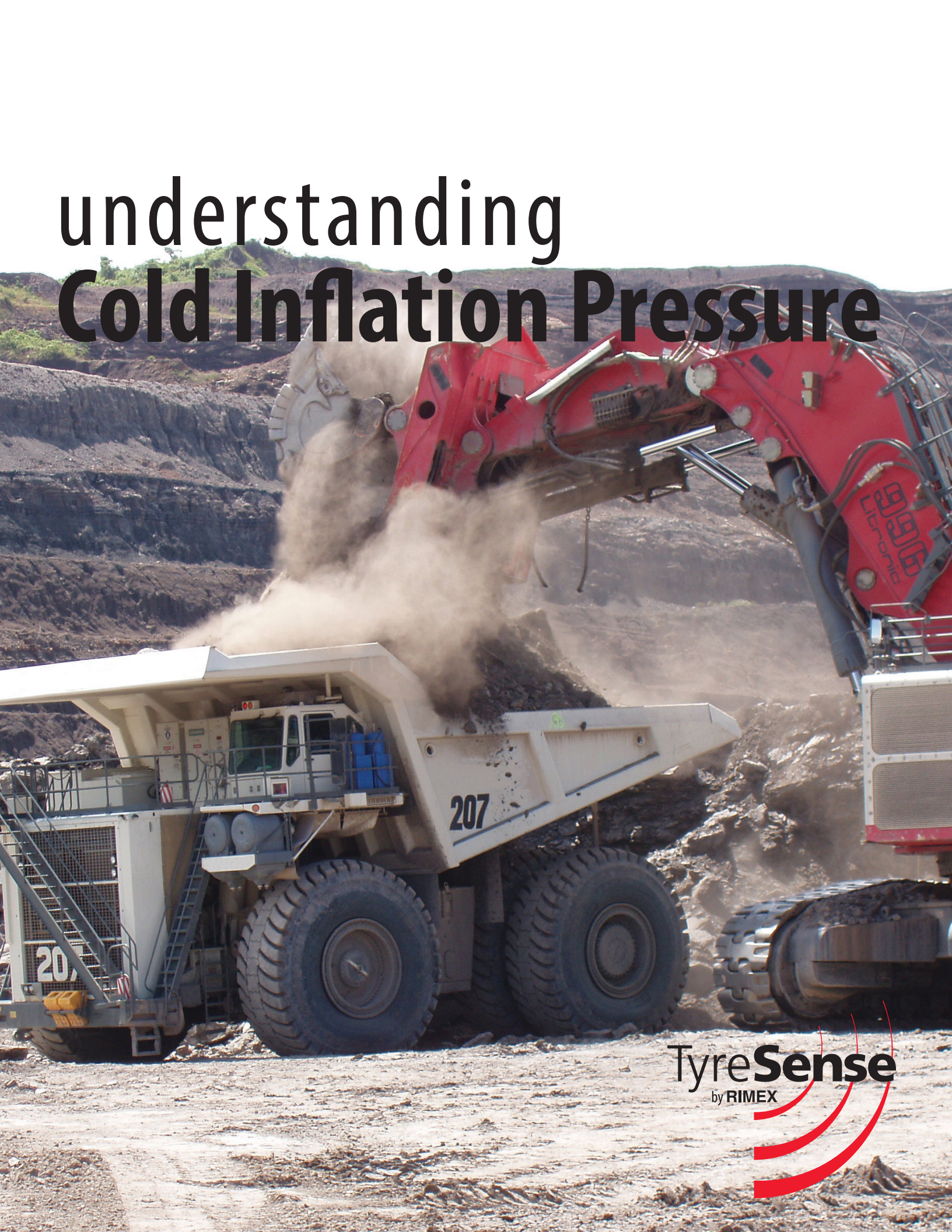
understanding
Cold Inflation Pressure



TyreSense
by RIMEX

WHAT IS COLD INFLATION PRESSURE?

The cold inflation pressure is the contained air pressure of a tire that would occur at an indexed temperature, usually 20°C or 68°F. This indexed temperature is based on the ideal ambient operating conditions for the tire. There is ambiguity in the definition of cold inflation pressure among tire manufacturers. Some manufacturers index cold inflation pressure to 18°C or 25°C, or have another definition altogether.

The pressure of a tire can change dramatically with temperature. By inflating a tire at an indexed temperature, the tire fitter can confidently avoid the risk of over or under inflation when the tire is put into service. Once inflated to the correct cold inflation pressure, the tire pressure and temperature should increase to the recommended working values set by the tire manufacturer. Optimum tire life and fuel economy occur at these recommended values.

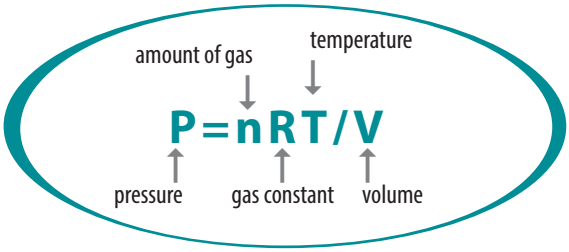
The pressure of a tire can change dramatically with temperature.

