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ELECTRO PNEUMATIC PRESSURISED FLUSHING SYSTEM FOR LHB COACHES

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ABSTRACT

The disposal of human waste is a very big problem for Indian railway. Incineration and chemical treatment of human waste has also been used to overcome the problem. However, all these methods are either unhygienic or not practically feasible alternatives. Overcoming these problems with Alteration & upgradation we prefer for Electro-Pneumatic flushing toilet system. Electro-Pneumatic flushing toilet for Indian railways, it secured the environment and make eco-Friendly. Water consumption also saved & corrosion caused by the faecal matter can be minimized. By supplying pressurised water in flushing system limited amount of water can be used for flushing operation this will reduce the water requirement per flushing. Due to pressurised fluid ensuring the cleanness of euro bowl.

Keywords: Railways, LHB Coaches, Railway Toilet, Electro-Pneumatic, Rail Coaches, Flushing System, Pressurised, Control Unit, Bio-Toilet.

I. INTRODUCTION

Electro Pneumatic Pressurised Flushing System (EPPFS) is positive displacement type having "Piston-Cylinder arrangement" type set up for creating pressurised water supply without allowing water coming into contact with pressurised air and has been designed to provide long trouble free service and uses standard components easily available from globally renowned manufacturers who have been operating in India for a long time and are well known for quality. While designing the System, safety and convenience of the passengers have been paid special consideration. The system is non-corrosive type and would render satisfactory performance for a long time. [4]

This electro pneumatically operated toiletry flushing system is designed for toiletry system in railways. By pressing the push button, the solenoid valve is energized for pre-set time, in turn making the water pump to flush the water completely and being ready for the next cycle. On completion of every flushing cycle, the green light provided in the Push button indicates for starting the next cycle. The cylinder delivers 1.5 ltr of water on completion of every flushing cycle.

The idea was how we can efficiently clean the toilet with minimal usage of water and energy with simple design and easy to use interface; for that pressurised system was ideal for the simple work and efficient cleaning for creating pressurised water supply without allowing water coming into contact with pressurised air cylinder is used in system, with electronic control and fast recharge of system ready for next cycle of usage.

The System would dispense 1.5 Liter water at pressure of 2-3 Kg/cm^2 each time with light pressing the Push Button Switch having metallic body and would be ready for next use in 7-8 Seconds. Our system is user friendly, modular in design, durable, portable and very easy to use install and maintain. All the electrical, electronic and pneumatic parts of the system are shock and vibration proof.

II. OBJECTIVE OF RESEARCH

- To design Electro Pneumatic Flushing System.
- To minimize water usage in flushing process.
- To Ensure rapid and efficient removal of waste from toilets.
- To Seamlessly integrate electro pneumatic flushing system with existing railway infrastructure.

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- To develop safer & user friendly system.

III. WORKING PRINCIPLE

An electro-pneumatic pressurised flushing system is an advanced and intricate device that is predominantly utilized in plumbing systems, specifically in toilets, with the main purpose of efficiently eliminating waste and thoroughly cleansing the bowl. The pressurised flushing system initiates by pressurizing the pressure chamber. To achieve this, compressed air is introduced into the chamber, gradually increasing the pressure within it. Once the compressed air is injected, the pressure in the chamber is carefully regulated to maintain a consistent and predetermined level.

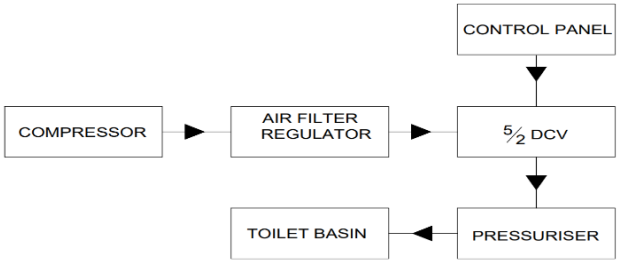

Figure 1: Block Diagram.

The initiation of the flushing process is facilitated by an electronic control system, which serves as the central mechanism responsible for triggering this operation. This control system can be activated through a variety of methods, including the use of a push-button or a manual lever. These different activation options provide flexibility and convenience for users, allowing them to choose the most suitable method for initiating the flushing process.

When the signal is received, the pneumatic system initiates the opening of the flush valve. This allows the pressure that has been built up in the pressure chamber to push the water out of the flush valve and into the toilet bowl. The release of pressurised water is rapid, resulting in a powerful flushing action that effectively removes waste from the bowl. The forceful expulsion of water from the flush valve ensures that the flushing process is efficient and thorough. The strong flushing action helps to clear the bowl of any waste material, leaving it clean and ready for further use.

Once the flushing cycle has finished, the flush valve will automatically shut to halt the water flow. This ensures that no more water is wasted and the system is ready for the next cycle. The closing of the flush valve marks the end of the cleaning process and prepares the toilet for the next user.

