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Fabrication of Semi Automated Pressurized Flushing System in Indian Railway Toilet

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Abstract—It is a well known fact that large number of people of all age groups travel by train. Irrespective of the type of train or class, one facet of the train that needs improvement is the cleanliness of toilets. An unclean toilet causes bad smell, which makes people uncomfortable. Further it affects people by spreading various diseases. One main reason for the lack of cleanliness is that people forget to flush the toilet often. To maintain toilets clean, separate routines are adopted but only periodically at major stations. Hence most of the time, toilet remains unclean. This project aims to design and fabricate the semi automated flushing system in toilets in railway toilets. The system will be fabricated in such a way that the water is flushed only when the passenger open and close the door. For this operation, a piston mounted on the door will follow the reciprocating motion; consequently the flush system will be actuated. Possible benefits are that minimum quantity of the water will be used efficiently, which reduces wastage of water. In order to make the cleaning more effective, the pressure of the flushing system is to be increased.

Index terms – flushing system, Indian railways, cleanliness, water saving, pressurized, simple, comfort

NOMENCLATURE

mm – millimeter
F – Force applied on the door (N)
A – Area of the cylinder (mm^2)
D – Diameter of the piston (mm)
L – Stroke length (mm)

I. INTRODUCTION

In order to manage railway, toilets are the main problem. They can be rectified by introducing new technologies to clean the toilet and reducing the human effort.

A. Necessity of Toilet

A toilet is a sanitation fixture used primarily for the disposal of human excrement and urine, often found in a small room referred to as a toilet/bathroom/lavatory. Flush toilets, which are common in many parts of the world, may be connected to a nearby septic tank or more commonly in urban areas via "large" (3–6 inches, 7.6–15 cm) sewer pipe connected to a sewerage pipe system. The water and waste from many different sources are piped in large pipes to a more distant sewage treatment plant. Chemical toilets are used in mobile and many temporary situations where there is no access to sewerage, dry toilets, including pit toilets and composting toilet require no or little water with excreta being removed manually or composted in situ.

According to The Global Water Supply and Sanitation Assessment 2000 by the World Health Organization, 40% of the global population does not have access to "good" 'excreta disposal facilities'--they live mostly in Asia and Africa. There are efforts being made to design simple effective squat toilets for these people. Usually, they are made by digging a hole, then installing a premade plastic squat toilet seat atop this hole, covering the walls with canvas.

B. Flushing System in Toilet

A flush toilet is a toilet that disposes of human waste by using water to flush it through a drainpipe to another location. Flushing mechanisms are found more often on western toilets (used in the sitting position), but many squat toilets also are made for automated flushing. Modern toilets incorporate an "S", "U", "J", or "P" shaped bend that causes the water in the toilet bowl to collect and act as a seal against sewer gases. Since flush toilets are typically not designed to handle waste on site, their drain pipes must be connected to waste conveyance and waste treatment systems. A flush toilet may be euphemistically called a lavatory, a pot (USA), a loo, a john, a water closet (abbreviated "W.C."), or simply "toilet". Tank fill valves are found in all tank-style toilets. The valves are of two main designs: the side-float design and the concentric-float design. The side-float design has existed for over a hundred years. The concentric-design has only existed since 1957, but is gradually becoming more popular than the side-float design, and Fluidmaster, founded in the United States by inventor Adolf Schoepe, makes them.

The side-float design uses a float on the end of a lever to control the fill valve. The float is usually shaped like a ball, so the mechanism is called a ball-valve or a ballcock. Cock is a term for valve; see, for example, stopcock. The float was originally made from copper sheet, but it is now usually plastic. The float is located to one side of the main valve tower at the end of a rod or arm. As the side-float rises, so does the side-float-arm. The arm connects to the fill valve that blocks the water flow into the toilet tank, and thus maintains a constant level in the tank.

II. GOAL

In order to achieve our goal, we must have clear objective.

