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Design And Fabrication of Deep Tank Cleaning Machine

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Abstract-
The goal of this project is to develop a mechanical device for cleaning cylindrical domestic water tanks. The mechanical system includes the brushes with motor, shaft, battery and arms. The arms are set, the pump is turned on, the motor draws power from the battery and rotates the shaft at low RPM and the brushes mounted on the arms start scrubbing the tank's inner walls with high torque. Water is one of those regular assets, which for certain reasons, particularly for drinking, is fundamental to each individual. We certainly realize that earth is made of water (three-fourth of the earth), but the whole fourth is not fresh water. In this way, it is our obligation to spare water, keep the new water as fresh as might be expected. The water which is pumped to our home is undoubtedly clean, but it is also the place where it is stored clean. Indeed, we are thinking about the water tanks that are overhead. The quality of your water depends primarily on how clean your tank is. Hence, it is very necessary to clean the overhead water tank. Our aim of this project is to develop mechanical system for cleaning cylindrical household water tanks.
Key words: Deep Tank cleaning machine , Arms, Brush, Gear, Scrub, Torque etc.

1. Introduction

Water Tank Cleaning Is Required Every day, we utilize the water in the tank for cleaning, bathing, mopping, washing clothing, and other household tasks. On the water's walls, ceiling, and floor, silt, scale, and algae accumulate over time. This deposit taints the water, rendering it unsafe for consumption. This water becomes contaminated over time by algae and bacteria that can eventually make us sick. As a result, water tank cleaning is crucial. Recent research has revealed that no automation-based equipment is employed to clean above tanks. This is due to the tank placements' varied heights and odd form. An attempt was made to create a machine by automating the tank cleaning procedure using the results of the prior survey. To address this issue, an alternative option has developed a strategy. Approximately 71% of people in India use sinter tanks. Following research, it was discovered that people had to deal with several challenges, including ongoing employment in unsanitary conditions, sporadic payments, and other challenging seasons. This study aims to offer a mechanical cleaning technique for domestic cylindrical water tanks. The reciprocating four bar linkage mechanism and the thread bar mechanism are the mechanical system's two primary mechanisms. The complete mechanical system is moved up and down utilizing a thread bar arrangement in order to clean the cylindrical tank. The setup holder is fixed to the tank, and the four-bar mechanism is attached to the thread bar. PVC brushes are installed on the ends of the four-bar linkage. The project's objective is to reduce human Laboure and avoid exposing workers to chemicals that might be harmful when they are cleaning the tank. Physically cleaning above tanks is a difficult chore in today's culture. In order to overcome this, we have focused on addressing the drawbacks of cleaning above tanks, and as a result, a mechanical system for doing so is created to offer high safety, high efficiency, quick cleaning times, and no environmental impact. A revolving handle is used to turn the thread rod. The arms will move up and down, and vice versa, when the thread bar is rotated anticlockwise.

2. Problem Identification

Every day we use the tank water for brushing and bathing, for cleaning and moping, for washing clothes and in other household chores. With the passage of time, sediments scale and algae get deposited on the walls, ceiling and floor of the water tank. This deposition contaminates the water and makes is unfit for use. With time algae and bacteria grow and breed in this water infect it and could make us fall sick eventually. Hence water tank cleaning is very important. By using contaminated water it make us unhealthy and cause sick for us. In order to avoid this we want use clean water. In most of the house we were using overhead tanks like San tech and syntax. In this project we have designed a mechanical system to clean the cylindrical overhead water tank cleaner.

3. Objective

With the passage of time, sediments scale and algae get deposited on the walls, ceiling and floor of the water tank. This eventually clog pipes. It is not hygiene which results damages the skin and it will effects on the health. Hence water tank cleaning is very important. To reduce the human efforts and to avoid the chemical influence on health of person entering the tank for cleaning. Automated water tank cleaning machine enables to save time and money and it provides high safety and high efficiency.

The main objective of this project is to develop an automated water tank cleaner using rotating brushes with less time and human effort.

