

## 7.12 Hydrocarbon Species Control Measures

### 7.12.1 Introduction

In Japan health damage problems of photochemical smog began from 1970, and countermeasures were implemented to reduce the emission of the causative substances, nitrogen oxides and hydrocarbon species. In addition in recent years countermeasures not only to photochemical smog, but also the hydrocarbon species like benzene, hydrocarbon included chlorine and so on which cause health damage by themselves have become a problem and those countermeasures to these substances have covered a very broad spectrum.

### 7.12.2 Hydrocarbon Species Emission Sources

This section discusses the stationary sources among hydrocarbon species emission sources relating to air pollution are reported. Major emission sources of hydrocarbon species in Japan are combustion facilities such as boilers, the petroleum-related industry including gasoline refueling, chemical industry, printing industry, motor vehicle industry, construction industry and dry cleaning industry. Hydrocarbon species substances exist in the atmosphere as vapor or mist. They are mainly fuel types and various solvents. The hydrocarbon species which are designated as hazardous substances and also widely used substances in Japan are methanol, acetone, methyl ethylketone, benzene, toluene and xylene and hydrocarbon included chlorine, trichloroethylene and tetrachloroethylene and so on. In addition, chlorofluorocarbon, which is a causative substance in depletion of ozone layer, and dioxin which was used as a defoliant in the Vietnam War, are both also hydrocarbon species.

### 7.12.3 Countermeasures to Hydrocarbon Species in Combustion Emission Gas

Due to the wide use of light type heavy oil in Japan, hydrocarbon species in emissions gases produced by combustion facilities like boilers are normally under 10 ppm. Decreasing hydrocarbon species in combustion emission gas depends mainly on the improvement of the fuel and combustion conditions. If a lighter fuel is used, hydrocarbon species generally decrease. It is effective due to improve combustion conditions to adjust mixed air volume. Generally the best air fuel ratio for heavy oil is 1.3 but as shown Fig.7.12.1 if the air fuel ratio is decreased, the concentration of hydrocarbon species in the emission gas increases <sup>1)</sup>. On the other hand, if the air fuel ratio is increased considerably, non-burned hydrocarbon occurs and the concentration of hydrocarbon species increases <sup>2)</sup>.

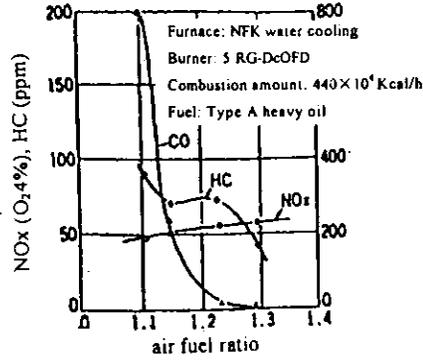


Fig.7.12.1 Relationship between NOx, CO, HC and air fuel ratio

#### 7.12.4 Gasoline Vapor Control Measures

In Japan, gasoline vapor emission during the refueling of gasoline stations by tanker lorries is one of the major causative substances of photochemical smog<sup>3)</sup>. This emission value of gasoline vapor rises according to increased air temperature, and as shown in Fig. 7.12.2<sup>4)</sup>. Therefore, if air temperature rises one degree, the volume of gasoline vapor emission increases by 10%. The main gasoline vapor countermeasure is use of the vapor return method. The equipment is shown in Fig. 7.12.3. This method is for sealing off the piping system and refueling and refluxing vapor to tank trucks during fueling. Because the equipment is relatively cheap, use of this method is mandated in major Japanese cities<sup>3) 5)</sup>.

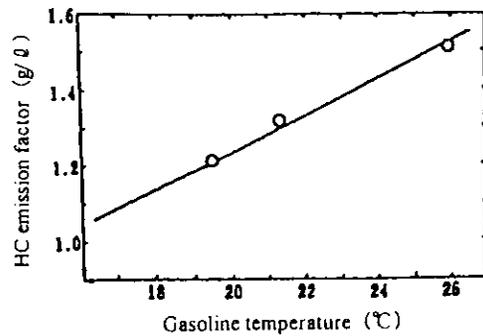


Fig.7.12.2 The temperature of gasoline and the volume of emission of hydrocarbon species during gasoline refueling.

