

A Study on Impact of Scheduled Preventive Maintenance on Overall Self-Life as well as Reduction of Operational Down Time of Critical Oil Field Mobile Equipment

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ABSTRACT

Exploration and production of Oil and Gas is a very challenging business on which a nation's energy security depends on. The exploration and Production of hydrocarbon is a very precise and time bound process. The striking rate of hydrocarbon in a drilled well is so uncertain that the success rate is only 31% in 2021 as per Rig zone. Huge cost is involved in drilling as well as production of hydrocarbon from a well. Due to this very reason, no one can afford to lose a well because of faulty machines which increases the Non-Productive Time (NPT). Numerous activities that include manpower and machines synchronized together works in a precise way to complete the full cycle of exploration, rig movement, drilling and production of crude oil. There are several machines both fixed and mobile are used in the complete cycle. Most of these machines has tight schedule of work operating in various drilling sites that are simultaneously being drilled providing a very narrow window for maintenance. Shutdown of any of these machines for even a small period of time delays the whole project and increases the cost of production of hydrocarbon by manifolds. Moreover, these machines are custom designed exclusively for oil field operations to be only used in Mining Exploration Licensed area (MEL) earmarked by government and are imported and very costly in nature. The cost of some of these mobile units like Well Logging Unit, Coil Tubing units, Nitrogen pumping units etc. that are used for Well stimulation and activation process exceeds more than 1 million USD per unit. So the increase of self-life of these units also generates huge revenues during the extended duration of their services.

In this paper we are considering the very critical mobile oil field equipment like Well Logging Unit, Coil Tubing unit, well killing unit, Nitrogen pumping unit, MOL Oil Field Truck, Hot Oil Circulation Unit etc. and their extensive preventive maintenance in our auto workshop. This paper is the outcome of 10 years of structured automobile maintenance and minute documentation of each associated event that allowed us to perform the comparative study between the new practices of preventive maintenance over age-old practice of symptom based corrective maintenance and its impact on self-life of the equipment.

Keywords: Preventive maintenance; Symptom based maintenance; Advanced machineries

INTRODUCTION

Oil India Limited is India's second largest National Oil Company with its headquarter in North Eastern part of India and pan India presence as well as overseas ventures in countries like, Russia, Mozambique, Venezuela etc.

The exploration and extraction of hydrocarbon is a tough business that requires precise skill, knowledge and technologically advanced machineries [1]. These machines are required in various stages of the whole process that includes exploration, drilling and production of hydrocarbon. Oil India Limited has 14 numbers of onshore drilling rigs and 16 numbers of works over rigs that work simultaneously on round the clock basis in different locations. Most of the oil field equipment is mobile in nature so that they can be easily deployed in

various drilling rigs. Lot of planning and management is required to deploy these machines among different drilling as well as work over rigs to cater the needs as these rigs are always in different stages of drilling and production cycle. This mobile equipment are regarded as the heart of exploration and production activities and unplanned shutdown leads to major disaster in terms of higher operating cost as well as Non-productive time. Breakdown of these machines for even a small amount of time during operations may lead to damage of the drill hole resulting abandonment of the whole process that leads to loss of unimaginable capital [2].

To address the issue, Oil India Limited has two dedicated Department namely, Well Stimulation Services (WSS) for planning, deployment and operations of these highly sophisticated mobile equipment

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and Logistics maintenance Workshop responsible for repairing and maintenance of the equipment, particularly the automobile parts.

This paper deals with automobile maintenance of a set of 26 numbers of such sophisticated mobile equipment considering 11 years of maintenance data fetched from ERP-SAP system. It has shown the comparison of planned preventive maintenance over unplanned breakdown maintenance of mobile equipment and corresponding benefits in terms of prolong vehicle self-life, reduction of non-productive time as well as reduction of major component failure. This paper also deals with the new technologies and unique custom made procedure adopted for the purpose to get the desired result in cost effective way.

METHODOLOGY

Glimpse of the vehicles considered for the study are shown in Table 1.

Table 1: Type of vehicle considered for Preventive Maintenance.

