Which Is Greener: Idle, or Stop and Restart?

Comparing Fuel Use and Emissions for Short Passenger-Car Stops

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Overview

The argument against parking and going into a business, rather than using a drive-through window, has been that the emissions and fuel use associated with restarting your car are greater than those incurred by idling for that time. Argonne National Laboratory undertook a series of measurements to determine whether this was true, by comparing actual idling fuel use and emissions with those for restarting. This work seeks to answer the question: Considering both fuel use and emissions, how long can you idle in a queue before impacts from idling are greater than they are for restarting? Fuel use and carbon dioxide emissions are always greater for idling over 10 seconds; the crossover times are found to vary by pollutant.

Background

***Figure 1**. Americans love their drive-throughs, but are they more fuel-efficient and environmentally friendly than parking and going into the restaurant?*

The bulk of idling research to date has focused on the effects of heavy- and medium-duty diesel vehicle idling. Most research has ignored passenger car idling—even at schools—as a source of emissions and wasted fuel. While idling in traffic is necessary for safety, vehicles can be turned off while waiting for passengers or for freight trains to pass. Consumers can choose to park and enter a fast-food restaurant, rather than idle in a drive-through line *(Figure 1)*. If each car in the United States idles just 6 minutes per day, about 3 billion gallons of fuel are wasted annually, costing drivers $10 billion or more. And they haven't gotten anywhere!

The U.S. Department of Energy Clean Cities Program uses its national network of almost 100 local coalitions to reduce transportation dependence on petroleum through the use of alternative fuels and efficiency measures, including idling reduction. The program therefore funded Argonne to measure idling fuel use by and emissions from light-duty vehicles and to compare these to start-up emissions to enable data-based decision making.

Testing

***Figure 2.** Ford Fusion Test Vehicle*

Argonne National Laboratory used a 2011 Ford Fusion mid-sized sedan sedan with a 2.5-L, 4-cylinder engine (175 HP) and 6-speed automatic transmission *(Figure 2)*. Its EPA fuel-efficiency label shows 23 mpg city/33 mpg highway and 26 mpg combined. We equipped the vehicle to measure numerous engine parameters and temperatures, including catalyst inlet and brick temperatures and oil and coolant temperatures. We collected data in one of Argonne's test cells at the Advanced Powertrain Research Facility (APRF), using a SemtechD emissions analyzer for emissions and a direct fuel flow meter for fuel measurement. The vehicle was prepared and run by using approximate Federal Test Procedure (FTP) standard ambient temperature testing criteria. The emissions of interest in this study include total hydrocarbons (THC), nitrogen oxides (NO_x), carbon monoxide (CO), and carbon dioxide (CO_2) *(Tables 1 and 2)*.

Table 1. Idling Emissions and Fuel Use per Second

NO_x (mg)	THC (mg)	CO (mg)	CO_2 (g)	Fuel (cc)
0.0097	0.266	0.108	0.588	0.279

- Criteria pollutant emissions were low for idling following catalyst activation.

Table 2. Comparison of Emissions from Cold Start, Restart, and Idling

Emission	Tier 2-Bin 5[a]	Cold Start	Restart	Idle 30 sec	Cold Start ÷ Restart
THC (mg)	878	191	44	8.0	4.3
NO_x (mg)	552	228	6	0.3	38
CO (mg)	31,290	2,970	1,253	3.2	2.4

[a] Total over 7.45-mi UDDS cycle

- Emissions from restarting were larger, but at least an order of magnitude lower than those from starting a cold engine.
- The catalyst cooled down slowly, so that restarts after times equivalent to a short transaction at a bank or restaurant are unlikely to allow the temperature to drop below light-off and incur large cold-start emissions.

Testing [continued]

Testing at 21°C ambient conditions on a late-model mid-sized American car shows that idling for more than 10 seconds uses more fuel *(Figure 3)* and emits more CO_2 *(Table 1)* than engine restarting.

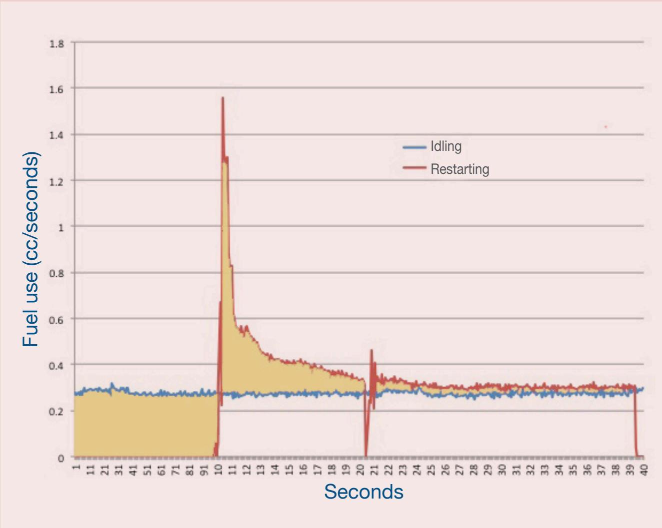

Figure 3. *The shaded area under the blue line (idling fuel rate) and the red line (restart) before the engine is restarted (at 10.1 s) represents the quantity of fuel that the engine would have burned if it were idling instead of being off, and the shaded area between the lines after the engine is restarted represents the excess on restart.*

Research Limitations

Data presented here are based on one vehicle at one temperature, with a small number of runs. Therefore, although several conclusions are suggested by this work, generalizations are unwarranted without additional work to confirm the extent to which the results apply, for the following reasons:

- Hot and cold ambient conditions are likely to affect results, as are the loads required to supply passenger comfort at those temperatures.
- Older vehicles and diesels are both likely to behave differently.
- More research is required to explain differences in THC emissions between the runs, as well as to make more generalizations regarding the emissions impacts of different restart/soak times. Additional research to fill in all these gaps would enable more conclusive statements concerning the differences in emissions between idling and restarts.

Acknowledgments

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For more information, please go to
www.transportation.anl.gov/engines/idling.html

Conclusions

- Idling for more than 10 seconds uses more fuel *(Figure 3)* and emits more CO_2 than engine restarting.
- Idling fuel usage varies from 0.2 to 0.5 gal/h for passenger vehicles across a range of sizes, and increased with idling speed.
- The vehicle warms up faster when driving than it does when idling.
- NO_x and THC emissions from restarting are larger, but at least an order of magnitude lower than those from starting a cold engine *(Table 2)*.
- For short stops, it makes sense to turn the vehicle off in order to minimize fuel use and CO_2 emissions. At least for the conditions evaluated in this work, the penalty in terms of criteria pollutant emissions is very small compared to cold-start emissions.

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