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STRATEGIES AVAILABLE FOR SELF- INFLATION SYSTEM**Prof. K. G. Maniyar*¹, Piyush S. Raibole² & Nikhil A. Mirge³**¹Asst. Professor, Dept. of Mechanical Engineering, MGI-COET, Shegaon, India^{2,3}Student, Dept. of Mechanical Engineering, MGI-COET, Shegaon, India**ABSTRACT**

Automobile is becoming an important part of daily human life. As per increasing demand the safety and comfort is always a big concern. One of the most important part of an automobile, tyre, are the most major concern of safety. Problems of under inflation is been a major danger to tyre life and safe working. According to some paper study it is known that a slight drop in pressure, will affect the tyre wear, safety, gas mileage and whole vehicle performance. As well as refilling it is a time consuming task, and it sometime become a major problem if refilling station are not available in time. To neglect the unwanted stress and waste of time for inflating the tyres, this SIT (Self-Inflating Tyre) system is designed. Looking forward to improve and perfect this modern way of driving this paper focuses on collectively study of available technologies in SIT sector. So as to overcome safety issues due to underinflated tyres.

Keywords: Automobile, Tyre, Self-inflating Tyre, Safety.

I. INTRODUCTION

In modern civilization automobile is becoming one of the most important factor. The use and demand of automobile has increased in last few decades. One of the most common problem for an automobile is improper inflation of tyre. As a fact 80% off commercial automobile on the road have at least one tire under inflated and 37 % of automobile have 1 Tier which is 20% or more under inflated. The pressure loss from tyre is a continuous process due to natural permeation of gas through the uncertain surface of any tyre, road condition, seasonal changes, etc.

The reason behind improper inflation of tyre is because owner is not conscious about exact optimal tyre pressure in certain condition, lack of pressure measuring device, improper maintenance of tyre and ignorance.

In the condition of improper inflation, tyre wear off very quickly. If the tires are under inflated it will wear on the outer periphery of tyre circumference and if the tire is over inflated it will wear up on the inner Periphery of tire circumference. In both the condition tyre life is reduced. [1]

Under inflation of tyre by 20 % increases the friction by 25% eventually it will reduce the tyre life for 30 % and 10% for inflation reduce the trading by 5 % due to the uneven friction of tyre with the road surface. An automatic self-inflation system will eliminate both the problem of cost and improper inflation since it is concerned with the adequately necessary pressure levels depending on tyre and environmental condition. The automatic air inflation system helps to maintain the pressure in tyres during the running condition of a vehicle. For the better performance of a vehicle depends on environmental conditions such as region, seasons, etc. it is important to maintain optimum tyres pressure. This system holds an important advantages in military vehicles & public transport like, increase fuel economy, safety of passengers in vehicle, reduce in tyre wear & overall safety of vehicle. This will ultimately preserve the tires as well as the fuel.



Figure 1. How tyres look like in different cases

II. OBJECTIVE

Looking towards the present increase in demand of automobile, safety is a major concern now a days. The only part of a vehicle which is not getting automated is tyres. The objective of this paper is to provide a collective study of available Technique in Self-Inflating Tyre Sector. This will contribute in proper future research and studies.

