Improvements in maintenance of Above Storage Tanks and its future

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***Abstract*— Above storage tanks mostly used for its cost efficiency, versatility and variety. But maintenance of above storage tank is an important issue. At industrial scale, flow of oil products is very important thing. The continuous flow of storage makes things running. ASTs provides comfort of large storage, but for large storage inspection is a big issue. Checking integrity of oil tanks is an important problem. Bottom of tanks are usually made of welded steel plates; the internal corrosion of tanks is main problem. Due to inaccessibility of inner section, tanks need to be emptied and made out of service for inspection. This cause disturbance both in terms of product flow and cash flow also. This paper will address the effective ways, which can made improvements in inspection and maintenance of carbon steel tanks. While keeping in mind the current limitations, ASTs floor will be under examination. ASTs floor is the most important factor, which plays an important role for inspection time.**

***Index Terms*—Above ground storage tank, floor, Inspection types, on-line services.**

Introduction *(Heading 1)*

Very important goal for distribution of supply is to have demands from customer on time. Supply must be effective and low price at the same time. In supply industry, it happens in forms of different storage units. These units used as stock savers to provide supply as swift, continual and efficacious.

World energy consumption sectors designated widely in to different industries. Petroleum industry is the main sector for meeting world energy consumption.

A Petroleum consumption in every country keeps on growing, particularly in developed and developing countries. Because of this, supply and demand are becoming very important factors. A sudden imbalance would cause outrageous price increase. Storage units is an important factor for keeping this balance.

In the case of petroleum industry, storage units are of two types, mobile and immobile units. In immobile units, aboveground storage tanks are most common, the main reason behind is their cost. There instalments are less costly and visual inspection is easy to do. Aboveground storage tend to vary in sizes, small sizes typically 60 thousand litres, to large sizes with huge storage capacity (in millions). When choosing ASTs, its lasting, durability, modification, hygienist and environment friendly keep in mind. Failure of ASTs, results into oil spill, it can be hazardous. These spills are ugly, costly, endangering health and environment, it also interrupts the solidity of supply operation. From integrity associated to it, cost for spillage cleaning have very adverse effects.

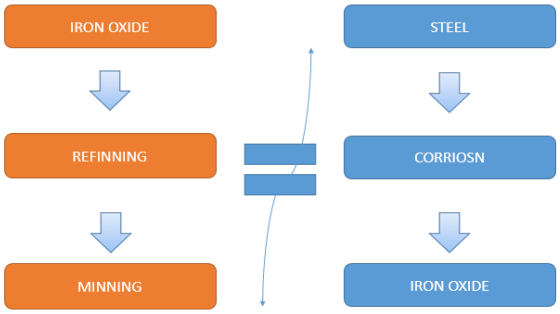
To make sure for safe services, aboveground storage tanks should be inspected in cyclic orders. There are two types of inspection, one is online inspection and other is off-line method. Right now, in petrochemical industry, off-line inspection used widely. For out of service inspection, tank need to be shut off and cleansed. This is a thorough process it will halt profit state of tank.

This process some time turns out to be a very time consuming, as any disruptive event could be possible during cleaning. During inspection, maintenance- engineers try their best to reduce off-service time.

Different companies putting their money, time to reduce inspection time and divert to more productive inspection. On-line inspection is swift, but when it comes to floor inspection, access with current devices is difficult. Successful technologies, which has been used for tank are faster, but most of them are related to out-off-service inspection.

This paper gives overview of different inspection methods applied to ASTs, and analysis of their quality of being productive. Less duration of out-of-service meaning less gap between demand and supply of oil, as every supplier and consumer can't afford delays. This paper also features basics of available inspection technology as well. Advantages, disadvantage, and comparison are deducted, so improvements in productivity of can be made.

Figure 1: Usually ASTs storage are made of steel. Main reason behind using are, they are cheap, strong and easily store large amount of oil. Left hand side showing refining step to made steel, right hand side is showing corrosion effects on steels. Life cycle of ASTs and corrosion are related with each other. More corrosion in tank means short life cycle.



