

Design and Development of Tank Cleaning Robot

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ABSTRACT:

Aimed at tackling the disadvantages of conventional oil tank sludge cleaning operations, a replacement oil tank sludge cleaning robot system is supposed for performing cleaning work instead of manual cleaning that's characteristic of low safety, low efficiency, very long time, environmental pollution problems. The robot system consists of a robot, jet spray, brushes, dozer blade, amongst them the modular structures are adopted within the robot, which makes it possible to assemble all subsystems within the tank after having put them into the tank through a narrow manhole; Based robot motion characteristics analyzed and discussed, matching the track, motors, other key components; supported finite element analysis and magnificence of the shovelling, high-pressure water jet, mechanical shovelling so one can clean the sludge effectively. The system tests have shown that the oil tank sludge cleaning robot is prepared to perform cleaning operations in adverse oil storage tanks effectively, safely, reliably by utilizing industrial water jet under atmospheric state.

KEYWORDS: Tank cleaning robot, Sludge remover, Tank sludge remover, Mobile robot, Robot for tanks inspection

I. INTRODUCTION

When oil storage tanks are put into use to store oil, especially crude oil, some heavy ingredients within the oil just like the mechanical impurities, gravels, soil, heavy metal salts, wax, asphalt so on would naturally send to the underside of the sand in line with the proportion of their weight to form sludge at the underside of the tank. It reduces the available volume of the tank to store oil to greatly influence the amount of oil the tank goes to store and transport. As a result, for every 3-5 years, a tank will receive regular inspection,

maintenance, tank sludge removal. At present, removal methods applied are hot oil circulation cleaning method, the chemicals cleaning method, mechanical cleaning method. The mechanical cleaning operation is performed by robots that are able to move freely within the tank to interrupt up and suck out the sludge at the underside of the tank. to wash oil tank manually not only means flammable, explosive, toxic environment working conditions but also an operation of low safety, low efficiency, very long time, and environmental pollution problems. Recently robots are successfully applied to clean tank appearance and tubes to completely reflect the advancement of robot technology and its practicality. As a result, the versatile cleaning robot has emerged. it's equipped with a high water jet and shovelling to clean the sludge within the oil vessel to alleviate workers from high-intensity labor and poor environmental hazards and improve security and reduce the sludge clearing cycle. The finding of the study would be of great help for the industry because, In spite of all the mandatory safety precautions and cavity entry procedures, accidents still occur while inspecting, cleaning, repairing the tanks. the atmosphere within the tanks still remains unsatisfactory and continues to pose health hazards for people. Also manual cleaning because of the poisonous gas, results in time delays in inspecting, cleaning, repairing tanks so developing a robot that cleans the tank is an efficient solution to beat several problems like time delays in inspecting, cleaning and repairing tanks, accidents which still occur inside the tanks onboard ships, manpower cost & health effects occur on human.

II. PROBLEM STATEMENT

Tanks are used to store fuel, oils, sludge, sewage, water, other fluids. When stored in tanks,

these fluids tend to remain inside the tanks forming layers of semi-solid substance. It's therefore imperative that the tanks are cleaned on a daily. This process, when administered by humans, tends to be hazardous, sometimes leading to explosions and accidents. The matter is also resolved by developing a mechanism type of a robotic arm that could perform cleaning tasks.

Objectives –

- (a) Cleaning Attachment
- (b) Repair attachments
- (c) Camera for inspection of tank and examination of defect
- (d) Quality Inspection Equipment

(e) Gas analyser for checking the percentage of oxygen and presence of toxic gases

We will design a prototype to assess the device of a robot system as a solution for tank cleaning operations. We are visiting design interactions ranging from supervisory control to the operation and a number of other control devices. This method would be very useful in every industry where there are oil and chemical tanks. Moreover, it'll even be beneficial in ships and cargo aircraft which are used for storage and transportation of chemicals. Through this method, we are able to save the lives of thousands of workers who face many health issues and some of them lose their lives due to the release of toxic gases at the time of cleaning..

III. WORKING

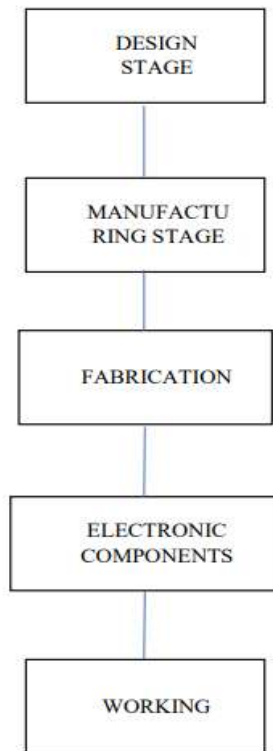


Fig 1. Methodology

The frame fabricated for our project is created of steel. It's welded accordingly for an arrangement of the system components. The frame along with the scale is shown in the figure below:

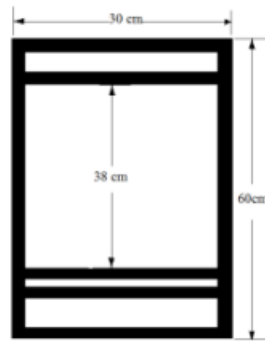


Fig 2. Robot Frame Dimension

Frame Specification:

- Size of Frame: 600 x 300 mm
- Material of Frame: Mild Steel
- Unloaded Weight of Frame: 2.65 kg

