

# Design & Development of Pneumatic Sewage Cleaning Machine

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**Abstract**—Cleaning of sewage line has always been a problem. Labors cleaning drain also leads to a high risk of infections due to large amounts of waste & chemical compounds in the sewage lines or manholes. Also throwing of bottles & plastics and other such objects into the gutters lead to narrowing and eventually blockage in gutter flow. This leads to overflow in many cases. This paper gives the detailed view and the new design of mechanical drain sewage cleaning mechanism to tackle these modern daygutter jamming issues. Our system uses an mechanical drain cleaning system that eliminates manual scavenging which lets fluids flow through it but catches large solid waste like bottles & plastic and accumulates it. . The design consists of various components like metal based teeth jaws, pneumatic cylinders, comprehensive pulley with strong rope mounted on a stand, The concept drawings give a brief idea of how the actual design look and performance tested by a mechanism. To test the mechanism working model is fabricated.

**Keywords**— scavenging, manhole, pneumatic actuator.

## 1. INTRODUCTION

Even after 65 years of Independence the country is struggling to ban the most inhuman and undignified human activity manual scavenging. All the while, we have completely neglected another equally degrading work, sewage cleaning, for which workers are employed on a regular basis by state governments and local bodies

It is almost as risky for a person to step into a manhole. Since 2010, there have been 356 such deaths, or about 44 every year. This annual average has already been outstripped in 2017 India's sewage system has killed 90 people so far.

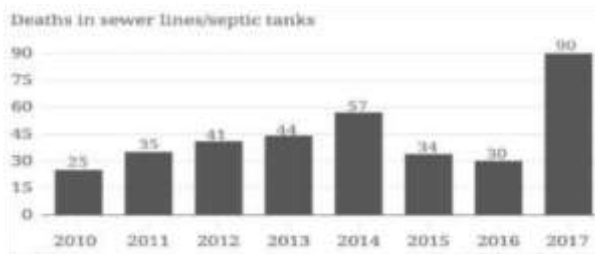


Fig. 1 Number of Death up to 2017

Various poisonous and explosive gases which are generally found present in sewers are: hydrogen sulphide (H<sub>2</sub>S), carbon dioxide (CO<sub>2</sub>), and methane (CH<sub>4</sub>) along with petrol vapours. These gases are largely produced when sewage is stable and septic, which more commonly happens in hotter climates. In addition to the production of these hazardous gases, oxygen get consumed by organic matter in their putrefaction, and thus resulting in shortage of oxygen inside the sewer, and may consequently cause difficulty in breathing. To collect the sewage waste from manhole we design and manufacture clamshell. The clamshell is a vertically operated bucket capable of working at, above, and below ground level. The clamshell bucket, as the name implies, consist of two scoop hinged together that work like a shell of clam. In past years these were hung from a lattice boom crawler crane now a days Pneumatic clamshell bucket that are mounted on the stick of Pneumatic hoes. the crane are used with a cable attached clamshell bucket.

## II. LITERATURE REVIEW

1] R.Sathiyakala1, (et.al.) 2016, 'Smart Sewage Cleaning System' "To avoid the impacts from the sewage waste and its harmful gasses, we proposed the smart cleaning system. Here, smart arm and E-Bucket plays an important role. Such as smart arm is used to lift the sewage. And the E-bucket (Electronic bucket) support evaporation of the water from waste & convert it into dry matters. This is also preventing the mosquito generation from the wastage.)After the evaporation process the waste is easily add with government wastage bank by the street cleaning sweepers without any kind of affection of the Bactria's and the sewage flues from the waste."

2] Mragank Sharma1, (et.al.), 'Design & Fabrication of Automatic Drainage Cleaning System using Solar Panel', "The chief function of the automatic drainage system is to collect, transport, as well as dispose the solid waste in the waste bucket by the help of claws.. Solid waste in drainage water includes empty bottles, polythene bags, papers etc. Impurities in drainage water can lead to blockage of the drainage system. In order to avoid such situation these impurities are needed to be taken out time to time for the continuous flow of drainage water. This project automatically cleans the water in the drainage system each time any impurity appears, and claws which are driven by chain sprocket grasp the solid waste and threw it into the waste bucket to avoid blockage. It even reduces the cost of manual labor as well as reduces the threat to human life."