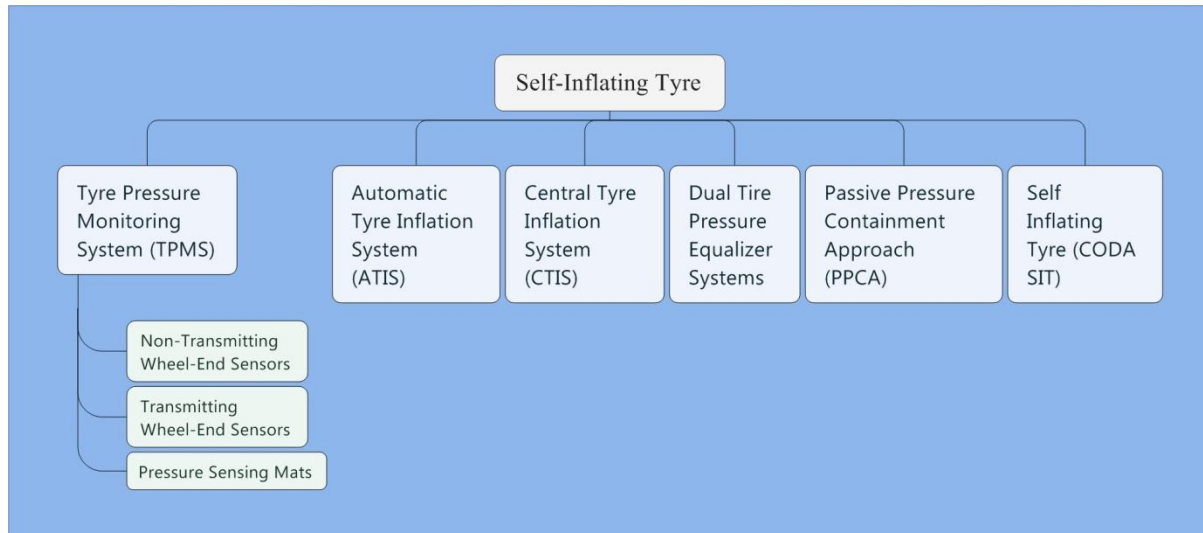


Figure2. Pre-Existing Self inflating Tyre Concept

III. LITERATURE SURVEY

After elaborative study of papers listed below we come across several SIT system. Self-Inflation system are widely used in military vehicle and some commercial heavy loading vehicle. Following are essential topics to be known during designing any SIT system.

A. Pre-Existing SIT Concept

Here are the commercially or non-commercially available SIT systems. [5][7]

i. Tyre Pressure Monitoring System (TPMS)

A TPMS monitors tyre pressure and temperature (if required), for each individual tire. TPMS are assigned to identify underinflated tires with assistance of a device that senses pressure and temperature and can transmits the data and displays it to the operator. [5] Action decision based on the difference between the target pressure and the actual measured pressure in the tire is monitored by TPMS for each tire based on a pre-loaded optimal pressure. Following are types of pressure sensors available for SIT:

a) Non-Transmitting Wheel-End Sensors

Non-transmitting wheel-end monitors tire pressure. It have an arrangement of sensors mounted to the threads of the valve stem. It does not transmit the tire pressure data so this is the most basic type of TPMS available. The NTWE sensor is designed to provide an indication of the tire pressure visually, it require the operator check every tyre of vehicle in order to see the tire pressure reading. This type can be used on tractor, trailer, or in combination.

b) Transmitting Wheel-End Sensors

TWES determines a direct measurement of the actual pressure for each individual tire that is fitted with a sensor. In both normal operating conditions as well as for pressure alerts the pressure condition of every tire is forwarded to the operator or to maintenance authority during any pressure alerts as well as for normal operating conditions. To transfer tire pressure information and other tire condition information to Internet and cell phone systems this TPMS can link to existing vehicle communications networks. A person may choose to receive the initial alert of a tire with low pressure then it will be sent to fleet maintenance personnel to determine what action should be taken or alert to a driver. Analysis for tire performance trends in working and someone may also link to a fleet's work order .Data can be collected in central databases and system for tire inspection and maintenance scheduling.

c) Pressure Sensing Mats

A small number of suppliers as a means to quickly measure and report the tire inflation condition automatically as a vehicle enters a garage or service center are developing pressure sensing "mats" or "plates". The pressure sensing mat can be installed on the inner surface of tyre, it consists of matrix of sensor that is arranged into metal plate structure. As a tire is driven across the plate at low speed, in a typical configuration, each sensor records an incremental load on the sensor area. The shape and contact area of the tire footprint and the total load being carried by the tire is determined by reconstructing the history of sensor loading as the tire passes. The tire inflation pressure is calculated from this information.

ii Automatic Tyre Inflation System (ATIS)

The Automatic Tyre Inflation System (ATIS) is able to operate automatically to restore the optimal tire inflation pressure to its target or pre-defined level, it operates without requiring any manual assistance to take decision of re-inflation. To maintain target pressure across a normal or typical range of ambient operating conditions this system will be function. The pre-defined target value being non-adjustable by the vehicle operator from inside the cab during vehicle because the system is pre-set to a single pre-defined pressure, or to a single target pressure per control unit. Actual tire pressure is typically not assigned for the tire/wheel assemblies connected to the system. The major difference between ATIS and CTIS is that the ability of CTIS to respond to an instant change in target pressure which will be achieved with the human interaction inside the cab. More often ATIS is intentionally design for a particular pre define pressure.

iii Central Tyre Inflation System (CTIS)

In the case of Central tire inflation system it uses the compressed air from the vehicle compressor to inflate the tire it extract air usually from break tanks. Pressure sensor, manifold, hoses and valve, harnesses and control/displays are the key component of the system. CTIS set-up includes an ECU in modification to an air regulating the system, in contrast to ATIS. The main advantage of this system is that the vehicle operator has the access to change the target pressure of tyre from inside the cab. If required the operator can change the pressure as per the road and environmental condition.

