Research & Design of Pressure Regulator and Analysis for LMV Vehicle

Guided by :- Mr. M L Thorat
Akshay Yelgatte , Harikesh Gadhave, Gitesh Gadre, Saikiran Pendkar,
Rashiklal Manikchand Dhariwal Sinhgad School of Engineering,
Warje, Pune-411046, India.

***Abstract*—** In recent passenger vehicle are hybrid engines with the different compensating devices are available for supplying the mixture of fuel and air. This devices fuel consumption rate is very high because of many factors. One of most important factor that affect the consumption of fuel is the Regulator. For proper supply through the regulator to engine the venturi kit is important to provide the necessary pressure drop & supply. In present day to reduce the pollution and fuel consumption the CNG vehicles are used as alternative to the SI engine. Still for the better performance and uniform fuel air supply there is the need to design the pressure regulator with effective analytical tools. In this regulator the mainly three parameters namely pressure drop and fuel discharge nozzle angle of the regulator will be analyzed computational fluid dynamics. This regulator will be designed and also we done the analysis use the CATIA software. The result obtained from the software will be analyzed for updated design of a regulator. This regulator will be modified as to sense the temperature of the engine and then regulator will flow the fuel to the engine. Because of this modification the it reduces the friction of piston with cylinder bore so the proper combustion will done so the performance of engine will be better. In common regulator the flow of the is directly supply to the injector for that it can damage the piston and cylinder our regulator is detect the temperature and the it will supply the fuel to the injector because of that it reduce the damage of the piston and cylinder bore..

1. Introduction

The pressure regulator is controlling the value pressure. It responds rapidly in downstream condition and reacts similarly to flow gaseous fuel until a predetermined pressure is achieved. Since the pressure regulator design responds to pressure condition system. The device is mechanical valve. The pressure regulator interact with the entire fuel system. This interaction can be subtle or obrupt and can allow the system to work safe, predictable manner and reliable. Or Function erractically in unsafe, unreliable and unpredictable manner. The stored energy of supply pressure is use the regulator to drive suitable gas flow through the regulator. To flow the require amount of gas in pressure regulator requires minimum amount of supply pressure. The maintaining the downstream pressure the inadequate supply pressure is in the storage cylinder. The inadequate cylinder valve or line solenoid valve size is the mainly small high pressure line size. The restriction in upstream coalescing filter and gas moisture or oil content can be restricted the supply to the regulator under dynamic flow condition. For precise fuel supply in natural gas cars, that's why need to maintain the flow pressure & temperature. The fuel pressure & temperature supply to the injector is maintain with the allowable valve regardless of fuel flow changes and tank pressure condition changes. It suppose to correct the injection amount in the engine control unit (ECU) for fuel pressure & temperature. The excessive release causes misfire or abnormal combustion beyond the limit of the correction. To keep fuel pressure & temperature within the allowable value under any operating condition the regulator must be designed for that and performance pf the foregin object such as oil and eye phenomenon due to decompression. The flow of fuel is to maintain the regulator. In exports the high volume of addition, the used fuel system is depends on the import loan, also fuel tank is considered. The key part of the fuel system is the regulator, it imported at high price. For an argent part that need to localized in a less time to ensure the price competiveness of domestic car companies and local spear part owners. To modifying the technology of natural gas regulators is evaluated as must go technology for the use of natural gas fuel. We need to recognize the future energy in the future. for the structure characteristics and requirement of regulators for the natural gas & hydrogen fuels are similar. So that compressed gas used at high pressure it is near about 220 bar or 250 bar. For this structure the hybrid and natural gas fuel are also required.

3. Fundamentals of Pressure Regulator

The gas pressure regulator is the typical schematic diagram is shown in fig . the linkage attached to the diaphragm at high pressure gas flow through an inlet orifice that is opened or closed by the disk. The diaphragm move with respect to the balance between pressure inside the regulator body & adjustment spring force. The regulated pressure increases the disk closes to restrict the incoming gas & when the regulated pressure is too low the disk open to allows more gas into a body cavity. The stability of the system depends on the amount of damping system and the damping comes from restriction flow within the regulator. In gas pressure regulator model define three control volumes that is are used in the dynamic analysis. Identifying the fig of body chamber, the upper &lower chamber. It is characterized by pressure of each control volume & the density as a function of time. The purpose of analysis is that to control volumes are use the mass flow through system. For this analysis the regulator is supply the gas at a certain temperature..