Ardhendu Prasad Nanda, 2009-2010, 'Design & Development of a Two-jaw parallel Pneumatic Gripper for Robotic Manipulation', The designed robotic gripper in this paper is a two jaw actuated gripper which is different from the conventional cam and follower gripper in the way that controlled movement of the jaws is done with the help of pneumatic cylinders using air pressure. The force developed in the cylinder is very gentle and is directly delivered to the jaws in a compact way. The design, analysis and fabrication of the gripper model are explained in details along with the detailed list of all existing pneumatic grippers in market. The force and torque for the gripper have been calculated for different set of conditions. The working of the model is checked for and observation for pay load is recorded at various pressures.

## III. CONSTRUCTION

Components are used for designing the sewage manhole cleaning machine are as follow:

### A. Double acting cylinders:

Cylinders are linear actuators which convert fluid power into mechanical power. They are also known as JACKS or RAMS. Pneumatic cylinders are used at low temperature and produce moderate forces and precise movement. Double-acting cylinders (DAC) use the force of air to move in both extends and retract strokes. They have two ports to allow air in, one for outstroke and one for in stroke. Stroke length for this design is not limited, however, the piston rod is more vulnerable to buckling and bending. Additional calculations should be performed as well.

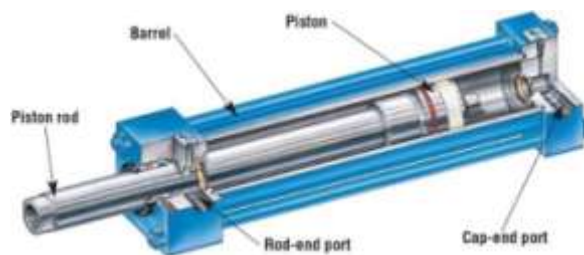


Fig. 2 Double acting cylinders

### B Pneumatic pipefittings

Pneumatic tubing is also available in a number of other materials both with and without reinforcement for use in standard applications. SMC fittings incorporate a positive tube seal while the fitting is under pressure which allows polyurethane tubing to be used



Fig. 3 Pipe Fittings

**C. Shaft**

Shaft is a common and important machine element. It is a rotating member, in general, has a circular cross-section and is used to transmit power. The shaft may be hollow or solid. The shaft is supported on bearings and it rotates a set of gears or pulleys for the purpose of power transmission.

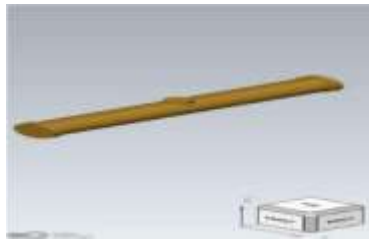


Fig. 3. Shaft

**D. 5/2 Solenoid Valve**

A valve is a device that regulates the flow of fluid (gases, liquids, fluidized solids or slurries) by opening and closing or partially obstructing passage ways. A 5/2 way directional valve. From the name it has 5 ports equally spaced and 2 flow positions. It can be used to isolate and simultaneously by pass a passage way for the fluid which. For examples hold retractor extend a double acting cylinder. There are variety of ways to have this valve actuated. A solenoid valve is commonly used, a lever can be manually twist to r pinch to actuate the valve, an internal or external Pneumatic or pneumatic pilot to move the shaft inside, sometimes with a spring return on other end so it will go back to its original position when pressure is gone, or a combination of any of the mention above.

**E. Clamshell**

A bucket's design features can drastically affect productivity rates on the jobsite. These factors include: the number of bucket cycles per operation; the average duration of each bucket cycle; the amount of material to be handled/processed; and the post dredge capping requirements. Let's first look at the obvious. When speaking in terms of productivity, the number of steps needed to complete a project is commonly the first to be evaluated. In a dredging operation, this would consist of how many cycles a bucket must make before job completion. The best way to decrease bucket cycles is to increase the bucket's payload. A larger bucket equals a larger payload which decreases bucket cycles and increases productivity. However, this is not the only way to decrease the number of cycles.

