Emissions of volatile and nonvolatile nanoparticles from HDDE running on different gas-diesel mixture fuels


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Experiments conducted under 25\% and 75\% load.

- The experiments were conducted on a 6-cylinder, 6 L, naturally aspirated, water-cooled, equipped with DPF, direct-injection HDDE of model year 1992 (Hino W06E).
- The HDDE test was under two loads, 25\% and 75\%, under steady cycle on a dynamometer.
- The test fuels included neat diesel (reference fuel), hydrogen-, methane- and natural-gas mixed with diesel.
- Aerosol sampling, dilution and thermal conditioning include:
  - a rotating disc thermo-diluter (Matter Engineering Model MD19-2E)
  - a thermal conditioner (ThC, Matter Engineering Model ThC-1).
  - The diluted exhaust samples were then measured at ~25 and 300\°C, with which the former is referred to as "volatile" and the latter as "nonvolatile" particles.
- Experimental system

Results and Discussion

Fig. 4 Size distributions of volatile (N\textsubscript{vol}) and nonvolatile (N\textsubscript{nvol}) particle number for HDDE running on different gas-diesel mixture fuels under 25\% and 75\% load.

Fig. 5 Emission factors of volatile (EF\textsubscript{vol}) and nonvolatile (EF\textsubscript{nvol}) particle number with and without DPF under 25\% and 75\% load.

Fig. 6 Size distributions of volatile (N\textsubscript{vol}) particle number with and without DPF under 75\% load.

Conclusions

- The use of gas-diesel mixture fuels resulted in increases of both volatile and nonvolatile particle number emissions, compared to that from pure diesel fuel, but have negligible effects on the size distribution. Such observations may be related to the replacement of O\textsubscript{2} by the fuel gas, decrease of A/F ratio, and hence more incomplete combustion or unburned fuel, indicated by the increase of HC emissions.
- The DPF is highly effective for the removal of nonvolatile nanoparticles, regardless of the engine load and gas-diesel fuel type, but not necessarily for volatile nanoparticles.
- The increase of HC emissions from the use of gas fuels (H\textsubscript{2} and CH\textsubscript{4}) may also increase the likeliness of new "volatile" particle formation downstream of the PDF.
- The increase of engine load (mostly in rpm) resulted in decreases of both volatile and nonvolatile particle number emissions, but slight increases of particle mode diameters. This may be attributable to the high particle number and thus stronger coagulation growth, under high load.
- The nanoparticles emitted under the tested conditions contained little volatile materials on the nanoparticles, except H\textsubscript{2}.
- The above results highlight that the benefits of gas-diesel mixture fuels for aerosol mass reductions are possibly accompanied by the increase of aerosol number emissions.

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