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June 3, 2010

Ms. Aubrey Sideco
Air Resources Board
California Environmental Protection Agency
1101 "I" Street
Sacramento, CA 95814

Subject: Motor vehicle fuel specifications for compressed natural gas

Reference: May 19, 2010, ARB meeting and presentation, "Compressed Natural Gas (CNG) Motor Vehicle Fuel Specifications"

Dear Ms. Sideco:

This letter communicates my comments regarding motor vehicle fuel specifications for compressed natural gas (CNG). It responds to the background, process, and schedule presented by ARB at the May 19, 2010, meeting regarding CNG specifications.

Summary

ARB's process to develop CNG motor vehicle fuel specifications should give careful consideration to the minimum Methane Number specification. A relatively high minimum Methane Number will enable future light-, medium-, and heavy duty natural gas vehicles with spark-ignition engines to take full advantage of methane's exceptional anti-knock characteristics and provide higher fuel economy and lower greenhouse gas emissions.

Discussion

Per the referenced presentation, ARB is considering replacing the current CNG specification (13 CCR 2295.5), which is prescriptive, with a performance-based standard. Potential performance metrics are Methane Number (MN) and Wobbe Index (WI). In my judgment, MN is much more important than WI for modern natural gas (NG) engines with electronic controls.

MN is of course a measure of a fuel's knock resistance, and, as such, it is analogous to Octane Number. While there is no rigorous correlation between MN and Octane Number, the fact that methane (MN = 100) is extremely knock resistant is well established. It is also well established that highly knock-resistant fuels enable higher compression ratios (and/or other performance-improving features such as higher boost pressure or more spark lead), which increase engine thermal efficiency.

Nearly all current light- and medium-duty natural gas vehicles (NGVs), and most heavy-duty NGVs, have spark-ignition (i.e., Otto cycle) engines. ARB is well aware of the exceptional emissions performance of NGVs with respect to both criteria pollutants and greenhouse gases (GHGs). Recent success in the application of three-way catalysts to heavy-duty spark-ignition NG engines is especially promising, although the thermal efficiency of these engines is slightly less than that of diesel counterparts.

All current natural gas engines are in fact modifications of gasoline or diesel engines. If the use of NGVs continues to grow as many stakeholders anticipate, at some point manufacturers will design engines specifically for natural gas. The ARB CNG specification will of course influence the design of these future NG engines. If this specification includes a low minimum MN (e.g., MN < 80), NG engines will be designed to operate reliably at this minimum MN (e.g., reduced compression ratio), and they will have higher fuel consumption and GHG emissions than if they were optimized for higher MN.

With respect to GHG emissions, there is actually a double effect of MN because both the thermal efficiency and fuel C/H ratio are affected. While these potential effects of MN on GHG emissions are quite small, the well-to-wheels GHG advantage of NGVs over counterpart gasoline and diesel vehicles is also small for many fuel pathways.

Considerable attention has been given to the fact that some heavy-duty NG engines can operate reliably with MN as low as 75 or even 65 for some engines. Of course, by analogy, gasoline vehicle engines can and have been designed to operate reliably with (R+M)/2 = 70 gasoline (where R and M denote the Research and Motor Octane Numbers, respectively). But use of engines designed for this gasoline would result in increased fuel consumption and GHG emissions compared to current vehicles fueled with (R+M)/2 = 87 - 91 gasoline.

Unfortunately, past and current test programs directed at assessing NG composition effects on light-, medium-, and heavy-duty NGV performance and emissions provide no useful information regarding the effect of MN on the fuel consumption and emissions of engines optimized for each NG fuel MN.

ARB's process to revise the motor vehicle fuel CNG specification should give full consideration to the near-term benefits of maximizing the portion of California-produced associated gas (and perhaps imported LNG) that can be supplied to natural gas distribution systems. But it should also consider the long-term benefits of CNG specifications that enable engines to be designed to take maximum advantage of NG's properties that can minimize fossil fuel consumption and GHG emissions. Any strategy to step up the CNG MN requirement if and when this is needed in the future should recognize the time and effort associated the current 13 CCR 2295.5 review.

Sincerely,

Charles Powars
Principal