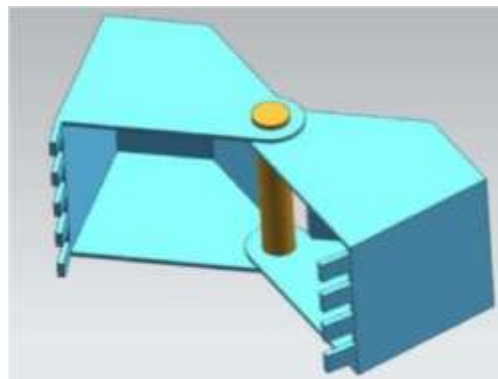


Fig. 3. Clamshell

#### IV. WORKING

Frame supports the bucket with wire rope on pulley and pneumatic arrangement of a machine. we used a compressor for a generation of compressed air. A compressed air is supply to the double acting Cylinder by means of hose pipe & 5/2 solenoid Direction control valve automatically using 24 volt DC supply. The buckets are provided at end of the pneumatic cylinder rod with supporting bucket pin arrangement. When the bucket is closed the sewage waste in the manhole collect in it and during opening of bucket the collected waste is dumped on ground. The upward and the downward direction of bucket is done by pulley and shaft we are mounted on frame. It is done with rotation of hand wheel manually. Lock pin is provided so that whole bucket arrangement not fall down. In this type of machine moderate pressurized air is used as the working fluid for the transfer of power, force and the motion to the system. The hand wheel and pulley are supported on main shaft. The force applied by operator on hand wheel transfer to the pulley. Pulley wound and unwound the wire rope due to which the bucket moves up and down.

##### Opening of Clamshell Bucket

- When the pump is on. fluid in the hoses from DCV enter in the Pneumatic Cylinder, The oil enter in cylinder from piston side
- Due to which oil applied pressure on piston so that piston extend. The piston rod is connected to the bucket plate is also move downward
- As the bucket plate move downward both the clamshell bucket move away from each other and rotated about the fulcrum. And clamshell bucket open and sewage waste from the manhole is collected in the tank.

##### Closing of Clamshell Bucket

- When the pump is on. fluid in the hoses from DCV enter in the Pneumatic Cylinder, The oil enter in cylinder from piston Rod side
- Due to which oil applied pressure on piston rod so that piston retracted. The piston rod is connected to the bucket plate is also move upward. As the bucket plate move upward both the clamshell bucket move toward each other and rotated about the fulcrum

#### V.DESIGN OF PNEUMATIC CYLINDER

For design parts detailed design is done and dimensions thus obtained are compared to the next highest dimensions which are readily available in the market. This simplifies the assembly as well as post production servicing work the various tolerances on workplace are specified in the manufacturing stage. The parts are to be purchased directly are specified and selected from slandered categories.

Pressure(P)=(Force (F))/area

By assuming pressure in working cylinder is  $P=6\text{bar}=0.6\text{ N/mm}^2$

And weight to be lifted by the actuator=  $20\text{kg}=200\text{N}$       $D \cong 30\text{mm}$

We select cylinder with diameter 30 mm as a standard

Available thickness  $\cong 3.5\text{ mm}$

Piston diameter=30 mm

Stroke length = 110mm

Piston rod diameter = 12mm      $a = c/\text{area of piston rod side} = 593.76\text{ N/mm}^2$

Force acting on during forward stroke

$F_a = 424.11\text{ N}$

Force acting on piston during return stroke      $F_r = 356.256\text{ N}$ .

#### VI. CONCLUSIONS

Manual scavenging is banned in India yet thousands of people are engaged in this profession. The labourers are not provided with safety equipments and are left to clean the sewer. Humans plunge into the manholes to remove the clogged waste with their bare hands. Many die inhaling toxic gas inside the sewer. As a ray of hope, a Kerala based startup, Genrobotics under Kerala Startup Mission have introduced a robot, Bandicoot to clean the man holes. The group of Nine young engineers have designed a spider structure robot with a bucket system to clean the man holes in

India in the coming years. The robot can clean up to eight manholes in four hours. The trials of the robot was successfully conducted under the supervision of Kerala Startup Mission and Kerala Water Authority. The aim of these engineers is to eliminate the social injustice of Manual scavenging

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