DANA SPICER® Optimized Tire Pressure System

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Optimized Tire-Pressure Management

Solutions to Increase Safety, Reduce Costs for Fleets, and Support Evolving Fuel Economy Regulations

According to a 2012 report[1] from the National Highway Traffic Safety Administration (NHTSA), underinflation is the leading cause of tire failure. Under any circumstances, proper tire inflation is one challenge for fleet owners and operators that has proven far too important to ignore.

Data from the Federal Motor Carrier Safety Administration[2] shows tires as a leading factor contributing to crashes involving commercial vehicles. Despite known statistics about the dangers, a 2010 Technology and Maintenance Council report[3] on tire pressure and inflation states that tires and wheels are still the second leading cause of roadside inspection citations. That same study also notes that for fleets, tires represent the second highest vehicle operating cost, and tire inflation is the No. 1 maintenance challenge. With the risk for dangerous blowouts and costs associated with underoptimized tires, fleet managers could gain major benefits from a reliable, comprehensive tire-pressure management system.

Meanwhile, increasingly stringent regulations are now a key global challenge, and the trend toward reduced emissions is aggressive. The cost of fuel combined with looming deadlines to meet new efficiency standards in the United States[4], Europe[5], and other locations worldwide are driving original-equipment manufacturers (OEMs) to look beyond engine and powertrain efficiency for improvements.

Legislation continues to evolve, as the U.S. Environmental Protection Agency (EPA) and NHTSA announced a proposal[6] in June 2015 to establish a second phase of greenhouse gas emissions and fuel-efficiency standards for medium- and heavy-duty vehicles. This proposal includes support for more technology options to help manufacturers meet standards, including automatic tire-inflation systems. The agencies call out the need for optimized tire pressure in order to maximize the efficiency of low-rolling resistance tires while recognizing the benefits of automatic tire-inflation versus monitor-only systems.

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Engineers have dug deep to find innovative solutions tied to aerodynamics, weight reduction, and improved tire rolling resistance. Tire-pressure optimization technology presents a unique opportunity to offer a comprehensive, smart solution for the commercial-vehicle industry.

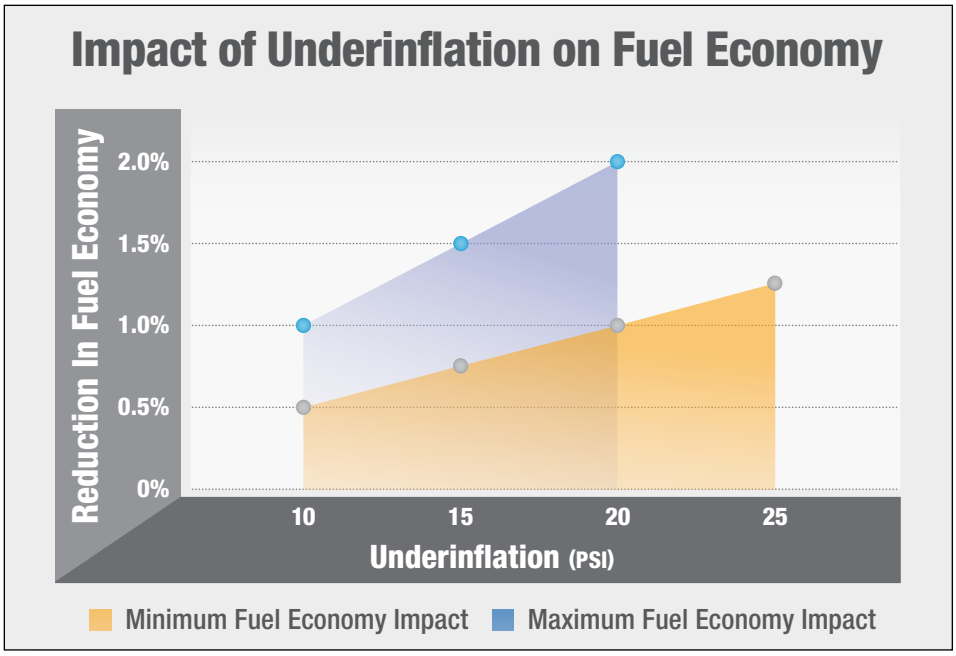
Factors that Cause Improper Tire Inflation

Tire pressure changes are caused by a variety of factors. Air simply seeping through the walls of a tire can result in a small loss, depending on the materials used to manufacture the tire. Objects such as nails or tacks stuck in the tread can cause slow leaks. Overtightening of valve cores and leaking valve stems can also lead to air loss. Additionally, if an operator accidentally hits the curb or runs over an object on the road, air loss can occur from the impact.