Type of vehicle	Name and Make	No of unit
	Hot Oil Circulation Unit Make: Kenworth, USA	3
	Coil Tubing Unit Make: Volvo, Kenworth, USA	8
	Mobile Crane Make: Groove, TIL	7
	Well Logging Unit Make: Kenworth, Peterbuilt, USA	5
	Oil Field Truck (OFT) Make: MOL, Belgium	3

Note: Total Vehicles- 26

Preventive maintenance vs symptom based (breakdown) maintenance

Maintenance of vehicles in Automobile Workshop is done in two ways.

- Planned scheduled maintenance within a specific interval of time. The interval of time between two successive servicing may be based upon different parameters such as odometer reading, running hours of engine etc. But till date, no scheduled servicing is based on fixed interval of time irrespective of utilization of the vehicle mainly to save cost and associated wastes that generates like change of lab oil, filters etc which sometime is redundant in nature [3].

- Unplanned breakdown maintenance or symptom based maintenance of vehicles. In modern automobile maintenance, symptom based maintenance is of least desirable even though major portion of maintenance in all type of automobile workshop is this type of maintenance only. Breakdown maintenance is unplanned type and cannot be predicted earlier. Due to its nature of unpredictability, the inventory carrying cost is higher since workshop need to stock all types of spare parts related to the vehicle. Also breakdown may happen in any time which effects the ongoing operations abruptly thereby increasing operating cost as well as Non- productive time.

In our Automobile maintenance workshop, we have studied 11 years of maintenance activities of 26 numbers of highly specialized oil field vehicles. From the year 2010 to 2015, we basically focused on symptom based maintenance and very minimal preventive maintenance [4]. The main reason was that since these vehicles are highly sophisticated and on high demand, so the user departments were reluctant to release it for preventive maintenance when basically no problem was with the vehicle. It is also a human behavior of getting things done. But on proper study it was found that the inventory cost associated with symptom based maintenance as well as manpower cost and non-productive time of these vehicles were in fact skyrocketing.

To overcome such unwanted situation and to narrow down the breakdown of the mobile equipment and associated lost, a major reform was undertaken in the year 2015 where it was decided to switch from symptom based maintenance to preventive maintenance. It was decided to perform Preventive maintenance of each vehicle after fixed interval of time of 6 months irrespective of other parameters like running hour, odometer reading etc. This decision was made since uses of these vehicles are very high so it is difficult to maintain correct log of other parameters as the parameters vary from vehicle to vehicle.

The major difficulties in adaptation of preventive maintenance of fixed time interval

- The waste component of consumables is relatively high. It is because some consumables like engine oil, fuel and engine oil filter, air filter etc. may not need to be changed at that particular time but it may fall short of the next servicing. Hence additional life of the consumables is compromised in this type of servicing.

- Since oil field mobile equipment operates in dusty and humid environment, therefore the clogging of air filter is relatively high and needs to be replaced frequently. The presence of water vapors in the air directly goes to air compressor which corrodes the internal parts and thereby frequent breakdown of air compressor. Hence more maintenance cost incurred in air filtration system.

- Due to operations in hostile environmental condition, water particle may mix up with the Engine oil. The same may happen due to malfunctioning of oil cooler. Ordinary Engine oil filter is not designed to separate the water from Oil. The Engine oil mixed with water eventually corrodes the engine components and as a result over the time the engine may cease to work [5]. The only possible solution is to replace the Engine oil frequently even if its property is not deteriorated in visual inspection which in turn increases the maintenance cost as

well as storage and disposal problem of discarded Engine oil. The frequent 6th monthly servicing produces huge quantity of discarded engine oil.

- As per the company's prevailing practice, the discarded engine oil is usually auctioned by tendering process every year. However, since we need to accumulate the engine oil in drums for longer time to make a lot of sizable quantity, rain water mixes with the discarded oil. Due to presence of considerable water content, almost no vendor is interested to procure it. So the used engine oil kept on piling up year after year creating huge problem of storage and also creates concern towards the environment.