4. Literature Review

Shubham srivastav "design and development of cylindrical water tank cleaner", january 2016. In this work they design mechanical system consists of two main mechanisms which arc gear mechanism and reciprocating four bar linkage mechanism. The gear used is worm gear which is used to reciprocate whole mechanical system up and down according to the height of cylindrical tank. Four-bar attach to the main shaft and its other end is attach to pvc brushes. Four bar linkage is designed in such a way that it adjust according to inside diameter of the tank. When the a.c motor is switch on the main shaft rotate in turn the linkage rotates and with the help of brushes, the wall and bottom of tanks gets cleaned. He conclude that overhead water tanks cleaning equipment's was conceived and developed. This equipment was found to be effective in cleaning cylindrical overhead tanks. During cleaning the rotating brush needs to move up and down manually for complete cleaning with the help of rotating handle of worm gear. The cleaning is carried out by rotating brushes at constant speed (120rpm).

Shelke prasad k. "automatic water tank cleaning machine" , feb 2017.in this design a mechanical system includes two main mechanisms which are rack and pinion gear mechanism and reciprocating four bar linkage mechanism. The rack and pinion arrangement is used to move whole mechanical system up and down for cleaning the cylindrical tank. The rack is fixed on the motor and the four-bar mechanism is attached to the motor shaft. Pvc brushes are attached to the ends of the four-bar linkage. Four bar linkage is made in such a way that it can be adjusted according to inside diameter of the tank. When the motor is started the linkage rotates and with the help of brushes, cleaning of wall ana base of tank takes place. He concludes that the water tank cleaner was used to clean the water tanks by using rotating brushes. 1nis method was more effective and safe than the conventional methods. This method is capable to clean water tanks within less time and human efforts.

S. Abhishekhet "design and fabrication of automatic system overhead tank cleaning" 4, april 2017.in this work present a concept of the mechatronics system consists of a grooved gear rod attached to two arms with brushes at ends. The two arms are connected to the gear rod by nut. By rotating the gear rod, the up and down motion of the two arms is achieved. The gear rod is rotated with the help of a d.c gear motor. The main grooved shaft is powered by an a.c motor. The motor and the shaft are connected by a rubber belt. The clockwise rotation of the main shaft will make the arms move and vice versa. The whole operation is controlled by a circuit consisting of relay switches, buttons, and pic microcontroller. The number of times for the operation to repeat can be fed into the circuit. He concludes that advanced model for tank cleaning system is cleaning the tanks thus making the operation user friendly. The working prototype is promising both in terms of imparting cleanliness and avoiding excess manpower.

Ms.smitagourkhedeet, "design & fabrication of drain cleaning machine" in this work the construction of drain cleaning mechanism is very simple; the equipments required for the machine are less. It mainly consists of electric motor, bearing, belt and pulleys, and other small materials like angular bar, etc. Using this equipments the garbage is cleared from the drains which somewhat cleans the water. The main purpose of the machine is to clean the garbage from chocked drains and increase the flow of drain water from flowing through them. In our drain cleaning mechanism two electric motors are used, one electric motor which is used to rotate the pulley with the help of belt. The motor is used for uplifting the garbage from drain through a plate. An electric motor is an electrical machine that converts electrical energy into mechanical energy.

Pramod b jachaket "computerized underwater robot to clean water tank" 4, 2016.cleaning of storage water tanks is a tedious job. Entire work needs to be done manually, and when manual work is considered, it is a risky task. Considering height of water tanks the shortage of oxygen can be a major issue. Hence the need for use of underwater robotic systems has become more apparent. They are developing a system in which user will remotely navigate the robot the way he wants as well as control certain operations like cleaning, brushing, sucking etc. This paper surveys a state of art for underwater robotic technologies. This project aims to provide key reference for future development in automated underwater cleaning. Hence we are implementing a new idea for wireless robot control system which will clean water tank efficiently without any human intervention in addition to that it will also save manual work, avoid accidents. This automated task is efficient to brush up impure water or bacteria at the core of water tank and suck the impure water for proper reuse or disposal.