Without a cold pressure inflation correlation chart, it is difficult to determine the amount of air in a tire at a given temperature. This is why inflating a tire to the recommended cold inflation pressure is so important.

TyreSense automatically formulates and displays the calculated cold inflation pressure, by taking the contained air pressure and chamber temperature into account. TyreSense uses an index temperature of 20°C by default, but this value is user configurable.

HOW ARE PRESSURE AND TEMPERATURE RELATED?

Pressure and temperature are correlated through the ideal gas law.



***P** is the pressure,*

***V** is the volume of the tire,*

***T** is the temperature,*

***R** is the gas constant,*

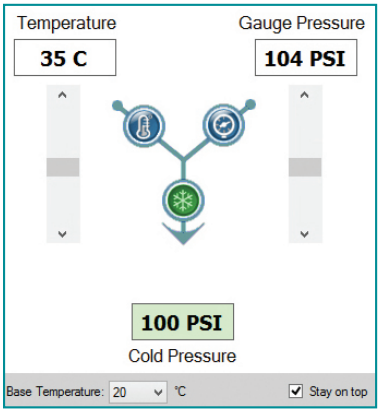
***n** is the amount of gas.*

The law states that any given change in temperature will result in a proportional change in pressure. The volume, amount of air, and gas constant of a tire typically do not fluctuate during vehicle operation, and any pressure change is usually a result of a change in temperature. Temperature changes within a tire result from friction, as well as heat transfer from other sources such as the rim/hub assembly and the external environment.

WHAT IS CALCULATED COLD INFLATION PRESSURE?

Cold inflation pressure is the pressure of a tire while it is at the indexed temperature. At any other temperature, the cold pressure must be calculated using the ideal gas law or cold inflation pressure correlation chart.

HOW DOES TYRESENSE CALCULATE THE COLD INFLATION PRESSURE?



TyreSense automatically calculates and displays the cold inflation pressure by formulating the known values of the tire chamber's air pressure and temperature. TyreSense uses an indexed temperature of 20C by default , however, this value is user configurable.

The ideal gas law cannot be used to calculate cold inflation pressure because of variables within the law that fluctuate among tires. For example, fluid contained within a tire can evaporate and change the composition of the air.

TyreSense uses a best-fit formula to calculate the most accurate cold inflation pressure for most conditions.

WHAT ARE THE ADVANTAGES OF KNOWING THE CALCULATED COLD INFLATION PRESSURE?

By knowing the calculated cold inflation pressure, operators are always aware of the amount of air in a tire. Slow leaks can be caught early, before excess tire wear and fuel consumption occur. Without calculated cold inflation pressure, slow leaks can be masked by increased temperature due to the deformation of a tire. As stated by the ideal gas law, increased temperature due to friction results in increased pressure when the amount of air contained in a tire decreases.

Tire manufacturers sometimes still warn against changing the pressure of a working tire, but this does not take into account the availability of calculated cold inflation pressure. When an operator is aware of a tire's cold inflation pressure, that pressure can be safely and accurately altered while a vehicle is in service. This allows operators to change the cold inflation pressure for different loads without waiting for the tire to cool.

HOW DOES LOAD AFFECT A TIRE?

Increasing the load on a tire increases its deformation. As the load builds up, the contact area between the tire and ground increases, while the sidewalls bulge outwards. The internal volume change caused by this deformation is negligible.

A highly deformed tire will heat up faster and hotter than a tire with a lighter load. This increase in temperature could lead to tire failure. As tire pressure increases, it will slow down, or stop the increase in temperature, but the tire may fail before this occurs.

Increasing the cold pressure of a heavily loaded tire will result in a lower operating pressure because of less heat generated from friction.

HOW ACCURATE IS TYRESENSE'S CALCULATION OF THE COLD INFLATION PRESSURE?

Based on nearly 20 years of gathering and interpreting tire pressure and temperature data, we feel that the TyreSense formula is very accurate. This being said, there are a variety of factors that can affect the accuracy of the calculation. Sources of error that can have an effect on the calculation can be external, internal, or other.

External Factors

External factors that can affect the accuracy of the calculation include: tire composition and construction, gaseous impurities contained within the tire such as water vapor, heat transfer, altitude changes, and other factors.

Atmospheric air pressure decreases approximately 3.3kPa for every 300 meters. Any change in atmospheric pressure will be directly proportional to the error in the calculated cold inflation pressure.

The wheel sensor is typically installed on the bead of the tire or on the rim. Both surfaces may heat up faster and hotter than the surrounding air, this heat will transfer to the sensor through the three modes of heat transfer; radiation, convection, and conduction.

Internal Factors

Internal factors include the composition and design of the wheel sensor itself. The TyreSense pressure sensor is potted and hermetically sealed to prevent gas and fluid from damaging the internal components of the sensor. The temperature sensor is located inside of the sensor and it can take some time for the heat energy to conduct through the enclosure and potting material.

The wheel sensor uses a diaphragm to prevent infiltration, the deflection of this diaphragm (mm/kPa) is subject to temperature. Colder temperatures reduce deflection, while higher temperature increase deflection. While this error is present, it is usually small unless the tire chamber is extremely cold.