- The diesel storage tank usually becomes dirty due to hostile working environment. The impurities eventually mix with fuel and reach to the combustion chamber. The fuel filters cannot separate the impurities of size less than 0.5 microns. The only possible solution is to frequent cleaning of fuel tank. During cleaning, the diesel that is already present in the fuel tank needs to be discarded for effective result of cleaning the system. All the vehicles under consideration have 02 numbers of fuel tanks of capacity 200 liter each. So it is obvious that cleaning of fuel tank during fixed preventive maintenance produce huge quantities of waste fuel.

- Almost all the operations of Oil Field Vehicles are controlled by hydraulics for running winches, pumps, lifting things etc. Hydraulic oil used for this purpose contaminates with metal chips generated from different hydraulic components due to its high operating pressure and temperature. Water also gets mixed in the tank as these vehicles works in open area under rain also [6]. Over the time, the contaminated hydraulic oil corrodes hydraulic components like hydraulic motor, pump, various valves, actuators etc. Due to high level of contamination, the hydraulic filters need to be replaced very frequently which increases the cost of maintenance. Moreover, the existing filtration unit cannot filter impurities of less than 0.5 micron. As per practice, the hydraulic oil around of 200 liters of quantity against each vehicle is replaced by every 6 month which increases the maintenance cost by manifolds.

System improvement and steps taken to mitigate the problems associated with preventive maintenance on 6th monthly basis

After elaborate study of the system adopted for maintenance and associated problems, the following steps were incorporated (Table 2).

Table 2: Preventive Maintenance service book.

Pictorial view	Name	Purpose
	Preventive maintenance schedule	To record information regarding 6 th monthly maintenance of each vehicle.

Design and development of duly authorized 6th monthly preventive maintenance schedule: An elaborate service book consisting of all the 26 numbers of vehicle has been designed and developed that contains minute details of each vehicle after every 6th monthly servicing. This book provides the health of the vehicle at a glance [7].

New technologies adopted for preventive maintenance and to curb the wastes generated during maintenance shown in Table 3.

Table 3: Types of Technologies adopted for Preventive Maintenance.

Pictorial view	Name of the product	Function of the product
	RCI Filter	External filtration system of engine oil. It separates impurities below .5 micron as well as water contamination. It gives support to the existing lub oil filtration system and thereby reduces the frequency of replacement of lub oil filters.
	Centri air Pre Cleaner	It separates all the water vapor present in air as well as large impurities before it is fed to the air filter and air compressor. It increases the life of combustion chamber by nullifying the chances of corrosion.
	Micfil Diesel Filtration Unit	It is used to separates the impurities and water content mixed with diesel in diesel tank. During washing of the tank the diesel that already present in the tank is purified and again used. The process nullifies the wastage of diesel during cleaning of fuel tank
	Micfil Hydraulic oil Purification System	It is used to separates the impurities and water content mixed with hydraulic oil. It has the capability to remove impurities less than .5 micron as well as all the water content present in the oil. The hydraulic oil need not to be discarded and can be used for many years. There is less load on existing hydraulic filter and hence eliminates the need of frequent change.
	Effluent Treatment Plant (ETP) to process used Engine oil	It is used to separate the contaminated water part from used engine oil. The separated water can be released to the environment safely. The pure and concentrated Engine oil is auctioned for further reuse in some machines as well as for recycling purpose.

Outcome of the 6th monthly preventive maintenance

After elaborate study of the preventive and breakdown maintenance data of last 11 years from 2010 to 2021 obtained from integrated ERPSAP system, we have found that the transition from previous symptom based maintenance system to preventive based maintenance system integrated with latest technologies has given desired result in all parameters such as reduction of equipment’s Non-productive Time, less failure of critical parts, lower maintenance cost and above all increased self-life of the vehicle [8]. We have successfully able to reduce and mitigate the waste generated during frequent preventive maintenance. The overall benefits obtained in the long run supersede the cost associated with the procurement of new technologies for efficient preventive maintenance.

RESULTS AND DISCUSSION

Final result of the interpretation of graphical representation

The following conclusion can be drawn from Figure 1 and Table 4.

