Reducing Cold Start Emissions with High Performance Vacuum Insulation

The call to reduce harmful vehicle emissions from both regulators and consumers alike has pressured vehicle manufacturers to look for solutions to improve exhaust sytems. Limiting - or better yet - eliminating cold starts is one such solution.

The term "cold start" refers to starting a vehicle when the catalytic converter is at ambient temperature conditions. A cold start greatly increases hazardous emissions and can also result in sub-optimal efficiency levels. A vehicle is not considered out of cold start until its catalytic converter has reached 350°C and above- a temperature range called "light-off" (see figure 1).

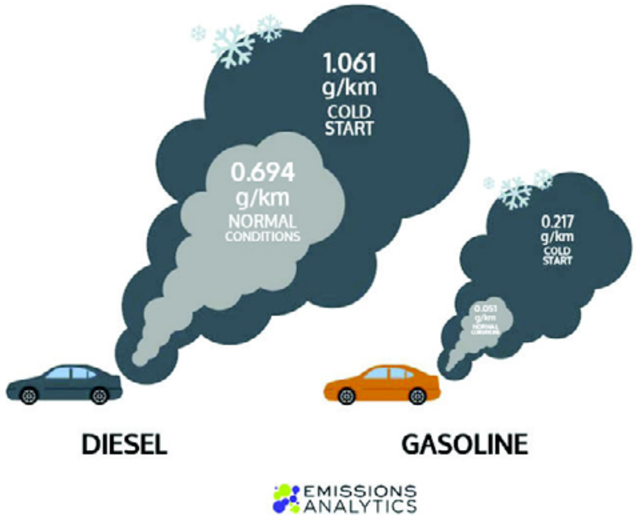

Figure 1: An illustration of NOX emissions during and after a cold start [2].

Before delving into cold start solutions it's important to examine the function of the catalytic converter- the main component of a vehicle exhaust system. The catalytic converter contains metal(s) that work to induce the chemical reactions that occur to change dangerous gasses (nitrogen oxides, carbon monoxide and hydro carbons) into water, carbon dioxide and nitrogen. Once at light-off, the catalytic converter filters up to 97% of these dangerous gasses (see figure 2).

To solve the problem of cold starts, car manufacturers have tried in the past to place the catalytic converter closer to the engine block of the car to conserve heat from the exhaust gasses. This solution, however, takes up a great deal of space under the already densely packed hood and extreme temperatures from the exhaust can creep up-stream and cause vapor to form in the gas lines putting the car into "vapor lock."

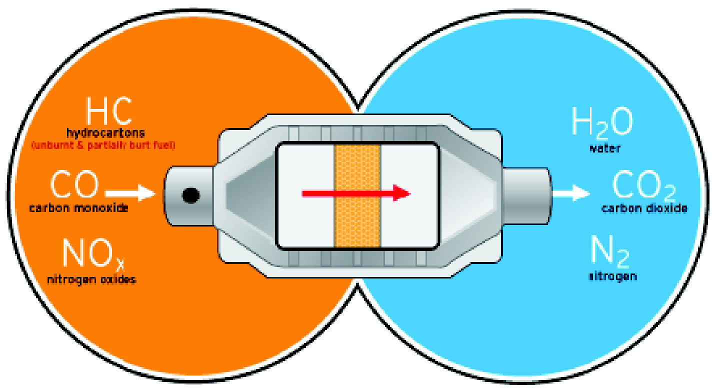

Figure 2: Harmful engine emissions enter the catalytic converter and exit as water vapor, nitrogen and carbon dioxide[4].

Another solution to minimize the cold start period is to add more thermal mass such as phase changing materials (PCM) to the exhaust line so that it retains heat for longer cold-soak periods, effectively ending cold starts for up to 13 hours after the engine has been run. Unfortunately, this is not effective in colder climates as the much chillier ambient temperature can still result in a cold start for the vehicle.

In addition, it takes much longer to reach light-off temperature with PCM due to the large addition of thermal mass resulting in an increase in emissions as well as hinderance to vehicle performance.

A third and perhaps the most viable solution places the catalytic converter in the rear and routes the engine exhaust via an exhaust line.

continue on next page

Reducing Cold Start Emissions with High Performance Vacuum Insulation continued

The issue with this method is essential heat is lost in the process of routing exhaust gases due to convection from the gas to the pipe and then from the pipe to the atmosphere. Insulon offers a passive, low footprint solution to this heat loss. By conserving heat in the transfer process from the engine block to the catalytic converter, Insulon concentrates heat on the catalytic converter which reduces the amount of time it takes to reach light-off temperatures (see figure 3).

