Development of Mechanical Fuel Injector Cleaning Machine in Cost Effective Manner

Himanshu Agarwal, Kaushalendra Kr. Dubey, Subhash Kamal

Abstract- When fuel injectors get polluted, it create obstruction in fuel flow and unable to allow spray pattern for proper combustion. In the present market Fuel Injector cleaning machine is used to clean the injectors with the help of controlled gasoline spray system. We have designed and developed for the most cost effective Rs 20,500 this is 10 times less than the existing fuel injector cleaning machine. The development of this work explaining conversion of electrical fuel injection system into mechanical type fuel injection system is cost effective, manually operated, multiple flow, single man powered and equally efficient with electrical system.

Keywords: - Injector, Air cylinder, Fuel cylinder.

I. INTRODUCTION

Fuel Injector cleaning machine is used to clean the injectors with the help of controlled gasoline spray system. The Discovery of Venturi in 1790 helps reducing the bore of pipe, it able to increase the velocity of fluid and get it to atomize the particles [1]. In 1875 venturi principles based wick carburators built by Siegfrid Marcus in first motor car for fuel injection system. According to German automobile publication in 1898 [1].“A Automotive-Zeithung” the Mayback carburator was a major improvement over the brush type atomizer and wick carburator. Around 1900 Butler develop venture based float type fuel injection system and it allowed greater protection against engine flooding. The fact about filtration/cleaning of fuel by refining methods were improved in 1910 with chamois switches, this system used by car owner to filter impurities from gas before pouring it into fuel tank. Improvement in design of injection and cleaning system between 1900 and late 1920s [1]. The first carburator cleaner system introduce on the 1915.In 1922 Rickenbacker used dry type air cleaner fuel system. In 1932 thermoststic automatic choke system was introduced. The four-barrel fuel injection system by Buick built in 1941 [1]. In the 1940s, hot rodder Stuart Hilborn offered mechanical injection for racers, salt cars, and midgets [2]. In 1949 Automotive Digest said”Some automobiles is nearing the climax in experimentation and may soon make it how to driving public”. During the 1955, other mechanical injection systems such as Hilborn were occasionally used on modified American V8 engines in various racing applications such as drag racing, oval racing, and road racing [15]. By 1986 practically all gasoline engines have electronically operated fuel-injection system instead of old type system [13].

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The development of this work relates to a direct spray injection cleaning system. This experimental work explain the design of Mechanical fuel injector cleaning machine on the basis of selection of 7L Air cylinder, 3L fuel cylinder, 4 olive oil bottles with each bottle have 100ml capacity, Air compressor, fuel filter, 4 injectors, 2 pressure gauges, 8 gates and safety valves & fuel rail. The conversion of Electric fuel injector cleaning machine to Mechanical type fuel injector cleaning machine is beneficial in low cost, easy and self maintenance for operator and can be install in any workshop.

II. EXPERIMENTAL DETAIL

In this experimental detail we describing the working function and the detail of each part of the machine which are as follows:-

A. Parts detail

a. Injectors

An injector, ejector, steam ejector, steam injector, eductor-jet pump or thermo compressor is a type of pump that uses the Venturi effect of a converging-diverging nozzle to convert the pressure energy of a motive fluid to velocity energy which creates a low pressure zone that draws in and entrains a suction fluid [17]. After passing through the throat of the injector, the mixed fluid expands and the velocity is reduced which results in recompressing the mixed fluids by converting velocity energy back into pressure energy. The motive fluid may be a liquid, steam or any other gas. The entrained suction fluid may be a gas, a liquid, slurry, or a dust-laden gas stream.

Fig. 1 cutoff view of Injector (http://oldfuelinjection.com/images/injector.jpg)

b. Air compressor

An air compressor is the central power source and your major investment. Air compressors are available in horsepower of 3/4 to 5, or even larger, with a variety of tank sizes up to 80 gallons. The capacity and the frequency and duration of use will determine the horsepower and tank size you'll need for your own projects. A 2hp or smaller will be adequate for most tanks around the house.

Fig. 2 Air compressor (http://2.imimg.com/data2/PK/XQ/MY-4797429/pet-bottles-air-compressor-250x250.gif)

c. Gate valve

The gate valve, also known as a sluice valve, is a valve that opens by lifting a round or rectangular gate/wedge out of the path of the fluid. The distinct feature of a gate valve is the sealing surfaces between the gate and seats are planar, so gate valves are often used when a straight-line flow of fluid and minimum restriction is desired [3]. The gate faces can form a wedge shape or they can be parallel.