Losing just a few pounds per square inch (psi) may not seem like a concern, but these losses over time can lead to trouble, especially when the problem isn't noticed right away. If drivers aren't checking every single tire on a regular basis, they may not recognize the warning signs that a tire failure could be imminent.

Dangers of Increased Wear and Tire Damage

According to the EPA[7], driving under the recommended pressure by as little as 10 psi can lead to a reduction in fuel economy between 0.5 and 1 percent. Improper inflation causes sidewalls to extend and contract, creating excessive heat and rubber fatigue. In this weakened state, tire wear is accelerated, traction is affected, and tires are more susceptible to damage. Additionally, as rolling resistance increases, more power is required to move the vehicle, which increases fuel consumption.



Source: "Maintaining Proper Tire Inflation Pressure," U.S. EPA[7]

Safety is another major concern, as a tire blowout on a steer axle can cause loss of control for the operator. Even if the driver maintains control, debris can create a dangerous hazard for other drivers. According to AAA[8], road debris is to blame for 25,000 crashes per year in North America.

There are also federal regulations to consider. If not followed, harsh fines could be imposed and a fleet's operation could even be shut down. Some of these tire-related violations carry hefty penalties up to eight points, which can adversely affect the safety record for both drivers and fleets.

Severe tire damage often results in an expensive road service call, potentially taking the vehicle and the operator out of service for an extended period. The cost of roadside downtime goes beyond the obvious expense of the repair and lost time for the driver. Missing a scheduled dock delivery could also lead to customer dissatisfaction, putting future business in jeopardy.

Tire-Pressure Monitoring: Unresolved Challenges

Although the risks associated with improper tire inflation are well known, the time and labor required for proper examination can be a hindrance. Drivers earn their pay behind the wheel, so traditional walk-around tire inspections that involve taking a pressure reading of every tire can be an expensive and lengthy process. For a fleet maintenance manager, checking the pressure of each tire on every truck in a fleet can be an extremely daunting task, yet given the efficiency, maintenance, and safety benefits of proper tire inflation, it's no surprise that fleet managers are showing increased interest in solutions that support maintaining proper pressure in their truck's tires.

With such a strong demonstrated need for fleets to improve tire maintenance, systems that monitor tire pressure have been on the market for decades. A tire-pressure monitoring system (TPMS) checks the pressure and temperature of each tire and

System Comparison

	Monitor Only	Optimized Tire-Pressure Management
Inflate and deflate capabilities	NO	YES
Requires driver to inflate tires	YES	NO
Ability to keep trucks on the road when a slow leak occurs	NO	YES
Warning of potential catastrophic tire events	NO	YES
Potential for weight, temperature sensing	NO	YES
Supported by EPA and NHTSA Phase 2 proposal to further reduce emissions and fuel consumption	NO	YES

Top Five Causes of Commercial-Vehicle Roadside Citations

1. Brakes
2. Tires and Wheels
3. Lights
4. Safe Loading
5. Steering

Source: "Roadcheck 2014," Commercial Vehicle Safety Alliance[9]

sends an alert to the operator when it drops below a preset value. The ability to detect a potential tire problem and prevent failure provides a major safety and efficiency advantage.

But a TPMS doesn't address the need to adjust the tire pressure, which means an operator or fleet manager still has to manually service the tire. Not all systems indicate which tire has the issue either, increasing the time and effort required to check every single tire. This either means an operator has to take time in the middle of a run for unscheduled maintenance, or worse, the driver might choose to ignore the warning and carry on for several thousand miles with an improperly inflated tire – an all-too-likely scenario that can lead to damage, as well as downtime, service, and replacement costs.

