Evaporative Emission Control Technologies for Gasoline Powered Vehicles

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Executive Summary

Evaporative emission control technology was the first to be used on passenger vehicles as a way to control smog forming hydrocarbons in the early 1960's. Evaporative emissions from motor vehicles constitute about half of the reactive organic gas (ROG) inventory in California [1] and nearly 40% in the Northeastern United States. Ozone is considered to be a respiratory irritant harmful to humans and plants and is regulated by the U.S. EPA which sets a National Ambient Air Quality Standard (NAAQS) for ozone concentration. Areas that are out of attainment or experience concentrations above this ozone concentration, like California, regulate evaporative emissions to reduce ground-level ozone. In addition to the negative health effects of ground level ozone, it is also a greenhouse gas.

Evaporative emissions are broken down into five primary sources; diurnal, running loss, hot soak, permeation and refueling. The magnitude of the relative components depends greatly on the engine design, fuel delivery and application. A brief description of the major types of evaporative emissions is given below.

Diurnal emissions result from the evaporation of gasoline due to temperature fluctuation during the day and night.

Running loss emissions represent gasoline that is vaporized from the engine and fuel system while in operation.

Hot Soak emissions occur during the first hour that the vehicle is parked after normal operation.

Permeation occurs continuously once the polymer components of the fuel system become saturated with fuel.

Refueling emissions occur as gasoline is pumped into the tank displacing the gasoline rich vapor.

The function of the automobile evaporative emission control system is to block or capture the above sources of vaporized hydrocarbons and prevent their release into the atmosphere. There are varying levels of complexity and efficacy of these controls with the most advanced systems equipped on partial zero emission vehicles being certified to California's PZEV standard under the state's LEV II emission standards.

Companies that manufacture evaporative emission controls have responded to the challenge of reducing VOC emissions from gasoline powered vehicles. Through their efforts, a wide range of cost-effective technologies have been developed to block HC emissions via the above mechanisms. Manufacturers of Emission Controls Association (MECA) member companies, together with engine manufacturers, have worked together to meet California's PZEV requirements on over 50 light-duty vehicles and employed evaporative canisters on motorcycles and marine engines.

Interest in evaporative emissions control has grown considerably in recent years around the world. MECA is engaged with California on their LEV III regulation that proposes to extend the most advanced evaporative controls across the entire on-road, light and medium-duty vehicle fleet. This document has been prepared to supplement information already made available by MECA on emission control technologies and provides an overview of the types of technologies being developed for new gasoline fueled cars and trucks.

Today's cleanest gasoline vehicles, certified to California's PZEV emission limits require near zero evaporative emissions and include additional technologies such as canister scrubbers to virtually eliminate bleed emissions from the carbon canisters during periods of low purge. Some vehicles also incorporate carbon based air-intake HC traps to prevent engine breathing losses from escaping through the intake manifold and air induction system (AIS) after the engine is shut off.

Today, viable emission control technologies exist to reduce fuel system based HC evaporative emissions from all types of spark-ignited engines including small handheld equipment up to large spark-ignited (LSI) vehicles. Applications include marine and recreational off-road vehicles. The major technologies that control permeation emissions include:

- Fuel tanks made of low permeation polymers
- Multilayer co-extruded hoses
- Low permeation seals and gaskets

Technologies designed to control diurnal, hot soak and refueling HC emissions include:

- Advanced carbon canisters
- High working capacity activated carbon
- Honeycomb carbons scrubbers
- Air induction system (AIS) HC traps

The most stringent evaporative emission control regulations are enforced in the United States. Vehicles certified to California's PZEV low emission vehicle standards must demonstrate near zero evaporative emissions from the fuel system at 0.054 g/test using a rig test of a vehicle's fuel system. The California Air Resources Board (CARB) is proposing to extend these requirements across the entire light-duty and medium-duty passenger vehicle fleet (<14,000 lbs GVWR) by 2022 as part of their LEV III regulations.

Demands on vehicle manufacturers to achieve higher fuel efficiency through the use of smaller displacement, boosted engines and hybrid electric powertrains will create challenging operating conditions for evaporative emission control technologies. The lower purge volumes that result from smaller displacement engines or hybrid systems under partial or full electric drive will require the development of specialty carbon adsorbents and advanced canister designs to achieve the lowest evaporative emissions demanded by future regulations. Gasoline vehicles in other parts of the world and SI off-road equipment everywhere can benefit from much of the same technologies applied to passenger vehicles in the U.S. This paper will describe the types of technologies that are being used to meet the current and future evaporative emission regulations.

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