Ahmad 'athifmohdfaudzi "clean water supply is important in ensuring good health of people ".. Water supply is distributed from water storage tanks. Sediment that accumulates over time in water storage tanks will deteriorate the water quality used by consumers. Water storage tanks are required to be cleaned once in every three years by water utility operators or tank cleaning service providers. Water supply disruption can be prevented and cleaning process wi be more efficient and cost effective. An rov is built to operate underwater and vacuum out sediments from water tank. Rovs development has been an on-going research and development area. Several university students, researchers and even companies are constantly improving current rovs system that can be suitable to use in various tank-cleaning applications.

Rov is able to suck out small amount of sediment from water tank with tank depth of 1 m. Lastly; future work on testing with bigger and thicker amount of sediment in real water tank can be done to further validate the rov cleaning effectiveness.

5. Work Flow Diagram

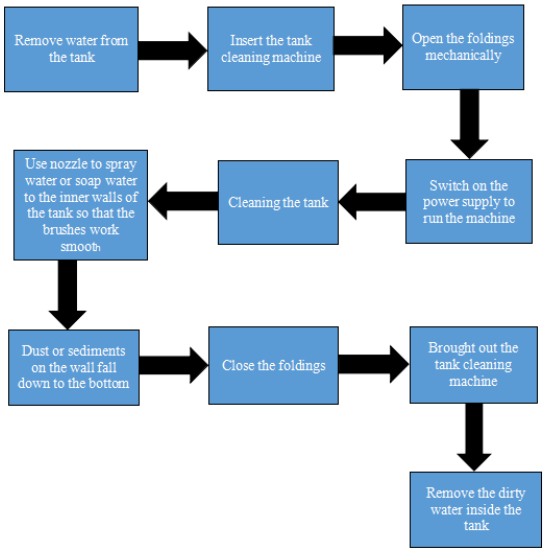


Figure 1. Work Flow Diagram

6. Experimental working

Motor draws power from the 12 volts, 7.5 ah battery and drives the shaft. Here the rotating motion of the motor is transmitted to shaft and then to the arms and brushes the induced rotating motion cleans the inner walls of the tank. The links are induced in order to make a lesser area during removal and to make the model induce inside the tank. The whole system is inserted in retracted position into the tank, the arms are then adjusted according to the tank. The arms are then adjusted according to the tank diameter in such a way that brush at end of the shaft touches the bottom of tank. Now the motor is switched ON. The arms start rotating along with the shaft. The brush mounted to the shaft is rotated at a speed of 30 to 90 RPM. The bottom is cleaning through horizontal brush and wall cleaning is through side brush. In this way the tank gets cleaned within minimum time. There is also a water nozzle that is used to spray water or soap water to the inner walls of the tank so that the brushes work smooth and the dust or sediments on the wall fall down to the bottom and then can be sucked out of tank.

The Shaft is installed at the motor & T-fashioned pipe the motor is connected to the pinnacle of the tank, after the whole configuration, the motor rotates alongside the brushes the internal surface of the tank walls. Hence the automated tank cleansing system works withinside an equal manner as a wall cleaner. Finally the water drainer through the opening of the tank through the usage of a pipe.