Systems that self-inflate tires take proactive maintenance one step further and use compressed air to inflate a tire when it falls below the correct pressure. Operating like a self-winding watch, they capture energy from a pendulum that swings when the wheel is in motion in order to inflate the tire when low pressure is detected. These aftermarket systems typically route air through hoses outboard, which connect to the tire valve and supply air to the chassis and cab. With long runs of these hoses exposed to the elements, the possibility for damage is increased, and they may even be susceptible to theft.

> The system will **significantly minimize total cost of ownership** through **reduced maintenance** resulting from **fewer tire repairs, lower tire replacement costs** achieved through **extending the life of the tires,** and **maximized fuel efficiency** through proper inflation.

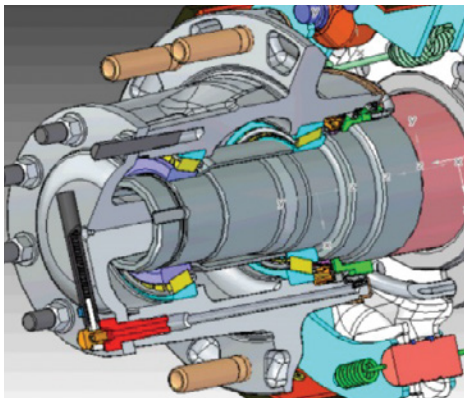
From an OEM perspective, the systems currently available are not tied to the fleet's existing diagnostics system, creating the potential for connectivity issues. Additionally, without the ability to record and analyze data from each inflation occurrence, there is no warning that a potential service issue may occur in the near future. While the tire is inflated for the time being, there is no information available as to when it became deflated, why it needed air in the first place, or how often each tire required attention over time. A slow leak may continue to be remedied without alerting the driver or the fleet to the problem, potentially shortening the life of the tire and causing significant damage over time.

Meeting the Need for Tire-Pressure Optimization

Dana has been a longstanding leader in tire-pressure optimization with decades of experience building tire-pressure management technology for the U.S. military. Drawing on this expertise, our engineers have developed an innovative product for the commercial-vehicle market that is capable of satisfying the significant unmet needs that exist today.

Engineered to automatically maintain proper inflation for both steer and drive axles, this tire-pressure optimization system will be the only solution to offer an inflate system for all tires on a linehaul tractor. It will also feature the unique ability to deflate, which may be necessary when tires are overpressurized or when additional traction is needed. The system will significantly minimize total cost of ownership through reduced maintenance resulting from fewer tire repairs, lower tire-replacement costs achieved through extending the life of the tires, and maximized fuel efficiency through proper inflation.

Dana's system is optimized for use with 6x4, 6x2, and 4x2 configurations. The first integrated system of its kind, it will be installed at the OEM level and is compatible with J1587 and J1939 SAE communication protocols. The system's electronic control unit will communicate issues requiring immediate attention to the dashboard display. A major advantage over currently available destabilized automatic inflation systems is that it can be integrated into a telematics package so the data can be sent back to home base, where the fleet maintenance manager can collect and analyze it over time to detect trends and make a prognosis on each tire's health.



Dana's tire-pressure optimization system is designed for tandem axles and non-driven steer axles from multiple manufacturers.

Based on Dana's technology for the government defense industry, this new system for linehaul trucks includes many of the features and benefits of the military version, but scaled to keep the total cost of ownership manageable for a fleet. One of the keys to this commercial-vehicle system's success is state-of-the-art rotary-joint technology, which is integrated with the axle and is responsible for supplying air to the tire. This patent-pending innovation, one of the biggest challenges to overcome, was developed by Dana engineers in collaboration with leading seal manufacturers. But with shared brain power between Dana's axle engineer experts and professionals skilled in the sealing industry, an optimized solution was found.

Utilizing the vehicle's existing compressor system for air, the pressure of each wheel end can be monitored and the psi can be set to a predetermined

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value per axle. The steer-axle system features a rotary joint with a cross-drilled spindle to supply air to the tires. With no excessively expensive or specialized equipment needed by the OEM for assembly and simple, minimal maintenance on the part of truck owners, fleet managers can benefit from payback on their investment in just 12 months.

