Air Pollution:

Control of Mobile Sources

Dr. Motasem Saidan

m.saidan@gmail.com

Introduction

- In the United States, mobile sources, which include automobiles, motorcycles, trucks, buses and off-road vehicles, are currently estimated to be responsible for about half of all emissions released into the air.

- Approximately 9,000 tons of carbon monoxide is deposited into the air each day in Los Angeles County.

- Transportation has become an indispensable part of our lifestyle. For this reason, sweeping controls on mobile sources of air pollution must be balanced against preserving a quality of life that depends so heavily on the use of transportation.

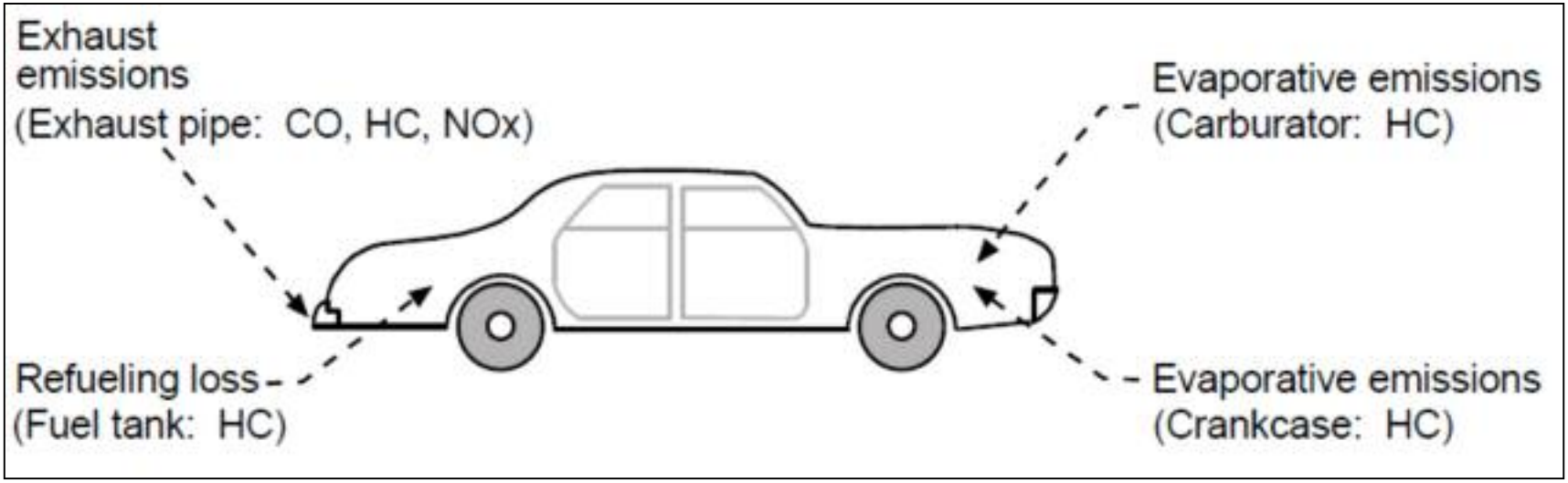
- Motor vehicles are by far the greatest mobile source of air pollution.

- These main areas of emissions are classified as evaporative, exhaust, and refueling losses. Evaporation of gasoline is a source of volatile organic compounds (VOC's) comparable in magnitude to the exhaust VOC's emissions.

Automobiles and Emissions

The four categories of evaporative volatile organic compounds emissions from motor vehicle fuel systems are:

(1) diurnal emissions,
(2) running losses,
(3) hot soak,
(4) refueling



- **Diurnal emissions** occur due to evaporation of gasoline, which increases as the temperature rises during the day, heating the fuel tank and venting its vapor.

- **Running losses** occur as the gasoline vapors are vented from the fuel tank while the automobile is operating and the fuel in the tank becomes hot.

