

Design and Fabrication of overhead tank cleaning machine

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Abstract—In this modern world, cleaning of overhead tanks manually is a tedious job. To overcome this we have aimed at tackling the disadvantages of cleaning overhead tanks, so an automatic system overhead tank cleaning is designed to provide high safety, high efficiency, less time for cleaning and to avoid environmental pollution problems. Purpose of this project is to clean domestic cylindrical water tank with the help of mechatronics system. 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. The achievement of this project is reduction of cost and manual labor because there will be harmful diseases for the person who will go inside and it will affect the health as well as the other human being who consumes water from the tank

Keywords— Grooved gear, mechatronics system, PIC microcontroller, relay switches

I. INTRODUCTION

METHODS OF WATER TANK CLEANING

Manual scrubbing in which wall and floor of tank are scrubbed to remove dirt, sediments, fungus and stains, but this method is more tedious and time consuming.

The water tank can also be cleaned by using chemicals to remove the dirt and sediments. The chemicals used may affect the human health. Pressurized water can be sprayed on the walls of the tank which will remove the dirt from the tank surface. These methods are time consuming and require more efforts for cleaning.

ALTERNATE METHOD

All methods of cleaning water tank as discussed above are time consuming and require more human efforts. So, alternate method is required for cleaning purpose, which will overcome the drawbacks of other methods. Therefore we are developing water tank cleaning equipment which requires less time and human efforts for cleaning.

Preventive Maintenance

In order to keep your tank cleaning machine servicing you as an efficient tool in your tank cleaning operations, it is essential to maintain its high performance by following a simple preventive maintenance programme, which will always keep your tank cleaning machine in good condition.

The following recommended preventive maintenance is based on tank cleaning machines working in average conditions. However, you will appreciate that a tank cleaning machine, which has a rough and dirty job to do, will need more frequent attention than one working in ideal conditions. We trust that you will adjust your maintenance programme to suit.

Water tanks are liquid storage containers, these tanks are usually storing water for human consumption. A water tank provides for the storage of drinking water, irrigation agriculture, fire suppression, agricultural farming and livestock, chemical manufacturing, food preparation as well as many other possible solutions

Water storage tanks must be maintained so that the quality of water in the tank is clean. Because of contaminated water can lead to diseases that can harm consumers. Unscheduled tank cleaning will affect the health of users. Therefore, storage water tank cleaning should always follow the schedule that have ready set by the user. There are two methods that usually used to clean the water tank. First is using manual method where a manual worker would get himself in the tank and scrub the wall that called conventional water cleaning that mostly cost so expensive. The second method is using 2 automated water tank cleaning. The development of underwater operations robot can solve one of the fundamental problems of clean and potable water to the people by cleaning the water storage tanks, which store water for long time and get sludge deposition at the bottom of the tanks. It is also an effective method to minimize time and danger thus saving human labour.

II.OBJECTIVES AND METHODOLOGY

OBJECTIVES:-

There are two objectives of this project:

- a) To develop cleaning machine to work in storage water tank.
- b) To create controller that can move the cleaning machine.

METHODOLOGY

This method is the traditional method of cleaning the water tank where a laborer would get into the tank and scrub the walls. This method is time consuming and needs more effort to clean the water tank. In this method, first the tank is emptied either by using a pump or open outlet. Then the laborer or person who cleans the water tank gets into the tank and cleans the internal wall using detergent and water. Then all internal surfaces are washed with plain water to remove all traces of detergent.