Gate valves are primarily used to permit or prevent the flow of liquids, but typical gate valves shouldn't be used for regulating flow, unless they are specifically designed for that purpose.

Fig. 3 Gate valve (http://www.bidgeepumps.com.au/store/images/Brass%20Gate%20Valves%20Non%20Tested.jpg)

d. Safety valve

A safety valve is a valve mechanism for the automatic release of a substance from a boiler, pressure, or other system when the pressure or temperature exceeds preset limits. It is part of a bigger set of pressure safety valves (PSV) or pressure relief valves (PRV). The other parts of the set are relief valves, safety relief valves; pilot-operated relief valves, low pressure safety valves, and vacuum pressure safety valves [3]. Safety valves were first used on steam boilers during the industrial revolution. Early boilers without them were prone to accidental explosion.

Fig. 4 Safety valve (http://newimg.globalmarket.com/PicLib/789/2026789/prod/0_1314172839656_l.jpg)

e. Pressure gauge

Many techniques have been developed for the measurement of pressure and vacuum. Instruments used to measure pressure are called pressure gauges or vacuum gauges. A manometer could also refer to a pressure measuring instrument, usually limited to measuring pressures near to atmospheric [3]. The term *manometer* is often used to refer specifically to liquid column hydrostatic instruments.

Fig. 5 Pressure gauge (http://i21.geccdn.net/site/images/n-picgroup/WIK_9694255.jpg)

f. Air cylinder

Pneumatic cylinders (sometimes known as air cylinders) are mechanical devices which produce force, often in combination with movement, and are powered by compressed gas (typically air).

Fig. 6 Air cylinder (http://i21.geccdn.net/site/images/n-picgroup/WIK_9296255.jpg)

g. Fuel cylinder

Cleaning fuel cylinder is used only for the purpose of the storage of cleaning fuel that is the mixture of diesel and the injector cleaner. In this cylinder the pressure gauge is fitted, which is used to measure the pressure of the fuel which is mixed with the compressed air at the time of cleaning the injectors.

Fig. 7 Fuel cylinder (http://i21.geccdn.net/site/images/n-picgroup/WIK_9894455.jpg)

h. Beakers or olive oil bottles

A beaker is a specialized piece of glassware which is designed to be used in scientific research. You may have worked with a beaker yourself, if you have ever taken a chemistry class. Beakers are cylindrical in shape, with flat bottoms so that that they can be set onto various surfaces, and they typically have a thick lip with a spout to make it easier to pour liquids [14].

Fig. 8 Beakers (http://picasaweb.google.com/116972255861927951169/FuelInjectorCleaner?gsessionid=audogWxUOzxScK9FOwQGCA#5195700749907998018)

i. Fuel filter

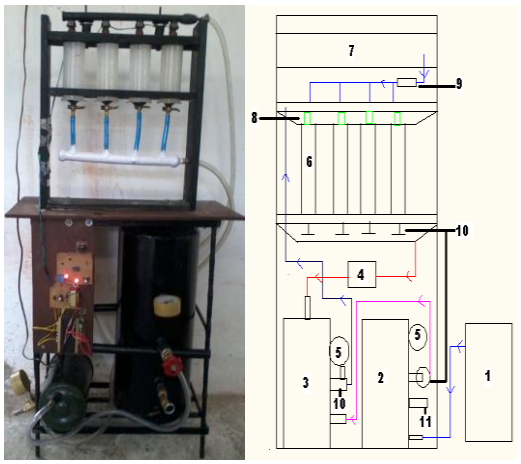
Fuel contamination is a fact of life. Preventing problems and equipment damage associated with contaminated fuel is primarily the responsibility of the end user. These responsibilities include the proper and timely replacement and servicing of the filters; selection of the fuel source, grade, and blend; and use of heaters, separators, and additives as required.