A. Objective

Primary objective:

Cleaning the train toilet basin automatically with more pressure than head pressure of the normal toilet flushing

Secondary objective:

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With less quantity of water, reducing water wastage, making efficient cleaning of toilet basin since water should be consumed efficiently in trains Tertiary objective:

Make comfort in using train toilets and enable the passengers to have good opinion about train management

B. Types of Toilet

Pit toilets

A pit toilet is a dry toilet system which collects human excrement and urine in a large container or trench and ranges from a simple slit trench dug in the ground to more elaborate systems with seating and ventilation systems as shown in fig 1. They are more often used in emergency, rural and wilderness areas as well as in much of the developing world. The waste pit or trench, in some cases, will be large enough that the reduction in mass of the contained waste products by the ongoing process of decomposition allows the pit to be used more or less permanently.

In other cases, when the pit becomes too full, it may be emptied or the hole covered with dirt. Pit toilets have to be located away from drinking water sources (wells, streams, etc.) to minimize the possibility of disease spread. Army units typically use a form of pit toilet when they are in the field and away from functional sewerage systems. The uses of correctly located pit toilets were found to prevent much of the spread of various diseases which used to kill many more soldiers than the bullets and artillery used in pre-1940 warfare.

Fig. 1 pit toilet

Dry toilets

Dry toilets, which use very limited or no water for flushing include the pit toilet (a simple hole in the ground, or one with ventilation, fly guards and other improvements) and composting toilet (which mix excrement with carbon rich materials for faster decomposition), incinerating toilet (which burn the excrement), the Tree bog (a simple system for converting excrement as direct fertiliser for trees as shown in fig 2. The pig toilet from the Indian state of Goa which consists of an outhouse linked to a pig enclosure by a chute is still in use to a limited extent but the subsequent use of the pigs for food carries a significant risk for human health. The unsanitary 'flying toilet' used in African slums where plastic shopping bags are first used as a container for excrement and are then thrown as far away as possible." This practice has led to the banning of the manufacture and import of such bags in Uganda, Kenya, and Tanzania.

A toilet that pays its users has been opened in Musiri, Tamil Nadu, India. It is the first of its kind. The faeces it receives are composted, and the urine is used as fertilizer for bananas and other food crops. Users are paid up to 12 U.S. cents a month. Before the introduction of modern flush toilets it was common for people to use a chamber pot at night and then to dispose of the 'nightsoil' in the morning; this practice (known as slopping out) continued in prisons in the United Kingdom until recently and is still in use in the Republic of Ireland.

Fig. 2 dry toilet

III. PROBLEM DEFINITION

This project is mainly aimed to increase exit pressure at the nozzle and to make efficient cleaning. Water capacity also be reduced.

A. Existing System

In rail transport, many passenger trains (usually medium and long-distance) have toilet facilities on board. These are often located at the ends of carriages. Toilets suitable for wheelchair users are larger, and hence trains with such facilities may not have toilets in each carriage as shown in Fig. 3. The traditional method of disposing human waste from train is simply to deposit the waste onto the tracks using what is known as a hopper toilet. This ranges from the toilets being a hole in the floor of the train, to a full flush system (possibly with sterilization). The 'hole in the floor' (also known as a drop chute toilet) system where waste is deposited on the track is still in use in many parts of the world, particularly aboard older rolling_stock. The principal drawback is that it can be considered crude or unhygienic – it litters railway lines and can produce health risks if the train is passing over a public waterway. Passengers may be discouraged from flushing or using toilets while the train is at a station.

Fig. 3 Railway Toilet

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B. Drawbacks

- Dirts are not effectively cleaned
- Large quantity of water is used for flushing
- Frequent cleaning of toilet is necessary
- More human effort is needed

C. Proposed System

Everybody have to open and close the train toilet door to go into the toilet. Hence we are using the force exerted on the door for compressing the water in the cylinder arrangement so that high pressure has been created on the outlet of the single acting cylinder as shown in Fig. 4.

