Automotive LPG and Natural Gas Engines

HIGHLIGHTS

- **PROCESS AND TECHNOLOGY STATUS –** Internal combustion engines running on liquid petroleum gas (LPG) are well-proven technologies and work much like gasoline-powered spark-ignition engines. Natural gas (NG) engines are also well-proven. They are typically used as spark-ignition engines for bi-fuelled (gasoline/CH4) cars, but have also been used, for example, in compression-ignition (i.e. diesel-type) engines for heavy-duty vehicles. Both LPG and NG are not used alone, but always in bi-fuel vehicles, in combination with gasoline. In bi-fuel vehicles two fuels are stored in separate tanks and the engine runs on one fuel at a time. Bi-fuel vehicles have the capability to switch back and forth from gasoline to the other fuel, manually or automatically. In the past, most bi-fuel vehicles were derived from native gasoline vehicles by adding a tank and an electronic injection regulation system for the alternative fuel. In recent years, the offer of 'native' bi-fuel vehicles has increased; they have two separate tanks and two alternative injection regulation programs.

- **PERFORMANCE AND COSTS –** Bi-fuel LPG cars can reduce greenhouse gas (GHG) emissions by 15% as compared to petrol operation. NG cars can achieve GHG reductions of up to 25%. The energy efficiency of engines running on natural gas is generally equal to that of gasoline engines, but is lower if compared with modern diesel engines. The conversion costs for LPG vehicles range from €1130 to €2740 (10-15% incremental cost). The conversion costs for light-duty NG vehicles are currently between €1640 and €2190 (10-15% incremental cost). When running on LPG or NG, CO2 emissions are at least 10% or 20% lower, respectively, if compared to gasoline. Actual emissions depend on the share of mileage run on petrol.

- **POTENTIAL AND BARRIERS –** In 2008, more than 7 million Natural Gas Vehicles (NGVs) were on the roads, most notably in Argentina, Brazil, Pakistan, Italy, India, China, and Iran, with South America leading the global market with a 48% share. The number of LPG/NG kits sold globally is estimated to reach 8.0 million by 2012. An appropriate infrastructure, along with governmental support, may accelerate the growth of LPG and NG as global alternative fuels. Bottlenecks that may slow down the development and deployment of LPG and NG technologies are the lack of appropriate infrastructure for fuel distribution and refuelling, the higher vehicle cost, and the competition from other fuel options (e.g. biofuels).

TECHNOLOGY STATUS AND PERFORMANCE – Internal combustion engines running on liquid petroleum gas (LPG) and natural gas are well-proven technologies and work much like gasoline-powered spark-ignition engines [18]. They are normally used as spark-ignition engines for bi-fuelled (gasoline/CH4) cars, but have also been used, for example, in compression-ignition (i.e. diesel-type) engines for heavy-duty vehicles. Both LPG and NG is not used alone, but always in bi-fuel vehicles, in combination with gasoline. In bi-fuel vehicles two fuels are stored in separate tanks and the engine runs on one fuel at a time[1]. Bi-fuel vehicles have the capability to switch back and forth from gasoline to the other fuel, manually or automatically. In the past most bi-fuel vehicles were derived from native gasoline vehicles by adding a tank and an electronic injection regulation system for the alternative fuel. In recent years the availability of 'native' bi-fuel vehicles has increased; they have two separate tanks and two alternative injection regulation programs.

- **LPG Vehicles** work much like gasoline-powered vehicles with spark-ignited engines. LPG is stored as a liquid in a separate steel or composite vessel at the pressure of 10 bar, although it can stand a pressure of 20-30 bar. LPG supply to the engine is controlled by a regulator or vaporizer, which converts the LPG to a vapour. The vapour is fed to a mixer located near the intake manifold, where it is metered and mixed with filtered air before being drawn into the combustion chamber where it is burned to produce power, just like gasoline. LPG injection engines, developed over the past 15 years, do not vaporize the LPG. Instead, the LPG is injected into the combustion chamber in liquid form. These systems have proven to be reliable in terms of power, engine durability, and cold starting.

In the 1970s Toyota made a number of LPG-only engines for cars. Today, most LPG vehicles are conversions from petrol vehicles. Many car makers offer conversion/bi-mode vehicles. LPG technology is rather popular in the European Union, Australia, Hong Kong, India, South Korea, Serbia, the Philippines, Turkey and Armenia. The world leader is probably Armenia where about 20-30% of vehicles run on LPG which offers a cheap alternative to diesel and petrol. LPG engines and fuelling systems are also available for medium- and heavy-duty vehicles such as school buses and street sweepers. For example, the school districts in Dallas, Denton, Texas, Portland and Oregon rely on LPG-fuelled school buses. [4].

[1] unlike flexible-fuel vehicles ("dual-fuel"), that store the two different fuels mixed together in the same tank, and the resulting blend is burned in the unique combustion chamber.

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