The ECU controls operation of Pneumatic system which helps to inflate flat tire. Air is also supplied to the tires for maintenance of constant pressure. This system are most often found in Off-road appliances characterized by fairly un-even surface condition and costly vehicle including heavy loading at mining sites, construction sites, military operations.

iv Dual Tire Pressure Equalizer Systems

Dual tire pressure Equalizer system is especially design for maintenance of same inflation pressure between the two adjoin tyre in a dual tyre assembly, in this arrangement Central sensor unit is attached to the wheel on outer side with tyre connector hose running from the unit to the inlet valve about tyres. This unit allows the flow of air to be directed only between two adjacent tyres. But this system is not able to add or remove air during the normal operating condition. For example, if temperature of inner tyre suddenly starts to rise faster than the outer tire resulting in high pressure into the inner tire, this system tends to determine the difference and will slowly transfer the air from inner tire to outer tyre, until both tires are operating at the same pressure. Unknowingly, if one tire of the dual assembly is punctured, the system will naturally transfer air from the non-leaking tire in a despite to balance the pressure between the tires.

v Passive Pressure Containment Approaches

The passive pressure contamination approach is the additional tyre pressure category which is design to maintain the air in tyre without any action to measure or report auto adjust inflammation pressure once and all the tire has been field completely, one of the method nitrogen inflation has a capacity to reduce the natural pressure losses due to diffusion through the tire over the air. In another arrangement the use of tyre sealant indifferent form is generally applied intentionally to reduce the air loss caused by any small puncture during working.

vi Self-Inflating Tyre (CODA SIT)

SIT is a tire integral technology that uses atmospheric air to inflate the tire automatically when a wheel is in motion, overcoming the natural loss of pressure and ensuring maintenance-free, constant adequate tire pressure over the entire lifetime of the tire. It uses peristaltic pumping phenomenon to pump atmospheric air into tyre to maintain optimal pressure. The whole pumping process done not involve any pump or compressor such as conventional SIT system. Self-Inflating Tire system is specially designed to enhance fuel economy and safety. As well as benefiting drivers by discarding unpopular pressure checks and inconvenient tire inflation problem, it helps to overcome the serious drawbacks of improper tire inflation.

B. System Components

The typical SIT system consists of following components. [2]

i Tyre Pressure Monitoring System (TPMS)

The tire pressure monitoring system is one of the most accurately engineered and precisely designed key component of any self-inflating tyre system. It is assigned to measure monitor and regulate the pressure into the tire as compared to optimal boundary values which are already set level. The values Upper Optimal Pressure and Lower Optimal Pressure are values such that they are 0.3 bars plus and minus optimum tyre operating pressure respectively.

As discussed above designer have many options for TPMS as per customer need among following commercially available system:

- ◆ NTWES
- ◆ TWES
- ◆ Pressure Sensing Mats



Figure 3. Pressure Sensor

ii Mechanical Control Unit (MCU)

Mechanical control unit is a mechanical arrangement which is provided for the operator to recalibrate and modify each tyre pressure manually.

iii Operator Control Unit(OCU)

Operator control unit is a user-friendly interface for the operator that monitor this place and give the operator to access the tire pressure according to the road and weather condition.

iv Tyre Pressure Maintenance System

Tyre pressure maintenance system is a set of components vehicle responsible for tyre pressure maintenance according to the pre-programmed or instant input given by the operator.

a. Rotary Joint

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Figure 4. Rotary Joint

b. Compressor unit

The compressor component is the one which produce the required pressurized air to tyres, thus its position will be critically considered since it will need to supply pressurized air to all wheels equally. The compressor unit/s also has to be powered by a secondary source rather than the battery to avoid overloading. [8]



Figure 5. Compressor

b. Pipe-network / air carriage system.

Pipe-network or air carriage system carry the pressurized air to the wheels upon request conveyed by the pressure sensor mechanism on the wheel. To avoid any chances of damage, it will be short and delicately attached in order to rotate wheels, usually it will be attached in main wheel assembly structures so as to sustain. Also it should be strong so they can resist the force due to pressurized air. [8]

C. Working Method

i Principle

In self inflating tyre system of any vehicle the pressure drop in a tire is sensed by the pressure sensor arrangement it is able to determine it in running condition. The sensor will send a signal to Central database. And decision will be taken automatically or manually. In case of low pressure air compressor will start supplying air to the tire until the tyre has achieved the adequate pressure. By using electronic sensors for switching of the circuits will take place [6].

