Contribution of Cold Starts to Real-World Total Trip Emissions for Light-Duty Gasoline Vehicles

H. Christopher Frey, Jiangchuan Hu, Behdad Y. Boroujeni, and Bin Liu.
Department of Civil, Construction and Environmental Engineering, North Carolina State University, Raleigh, North Carolina 27695

**Background**

- Hot stabilized tailpipe emissions are generally decreasing.
- Cold start emissions remain high comparing to hot-stabilized emissions. It typically takes several minutes for the catalyst to warm up before reaching its “light-off” temperature.
- Motor Vehicle Emission Simulator (MOVES) model from EPA estimates that cold starts contribute 60% to 80% of trip CO emissions and over 90% of trip HC emissions.

**Objectives**

- To quantify cold start emissions for CO, HC, and NOx for a variety of light-duty gasoline vehicles
- To quantify the contribution of cold start emissions to total trip emissions
- To evaluate MOVES predictions of cold start contributions to total trip emissions

**Methodology**

- **Cold Start Measurement**
  - Prior to cold start measurement, vehicle must have a soak time of 12 hours or more
  - After starting engine, idling for 15 minutes
- **Hot-Stabilized Measurement**
  - Vehicle driven on four standard routes in Raleigh/RTP area
  - Vehicle was idling for a short amount of time between each route
- **MOVES Model Estimation**
  - Cold start excess fuel use and emissions were estimated based on vehicle type, age, fuel, and ambient conditions
  - Hot-stabilized fuel use and emissions were estimated based on vehicle type, age, fuel, ambient conditions, and second-by-second speed profile in each route

**Results and Conclusions**

- MOVES provides higher estimates of cold start CO and NOx contributions compared to empirical estimates for 70% of the vehicles, and provides higher estimates of cold start HC contributions for over 90% of the vehicles.

**Acknowledgement**

This material is based upon work supported in part by the National Science Foundation under Grant No. CBET-0756263 and by the Southeastern Transportation Research, Innovation, Development, and Education (STRIDE) Center. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation or STRIDE.