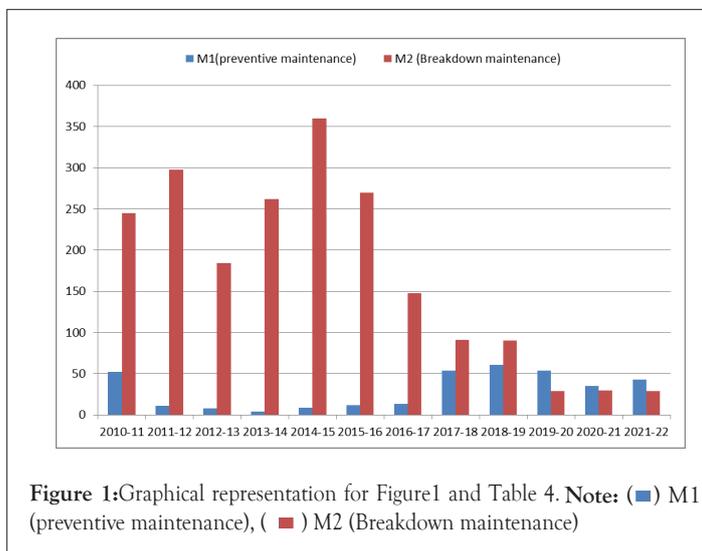


Table 4: Data received from SAP-ERP System (Plant maintenance Module) of Oil India Limited.

Year	M1	M2
2010-11	52	245
2011-12	11	298
2012-13	8	184
2013-14	4	262
2014-15	9	360
2015-16	12	270
2016-17	13	148
2017-18	54	91
2018-19	61	90
2019-20	54	29
2020-21	35	30
2021-22	43	29

From the graph it can be clearly understood that the number of breakdown report from year 2010 to year 2015 is very high when the symptom based maintenance system was adopted whereas breakdown report attended per year is continuously decreasing from the year 2015 to the year 2021 when the preventive based maintenance system is

adopted. As the number of preventive maintenance from the year 2016 to 2018 increases, the overall health of the vehicle has also improved.

From the year 2019 to the year 2021, the breakdown report attended each year is in fact lower than the number of preventive maintenance. The total number of report attended (Preventive+breakdown) during this period is much lower than the total number of reports attended during 2010-2015. This has shown that the overall self-life of the vehicle under consideration has increased substantially. The operational and financial costs associated with the unplanned breakdowns as well as Non-productive time of these sophisticated equipment has reduced.

Replacement of vital components of equipment has greatly reduced due to frequent preventive maintenance. Accordingly the inventory of spare parts is also decreased. In symptom based maintenance all types of spare parts need to be stored as it is not possible to predict the failure of exact component. This type of maintenance not only increases the inventory carrying cost but also increase the storage space. Preventive maintenance due to its planned nature eliminates this problem [9].

In the year 2020 and year 2021, even though number of preventive maintenance is little low in comparison with the previous year’s data due to COVID 19 scenario, yet the breakdown maintenance remained all-time low. It has truly shown the indication of improvement of overall health of the vehicles due to frequent preventive maintenance.

CONCLUSION

There is no doubt that preventive maintenance plays a key role in automobile maintenance in terms of availability of vehicle, reduction of maintenance cost as well as overall self-life. Due to increasing market competitions, the auto workshops must have to equip with latest technologies and strict quality controls for survival. Customers always feel happy if automobile workshop can assure them of less breakdown of their vehicle which in turn minimizes cost of on road operations.

This paper has successfully shown the importance of preventive maintenance to reduce the costly breakdown of vehicle. This paper has also shown the latest technologies that can be adopted even to minimize the preventive maintenance itself over the course of the vehicle life time.

The result obtained from this paper is significant for automobile workshops that have internal or external customer or both to cater more reliable and quality services. This paper has well established the fact that a never tried before concept of preventive maintenance after fixed interval of time equipped with right kind of technologies can bring result of such magnitude. The outcome of these 11 years of experiment can be taken as benchmark in the field of preventive maintenance of equipment.

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