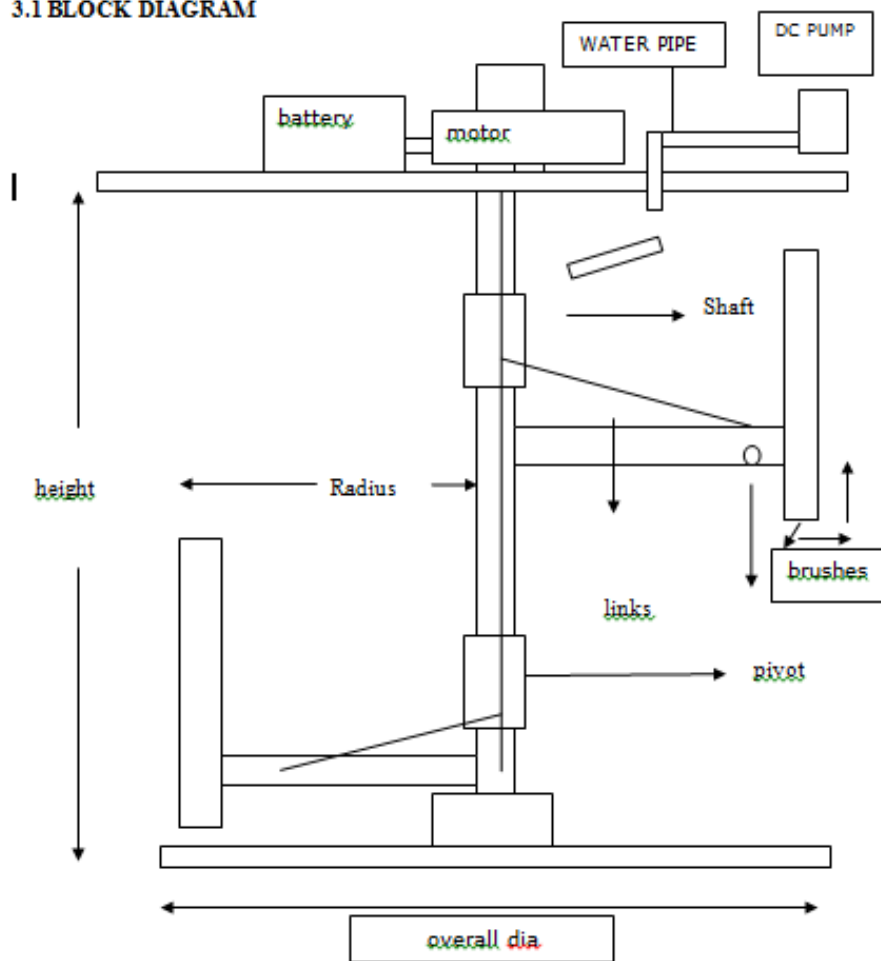
After cleaning, disinfect the water tank with HTH chlorine. Let the chlorine stand in the tank for 12 to 24 hours to ensure that the tank is fully disinfected. Completely empty the tank and carefully dispose off the disinfecting water as it will contain a high concentration of chlorine.

Refill the tank with clean water and allow water to stand for 30 minutes. Test the residual chlorine left in the tank using a comparator. If the residual chlorine concentration is 0.5mg/l or less, the tank is safe to use for water storage. If the concentration is greater, again empty the tank and refill with clean water. Re-test to check if that the chlorine concentration is 0.5mg/l or less.

In this method, cleaning of water tank involves three important steps: First, clean the tank, second, chlorinate the tank and third, check the chlorine concentration. But this method is very difficult and time consuming where the size of the water tank is large. Manual method is suitable for individual homes or buildings having small sized water tanks.

III. BLOCK DIAGRAM AND WORKING PRINCIPLE

3.1 BLOCK DIAGRAM



WORKING PRINCIPLE:

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 included in order to make a lesser area during removal and to make the model induce inside the tank. There is also a water pump 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 brushes help in removal of the salt and other waste materials inside the tank.

IV. EXPERIMENTAL METHODS

Water tank cleaning at regular intervals is important for the health of mankind. Water from water tank is used for bathing, brushing, washing and even for cooking. Not cleaning the tanks at regular intervals sometimes leads to compromising on the health of habitants. Around 60 per cent of diseases caused to humans are water-borne. Contamination of water is the major cause of illness to mankind and water getting contaminated mostly through improper maintenance or not cleaning water tank at regular intervals. Cleaning and disinfecting of the water tank is very important where a number of individuals work or reside, such as apartment complex or a commercial building, medium or large office complexes, restaurants, etc. It is the duty of the water tank owner or property manager to keep the water tank clean and prevent contamination of water.

