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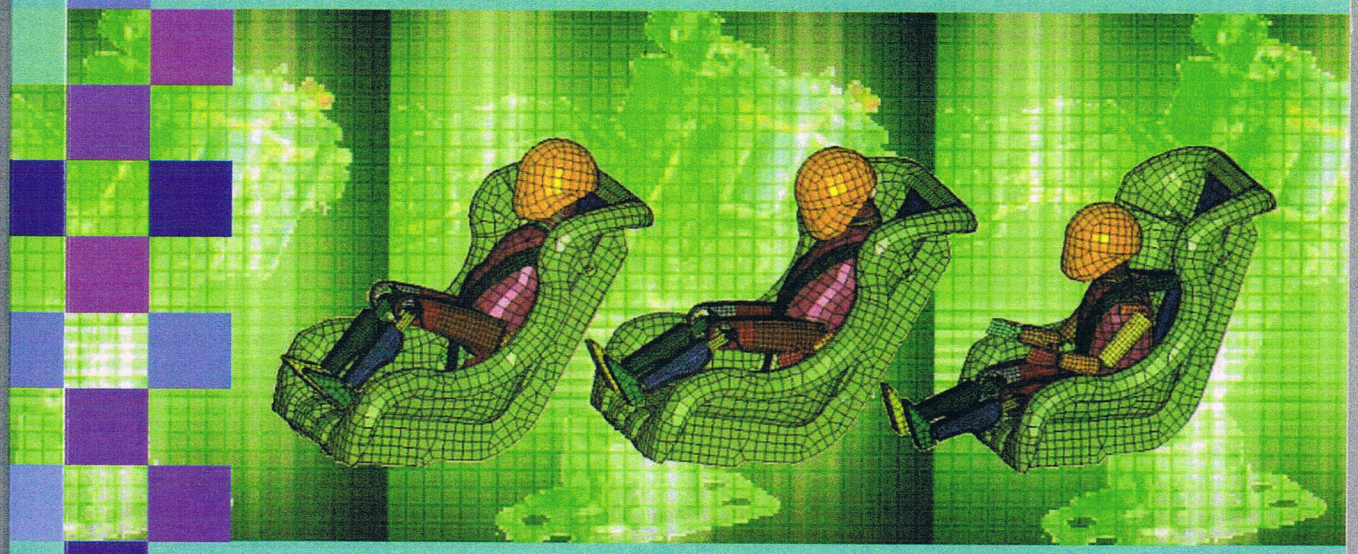

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Design and Development of Automatic Tyre Pressure Controller

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***Abstract*- Automobile tyre pressure seldom considered as important aspect in ensuring user safety, economical driving and maintenance cost reduction. The research shows that properly inflated tyres can safe tyre life up to 20% which is nine months more of its life span. It can also save fuel from 4% to 10%, increase braking efficiency up to 20%, lightens steering system and ease self steer. Therefore, Automatic Tyre Pressure Controller (ATPC) has been idealized and invented to ensure correct pressure is inflated into the tyre regardless of the setting on the pressure source: e.g. kiosk, compressor, foot inflator, etc. The device will alert the user upon reaching the appropriate pressure by a hissing sound. This product has won few medals at international invention and innovative competitions for its novelty and practicality.**