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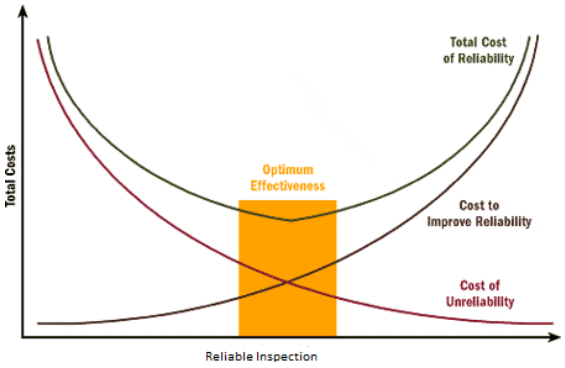
I. ASTs CHARACTERISTICS AND MAINTENANCE :

Storage units are essential part for trading petrochemical products. World oil consumption per day is 93,250,000 barrel (Wikipedia), and in U.K it is 1,608,000 barrel/day. These consumptions are huge values, for usage at this level big oil tanks needed. ASTs are perfect choice for storage at this level. Their storage capacity can go up to 1-1.5 million barrel. Mostly storage tanks are made of carbon steel, their thickness depend upon relative function. Carbon steels tanks designed to meet consumer need and industrial standards, design should be reliable for chemical, oil and petrochemical storage requirements.

At one side carbon steels provide luxury of storing large amount of oil, however, the major drawback associated with carbon steel is corrosion and this in turn impacts on maintenance schedules and the overall life cycle of ASTs [3]. It has been reported that for a new tank, corrosion normally becomes an issue after around 15 years [4]. As such, guidelines from API [5] or EEMUA [6] recommend out-of-service maintenance frequencies as often as every 3 years but more typically every 10 years.

Main area of inspection in every oil tank is floor, corrosion happens on both sides of floor. It is impossible to have visual inspection on downside. Currently, out-of-service methods are used for inspection of floor corrosion. Off-line Inspection is a very costly procedure -not only it stops tanks from working, which is a big loss, it also adds up extra cost for inspection. Trained engineer usually performs these inspections with special designed instrument for specific tanks.

The remainder of the paper focusing on on-line and off-line inspection techniques, with an emphasis for suggested improvement in current scenario.



The optimization process in Figure 2.

We can see that there is a given and take between cost and reliability of storage units. More money on reliable inspection means more cost. There is a trade going on to optimize operation of tanks in relation to cost. Supplier prefer those options; in which tank remain in service and inspected at the same time.

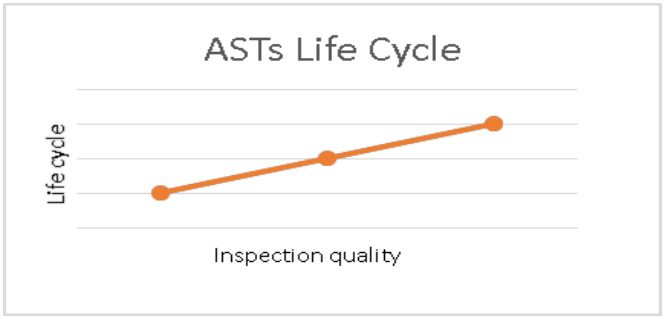


Figure 3. Is showing a relation between the life cycle of storage unit and inspection quality. Increase inspection quality means increase in life cycle of tanks.

II. OF-LINE INSPECTION TECHNIQUE FOR ABOVEGROUND STORAGE TANK FLOOR MONITORING

There are different NON DISTRUCTIVE TECHNIQUES available in market which do of-line inspection. Most used available techniques are

1. MFL (Magnetic flux leakage)
2. Ultrasonic inspection.
3. LFET (Low Frequency Electromagnetic Technique)
4. SLOFEC (Saturation Low Frequency Eddy Current).
5. Visual inspection

Most of the commercially available devices are based on magnetic flux leakage techniques. For higher sensitivity, ultrasonic techno available as well. Both these techniques required to have cleaned floor for inspection. Surfaces should be free of dirt while inspecting. Magnetic flux is more tolerated of general dust and debris. Magnetic flux leakage approach is the ability to cover large percentage of floor area quickly. While on the other side, ultrasonic approach is to suspect areas i.e. badly effected weld plates, and those sites where MFL readings are not satisfactory. Most of the consumer prefer MFL

devices for inspection. Main reason is their speed of inspection and results are satisfactory.

In magnetic flux leakage detection system, the measuring result of hall sensor consists of two parts: leakage magnetic field resulted from defects and air coupling field [7]. Magnetic flux leakage principle can be understood by solving Maxwell equations. The differential forms is

$\Delta.H = 0$ (1).

$\Delta.B = J$ (2).

In the equations: B is magnetic field density vector, H is the magnetic field strength vector, J is the equivalent field current density vector produced by permanent magnet[7].

Next section of paper will be about optimization in efficiency of MFL.

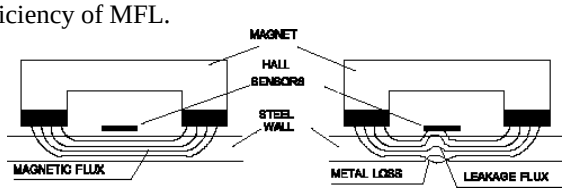


Figure 4. Illustrate the principle of MFL using Hall Sensors.