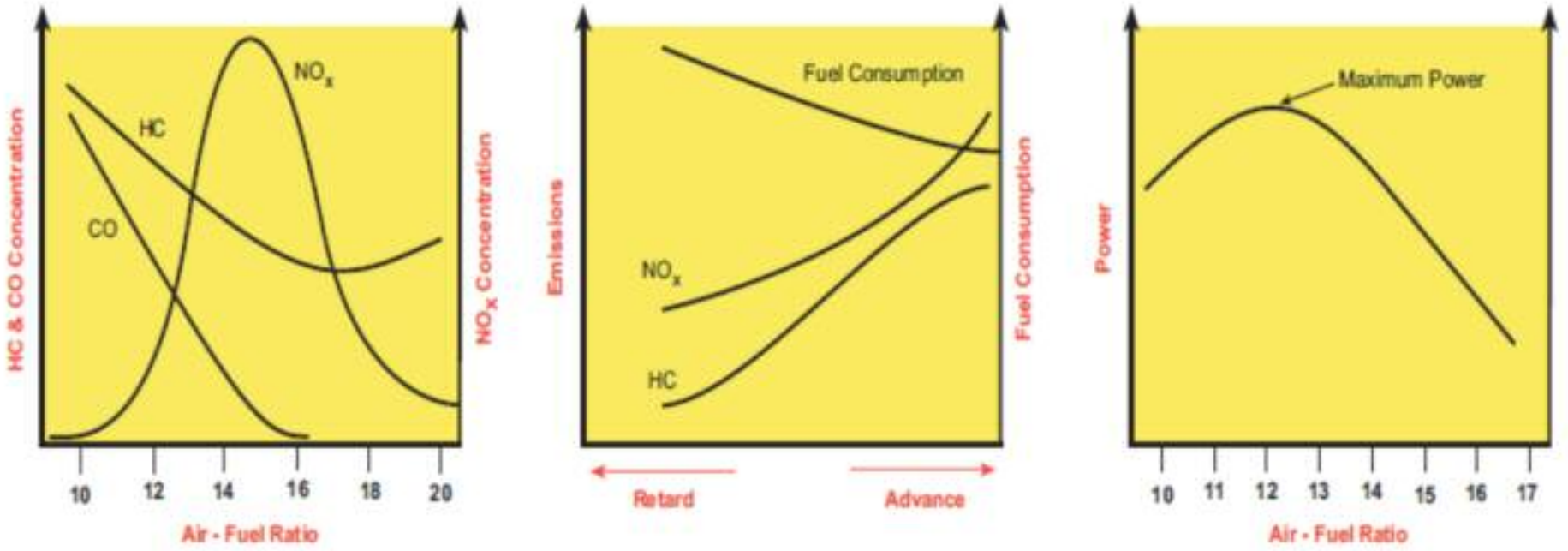
- **Hot soak** emissions are released when the engine is turned off after operation and remains hot for a period of time after, which the gasoline continuing to evaporate until the engine reaches ambient temperatures.

- **Exhaust pipe emissions** are the most significant source of automobile pollution. Exhaust accounts for approximately 90% of the pollutant emitted by an automobile.

- **Refueling losses** of gasoline occur each time that a vehicle is refueled. The amount of gasoline vapors in the automobile fuel tank increases as the quantity of liquid gasoline in the fuel tank decreases

- Pollutants in the exhaust gas consists mainly of unburned hydrocarbons, carbon monoxide, nitrogen oxides, particulates, and hazardous compounds (i.e. benzene, acetaldehyde, formaldehyde and 1,3-butadiene). Nitric oxides and carbon monoxide are formed during the combustion process and leave the engine with other combustion products (i.e. carbon dioxide and water vapor).
- The formation of nitric oxide (NO) occurs due the high temperature and pressure break down of oxygen and nitrogen atoms with the engine combustion from the induced air. These atoms recombine to form NO, NO2 and N2O. together they are referred to as NOx.
- Spark Ignition (SI) engines are typically high in NO and are estimated to be over 95%, although under some conditions N2O may constitute over 10% of the total NOX emissions.
- Carbon monoxide (CO) formation results from the incomplete oxidation of carbon in the fuel to carbon dioxide. Carbon monoxide production from the engine combustion reaction increases sharply with decreasing air to fuel ratios.
- CO emissions in newer spark-ignition engines can be adequately controlled by maintaining combustion at close to stoichiometric and with the use of a catalyst control system.

