Study on the Promotion of a VOC (Volatile Organic Compound) Recovery Unit for Service Stations (SS)

1. Overview

At gasoline service stations, liquid gasoline inevitably vaporizes and dissipates into the air when filling cars and when offloading gasoline from lorries to the underground storage tank of the service station. When you fill your car by yourself, you have probably noticed a swaying haze rise up from the filler cap as you fill the fuel tank. This is gasoline vapor.

Gasoline and other such volatile chemical substances such as toluene, xylene, ethyl acetate and various organic chemical compounds that transform into a gaseous state when exposed to the atmosphere are collectively called volatile organic compounds (VOC), and are considered health- and environment-damaging pollutants. VOC, in particular, are known to cause air pollution by producing irritating photochemical oxidants in the presence of nitrogen oxide (NOx) and sunlight. Furthermore, VOC are also a source of concern as a secondary cause of suspended particulate matter (SPM) and PM2.5 (SPM with particulates that are smaller than 2.5μm), which has become a controversial subject in recent years.

International initiatives are being taken to reduce VOC emissions, including in the EU, where a requirement has been imposed on large service stations to install VOC recovery units by 2018. In Japan, voluntary VOC reduction initiatives have conventionally been implemented. Meanwhile, the revised Air Pollution Act has stipulated an even stricter emission regulation in 2006, and Tokyo and some other local governments have made VOC reduction compulsory by local ordinance.

Fueling island at SS949
(photo provided by JX Nippon Oil & Energy Corporation)

Gasoline vapor is not only a source of odor and air pollution, but could also become a source of fire if ignited, not to mention a loss of gasoline itself to the service station owner.

The project thus aimed to explore the possibility of introducing to the Middle East and Southeast Asia a recovery unit (VRU) that liquefies and recovers gasoline vapor at service stations.

The project was begun in fiscal 2011, and is being implemented under the leadership of JX Nippon Oil & Energy Corporation. In fiscal 2013, a demonstration unit was operated at a service station in Abu Dhabi to acquire data, and an attempt was made to optimize the VOC recovery unit. At the same time, the possibility of implementing the project in Middle East oil-producing countries other than UAE and in Southeast Asia was also surveyed and examined.

In general, two stages of VOC recovery at service stations are commonly employed. Stage 1 is recovery during the offloading of gasoline at the service station (recovery of gasoline vapor emitted from the underground storage tank of the service station when offloading gasoline from the lorry to the underground tank), and Stage 2 is recovery when pumping gasoline into cars (recovery of gasoline vapor emitted from car fuel tanks when filling the tank with gasoline at the service station). Stage 1 VOC recovery is further divided into two methods. One method is to have the delivery lorry recover the gasoline vapor from the underground storage tank (the lorry transports the gasoline vapor back to the oil terminal and changes it back into liquid form), and the other is to install a recovery unit in the service station and return the gasoline vapor back into the underground storage tank in liquid form. This project adopted the method of installing a recovery unit that uses silica gel as an adsorbent in a service station, to return gasoline vapor back into the underground storage tank of the service station in liquid form.

The VRU that was transferred to SS949
(photo provided by JX Nippon Oil & Energy Corporation)

Joint inspection prior to commencing demonstration operation
(photo provided by JX Nippon Oil & Energy Corporation)

2. Test Operation in Abu Dhabi

In fiscal 2012, a VOC recovery unit was initially installed in SS970 and data were acquired, but ADNOC Distribution (the affiliate dedicated to distribution/marketing by the state-run oil company ADNOC in Abu Dhabi), the counterpart in the project, instructed the demonstration unit to be moved to a different service station (SS949) for safety reasons, in 2013. Thus, the existing VOC recovery unit was moved from SS970 to SS949 in fiscal 2013, as instructed.

3. Evaluation of the Test Operation Result

(1) Evaluation from the environmental perspective

Currently, UAE has no environmental regulations and standards concerning VOC emission. Therefore, comparisons were made against Japanese standards. In Japan, VOC emission from service stations is regulated by local ordinance of large cities such as Tokyo. Japan's Air Pollution Prevention Act also regulates VOC emission from refineries and tanks in oil terminals, but does not provide for VOC emission from service stations.

(2) VOC emission standards for service stations regulated by local ordinance (Tokyo, etc.)

Although recovery rate did not reach 98%, the figure originally targeted, the requirement of installing a VOC recovery unit with an 80% or higher recovery rate in service stations has been satisfied.

(3) Evaluation of economic viability

During the three-month demonstration period, 9,247 kg of hydrocarbons were recovered using the VOC recovery unit. When assuming a gasoline vapor density of 700 kg/kl, the amount of gasoline recovered equals 13.21 kL, worth a total of 21,136 AED (gasoline unit cost calculated at 1.6 AED/L).

4. Introduction to Countries Other than Abu Dhabi

Through surveys conducted in the project, it was found that service stations operated by Kuwait Petroleum Company (KPC) have already begun Stage 1 VOC recovery at oil terminals from several years ago, like in UAE, and the installation of facilities for Stage 2 VOC recovery (recovery of gasoline vapor that is emitted when gasoline is pumped into cars at service stations) has also been completed.

In Qatar and Bahrain, commercial vapor recovery was considered not to be economically viable, as there are few service stations in these countries (70 in Qatar, 16 in Bahrain).

The surveys thus revealed that VOC recovery initiatives are already being pursued in Middle East countries where gasoline recovery is judged to be economically viable, while in Asia, needs for VOC recovery are expected to grow hereafter in South Korea and China, as VOC emission regulations have just recently been established, and potential markets are also expected to emerge in Indonesia and other countries where no emission regulations yet exist.

While the project came to a close in fiscal 2013, a plan is underway to implement a VRU introduction project in Indonesia with the incorporation of new ideas.

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