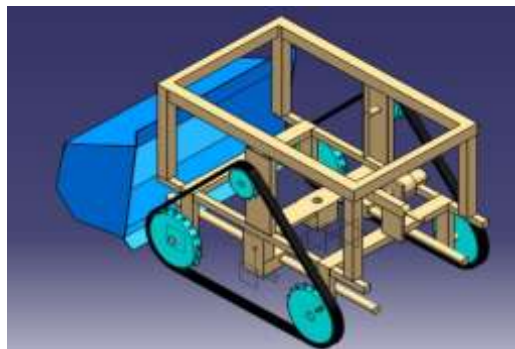


Fig 3. Cat-part of tank cleaning robot

1) **Hardware Requirement**

1. Johnson Motor
2. Wiper Motor
3. Brushes
4. Cycle Gears
5. Cycle Chain
6. Bearings
7. Battery
8. Shovelling attachments

IV. LITERATURE REVIEW

A massive amount of oil residues are created within the tanks that store and process oil products are a big concern for the oil business. This report aims to review the applied clean-up methods available within the world market and to spot the foremost efficient, safest, most economical, most environmentally friendly cleaning process. Petroleum residues are an unavoidable process

within the petroleum industry that the companies must get used to. The most reason for cleaning is that the residues are generated gradually by the settling of the heavier elements contained in petroleum. These residues occupy considerable space within the tanks, reducing their capacity and altering the standard of the products. except for everything else we mentioned, there's also the necessity for a few scheduled inspections which are required by the operating regulations. These activities can't be administered with the presence of residues inside the tank. Companies have focused on finding cleaning methods aimed toward staff safety, cleaning efficiency, time/money savings, environmental protection. The methods which will be accustomed clean up a tank may be manual or robotic.



Fig 4. oil tank bottom sludge

In most cases, staff entry inside the tank is required to finish the work, but the time spent within the tank and therefore the number of individuals varies per the procedure. A number of the goals or an efficient clean-up are to scale back the amount of staff entering a permit-required confined space because of exposure to hazardous environments carries a variety of risks. In the latest years, there has been an increased rate of accidents which is backed by studies. Also, the necessity to cut back cleaning costs and increase safety has focused on more automated methods that need less labor and have proven safer. Another major objective is to take back the oil present in large percentages within the sludge residues that are deposited at the bottom of the tank. Plenty of case studies have shown that the revenue generated by oil recovered from sludge outweighs the prices of the cleaning operation. Moreover, with environmental regulations becoming stricter each year, the safe transportation and storage of the sludge, inside a control system circuit, and other cleaning waste from the tank to a particular site and from there to the waste treatment plants is additionally a crucial thing about an efficient cleaning method. The sludge at the nozzle of a tank, shown in Figure 1, consists mainly of. Before cleaning a tank, an analysis of the tank residues is vital so as to spot their chemical composition. The degree of sludge at the underside is split into three main layers. Within the higher layer, there are many hydrocarbons that are lighter than water, within the middle layer, there's mainly water, and within the lower layer are the solid residues.

1) Oil Tanks Cleaning Methods

1. Manual Cleaning: Manual cleaning is one of the primary methods employed in the industry because it doesn't require any special technology or study. The equipment needed to finish the project is the simplest available within the market, and also the staff to perform the task are often easily specialized. The actuation behind the method is that the workforce which, using vacuum pumps or trucks, winches, trolleys, pressurized water, other simple mechanical means, tries to get rid of sludge with water and solid residues from the within of the tank and store them in properly configured storage areas outside the tank.

2. Robotic Cleaning: In the latest years, robotic cleaning has been a new technology that has been applied within the refining industry for cleaning tanks, pits, other reservoirs. It's not the foremost common choice, because it continues to be in its infancy and its many advantages haven't been made known worldwide to achieve the boldness of tank owners. Nevertheless, the space for development is great. It came from the common have to avoid exhaustive manual human labour in confined spaces, with a harmful atmosphere that poses many dangers. This method replaces human labour with a self-directed cleaning method that doesn't require the permanent presence of persons inside confined spaces (e.g., a tank) as the equipment is handled from the robot.

| Sr.No | Ref. no. Concerned Author(s) and years | Concept used | Claimed by concern authors(s) | Our findings |
|-------|--|---------------------|-------------------------------|--------------------------|
| 1. | Thonge Suraj , Shelke | A mechanical system | The authors observed that | Adjustment of the system |

| | | | | |
|----|---|---|---|---|
| | Prasad, Wakte Vaibhav , Thonge Sharad , Prof. Shinde ,(2017) | which clean the tank mechanically using brush, rack and pinion , bar linkage and the motor. | the Cleaning is done more effective than the convention al methods. | inside the tank is very difficult. |
| 2. | S. Abhishek, D. Kiran, P.Praveen and Dr. K. L. Senthilkum ar (2017) | A mechanical system which clean the tank mechanically using brush, rack and pinion , bar linkage and motor. | The authors observed that the Cleaning is done more effective than the convention al methods. | Cleaning of the tank using this systemis not effective. |
| 3. | Prayosha innovative (2017) | Sediment clean water tank cleaning machine which clean sedimentsin the tank. It is a vacuum cleaner type system which | Sediment clean water tank cleaning machine which clean sediments in the tank. It is a vacuum cleaner type | Only clean the sediments in the tank not the scale and algae inside the tank. |

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| | clean the tank without removing the water from the tank. | system which clean the tank without removing the water from the tank. | |
|--|--|---|--|

V. CONCLUSION

1. The oil tank cleaner was accustomed clean the oil tanks by using rotating brushes.
2. This method was simpler and safe than the traditional methods.
3. This method is capable to wash oil tanks within less time and human efforts.
4. This robotic model is used for cleaning sludge in tanks thus making it more user-friendly.

FUTURE SCOPE

This tank cleaning robot can be further enhanced by the inclusion of water jet spray for effective tank cleaning and an gas analyser which can be used to analyse the oxygen content and to determine the presence of toxic gases at the bottom of tank.

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