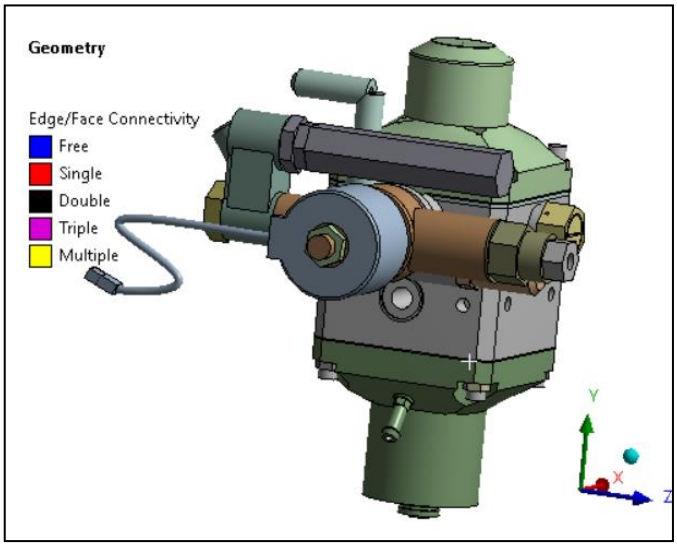
4. Problem Statement

The gas pressure regulators are important in the role of transfer of natural gas to the injector. To distribute natural gas to the injector its pressure is reduced to 20 to 300 mbar by service pressure regulator and it is brought into use of consumer. Mainly there are two types of service regulator first one is single stage and second one is two stage regulator. the working operation of the both function is same. The difference between in two stages is that the pressure reduction takes place. The two stage is getting more stable and sensitive outlet pressure flow rate of gas. The two stage pressure regulator is mostly used in vehicles.

5. Technical Advancement

The technical advancements is offered by the present invention. It will be add to the economic advantages of the invention. Include the realization of diagram operated CNG regulator having a simple structural configuration, a diaphragm operated CNG regulator that is compact in size, a diaphragm operated CNG regulator that reliable and sensitive and a diaphragm operated CNG regulator with multi features that reduced no. of components in CNG system. The no. of joints in the system is reduced and use of high pressure tubing in the CNG system is eliminated and the cost of the system is considerably reduced. the various physical parameters are considered the numerical values. The dimensions & quantities are only approximate values and it envisaged that the value higher or lower than numerical value assigned to the physical parameters. The dimension and quantities fall within the scope of the invention unless there is a statement in the specification to the contrary. While consideration emphasis has placed herein on the specific features of the preferred embodiment. This is made by the additional parameters like water inlet outlet in between them there is the temperature sensor is mounted on regulator to sense the temperature of engine & maintain the supply of natural gas.

6. Modal



7. Material used

Body: Aluminium

Bolt & Nut: Brass

Spring: Structural Steel Wire,

Cap – Stainless Steel.

For the development of dynamic equation of pressure we use the assumption of adiabatic and reversible process inside regulator ducts, so we can use the isentropic relation between pressure (*P*), density, and specific heat ratio.

8. Standard structural values

The Temperature of Coolant is 100°C / sec. As per the Aluminum & structural steel body the convection of steady state is 22°C.

So to calculate the flow coefficient:

Cy = (Q√G*T)/256*P1*sin(100*√(P1-P2)/P1

Where, P1 is Pressure of Gas at inlet 23.20 Psi ==1.6 bar

P2 is outlet Pressure of gas is 20.30 Psi==1.4 bar

T Temperature 1200 Q Specific Gravity 0.587

Then cv is calculated = 0.108

Then, Velocity of pipe

Given,

Q=2.2 m3 /h

A=19.63 mm2

V= 278.

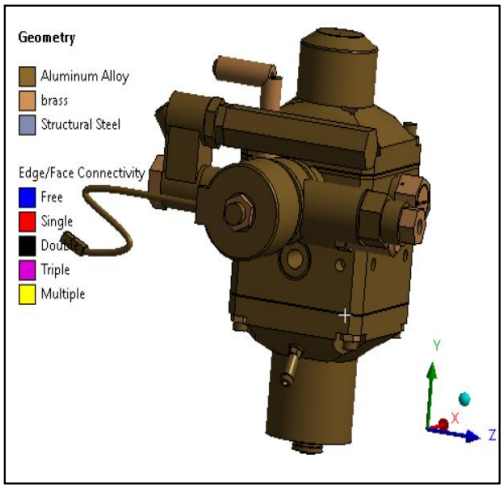
Q/A :. 278*2.2/19.63 V=31.15 m/sec Calculating the outlet Pressure Normal Inlet Pressure is 220 bar.