III. Optimization of MFL:

Signal to noise ratio for MFL is very low. The fast approach and sensitivity gives it edge in tank inspection industry. Different companies finding ways to make improvements in efficiency of MFL.

Sensitivity of MFL depends on different factors. Air coupling magnetic field, 3-D dimension and position of defect, anticorrosive coating, roughen material and false defects effects sensitivity.

Air coupling magnetic field between sensors is quite big. This usually effect sensitivity of MFL and results in to false alarms. Magnetic shield structure should be introduce for reducing false magnetic fields.

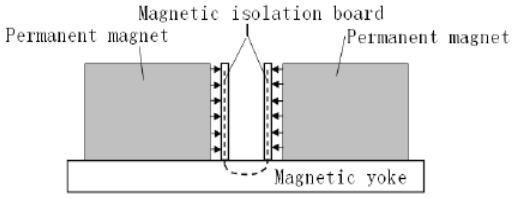


Figure 5. Showing proposed magnetic shielding structure.

Another proposed solution is about improvements in sensors of MFL. Generally most of the MFL devices are using Hall sensors, but eddy current sensors can be used. This improved MFL with new sensors called SOFLEC (Saturation Low Frequency Eddy Current). Current motor speed of MFL devices for better sensitivity is constant, which is a problem for reducing inspection timings. By using eddy current sensors, we don't need to worry about constant speed, and we can move it at swift rate.

SOFLEC is a fast screening method, it is better in sensitivity than MFL. Thickness of steel wall can go up to 30mm, while in case of MFL, it is about 22mm. SOLFEC receiving positive feedback in market, and it has the potential to replace MFL in market.

IV. ON-LINE INSPECTION TECHNIQUE FOR ABOVEGROUND STORAGE TANK FLOOR MONITORING:

There are different number of online technique available which could be feasible for online inspection of large tanks. Proposed techniques are

1. Volumetric measure
2. Acoustic emission
3. Soil vapour monitoring measurement
4. Inventory control

Precision volumetric testing method is used to detect leaks in aboveground storage tanks, but it doesn't give leak location [1]. Sources of noise in this method are temperature fluctuations, leaking valves, geometry and deformation in structure [1]. Soil testing monitors use composite that flow through floor and change in it concentration determines leak.

Inventory method keep the data of removal or inclusion of oil. Any leak will be detected if amount of fuel is less than expected. Noise sources could be meter error, human error, temperature changes.

Acoustic Emission (AE) is the most effective method of them all. It consider as the strong contender for replacing all current technologies for floor inspection. Next section of paper will describe AE in detail.

V. Inspection by using Acoustic Emission (AE).

Rapid release of energy from any localized material with in suspected source produce elastic wave. This generated elastic wave is called Acoustic emission. Main plus for this method is that it can detect failure at early stage of failure.

With superior efficiency as compare to non-destructive methods, AE is being adopted all around the world. The prime feature in this technology is no need to empty tanks. So the balance between demand and supply remain constant. Inspection cost also fell down with increase in accuracy. This procedure is not economical but also good in terms of environment.

A.E time of inspection is about 4-16 hours, during which no take in or out of fuel done. Different sensors around large storage tank mounted on, with all pumps, valve closed and data is recorded for about 1-2 hour. After that data will be analyse and inspected using analytical software's.

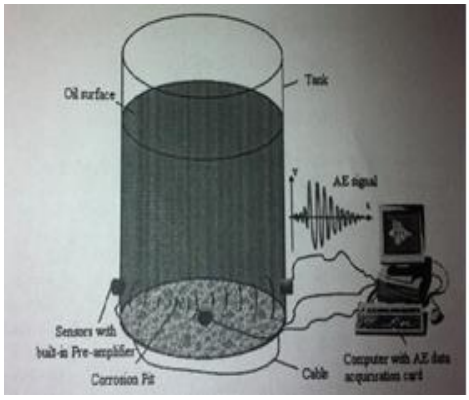


Figure 7. Pre-amplifier sensors attached at lower side of tank. These sensor detects pulses of energy from tank floor and around wall.

Sources of noise are weather, ambient noise, and leaks from tank, structural deformation, water layer and computational errors.

VI. SUGGESTION FOR OPTIMIZATION IN INSPECTION

I am comparing current techniques for inspection and their time duration. Starting from off-line inspection techniques and their optimization.

