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Economic Automobile Immobilizer

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Abstract

The number of vehicles stolen in India per year is significantly high. While there have been advancements in the modern vehicular security mechanism, we must notice the fact that modern day security is digitized. Digitization of security led to the involvement of ECUs in vehicles. ECUs are expensive pieces of machinery and increase the cost of a vehicle. Thus, a lot of entry level vehicles do not come equipped with an ECU in the first place.

The automobile immobilizer that we've designed, provides security to vehicles without involving an ECU at all. By shutting down the fuel supply to the engine, we manage to completely stop the ignition of the vehicle, thus preventing it from being driven away by anyone else but the legitimate driver.

In order to show how this will work, the shutter shall be fabricated from Steel and shall be tested on a rubber pipe attached to a suction pump. This demonstration shall let us know about the feasibility of this design and shall bring in further insights into this model

1. Introduction

The modern immobilizer used in vehicles is a complex mechanism involving a lot of electronics, circuitry and ECU involvement. While this is successful, it adds to the cost of the vehicle. So it seems that **"safety is a privilege that can only be afforded by the rich"**. By means of this project we mean to **break this myth**.

Entry level cars such as TATA Nano, Maruti Suzuki Alto are mostly bought by people in the lower economic bracket thus in order to save costs, such cars come without an immobilizer. Our project is aimed at providing vehicular security at minimal costs that can be affordable to all.

An **immobilizer** is an electronic security device fitted to an automobile that prevents the engine from running unless the correct key (or other token) is present. This prevents the car from being "hot-wired" after an unauthorized entry has been achieved.

The main objective of the project is to install a safety mechanism that cuts off the vehicles air intake the moment the remote is clicked or the requisite electronic signal (Probably via a proximity sensor) is given, thus making ignition impossible. Our device uses an **Iris Shutter** that shall be installed at a feasible position in the vehicle, from where it shall cut off the air supply to the engine. Thus, even if someone breaks into your car, and even manages to hotwire it, he won't be able to drive the car, thus preventing it from being stolen.

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2. Design of Iris Shutter

Our device uses an Iris Shutter that shall be installed at the air intake manifold in the vehicle, from where it shall cut off the air supply to the engine.We've decided to use an iris shutter using a sliding clip mechanism instead of a spring shutter. A spring shutter becomes inefficient if even a single spring wears out or becomes inefficient. Thus, we landed on the sliding clip mechanism.

3. Design of Leaves of Shutter

Iris shutter has been an evolution from the shutter of a camera. Shutter Leaves act as the flaps which shall open/close the opening in the middle of the shutter and hence their design plays a crucial role in the design of shutter.

4. Number of Leaves

We designed 2 shutters of suitable dimensions, one being a 6 leaf shutter and other being a 5 leaf shutter. We found that a five leaf shutter was found more feasible for the design.

Out of the two designs of the iris diaphragm that we made, we have decided to use the 5 leaf iris shutter design due to the following reasons:

- Ease of manufacturing
- Lower cost of manufacturing
- Lesser turbulence during the flow of fluid through the shutter

5. Proposed 5 Leaf Shutter Design

Shown in the figure is a 5 leaf shutter design with following specifications:-

- Length of whole apparatus is 20.8cm.
- Diameter at inlet pipe is 3.6cm and at outlet pipe is 3.0 cm.
- Shutter design consists of 4 discs namely base plate, blade layer, actuating ring, cover plate, static ring and rods.
- Diameter of whole of shutter(with casing) is 18.2cm.
- The shutter and ring assembly is held together by 10 threaded screws of pitch 0.4mm and diameter of 2mm, head diameter being 4mm.
- Each of the screws are placed symmetrically at an angle of 720 to ensure minimum separating forces when the shutter is closed.
- The shutter will open and close in a rotation angle of 290 and the method of actuation of rotation of blades will be finalized only after the torque calculations and analysis is done.
- The design of inlet and outlet pipes are taken in reference to the authentic inlets and outlets of a Venturimeter to ensure smooth flow of air through the shutter.