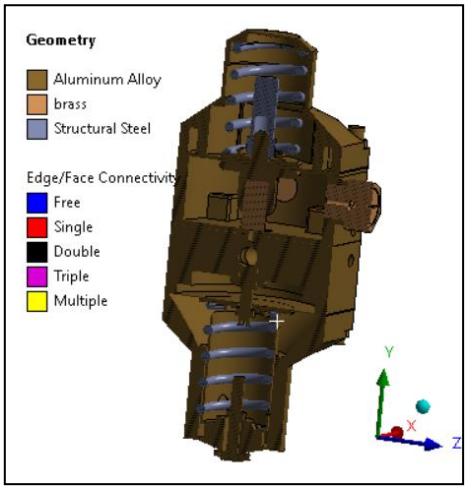
Formula = Cv=Q*(√G*T)/256*P1*sin[100*√(P1-P2)/P1

Then,

0.108 = 25*(√0.581*120)/256*220*sin[100*√(220-P2)/220]; P2 = 0.16 Bar.

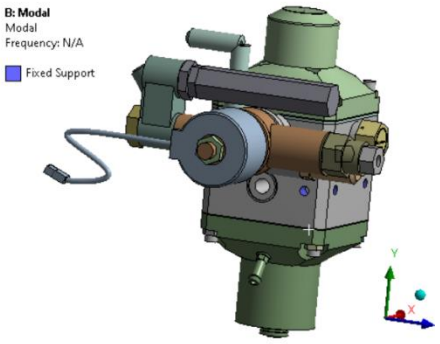
7. Material analysis

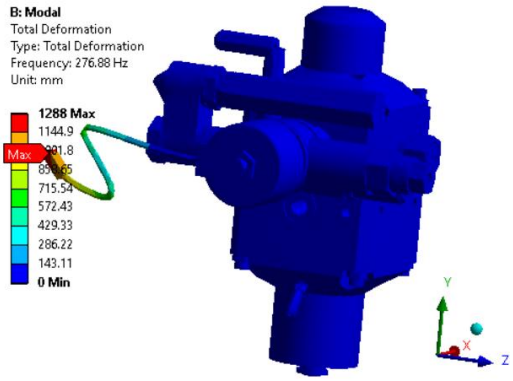




8. Ansys of model

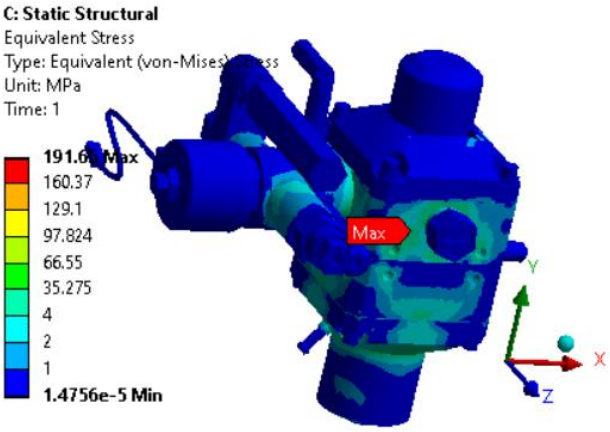
Vibration analysis:-



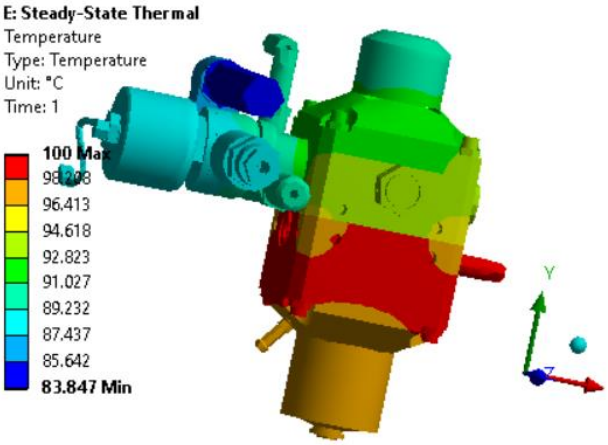


Tabular Data		
	Mode	Frequency [Hz]
1	1.	276.88
2	2.	311.75
3	3.	423.99
4	4.	792.06
5	5.	866.09
6	6.	943.26