I. INTRODUCTION

Many of us are not aware about the importance of tyre pressure and assume that tyre pressure does not give significant effect on the vehicle and its performance. The research findings show that air pressure in the car tyre drops 10 to 20 kPa a month in which this is equivalent to adding a 70 kg person into the car. The facts are that, tyres with proper inflated pressure can safe tyre life up to 20% which is nine months more of its life span. It can also save fuel from 4% to 10%, increase braking efficiency up to 20%, lightens steering system and ease self steer. Inflating correct tyre pressure can also prevent tyres from over heating, explosion and on the other hand, it can ease motoring and reduce maintenance cost. Knowing the air pressure kiosk at fuel stations may fatigue due change of climate and may not provide the desired pressure, yet many of still rely and assumes the pressure into the tyre will be the pressure set on the kiosk. To ensure 'what is desired is what you get', an invention has been devised to automatically control the input pressure into tyre regardless of the pressure set on the kiosk. In another word, the kiosk can be set to any higher pressure value and upon reaching the appropriate tyre pressure, the device will alert the user by hissing sound indicating the endurance. This device is not only limited to be used with kiosk, instead it can also be used with foot inflator, hand inflator, industrial air compressor or any other air pressure resources. This device fascinates many people during exhibitions as it possesses many advantages such as no more hustle of setting correct tyre pressure on the kiosk, alerts user automatically, no counter measuring is required, multi level preset can be done, plug & play and can be operated almost by anybody including kids above 6 years at home. Under inflated or over inflated tyres often caused by incorrect tyre pressure where ranges out of the researched pressure values by the tyre manufacturer(s) would cause critical impacts on safety and motoring cost. The lack of awareness and knowledge about tyre pressure leads us to 'never mind' attitude without knowing the great benefits that can be gained by proper inflation.

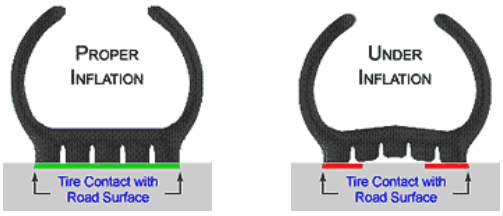
II. FACTS ABOUT PRESSURE DROP

It is just like an inflated balloon which loses the pressure and contracts over the time, the air pressure in the car tyre drops 10 to 20 kPa every month too. Drop of each 10 kPa is equivalent of adding a 70 kg person into the car and indirectly, overloading occurs without any passengers in the car. This will not only cause the tyre to damage and expose user to danger, but would also cause greater drag to the car damaging associate parts and steer connections of the car.

III. ADVANTAGES OF PROPER TYRE PRESSURE

The detail market survey and research findings of Bridgestone tyres validate the facts bulleted below where, proper tyre pressure can:

- Safe tyre life up to 20% (extra 9 months)
- Save fuel from 4% - 10 %
- Increase braking performance 20 %
- Lighten the steering system and ease self-steer
- Prevent tyre from over heating and explosion
- Ease motoring and save cost



(a) (b)

Fig. 1: Inflation and surface contact determining braking performance. (a) Properly inflated (b) Under inflated

IV. Effect Of Under Inflated Tyre

Severe defects and danger would occur onto under inflated tyres where, they are exposed to over loaded and excessive heating conditions. Fig. 2 and Fig. 4 clearly show the respective phenomena which occur due to this condition.

A. Overloaded

The phenomena and analysis of under inflated tyres which causes terrible overloading onto automobile is clearly shown in Fig. 2 below.

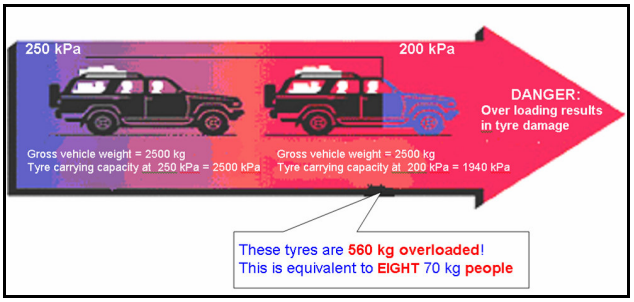
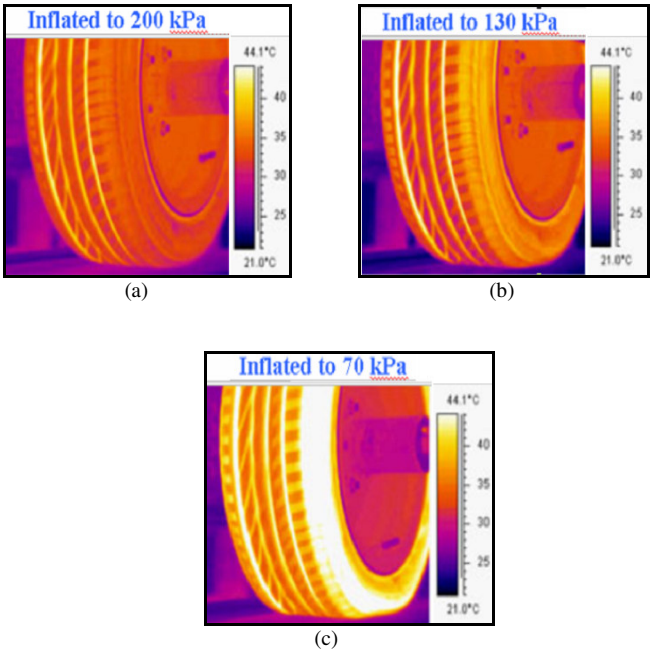