We are connecting a pipe with the inlet and outlet of pipe so that non return valve is placed on the pipe which prevents the backward flow of water. The second non return valve makes water to pass through so that when high pressure has been created, it opens and the water has been flushed forcedly with high pressure into the basin.

The flushing system will use water efficiently to reduce the wastage of water. The pressure of the flushing water is to be increased in order to make the cleaning more effective and to reduce the water capacity.

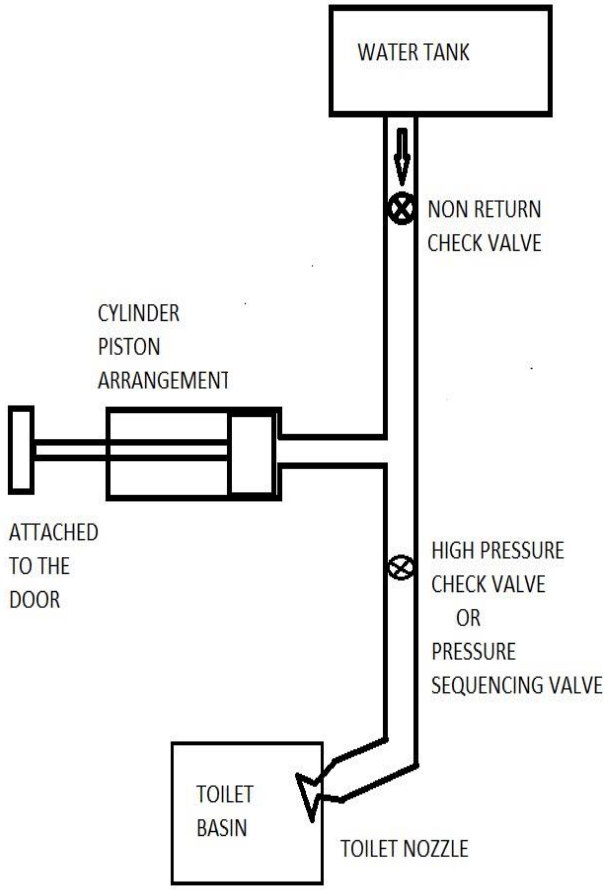

Fig. 4 Block diagram for proposed system

D. Working Principle

The working principle of our project is same as that of reciprocating pump in which the water is sucked upward due to vacuum creation and it comes outward of the pump due to the piston movement. Like that, when the train toilet door opens, vacuum created and water moves inside the cylinder and when door closes, water comes out through the nozzle with high pressure.

E. Major Advantage

- Automated flushing during door motion
- Low quantity of water is consumed effectively with high pressure
- No electricity is required

IV. METHODOLOGY

To design and fabricate the semi autonomous flushing system with more pressure at the exit, we need to be specified with material specification as shown in table (i).

A. Selection of Material Specification

Table (i) Material Specification

S.NO	MATERIAL	SPECIFICATION
1	CYLINDER	DIAMETER= 60mm, LENGTH= 400mm
2	PIPE	DIAMETER= 12.5mm
3	CHECK VALVE	DIAMETER= 12.5mm
4	U BEND	INNER DIAMETER= 12.7mm
5	WATER TANK	DIAMETER= 600mm, HEIGHT= 300mm
6	BASIN	LENGTH= 400mm, BREADTH= 200mm

V. DESIGN AND FABRICATION

To design the semi autonomous flushing system in railway toilet, we need some specific dimension which we got from design calculation. Fabrication plays a major role in every project. Fabrication process to be choosed should bring more accuracy to the model.

