# Key Messages from AMF Research

## Annex 44 January 2019

# Research on Unregulated Pollutant Emissions of Vehicles Fueled with Alcohol Alternative Fuels

**Finland** – The Technical Research Centre of Finland (VTT); Tampere University of Technology (TUT); Finnish Meteorological Institute (FMI)
**Canada** – Environment and Climate Change Canada and Natural Resources Canada (PERD) and Transport Canada (eTV)
**China** – China Automotive Technology & Research Center (CATARC)
**Sweden** — Ecotraffic on contract from the Swedish Transport Administration
**Israel** – Technion, JRC VELA lab, Ministry of Energy and Water Resources

### Major Conclusion

The use of alcohol fuels blended with gasoline in vehicles can reduce engine out emissions of HC and CO. With the increase of alcohol content in fuels, BTEX, olefins, PM and PN decrease proportionally and depending on the type of alcohol used formaldehyde or acetaldehyde emissions can increase. Emissions were highest during engine start-up but the three-way catalyst has a great ability to reduce the carbonyls, aromatic hydrocarbons and olefins, when it lights-off. The effect of test temperature was evident for most emissions. The regulated and unregulated emissions at low ambient temperature are significantly higher than those at standard ambient temperature. Emissions of CO2 and CO2e GHG may also be decreased with the use of oxygenated fuel.

### Background

Many countries support the use of alcohol alternative fuels. However, the use of these fuels in vehicles may results in increased emissions of unregulated pollutants; some of which might have very strong stimulation and sensitization which could significantly impact human health.Therefore, it is necessary to investigate the unregulated pollutant emissions from vehicles fueled with alcohol alternative fuels. Furthermore, the research examined the influences that measurement methods, automotive technology, alcohol content in the fuel, ambient temperature, and test cycles have on the vehicle unregulated pollutant emissions.

## Research Protocol

China served as Operating Agent of this Annex. The impact of ethanol blends from E10 to E100 and methanol blends from M15 to M30 on emissions from light-duty vehicles were investigated. Chassis dynamometer tests were conducted using various test cycles and driving patterns with ambient conditions down to -18°C. The test vehilces included both port fuel injection and gasoline direct injection technologies. The impact of fuels on evaporative emissions was also investigated.

Key findings from the project can be summarized as follows:

- Emissions of BTEX were significantly decreased with the use of alcohol blended fuels and this decrease was proportional to the amount of oxygenate in the fuel.
- The use of alcohol fuels decreased emissions of both particle mass and particle number
- CO2 and CO2eGHG emissions were either decreased or remained the same with the use of the alcohol fuels.
- Emissions such as formaldehyde, acetaldehyde, toluene, propylene and 1,3-butadiene have the highest peak during the first acceleration condition. Then as soon as the catalyst lights off, the emissions values gradually reduce to nearly zero and remain stable throughout the driving cycle.
- Using low-content alcohol fuels (M15 and E10) does not have statistically significant effects on carbonyl emissions. For unregulated emissions of middle-content (M30 and E20) alcohol fuels, unburned methanol or ethanol, formaldehyde, and acetaldehyde increase proportionally (not more than 2 times), and BTEX, propylene, 1,3-butadiene and isobutene decrease slightly compared to those emissions from gasoline vehicles. For high-content (E85) alcohol fuels, formaldehyde and acetaldehyde were 3 and 9 times higher respectively with the use of E85 compared to E0, and BTEX emission rates were approximately 70% to 84% lower with use of the E85 fuel compared to E0 at 22℃.
- Effect of test temperature was evident for most emissions. The regulated and unregulated emissions at low ambient temperature are significantly higher than those at ambient temperature. Acetaldehyde was roughly two orders of magnitude higher on E85 than on E0 at -18℃. Reductions in BTEX by approximately 50% were also observed at -7℃ and, to a lesser extent at -18℃, due to the use of the E85 fuel.
- The average unregulated emissions levels of GDI and PFI test vehicles are in the same order of magnitude. Although there are differences in the average emission levels from the same light-duty vehicle during different driving cycles, the largest variation is not more than 2 times.
- The difference of HC emissions in the entire process of the evaporative emission tests of E10, gasoline and M15 fuels is small. Although there is a difference of unregulated emissions in the diurnal test of three fuels, the difference is very small.
- In order to verify the accuracy and consistency of various measurement methods,instantaneous emisisons of CO, CO2, and NOX pollutants as well as cycle average emisisonf of CO, CO2,NOx, formaldehyde, acetaldehyde, benzene and toluene were compared.