7. Design Analysis

- **2D Line diagram view**

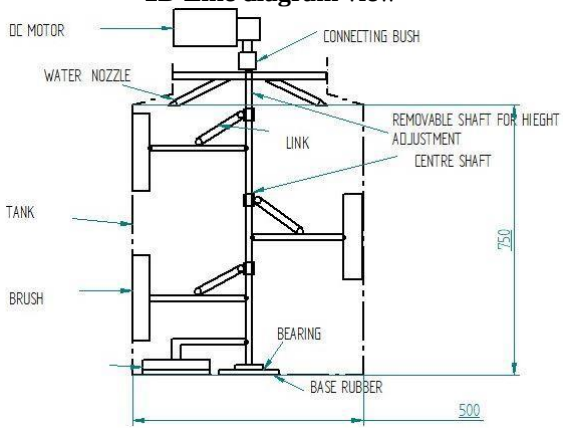


Figure 2. 2D Line diagram view

- **3D Software view**

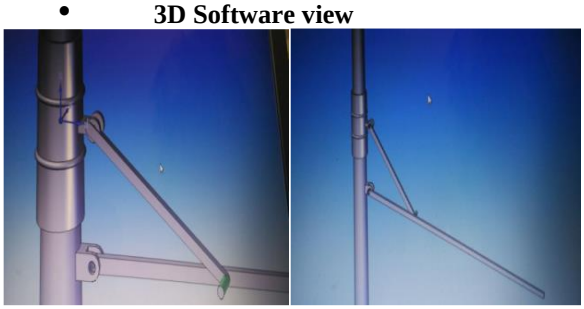
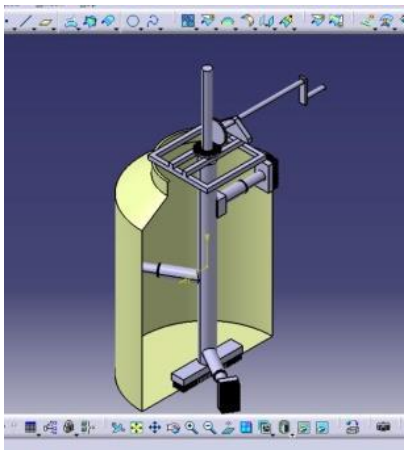


Figure 3. 3D Software view

These two images help to understand how the closing and opening the arms take place while mounting on water tank. This part has been done in solid edge according to the dimension of the overhead water tank cleaner.



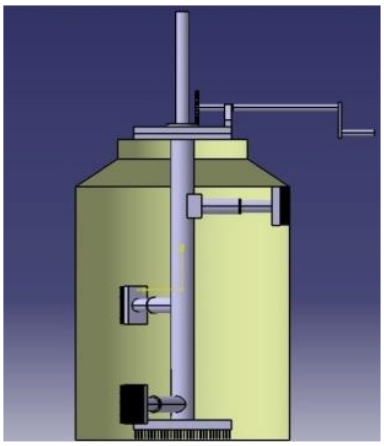


Figure 4. 3D figure of water tank cleaning machine

Figure 5.Frame of the model

8. Calculation

- **Calculation for nozzle diameter**

P1-Inlet pressure at the nozzle=120bar
P2-Outlet pressure of nozzle=1.01325bar (Atmospheric pressure)
V1-Inlet water velocity, (nearly equal to zero)
V2-Outlet jet velocity=?
According to Bernoulli's theorem

$$\frac{P_1}{\rho g}+\frac{V_1^2}{2g}+Zg=\frac{P_2}{\rho g}+\frac{V_2^2}{2g}+Zg$$

Where, ρ -Density of water=1000kg/m3
Z-Datum

g, acceleration due to gravity=9.81m/s2
4.3.2 To find the jet velocity:
1bar= 105Pascal

$$\frac{120\times10^5}{9.81\times1000}=\frac{1.01325\times10^5}{9.81\times1000}+\frac{V_2^2}{2\times9.81}$$

V2=154.26m/s
mass flow rate, m = 0.0971 kg/s
m= ρav2 kg/s
m = 0.0971 kg/s
a=Area of the nozzle orifice
By solving , a=6.291×10-7 m2
Diameter of nozzle orifice=8.957×10-4m