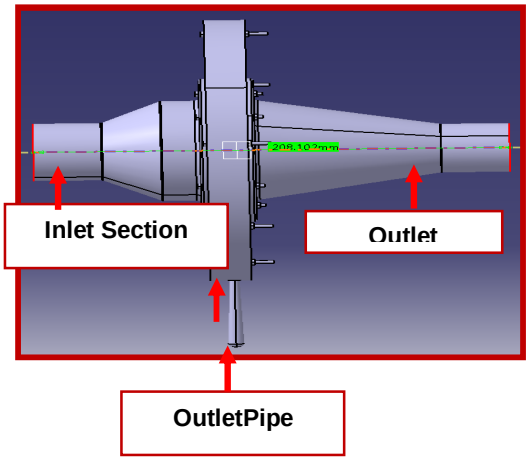

Figure: 1-SIDE VIEW

6. Geometry Analysis

- Geometry analysis is done to check if the geometry made is feasible or not. This analysis checks short edges, small faces, knife edges, knife vertices, discontinuous faces and discontinuous edges.
- Geometry analysis done on the blade of our designed part was a success and no errors were found in the analysis.

7. Simulation Analyses on Blade

- We have carried out our analyses on the blade to test whether it can withstand the pressures that the air-

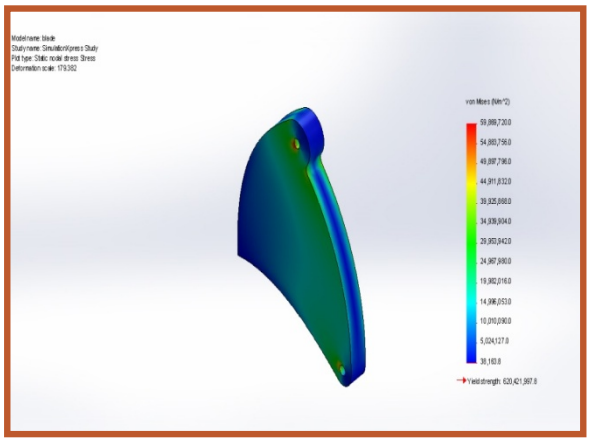

Fig: 3. Stress Analysis on Blade at 3.7 bar

- fuel mixture will exert during the suction stroke incase the vehicle is started when the shutter is in closed situation.
- Two pressure values have been taken as input parameters i.e. 3.7 bar and 6bar. The former is a close-maximum limit case however the latter is the safety limit considering the situation when shutter is put in vehicles with superchargers, turbochargers and other complicated equipment.
- The design passed in both the cases and no failure points/stress points were found in the analysis and hence the design of blade leaves were concluded to be safe for use.

8. DFM Analysis

- DFM Analysis is carried out to check if our design suits the industrial standards.
- We carried DFM Analysis on blade and there were 8 successes and 2 failures. However the

failures were not significant because the software considers a diameter of 3.048mm as a standard drill bit size but holes in blade are of 3.0mm diameter. Second issue considers fillets to be milled however we will get the blade cut out by suitable methods.

- This issue can however be neglected in practicality.

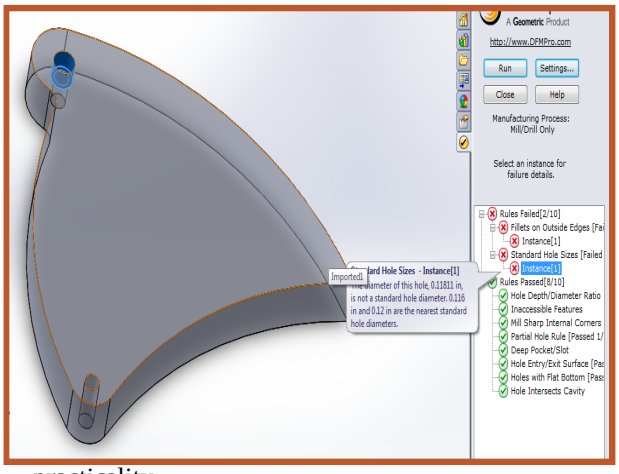

Fig: 4–DFM Analysis on Blade

9. Flow Analyses in Shutter

- Flow analyses are carried out for a body to check the flow patterns of air and water in a closed vessel. Various parameters like mass flow rate, pressure and volume flow rate can be varied to change the situations and study the behavior of the designed part.
- We have carried out 4 flow analyses in their totality covering situations from ideal to the limiting cases. Ideally the pressures and mass flow rates at the time of suction are 3.7bar 8g/s respectively, however the limiting cases being 6bar and 15g/s. Making all possible permutations and combinations in these values, we have carried out analyses on proposed 5 leaf iris shutter, and the design passed in all the flow analyses carried out.