Other Factors

Most customers analyze the calculated cold pressure through the data log. The data log provides a maximum and minimum pressure, and maximum temperature over a given time period, usually fifteen minutes. The TyreSense client uses the average pressure and the maximum temperature to calculate the cold inflation pressure. If the tire experiencing dramatic pressure changes over the logging interval, the calculated cold pressure may have an increased error because the maximum temperature did not occur at the average pressure of the log interval. Real-time snap shots through the client, server, or display unit do not have this additional source of error.

WHY ISN'T THE COLD INFLATION PRESSURE CONSTANT IN THE DATALOG?

Errors caused by external, internal, and other factors create the uneven appearance of the cold inflation pressure on the datalog. The calculation displayed is raw and not filtered or smoothed. However, the important feature of the calculation is the overall trend that it depicts. For example, it can show us if the cold inflation pressure is decreasing, and indicate if the tire had been inflated to the correct cold inflation pressure.

WHY DOES TYRESENSE USE A BEST-FIT METHOD TO CALCULATE COLD PRESSURE?

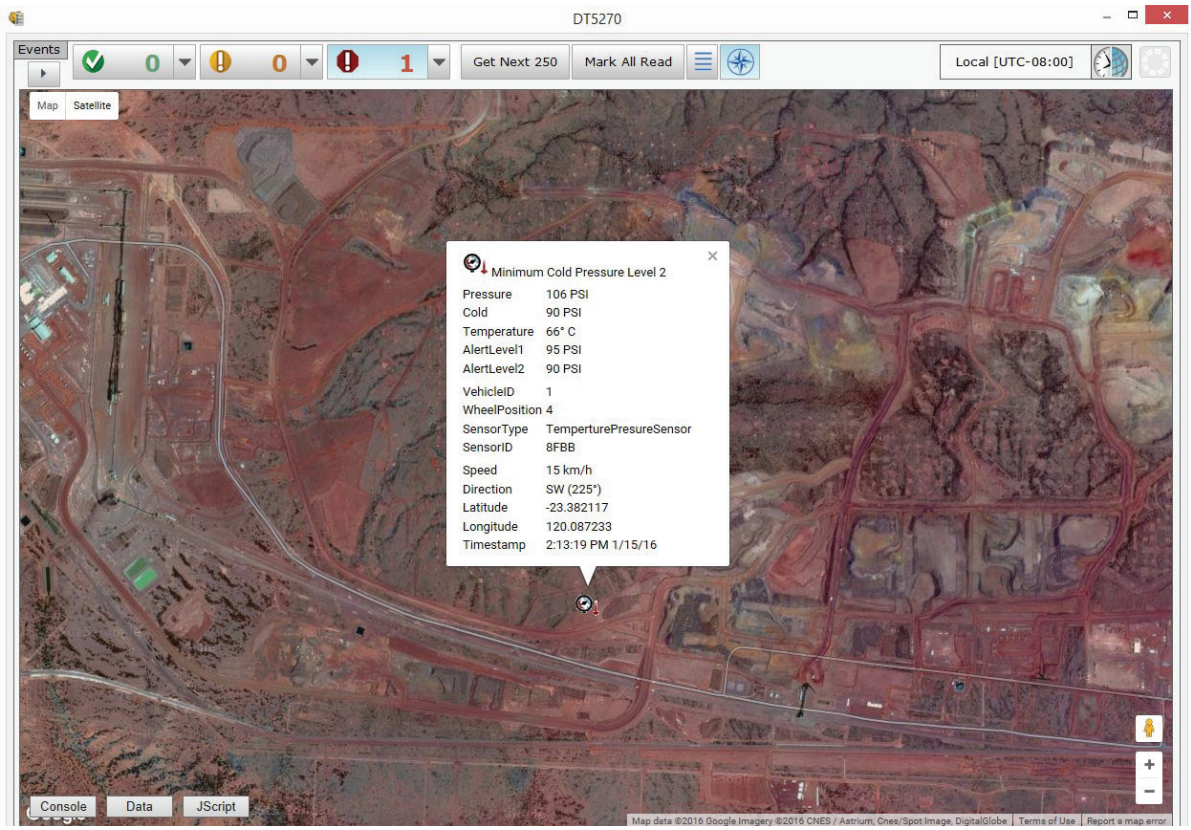
TyreSense reduces misinterpretation by offering a single method for calculating cold inflation pressure. As industry is beginning to understand the value of real-time calculated cold inflation pressure, TyreSense provides a common value for all its products. This may evolve as further data are obtained through the TyreSense Server database.

CAN TYRESENSE CALCULATIONS OF COLD PRESSURE BE CONFIGURED?

Yes. The TyreSense Receiver unit has a configurable index temperature used to calculate the cold inflation pressure.

DOES TYRESENSE GENERATE ALERTS BASED ON COLD INFLATION PRESSURE?

Yes. TyreSense offers the ability to set a minimum cold inflation pressure alert. A decline in the calculated cold inflation pressure usually indicates a leak, as a result, TyreSense will trigger an alarm if the pressure drops below the minimum cold pressure alert level.



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