



AIR PERMEABILITY INVESTIGATION TOWARDS AUTOMOTIVE TYRE PRESSURE SUSTAINABILITY AND LIFE SAVING

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ABSTRACT

One of the main reasons for major road accidents which often lead into loss of life's is the catastrophic tyre failure caused by vehicles running with improper tyre pressure. The phenomena where tyre loses pressure naturally and contracts over time is called air permeation, which is identified to be the main cause of tyre to deflate but rarely can be realised by naked eyes. Properly inflated tyres can save tyre life up to 20% which is equivalent to nine months of its life span, save fuel from 4% to 10%, increase braking efficiency up to 20%, lightens steering system and ease self-steer. Therefore, this paper reveals the investigation findings by analysing the factors that affect the air permeation that eventually causes pressure loss in an automotive tyre. The experimentations were performed in both static and dynamic conditions where they were also tested with and without loaded situation to extract precise data of the pressure loss from tyre. The results show that no matter what type of tyre or condition it undergoes, it still experience pressure drop but at different rate subjected to air properties, temperature, tyre materials and mechanical fittings of the wheel.

Keywords: tyre pressure, pressure loss, air permeation, porous material, tyre air leak, tyre safety.

INTRODUCTION

Automotive tyres are basically made of natural and synthetic rubber where their hybridization acts as many role plays not only in providing comfort, but also ensure safety while it's rolling at different types of road conditions and operational temperature. The only medium that transfers the whole lot of vehicle load onto the road is tyre. As tyres supported by the wheels, it provides a cushion between the road and the vehicle suspension, provides traction for both acceleration and braking, resist lateral forces for safe cornering, stability and better handling. With the assistance of the air pressure inside them, tyres are responsible to support the overall weight of a vehicle too [1].

Automobile tyres naturally undergoes gas escapism upon several causes, which then requires regular inflating to replace the air loss in order to sustain proper tyre pressure. Tyre pressure drops mainly due to pressure lose or air escapism from the tyre. Besides tyre quality and tyre materials, improper tyre pressure is the main factors led to catastrophic tyre failure and eventually leads to major road accidents [2, 3]. Furthermore, the research finding also shows that every 20 kilopascal pressure drop in a tyre is equivalent of adding a 70kilogram person in to the car [4] which indirectly causes to excessive tyre wear and might result in serious road accidents due to poor control and stability of the car. Micro molecular gases can easily escapes to the atmosphere from a pressurized vessel through the interface fittings and absorption through porous materials. Studies also shows that an automobile tyre naturally releases about 10-20 kPa of pressure every month regardless of tyre brand used [4].

LITERATURE REVIEW

Besides tyres are punctured by sharp objects on the road, such as steel nails, the tyres do experience natural air leakage caused by its porous material and mechanical fitting of the wheel. This pressure leak is called air permeability. Since tyres are made of rubber hybridized and manufactured by combining of materials such as natural rubber, butadiene rubber, halo-butyl rubber, polyester cord and rubber coated fabrics which is a form of porous material, literally shows that even properly fitted tubeless tyres which are free of mechanical leaks can still have significant pressure loss via permeation [5,6] which shown in Figure-1. Over the time, air molecules would make their way through the maze of molecular chains and escape especially through the tyre sidewalls [7]. Other factors which contribute to tyre air permeation are the excessive operating temperature [8-11] and the existence of oxygen molecules in compressed air used for inflating the tyre. These molecules are much smaller than nitrogen and would eventually escape to the atmospheric through tyre wall. On top of that, portion of oxygen moisture would also evaporate causing pressure drop in the tyre [12].