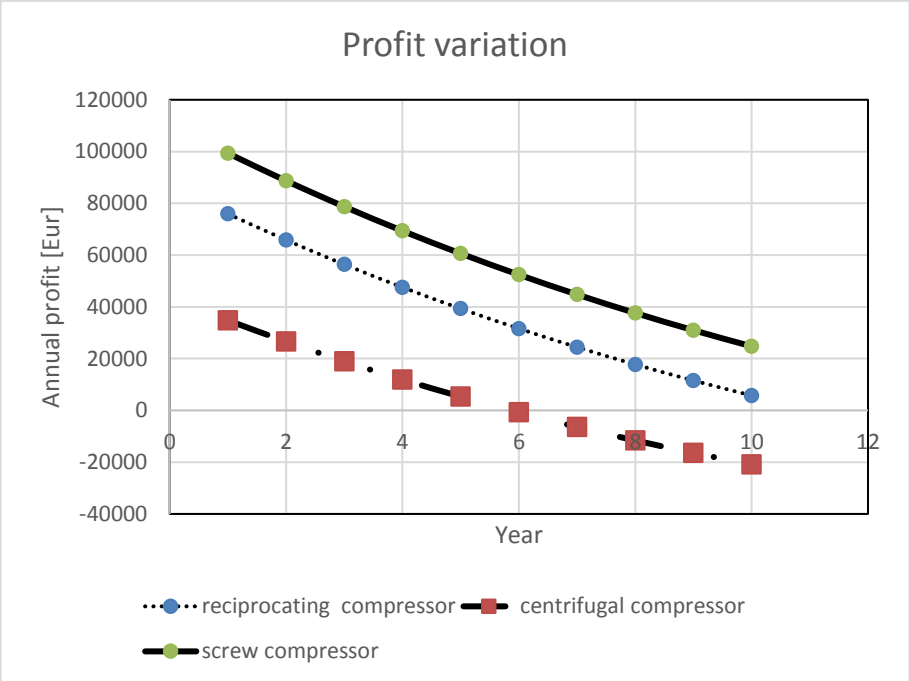

Fig. 2. Variation of the annual profit.

Table 6. Results of the analysis.

Cases	Purchase price, Eur	Total revenue, 10 years program, Eur
1	300,000	376,016
2	210,000	41,530
3	280,000	587,226

Conclusions

The proposed concept is primarily aimed for Oil & Gas industry which in is crisis at this moment (35.10$ - Brent Crude Oil and 13 Eur/ MWh natural gas). However, this is the perfect moment to implement some cost reduction methods. One of these cost reduction methods is called TCO (Total Cost of Ownership). TCO analysis is a cost benefit analysis that determines the economic value of an investment. A TCO analysis includes total cost of acquisition and operating costs. It is used to gauge the viability of any capital investment. The TCO concept is widely used in the equipment industry. For example, TCO defines the cost of owning an equipment from the time of purchase, through its operation and maintenance to the time it is sold or decommissioned. The application of compressor selection show that can be a great difference between the results of the solutions chosen. The selection based on composition, nature of the product, operating parameters, prices involved, combines many elements that lead to the best solution of achievement.

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Analiza achiziţiei echipamentelor dinamice pe baza costului total de proprietate

Rezumat

Datoria scăderii preţului ţiţeiului cu peste 60 % de la sfârşitul anului 2014 până în prezent. marile companii din industria de petrol şi gaze s-au concentrat din ce în ce mai mult pe metode de reducere a costurilor. Una dintre aceste metode este utilizarea costului total de proprietate (TCO) la achiziţie pentru diferite tipuri de echipamente. Aceasta metoda de reducere a costurilor include cheltuielile directe şi cheltuielile indirecte menite să compare potenţialii ofertanţi cât şi să ajute actualii proprietari în a lua o decizie la achiziţie pentru o perioada de 10 ani sau pentru întreaga durată de viaţă a echipamentului. Articolul descrie o procedură de selecţie şi analiză destinată a fi utilizată în cadrul companiei OMV Petrom, însoţită de un exemplu numeric, în cazul unui proces de comprimare.