A case study using a two foot long Insulon part shows that with an inlet conditions of 850°C at 70 SCFM (standard cubic feet per minute) flow rate, there is only a 90°C temperature drop across the Insulon tube (see figure 4).

While reducing harmful emissions may seem like a daunting battle, the use of Insulon is a solution for reducing the cold start period.

Pollutant	Conventional TWC (g/mi)	TWC with VCI (g/mi)	Decrease in Emissions (%)
UHC	01.94	0.031	84%
CO	1.463	0.131	91%
NO_x	0.135	0.066	51%

Figure 3: Reduction in emissions from a standard three-way converter to a vacuum insulation three-way converter with variable conductance[3].

For more information, call us at (516) 320-9995 or email us at inquiries@conceptgroupllc.com.

1. Burch, Steven. Potter, Thomas. Keyser, Matthew. Benson, David. "Thermal Analysis and Testing of a Vacuum-Insulated Catalytic Converter" NREL Technical Paper #473-7072 (1995).

2. Emissions Analytics. August 16, 2015. Retrieved From https://www.emissionsanalytics.com/news?category=Infographic.

3. National Renewable Energy Laboratory (NREL), "Technology Brief: Keeping the Heat on Cold-Start Emissions", http://www.nrel.gov/vehiclesandfuels/energystorage/pdfs/techbr.pdf, Accessed 30th Nov, 2013.

4. The University of Utah. "Pollution Sources" Feb. 5, 2014. Retrieved From https://www.kued.org/whatson/the-air-webreathe/background/pollution-sources.

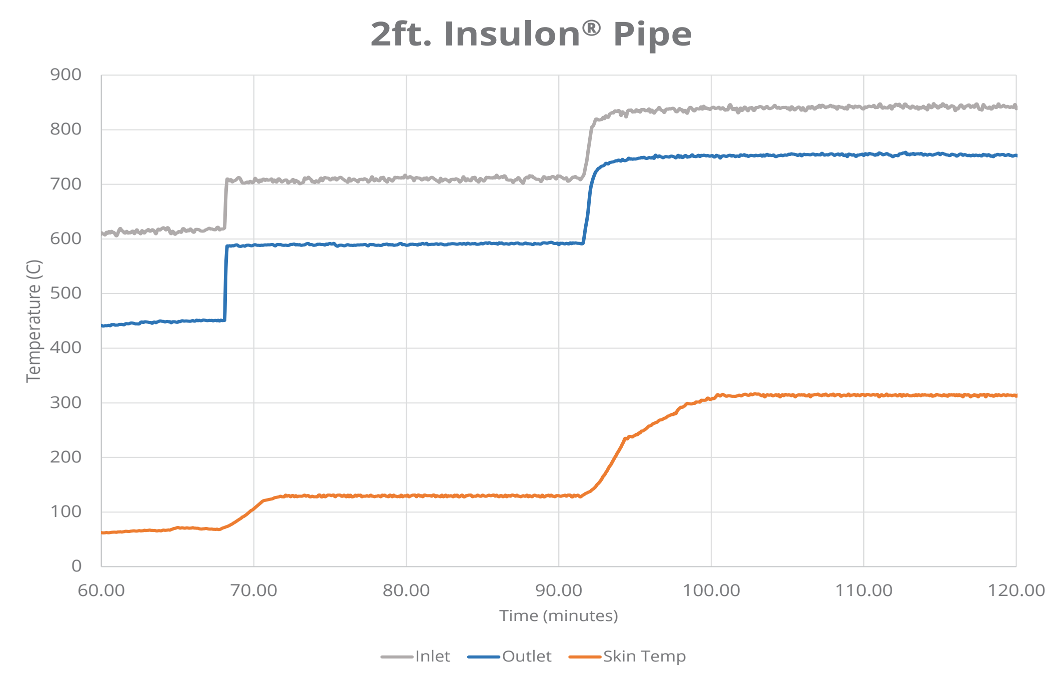

Figure 4: Insulon® case study showing temperature drop across two foot tube wrapped with Insulon and the skin temperature mid-length of the tube on the outer surface.