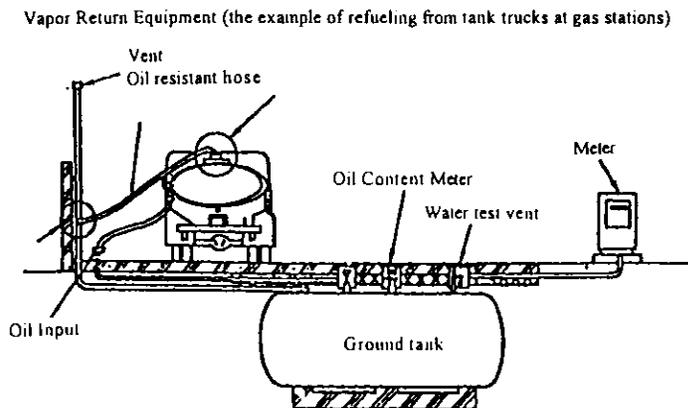


Fig.7.12.3 Vapor Return Equipment

### 7.12.5 Hydrocarbon Species Treatment Apparatus

Treatment methods of hydrocarbon species are broadly divided into the condensation method, absorber method, adsorption method, direct combustion method, and catalyser oxidation method. The adsorption method is already reported in 7.10.

#### (1) Condensation Method

This is a method of recovering vaporized hydrocarbon species by cooling and condensing at a temperature below its boiling point. So it is suitable for cases when there is a high concentration of hydrocarbon species and a small gas volume. In many cases it is rare to use this method only by itself; it is usually used as a pretreatment before using absorber or adsorption equipment. It is used for substances of low boiling points like gasoline and toluene.

#### (2) Absorption Method

This is a method using absorber which has a high solubility for hydrocarbon species gas for contact absorption. Kerosene, light oil, acetone and alcohol are generally used as absorbers. It is used when refueling to tanker lorries from main tanks in oil refineries, but in many cases gas solubility toward absorbers is influenced by temperature, so in Japan the removal ratio may be varied according to the season. When the gas has reactivity against acid or alkalinity, caustic soda or potassium permanganate solution are used in the absorber.

#### (3) Direct Burning Method

With this method, if the combustion efficiency is high then there is a more than 95% removal ratio regardless of the concentration of hydrocarbon species, and it can be used with all the hydrocarbon species except those which emit toxic gases ( $\text{Cl}_2$  etc.), such as hydrocarbon included chlorine. But because supplementary fuel is necessary, this method is often used as removing countermeasures for dust emitted from incinerator or with afterburner for vapor plume removal after the scrubber.

#### (4) Catalyser Oxidation Method

This is a method for the complete combustion of hydrocarbon species gas under combustion conditions of 250~350°C and between 0.1~0.3 seconds with catalysts such as platinum or nickel. The fuel cost with this method is 30~40% lower compared to the direct combustion method. But caution is required when using this method, as the catalyst may be contaminated by some types of emission gases and the catalyst has selectivity towards gases. Also, it is necessary to raise the temperature of low temperature gases. The relationship between gas temperature and oxidation ratio is shown in Fig.7.12.4<sup>6)</sup>.

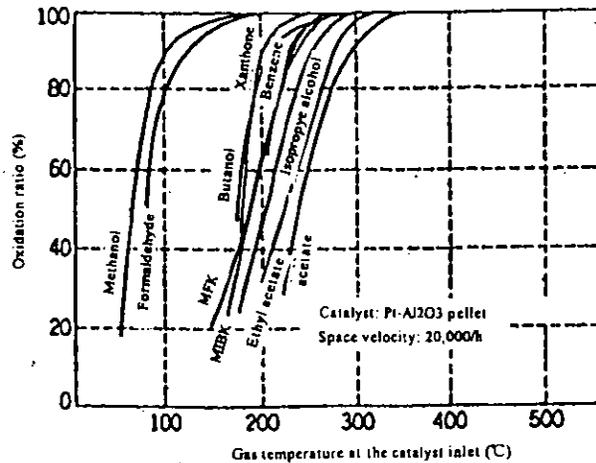


Fig.7.12.4 An Example of gas temperature and oxidation ratio in catalytic combustion method

### 7.12.6 Countermeasures of hydrocarbon included chlorine

Trichloroethylene and tetrachloroethylene, which are extensively used in the electronic and dry-cleaning industries, have become a problem in Japan. It is necessary to suppress as much as possible the emission of these two substances from rooms and tanks before emission gas treatment, and to control the loss of solvents for example, by having a large vapor cavity ratio in the vapor cleaning tank.

### 7.12.7 Chlorofluorocarbon

In chlorofluorocarbon recovery, the activated carbon adsorption method is common. With other methods, treatment of the emitted halogen group is necessary. It is also important for vehicle air conditioning units and refrigeration units which include chlorofluorocarbon not to be dismantled outdoors.

In Japan, the major dioxin emission source is thought to be waste incinerators. It has been reported that the ingestion quantity of dioxin in the atmosphere around municipal waste incinerators is 0.9~1.2 pg/kg/day<sup>7)</sup>. As a countermeasure to this, low temperature dust collection, which does not include corona discharge, is efficient. There has been a gradual conversion of municipal waste incinerators from high temperature dust collection with electrostatic precipitators to low temperature dust collection using bag-filters.