A. Design Calculation for Single Acting Cylinder

Pressure to be exerted by the cylinder = 1.5 bar

F/A + atmospheric pressure = 1.5 bar

$120/ ((3.14 \times d^2)/4) = 1.5$ bar

$d^2 = 3.057 \times 10^{-3}$

d = 55.2 mm

Diameter of piston = 55.2 mm

Volume = 10^6 mm^3

$(3.14 \times (55.2^2) \times L) = 1000000$

L = 400 mm

Stroke length = 400 mm

B. Design Calculation for Pipe

D = 12.5mm

Pressure = $f/a = 120 \times 4 / (3.14 \times (d^2))$

$= 0.9783$ N/mm^2 = 9.783 bar

C. Fabrication Process

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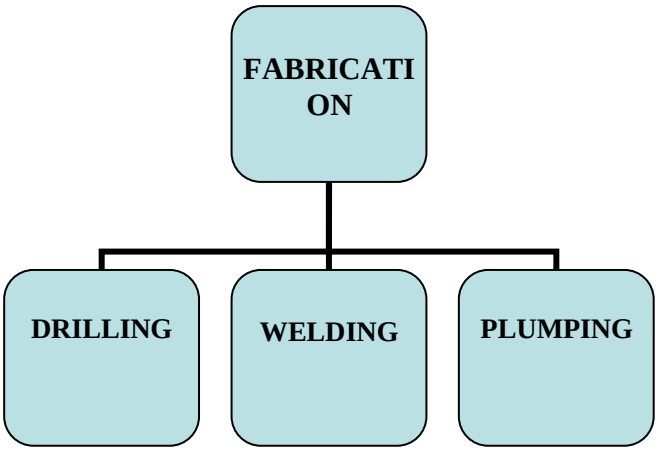

Fig. 5 flow chart for fabrication process

Drilling

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips from what will become the hole being drilled. Drilled holes are characterized by their sharp edge on the entrance side and the presence of burrs on the exit side (unless they have been removed). Also, the inside of the hole usually has helical feed marks.

Welding

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing coalescence. This is often done by melting the workpieces and adding a filler material to form a pool of molten material (the weld pool) that cools to become a strong joint, with pressure sometimes used in conjunction with heat, or by itself, to produce the weld. This is in contrast with soldering and brazing, which involve melting a lower-melting-point material between the workpieces to form a bond between them, without melting the workpieces.

Plumbing

Within industry, piping is a system of pipes used to convey fluids (liquids and gases) from one location to another. The engineering discipline of piping design studies the efficient transport of fluid.

Plumbing is a piping system that most people are familiar with, as it constitutes the form of fluid transportation that is used to provide potable water and fuels to their homes and business. Plumbing pipes also remove waste in the form of sewage, and allow venting of sewage gases to the outdoors. Fire sprinkler systems also use piping, and may transport non potable or potable water, or other fire-suppression fluids.

D.Photos/Figures about the Model

The below fig. 6 shows how the cylinder and the door attached in this project so that when the door open and close, the piston reciprocates inside the cylinder. The fig. 7 shows the whole set up of our project after assembling as required.

Fig. 6 Closer view of cylinder and door attachment

Fig. 7 Photo of whole set up

VI. RESULT AND DISCUSSION

Since toilet cleaning is the major problem in railways, there is no way other that solving it using technological ideas. We have proceeded our projects with good results.

A. Practical Implementation

We have done our project with all the features as mentioned. Every part is working well. The results obtained are mentioned below

- pressure at the exit is more than 1.5 bar(approx.)
- dirt cleaned effectively with this pressure
- ½ liter capacity of water is saved and also more efficient
- man power for cleaning the toilet basin is widely reduced

B. Cost Estimation

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Table (ii) cost estimation

S.NO	PARTS	COST (RS)
1	WATER TANK	200
2	SINGLE ACTING CYLINDER	300
3	CONTROL VALVE	300
4	DOOR SETUP	100
5	PIPE	200
	TOTAL	**1100**

C. Major Application

- Mainly in Indian railway train toilets
- In college hostels
- In government offices
- In public toilets
- In hotels

VII. CONCLUSION

Cleaning of toilet had done effectively with more pressure. Since wastage of water is reduced, the water had been consumed more efficiently. Further toilet had been maintained clean because of automated flushing, when the passenger opens and closes the door. As far as the cleanliness is maintained, bad smell and spreading of diseases can be reduced much better. This makes the passenger's journey more pleasant.

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