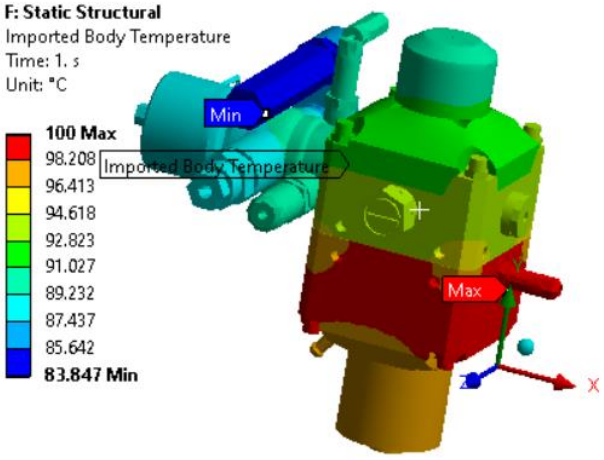
Static structural analysis:-



Steady state thermal analysis:-



Static structure body temperature:-



7. Conclusion

When the flow inside the Regulator was analyzed for different angles of throttle plate opening, it was found that the pressure at the throat of the venturi decreased with the increase in opening of the throttle plate.

When Engine's Water is come in to the regulator, the temperature Sensor in the Regulator Will sense and we found I result that, whenever engines temperature is reaches 100 ° C, The supply remains close. And when temperature goes above 100 ° C, it will discharge Gas through regulator. When the throttle plate opening increases then the flow of air through the carburetor increases but the fuel flow remains constant. But as obtained from the analysis above the pressure at the throat the throat also decreases with increase in opening of the throttle plate so the flow of fuel from the float chamber into the throat increases and hence the Supply will be delivered with engine's performance.

8. Reference

[1] D. Vujic and S. Radojkovic, "Dynamic model of gas pressure regulator," Mechanics, Automatic Control & Robotics, vol. 3, no. 11, pp. 269–276, 2001. [2] S. Sunil, U. Pandey, B. S. Jeevanlal, M. Radhakrishnan, and C. Amarasekaran, "Mathematical modeling of pressure regulator for cryogenic applications," in Proceedings of the 37th National & 4th International Conference on Fluid Mechanics and Fluid Power, FMFP10-CF-30, Chennai, India, December 2010.

[3] A. R. Shahani, H. Esmaili, A. Aryaei, S. Mohammadi, and M. Najar, "Dynamic simulation of high pressure regulator," Journal of Computational and Applied Research in Mechanical Engineering, vol. 1, no. 1, pp. 17–28, 2011. [4] N. Zafer and G. R. Luecke, "Stability of gas pressure regulators," Applied Mathematical Modelling, vol. 32, no. 1, pp. 61–82, 2008. [5] B. Delenne and L. Mode, "Modeling and simulation of pressure oscillations in a gas pressure regulator," Proceedings of American Society of Mechanical Engineers, vol. 7, 2000.

[6] E. G. Rami, B. Jean-Jacques, G. Pascal, and M. Francois, "Stability study and modeling of a pilot controlled regulator," Material Sciences and Application, vol. 2011, no. 2, pp. 859–869, 2011.

[7] J. Shipman, A. Hosangadi, and V. Ahuja, "Unsteady analyses of valve systems in rocket engine testing environments," in Proceedings of the 40th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, Fort Lauderdale, Fla, USA, 2004.

[8] H. Ortwig and D. Hubner, "Investigation and CFD simulation of flow forces inside a mechatronic pressure controller for CNG engines," in Proceedings of the 12th Pan-American Congress of Applied Mechanics, Barcelona, Spain, 2012.

[9] B. K. Saha, "Numerical simulation of a pressure regulated valve to find out the characteristics of passive control circuit," Internantional Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering, vol. 7, no. 5, pp. 936–939, 2013.

[10] X. Du and S. Gao, "Numerical study of complex turbulent flow through valves in a steam turbine system," International Journal of Materials, Mechanics and Manufacturing, vol. 1, no. 3, pp.