How to Clean the Water Tank

Most of them do not know that they need to clean their water tank regularly. Water storage tanks must be kept clean to prevent sludging, sediment and prevent water-borne diseases. Keeping the water tank and reservoir clean is an important part of maintaining the water facilities of a building. There are two methods generally adopted in cleaning a water tank. One is the manual method where in a laborer would immerse himself in the tank and scrub the walls. Another method is tank cleaning with high water jet cleaners, anti-bacterial agents and disinfectants. This is also known as automated water tank cleaning.

Firstly whole water is removed from the tank. Detergent is then sprayed on the inner wall of the tank for easy removal of dirt. The whole system is inserted in retracted position into 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. This causes scrubbing of inner wall of tank by the brush attached to the ends of linkage. In this way the tank gets cleaned within minimum time.

The tank cleaning machine works with the help of motor through which shaft is coupled to it vertically, the shaft is welded with the mild steel links and a ball bearing is welded beneath to achieve the rotary motion.

V. EXPERIMENTAL CALCULATION

DC GEARED MOTOR

60RPM 12V DC motors with Metal Gearbox, 15mm shaft dia, Shaft length 15mm,

Stall Torque = 25kgcm torque, No-load current = 800 mA(Max), Stall current = upto 9.5 A(Max).

Considering brushes coming in contact with tank surface.

$$P = 1.47 \text{ N/mm}^2$$

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$$\text{Pressure} = \text{Force} / \text{Area}$$

Area of contact of blades to the soil considering

Length of contact of blades 152.4 mm

Width 76.2mm

$$\text{Area} = 152.4 * 76.2$$

$$A = 11612.88 \text{ mm}^2$$

$$\text{Pressure} = \text{Force} / \text{Area}$$

$$\text{Force} = 1.47 * 1161$$

$$= 1706 \text{ N considering } \approx 1700 \text{ N}$$

$$\text{Force} = 1700 \text{ N}$$

HORSE POWER

For electric motors, power or horsepower can be calculated from the torque and speed.

Horse power is given by $\text{rpm} * \text{torque} / 63025$

63,025 is a constant when using RPM for speed and in-lbf for torque units. 5,252 is another common constant if the speed is in RPM and torque is in ft-lbf. If the units are different then simply make the unit conversion.

So we are converting torque which is in kg/cm to in/lbf ie 25kg/cm will become 21.7 lb-in ..

So the power of the motor would be $10 * 21.7 / 63025$

Which is equal to $3.44 * 10^{-3} \text{ HP} = 0.00344 \text{ HP}$

If we use a motor of .128 HP the following calculations can be made-

$$0.00344 \text{ HP} = 2.5353 \text{ Watts}$$

$$\text{Power Input, Pin} = 2.5353 \text{ Watts}$$

$$\text{Power output, Pout} = \text{Pin} \times \text{Efficiency}$$

Efficiency of an electric motor to convert electrical energy to mechanical work done is assumed to be as 90%.

At 90 % efficiency

$$\text{POWER OUTPUT, POUT} = 2.5353 \times 0.9 = 2.28177 \text{ WATTS}$$

As we know that,

$$\text{Power} = \text{Torque} \times \text{angular velocity} = T \times \omega$$

$$\text{Power} = \text{Force} \times \text{shaft radius} \times \text{angular velocity}$$

$$2.28177 = 1700 \times r \times \omega$$

$$r \times \omega = 0.001342 \text{ m/sec} \quad \text{----- Equation 1}$$

$$\omega = 2 \times \pi \times n / 60 = 2 \times \pi \times 10 / 60 = 1.0471 \text{ radians/SEC.}$$

VI.SUMMARY AND CONCLUSIONS

The water tank cleaner is used to clean the water tanks by using rotating brushes. This method is more effective and safer than the conventional methods. This method is capable to clean water tanks within less time and human efforts. Automated control can be implemented by using remote . Water is sprayed all over the inner walls of the tank and the rotating brushes clean the outer walls and the cleaning of tank is achieved.

VII.SCOPE OF FUTURE WORK

- a) Design and build the water tank cleaning robot. For example, build the robot that can operate under the water and for specific storage tank with a flat surface only.
- b) Study and design controller that can control the movement of the robot.
- c) Develop the mechanism in the robot such as camera video that provided to allow an operator to monitor the progress of the vehicles

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