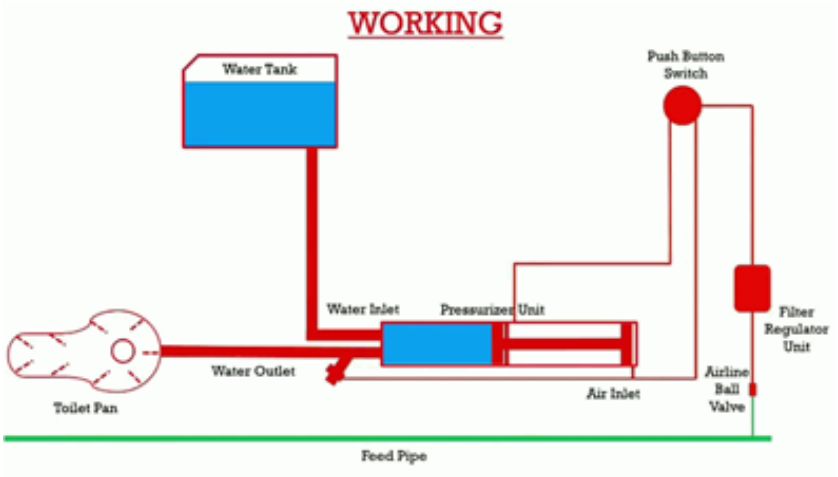

Figure 2: Working.

IV. DESIGN CALCULATION

For designing of system selection of cylinder is most important part; As most working electro – pneumatic pressurised flushing system is depending on the cylinder. Once cylinder is selected the other component selection will be on basis of cylinder calculation.

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Selection of Cylinder:

Available Data:

Pressure 3 Kg/cm2

Energized force: 2356.2 N [2]

Force in Kg:

$$= \frac{2356.2}{9.81}$$

$F = 240.18$ Kg [4]

Bore diameter:

$$P = \frac{F \times \pi \times D^2}{4}$$

$$3 = \frac{\pi \times 240.18 \times D^2}{4}$$

D = 100 mm

Stoke length:

$$V = \frac{\pi \times D^2 \times L}{4}$$

$$1.5 \times 10^6 = \frac{\pi \times 100 \times L}{4}$$

……. (1ltr = 106 mm3)

L = 190.98 mm

Calculate the diameter of the water pipe

Given:

Air pressure (P): 3 bar

Discharge (Q): 1.5 liters

Flow rate: $\mathbf{7.5 \times 10^{-4}\ m^3/s}$

Bernoulli's Equation and Continuity Equation:

$$v = \sqrt{\frac{2P}{\rho}}$$

$$= \sqrt{\frac{2 \times 300{,}000}{1000}}$$

$$= \sqrt{600}$$

$$\boldsymbol{v = 24.49\ m/s}$$

Using the Continuity Equation:

$$A = \frac{Q}{v}$$

$$A = \frac{7.5 \times 10^{-4}}{24.49}$$

$$\boldsymbol{A = 3.06 \times 10^{-5}\ m^2}$$

Rearranging for d:

$$d = 2\sqrt{\frac{A}{\pi}}$$

$$d = 2\sqrt{\frac{3.06 \times 10^{-5}}{\pi}}$$

$$\boldsymbol{d = 0.00624\ m}$$

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0.00624 × 39.37 in/m ≈ 0.245 in

d= 0.245 in

The calculated diameter is approximately 0.245 inches, which corresponds to a nominal pipe size of 3/4 inch.

V. MATERIALS

Following materials are required for the Electro – Pneumatic Pressurised Flushing System.

Table 1: List of Components.

Sr. No	Components	Description	Quantity
1	Electric Push Button Switch	Material: SS IP Rating: 65	1
2	Control Panel	Material: SS IP Rating: 65	1
3	Solenoid Valve	5/2 DCV ¼" with mounting	1
4	Y-Strainer	Martial: SS	1
5	Water Pressurization System	D = 100 mm; L = 240 mm	1
6	Angle seat piston valve	Material: SS	1
7	Air FRL Unit	Metallic Body	-
8	Non-Return Valve (NRV)	Port Size: ¼"	1
9	Manual Push-Button Flush Valve	Metallic Body Port Size: ¾"	1
10	Water Fittings & Piping	Material: SS Size: ¾" (OD=26.06 mm)	3

VI. CONCLUSIOIN

In conclusion, the development and implementation of the electro-pneumatic pressurized flushing system have demonstrated significant improvements in efficiency and effectiveness, addressing key issues in traditional flushing methods.

In terms of energy consumption, although the electro-pneumatic system requires additional power for its operation, the overall energy usage remains relatively low when compared to the significant water savings achieved. By implementing efficient energy management strategies, it is possible to further optimize power usage and minimize any potential wastage. When it comes to performance, the electro-pneumatic system outshines its counterparts by offering superior response time and flushing effectiveness. With faster response times and more consistent flushing, this system enhances the overall user experience and ensures better hygiene.

The electro-pneumatic system demonstrates greater adaptability compared to other systems, as it can easily incorporate advanced features such as touchless activation, variable flush volumes, and enhanced accessibility options. This flexibility not only enhances user convenience but also ensures compliance with accessibility standards.

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