The system automatically takes action on data that a monitor-only system would merely report, with the capability to monitor tire pressure and inflate or deflate when required. This allows fleet managers to eliminate dependence on the malfunction indicator lamp to alert the driver to potential problems, freeing the driver from making judgment calls that could affect safety and efficiency. Additionally, downtime is reduced for operators since the need to pull over to check each tire is eliminated.

Tire checks consistently performed by the system ensure that each tire is properly inflated to a pressure equalized with the other tires on the tractor. The system will adjust tire pressure as needed, record each occurrence, and create a data pattern that can alert the fleet maintenance manager to examine small issues and head off larger problems before a major failure occurs.

While the system can be designed with basic functionality, further options may include a multi-channel system that can regulate up to eight wheel ends separately, as well as the ability to measure each tire's contained air temperature inside the chamber.

Overall savings will vary from fleet to fleet depending on a variety of factors, including the number of miles driven annually and truck configuration, along with average fuel prices, service expenses, and tire-replacement costs. But all fleets will benefit from fuel economy improvements coupled with savings achieved by avoiding catastrophic tire events. In fact, the new proposed rules from the EPA and NHTSA[10] on Phase 2 standards include a 1 percent credit toward fuel economy targets for fleets that utilize automatic tire-inflation technology. This credit does not apply to monitor-only systems.

Dana engineers have drawn on decades of experience building tire-pressure management technology for the U.S. government defense industry.

Dana is currently conducting road trials to test the system's configuration and quantify the benefits associated with this technology. In a conservative industry where performance is critical, feedback from these trials confirms that fleet customers are aware of the downfalls of monitor-only systems. These systems take the driver out of the equation when it comes to maintaining proper air pressure, which will become increasingly important as new technologies surface to further decrease driver engagement, such as autonomous-driving vehicles.

Increasingly complex systems require engineering expertise from numerous disciplines to improve performance, and collaboration is critical to discovering the next generation of innovations for the transportation industry. Open discussion between suppliers, OEMs, and other industry leaders is the only way to ensure total compatibility and alignment. With the new commercial-vehicle tire-pressure optimization system from Dana, the world leader in tire-pressure and mobility technology, maximum efficiency can be achieved.

Sources

[1] *http://www-nrd.nhtsa.dot.gov/Pubs/811681.pdf*

[2] *http://www.fmcsa.dot.gov/safety/research-and-analysis/large-truck-crash-causation-study-ltccs-analysis-series-using-ltccs*

[3] *http://www.trucking.org/ATA%20Docs/About/Organization/TMC/Documents/Position%20Papers/Study%20Group%20Information%20Reports/Tire%20Pressure%20Monitoring%20and%20Inflation%20Maintenance%E2%80%94TMC%20I.R.%202010-2.pdf*

[4] *http://www.epa.gov/otaq/climate/regs-heavy-duty.htm*

[5] *http://ec.europa.eu/clima/policies/strategies/index_en.htm*

[6] *http://www.nhtsa.gov/About+NHTSA/Press+Releases/2015/hd-trucks-phase-2-standards*

[7] *http://www.epa.gov/smartway/forpartners/documents/trucks/techsheets-truck/420f11005.pdf*

[8] *https://www.aaafoundation.org/sites/default/files/Crashes.pdf*

[9] *http://www.cvsa.org/programs/documents/op_airbrake/2014/Roadcheck-2014-Results-Summary-FINAL.pdf*

[10] *http://www.gpo.gov/fdsys/pkg/FR-2015-07-13/pdf/2015-15500.pdf*

For more information

visit danacv.com/optimized-tire-pressure-system-calculator

Visit our website for more information, including an optimized tire-pressure system calculator to help determine potential savings you can achieve with Dana's solution.

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Since joining Dana in 2011, Sidders has been involved in the product design and development of new automatic tire-inflation technologies for the military, off-highway, and commercial-vehicle markets. Responsible for guiding ACCS product engineers, helping production customers, and working on new product concept development, he has more than 10 years of experience in chassis control and mechatronics. Sidders has a bachelor's degree in mechanical engineering from the University of Toledo.

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