SUMMARY OF SWEDISH EXPERIENCES ON CNG AND"CLEAN" DIESEL BUSES

Peter Ahlvik

Ecotraffic ERD3 AB

ABSTRACT

In Sweden, emission tests were conducted on compressed natural gas (CNG) and diesel buses in the 1990's as part of several governmental programs in this area. A summary of the evaluation presented at DEER 2001 is provided. In addition, a comparison between the Swedish results and some of the more recent results from the U.S. studies is made.

The analysis of the Swedish results showed considerable improvement on the diesel buses by reformulating the diesel fuel and by fitting aftertreatment devices. Particulate filters (DPF's) can reduce particle emissions from diesel buses to a level similar to that of the CNG buses. The NO_X emissions can be reduced by some 50 percent by using retrofit exhaust gas recirculation (EGR) systems, but the level was still higher than for the best CNG buses.

CNG had a positive impact regarding several of the effects investigated, e.g., acidification and local NO_2 emissions. In other cases (e.g., ozone-forming potential), the difference between the best options was small. The cancer risk index is largely dependent on the unit risk factors, but the overall result in this case did not vary much between the sets of risk factors used. Clean diesel fuel with a particulate trap and CNG/biogas were the options with the lowest cancer risk index. The impact on the greenhouse gas emissions was the most significant advantage for the biofuels.

It is interesting to note that there are both similarities and differences between the engine technology used in Sweden and the United States. First, it should be noted that the U.S. buses are relatively new, i.e., Model Year 2002-2001, while the Swedish tests originate from the 1990's. A large proportion of the diesel buses in Sweden use oxidation catalysts, DPFs or EGR in combination with DPF. Practically all CNG buses in Sweden are equipped with oxidation catalysts, whereas until recently, relatively few have been using oxidation catalysts in the United States. However, it is suspected that the first generation of CNG catalysts has poor durability. Closed loop control was not used on the older Swedish CNG buses but was introduced in 2002.

The "best" test results on CNG in Sweden indicated surprisingly low NO_X emissions in comparison to most U.S. results. A more advanced combustion system on the (newer) U.S. diesel engines yielded lower HC emissions and, thus, also less harmful toxic VOCs, e.g., PAH emissions and formaldehyde. The results for twelve tri+ PAH species analyzed in all studies were compared, indicating a great reduction potential for fuel reformulation and catalytic DPFs. The PAH level for CNG without catalyst was significantly higher, but the impact of a catalyst still has to be assessed. An efficient oxidation catalyst is also essential to achieve low levels of formaldehyde for CNG buses. The results on 1,3-butadiene tended to be somewhat inconclusive.

A valid conclusion from all test results is that aftertreatment devices are crucial to achieve low emissions, regardless of fuel used. It is expected that future development on engines and aftertreatment devices will diminish the advantage of the alternative fuels regarding many of the effects on health and environment. On the contrary, the impact on greenhouse gases from some biofuel options will be more pronounced in the future.