Fig. 2: Scenario of how difference of 50kPa causes severe overloading of 560kg due to under inflated tyres. Thanks to [1,2]

B. Heated- Up

Under inflated tyre causes excessive heat dissipation where it increases wear rate, easily damages the tyre and exposed to the risk of explosion. Thermal imaging of tyres with different inflated conditions (a), (b), (c) are shown in Fig. 3.



(a) (b) (c)

Fig. 3: Thermal imaging of different tyre pressure (a), (b) & (c). Thanks to [1,2]

V. Methodology

The methodology designed to carry out the entire task to completion and development of ATPC prototype is shown in Fig. 4. The development experienced multiple near-net design stages and prototypes in order to meet the precise output during operation.

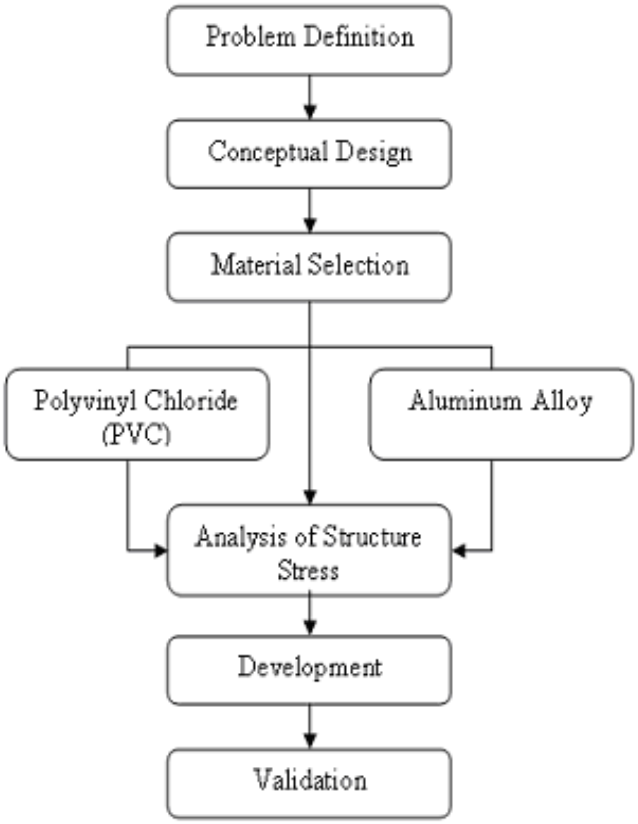


Fig. 4: Brief methodology of the research work

VI. Finete Element Analysis (FEA)

Since ATPC was categorized and designed based on ASME code VIII & IX, the critical investigations has been carried out to ensure it is safe to use under few operational and non-operational conditions [3, 4]. The results of the analyzes for PVC and Aluminium is shown by Fig. 5 and Fig. 6 respectively. The outcome shows that, the design is safe to be operated under specified conditions as the materials were optimized accordingly to ensure safe operation while avoiding over design.