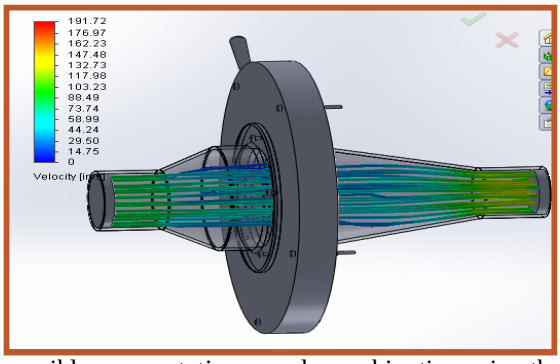

Fig: 5. FlowAnalysis on Shutter at 3.7bar and 8g/s

10. Prototyping

- The prototype shall involve an air compressor that would throw air at a pressure which is equal to the inlet pressure of air in an automobile. The iris shutter mechanism will be placed at the outlet of the compressor. Once the compressor is on, we shall close the shutter in order to imitate the safety measure. A relief valve shall be attached to the compressor to prevent any damage to it once the shutter is closed. At the same time, an anemometer shall be used to check if there is any leakage. The aim is to keep the leakage at minimal so that ignition isn't possible.
- To make our project a success we estimate the following requirements:-
- An air compressor supplying air at 2-6bar.
- Connecting pipe of diameter as per the design made.
- Material for conditioning of shutter which shall majorly include aluminium and alloy steel.
- Servo motor.
- Gears.
- Design Software: Solid Works 2013, CATIA V5R200.
- Anemometer.
- Base for apparatus (preferably a thick ply board). Pressure relief valve.

11. Feasibility and Future Scope

11.1 Feasibility

The modern immobilizer used in vehicles is a complex mechanism involving a lot of electronics, circuitry and ECU involvement. While this is successful, it adds to the cost of the vehicle. So it seems that "**safety is a privilege that can only be afforded by the rich"**. By means of this project we mean to "break this myth". In a country like India which is one of the biggest markets in the automobile sector with a large number consumers being at the bottom of the pyramid.

Entry level cars such as TATA nano, Maruti Suzuki Alto are mostly bought by people in the lower economic bracket thus in order to save costs, such cars come without an immobilizer. Our project is aimed at providing vehicular security at minimal costs that can be affordable to all.

The engine immobilizer, that we are going to fabricate as our project, has a number of advantages over the immobilizers installed in an automobile. The automobile can be started by disconnecting the security system from the battery. On the other hand, our immobilizer engages itself, the moment the signal

is sent to it. Therefore even if the battery is disconnected later, it shall have no effect on the shutter. Also, if somebody has an unauthorized access to the vehicle and tries to hotwire it, the shutter would remain unaffected, and would continue preventing ignition, thus making it a highly efficient automobile security system.

12. Future Scope

The essence of this project lies around its simplicity. And because of its simplicity, it has a high scope of further enhancements in the future.

- This mechanism could later be provided with a small independent battery so that the mechanism doesn't remain shut in case of a dead car battery.
- The shutter could be linked to an emergency phone number, through which the owner can cut off air supply to the engine at any point of time by simply sending a text message.
- There are endless possibilities as to how this device can be made more and more intricate in order to make it more secure.

13. Conclusion

This project is our effort to provide a simple yet efficient, and economical automobile immobilizer that can be installed into all kinds of vehicles, without increasing its cost.

"With the completion of this project, we wish to make vehicular security not a luxury that is enjoyed by the rich, but a privilege that can be enjoyed by everyone who owns a vehicle."

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