Fig. 9 Fuel filter (http://image.made-in-china.com/4f0j00SeEQlOGFbhoz/Fuel-Filter-16400-03J00-.jpg)

B. Working of fuel cleaning system

In this working there is a air cylinder in which pressure gauge, safety valve and gate valve are attached and on the other side there is a fuel cylinder in which there is also pressure gauge and gate valve are attached and both cylinders are connected and fixed on a iron frame. There is an external source called Air compressor through which air is filled in the air cylinder upto 40-45psi and this can be measure through pressure gauge & there is a safety valve called as pressure relief valve if excess amount of air is filled release that air from this valve After that we open the gate valve and pass the air into the fuel cylinder. In the fuel cylinder air is mix with the fuel and there is a control panel attached on the frame and connected to injectors by connectors & at the top there is a fuel rail in which the Injectors are connected and the fuel air mixture goes into the injectors through pipe and the fuel comes into and bottom of this beakers which are fixed in the wooden frame & the operation perform is switch on for 120-150s after switch off the panel the operator measure the fuel level of the beakers if the level of the fluid is up and down it means the injector is not clean and if level of all fluids are equal then all injectors are cleaned. After that there is a gate valve at the bottom of the beakers which is open and the dirty fuel goes into the fuel cylinder and there is fuel filter which is attached in between the beakers and the fuel cylinder through which dirty fuel filtered and then goes into the fuel cylinder [16].

C. Experimental setup diagram



1. Air Compressor **2.AirCylinder**

3. Fuel Cylinder **4.Fuel Filter**

5. Pressure Gauge **6. Beakers**

7. Control panel **8. Injectors**

9. Connector **10. Gate valve**

11. Safety valve

Fig. 10-11 Model and line diagram of mechanical fuel injector cleaning machine

III. DESIGN AND COST BALANCE SHEET

A. Design

In the design of machine there is a air cylinder size of 7L 52cm length & 24cm diameter and it is sufficient to fill the air if the size is less there is a problem to fill the air or it can explodes in this there is a pressure gauge, safety valve and gate valve are attached and in the fuel cylinder size of 3-4L 24cm length & 15cm diameter and it is also sufficient to fill the fuel and pressurize the air fuel mixture there is also a pressure gauge and gate valve are attached and both cylinders are connected and fixed on a iron frame. At the top there is a fuel rail 38cm length sufficient to supply the fuel in which the Injectors are connected and bottom of this the beakers of 120ml are fixed in the wooden frame. The control panel are attached on the frame and connected to injectors by connectors. The fuel inlet & outlet is connected to the fuel cylinder and fuel filter is attached between fuel outlet and fuel cylinder. We attached the fuel filter into the exhaust side not into the inlet side because the dirty fuel comes without filtered it goes into the fuel cylinder and in the cylinder sludge deposits and a condition comes when the fuel cylinder does not work properly.

B. Cost balance sheet

a. Electronic fuel injector cleaning machine cost with kit cost

Cost: Rs 190000 (4 Cylinders)

b. Mechanical type fuel injector cleaning machine for petrol injection system

Table. 1 Cost balance sheet

PART	MATERIAL	SPECIFICATION	QTY.	PRICE (RS)
Injector	Autoclavable	12V DC	4	2500
Fuel Rail	Rubber Plastic	L= 380mm D= 25mm	1	800
Air Cylinder	Stainless Steel	L= 520mm D= 240mm	1	2300
Fuel Cylinder	HDPE	L= 240mm D= 150mm	1	1000
Control Panel			1	2000
Iron Frame	HSS	500mm*670mm*250m	1	700

		m		
Wooden Frame	Wood	420mm*460mm*90mm	1	500
Pressure Gauge	Stainless Steel		2	320
SafetyValve	Carbon Steel		1	270
Gate Valve	Stainless Steel		6	1200
Fuel Filter	Synthetic	L= 75mm D= 50mm	1	200
Beakers	Fibre	L= 150mm D= 50mm	1	350
Connector	Steel		8	50
Pipe	Rubber	L= 4500mm	7	150
Nut Bolt	HSS	1.5 inch	13	58
Fuel	Petrol	4L		296
Lock Pin	Stainless Steel		4	20

Project Part Cost : Rs13,000
Maintenance Cost : Rs1,500
Transportation Cost : Rs6,000
Total Cost : Rs20,500

IV. RESULTS AND DISCUSSION

When all the process complete then the result comes out is that it is cost effective, safe from electric shocks, parts can easily available and one operator can do self maintenance in comparison with electronic machine because when electronic machine breakdown it require an engineer which come from that company from which this machine was purchased and the engineer takes 3-5 days to come.

V. CONCLUSION

(i). The conclusion is that now a days company manufacture electronic fuel injector cleaning machine which is very costly with 1,90000 Rs.
(ii). Mechanical fuel injector cleaning system cost is 10 times less than the existing electronic type fuel injector cleaning system.
(iii). All assembled parts of mechanical type fuel injection cleaning system available in market, and easy to install in small scale of automobile workshops.
(iv). Simple operating system and less maintenance.

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