Exhaust Emissions Related to Automobile Engine Operating Parameters

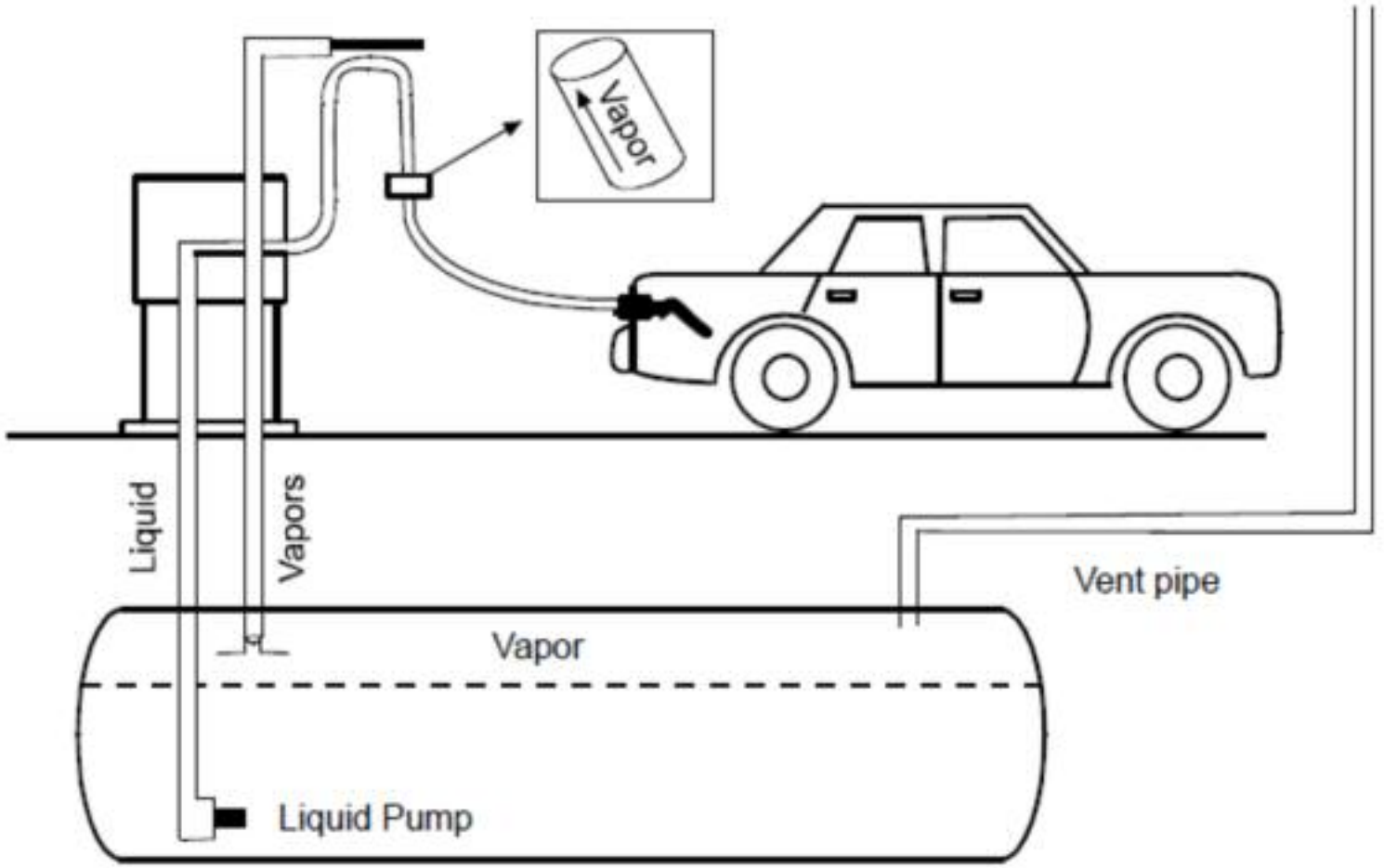


- Starting a car cold increases trip emissions compared to starting the car warm.

- For a 7.5 mile trip by a typical car in 2000, the vehicle emits about 8.7 grams of NOx and 95.1 grams of CO if the engine is already warm. If, however, the engine is cold, an additional 1.4 grams of NOx and 37.8 grams of CO are generated.

  As a result, for a 7.5 mile trip, starting the car cold generates about 16 percent more Nox and 40 percent more CO than starting the car when it is warm.

Stage II Gasoline Vapor Recovery System



Control of Exhaust Emissions of unburned HC & CO

- Fuel modification: volatility, HC types, additive contents
- Minimization of pollutants from combustion chambers: This approach consists of designing the engine with improved fuel-air distribution systems, ignition timing, fuel-air ratios, ..etc.
- Further oxidation of pollutants outside combustion chamber: This oxidation may be either by normal combustion or by catalytic oxidation.