- **Force calculation**

Force acting on the nozzle body , F=ρav2 N
F=1000×6.291×10-7×154.262N
F=14.97N

- **Torque calculation**

Torque of motor required to provide reciprocating motion to the slider , T=f×l Newton.
Total force on the crank of the motor f=(m1+FR+RN)
Where;
m1 = weight of the components connected to the slider
=2kg×9.81m/s2
=19.62 N
FR =Frictional force on slider
=Weight of the components on slider ×coefficient of friction between slider and main tube
= 2×9.81×1.2 N
=23.544 N
Coefficient of friction for metal to metal contact is 1.2*
RN = Reaction force on slider
=14.97×COS(45)
=10.5 N
f=[2×9.81+2×9.81×1.2+14.97cos(45)] N
f=53.664N
l=0.04 m
Hence torque, T=53.664×.04 N
T=2.1465 Nm

- **Power Calculations For Motor**

Power of the motor, P= T×ω Watts.
Where ;
T =Torque of the motor.
ω =Angular velocity of the motor.
T =2.14656Nm
ω = (2×π×N)/60 rad/sec.
N=Speed of the motor
=60 rpm
ω=6.283 rad/sec
Power, P=2.1465×6.283 W.
Power,=13.48 Watt.

9. Results And Discussion

The mechanism was tested on a 200 ℓ water tank and the observations are:
Height of submersible motor = 25cm
b. Minimum water level that should be available to start the submersible motor is greater than 3/4th to the height of the submersible motor.
P = 2 π N T / 60
P (Pressure) = 0.3KW
I (Current) = 4-5 A
N (Speed) = 1500 rpm

T (Torque) = 1.91 N-m
T = F*r
d (Diameter of submersible motor) = 18cm
r (Radius of submersible motor) = 9cm = 0.09m
F (Centrifugal Force) = 21.22 N
The range of sludge density that the system could clean is less than equal to 1.49 g/cm3.
As per the test, the submersible motor should be turned on for 5 minutes.
Sedimentation time takes place in 4 hours.

The pump is turned on for 3 minutes, as in this time it takes out the water with dust and dirt.
Total time for the process is 4 hours 7 minutes.
The tank can be placed in the center or side of the circular tank.

The pump is placed according to where the dust is settled down.
A more accurate result is obtained when a wiper-like structure is attached to pump so that more surface area is obtained for suction.
The experimental set up is shown in below figures.

Figure 6. Project Model

The testing of the project has been successfully carried out with help of mechanism what we have attached. We have designed the system considering economic factor and we have replaced the motor with spiral bevel gear. We are able to operate spiral bevel gear at 70RPM manually. We have cleaned the water tank without electricity. After cleaning the side and bottom of the tank the drain water supply is used for final washing of the tank.

10. Advantages

Following are the advantages of this system:
a) No or Zero usage of chemicals, or detergents that may hamper water quality.
b) Zero water drainage due to use of a candle.
c) Less human intervention due to automated processes.
d) Submersible motor and water pump cannot be turned on simultaneously. Also, during sedimentation time both the other devices cannot be switched on.
e) Turbidity sensor provides real-time clarity of the water.
f) Application provides manual turn-on of submersible motor and water pump.

11. Limitations

Following are the limitation of the system:
a) Sidewall of the tank cannot be cleaned.
b) Light-weightedted particles i.e. less than 1.49 g/cm3 cannot be settled
c) Unexpected interruptions due to Interruption in light, Particles getting stuck in machinery.

12. Conclusion

The designed tank cleaner cleans the tank walls using a spinning brush. This new system is more efficient and secure than the old one. The mechanism used to move components for cleaning purposes is basic in design and straightforward to repair if it fails. The use of a manually operated water tank cleaning machine prevents humans from suffocating while inhaling harmful agents throughout the cleaning procedure. The machine has been thoroughly tested and rebuilt in order to fulfill modern tank cleaning procedure standards. As a result, our project's design is capable of minimizing both human work and time spent cleaning the tank.

13. Future scope

• This system is user friendly and time saving also the cost is less hence it can be used in the future water tank cleaning purpose.
• The machine can be operated on solar energy. It can be fully automated by using sensors. The machine can be remotely operated.
• The system could be more compact and light weighted and more user-friendly and efficient by improvement in the design and using some other advance equipment.

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