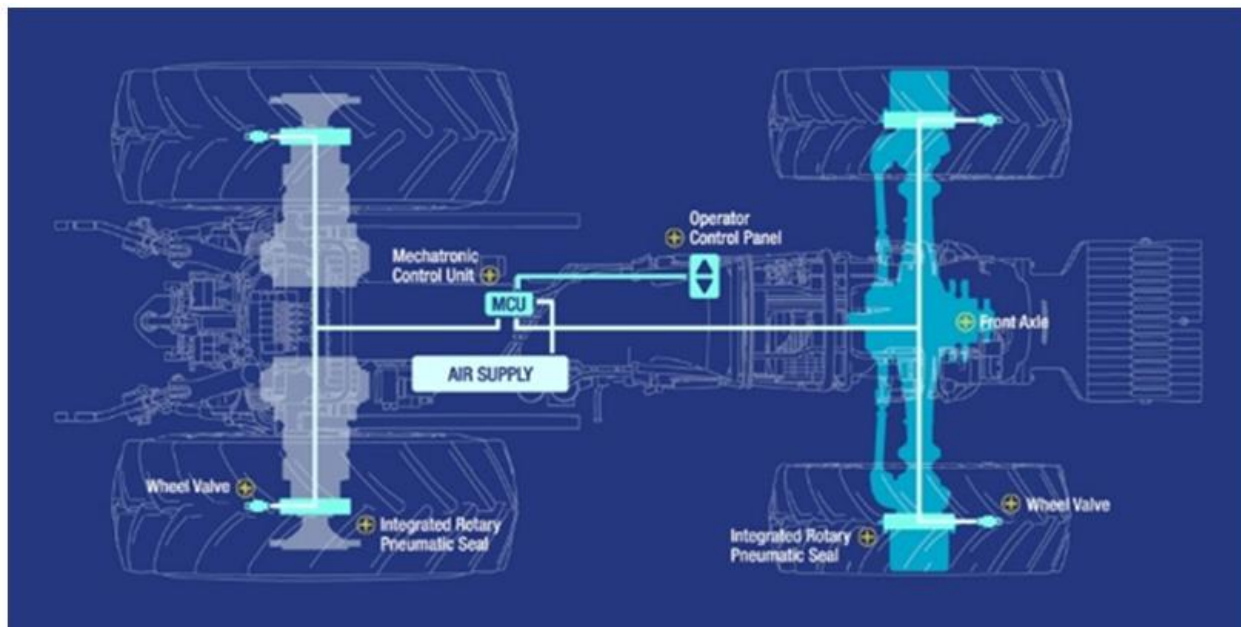


Figure 6. Schematic of SIT [8]

ii Working

In a commercial self-inflating tyre system, the compressor is attached to the tire with the help of piping networks through a Rotary joint. The dropping pressure is sensed by the pressure sensors that are attached between compressor and tyre. The system has redefined two limits of pressure data upper limit and lower limit with the difference of 5 bar to the optimal level. If the tire achieves the pressure of upper limit or lower limit this will automatically initiate the supply of pressurized air. Usually compressor work on 12 volt dc supply that is provided by car batteries or auxiliary batteries supplied to the system. A non-return valve is used to avoid the back pressure to return into the compressor from tyres. Similarly when the tire pressure reduces below the lower limit of the tyre while the vehicle is in running condition the pressure sensor detects the air drop below the lower limit and starts the compressor to supply here at pressure to under inflated tyre. When the tire achieves the predefined pressure level the pressure sensor will sense the change in pressure and commands to stop the air transfer. This is how self-inflating tyre helps to maintain the required pressure all the time.

IV. SCHEMATIC

A typical schematic system of Self-Inflating Tyre system can be represented as shown in Figure 6. The schematic is flexible to make changes as per customer needs. Above mentioned design is nearest to CITS type Self-Inflation Tyre. [3][8]

V. RESULT & DISCUSSION

The improper inflating of tyre affect the tyre wear, safety, gas mileage and whole vehicle performance. Condition of underinflated tyre leads to wear the tyre on outer periphery of circumference due to ground tyre interaction. Similarly the over inflation lead to wear of tyre on central periphery of circumference due to more ground tyre interaction. This ultimately wear up a certain part of tyre rapidly, which eventually decrease tyre life and healthy working.[4]

VI. CONCLUSION

The Self-Inflating Tire system has potential of succeeding as a new emerging product in the automobile supplier industry. It explicitly overcome the needs of the consumers by maintaining exact tire pressure conditions for:

- Reduced tire wear
- Increased fuel economy
- Increased overall vehicle safety

Because such a product does not currently exist for the widely commercial and domestic vehicles, the market conditions would be favorable for the introduction of a self-inflating tire system.

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Although any error occurs, is our own and should not tarnish the reputation for these esteemed person.

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