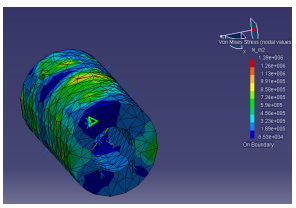


Fig. 5: FEA for PVC prototype

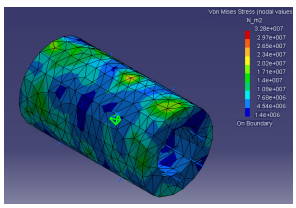


Fig. 6: FEA aluminium prototype

VII. About The Invention / Product

a) Novelty

- To control and limit tyre pressure (input can be almost at any pressure level).
- Relieves excessive air from tyre (in case of over inflated).
- Simple operation, cheap but effective.
- First of its type in market.

b) Advantages

- Can be confidently used with air compressor and manual inflators (without pressure indicator)
- Alerts user upon pressure is sufficient (hissing sound)
- No counter measuring is required (pressure monitoring stick)
- No more hustle of setting correct pressure on the kiosk
- Multi level preset value (customized)

c) Potentials

- Highly potential to be commercialized
- Cheap (Expected to be < RM 50)
- Value for money (worth practicing)
- Easy to use (plug and play)

VIII. Operating Procedures

The ATPC will be used as an intermediate unit between the pressure source and target to be inflated. At this point, the input pressure can be at any amount of pressure which is more than the desired pressure. Upon reaching the intended pressure, the device alerts user in which the user can then stop inflating and dismantle it.

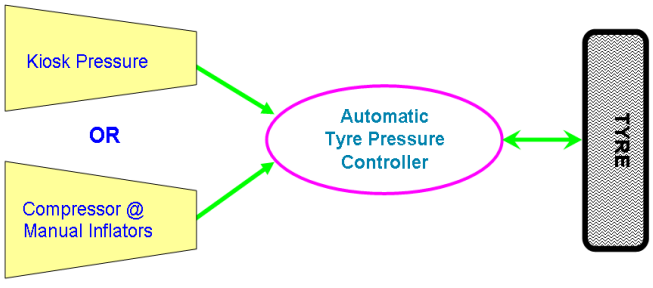


Fig. 7: The schematic of operating procedures

On the other hand, if a tyre has been over inflated for some reasons, once reaching home ATPC can be hooked-up without pressure source and it will help to release the excessive air from the tyre where, there will be hissing sound until the tyre pressure drops to the intended pressure. This will enable us to regulate the tyre pressure almost at any place any time. Fig. 8 elaborates further on how the ATPC can be used together with other pressure resources to inflate tyres.

Fig. 8: Tyre inflation with ATPC

IX. Results And Discussion

The invented ATPC was designed with two different materials as mentioned earlier. The aluminium type with three pre-set values and the PVC type with only one pre-set. This is because the design falls under the principle of pressure vessel and it has to comply to ASME code VIII for safety and design purpose. Fig. 9 and Fig. 10 shows the aluminium and PVC based ATPC respectively. ATPC with three presets seems to

be more durable as it was made of harder material. But considering to store it in the dash-box and no items in it should damaged, the ATPC was redesigned into PVC with single preset considering the lack of material toughness.

Fig. 9:.ATPC made of aluminium with three pre-sets

The ATPC made of PVC are made into few settings of single pre-set. They were produced for 200 and 250 kPa. The operating principle for PVC was differed a little [5,6] to ensure the operating parts are interconnected during inflation without any failure and good repeatability.

Fig. 10: ATPC made of PVC with single pre-setting

X. CONCLUSSIONS

After completing the design, development and testing, ATPC was found to be very promising in delivering the preset pressure values with the error of less then 1% under dynamic loading and fatigue cyclic test. The test confirms that the entire operating system can sustain up to seven years without any major diversion in pre-set values. The ATPC has been patented under commercial name and it is currently in the process of commercialization. Its ability to inflate the tyre to a limited pressure and relieving an excessive air from over inflated tyre is expected to be very helpful in maintaining the tyre pressure to a recommended pressure easily as ATPC can be used together with mechanical inflators at home.

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