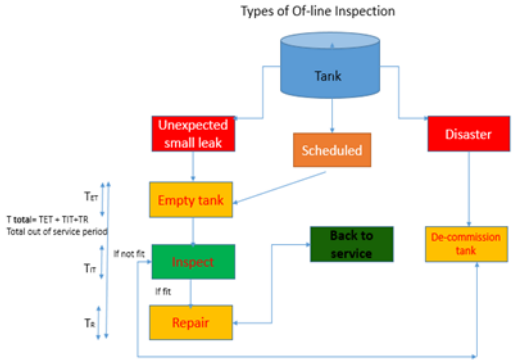


Figure.8 is showing general of-line inspection possibility. Inspection happens either because of scheduled check or unexpected leak.

T-Total is the total time for inspection. It depends upon inspection time, emptying tank and repairing. While our area of concern is inspection, T-IT is the time we will concentrate. If we optimise current of-line technique, we can make this time as much as shorter. We can not only decrease T-IT but also increase efficiency. Available improved techniques are not efficient but they also low in cost as well. This will not only decline cost of inspection but also improve the out of service time. Improvement in out of service time with in its self is cost efficient task.

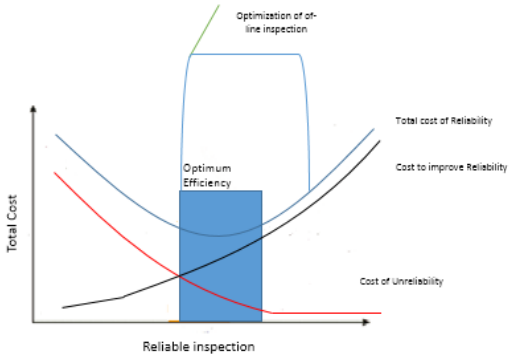


Figure 9. We can see that by improving speed of inspection, we can go quite close to ideal optimum efficiency. Out-of service is still not ideal option because of following factors

1. Emptying tank time.
2. Repairing time.
3. Time is money in this case. Decrease in time means increase in efficiency.

Now we will observe hypothetical model of in-line inspection.

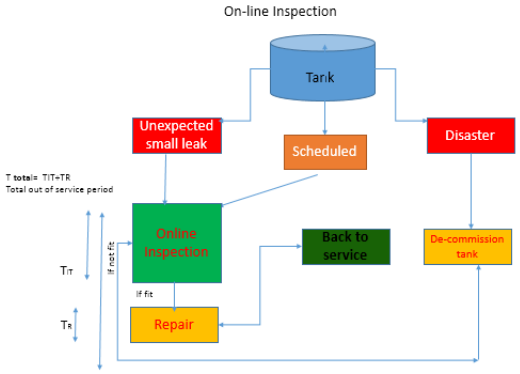


Fig .10. online inspection method with improvements.

Future technologies are trending towards on-line inspection. Hypothetical structure of on-line inspection is shown in figure 10. Main advantage of this technology is that inspection can be done during service condition of tanks.

In online inspection total out of service tenure depend upon only repairing time. There is no point of emptying tank for inspection. This add huge boost to inspection efficiency of not only tank, but it also decrease the cost of reliability. If we draw again graph of cost and reliability, we can analyse optimization of line inspection.

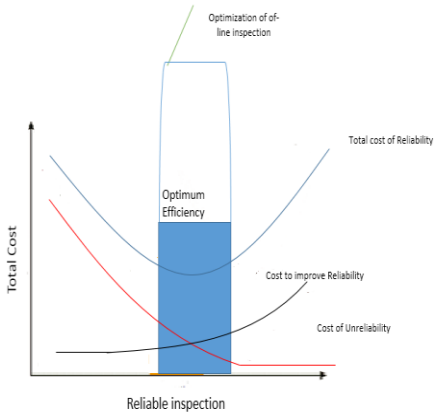


Fig. 11. Efficiency improvements

By using online inspection, cost to improve reliability decrease a lot. Due to this, optimization factor of on-line inspection is in ideal efficiency area. These result are showing a very promising result in future. Not only reliability of tank life will increase also expending cost will decrease as well.

VII. Conclusion.

Above ground storage tanks plays core role in developing a balance between supply and demand. Their life cycle with healthy condition is an important factor, which depend upon its maintenance. This paper reviewed the present inspection techniques and predict future of inspection. Out of service inspection is a costly process, future methods are still in research period. This paper also analyse the ways by which present methods can be improve.

Goal of this paper was to maximise current maintenance and try to reduce factor which are affecting its efficiency. At the same time, on-line inspection is showing great deal in reducing cost of inspection and speed. These factor will add great amount of profits to lifetime earnings of storage units.

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