

(M: Next generation of gas distribution)

## **HIGH EFFICIENCY GAS DISTRIBUTION SYSTEM - Investigation for vertical buried pipe type gas holder -**

Mitsunori Komori, Kyosuke Wakasa, Tomoaki Takeuchi, Yoshiyuki Shimoda, Toshiyuki Mori,  
Takeshi Sakurai, Kaori Numata, Mitsuhiro Kohara, Takeo Kawamura, Ken Shoda  
Toyonari Ishimori, Aki Koyanagi, Gen Fujii

### **INTRODUCTION**

In order to cope with rapid increase of natural gas demand, gas distribution companies have to consider increase of efficiency for gas distribution network. Gas storage system is needed for peaks shaving in gas distribution systems to increase its efficiency. In gas pipeline network, gas storage systems are used to store city gas during low consumption time and discharged the stored gas in the peak time. This will increase the efficiency of gas distribution systems.

In general gas storage system is placed on the land, and this method is well known and well established. However, in a populated area such as Tokyo, where land space is limited and human safety becomes crucial issue, burying gas storage system in the land is one most preferred method. To satisfy the requirement, vertical buried pipe type gas holder is proposed instead of sphere type due to its simplicity in burial technique. Drill the land, put the pipe type gas holder in, and bury it.

The Japan Gas Association has investigated the high efficiency gas distribution system that is vertical buried pipe type gas holder, in order to resolve safety issue for quite new type gas holder in urban populated area. As a result of aseismatic analysis, vertical buried pipe type holder has enough earthquake resistance. The charge-discharge characteristics of vertical pipe type holder that has high aspect ratio have been studied by experiments compared with simulated results.

### **OUTLINE OF THE SYSTEM**

Fig 1 shows schematic image of high efficiency gas distribution system. In order to install in populated urban area, this system needs high safety level and compact size, so that the gas holder has to be longitudinal direction underground pipe type with high pressure. The vertical buried pipe type gas holder has high earthquake durability by aseismatic analysis, so this shape contributes to high safety level. The high pressure storage with compressor and regulator contributes to compact size, and two 600mm dia. 30m pipe with 7MPa are able to store 1,000Nm<sup>3</sup> natural gas.

Installation target of this new system is low and medium pressure gas pipeline network, for mainly below 0.3MPa line to cope with daily peak shaving. Even a small amount of gas storage volume is possible to supply natural gas efficiently and stably, by dispersed installation of compact size pipe type holder. Fig 2 shows dispersed installation image of high efficiency gas distribution system.

There are two main problems have to be solved to assure safety level. One is to establish earthquake-resistance design method, the other is to clarify charge-discharge characteristic of high aspect ratio vertical pipe type holder.

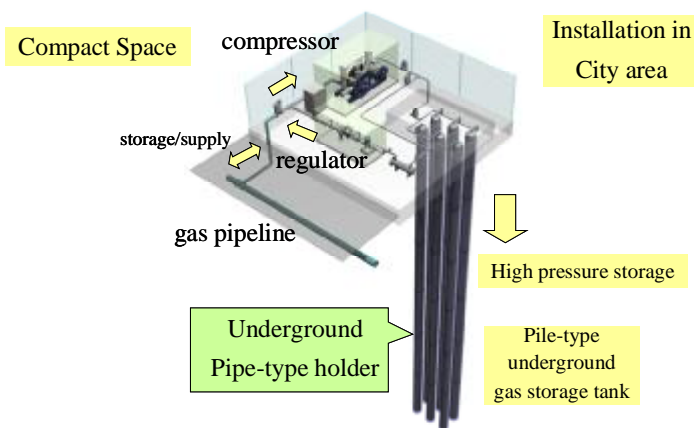


Fig1. vertical buried pipe type gas holder

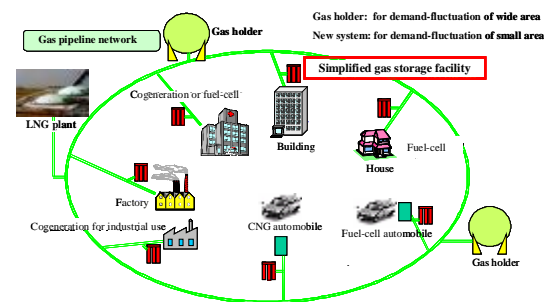


Fig2. dispersed installation of the system

## RESULT OF ASEISMIC ANALYSIS

Aseismic analysis method for vertical buried pipe type gas holder has not been established. Fig 3 shows aseismic analysis procedure. We confirm earthquake durability using following procedure.

- (1) Input real earthquake wave to ground basement, and require response displacement for each geological strata.
- (2) Input each displacement to beam and spring model of pipe type holder, and calculate maximum displacement of beam model.
- (3) Input maximum displacement of beam model to detail pipe holder model using FEM analysis, and calculate maximum strain.

The vertical buried pipe type holder suffering from very strong seismic motion (level 2) has good earthquake resistance performance. Calculated performance is that operation can be resumed immediately without any repair.

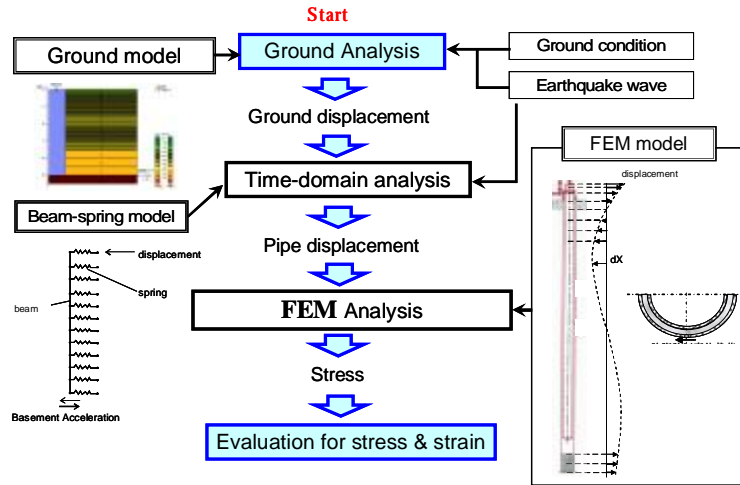


Fig3. Procedure of aseismic analysis for buried pipe holder

### RESULT OF CHARGE DISCHARGE CHARACTERISTIC

The charge-discharge characteristics of high aspect ratio vertical pipe type holder have been studied. Pressure and temperature at different point were measured by experiments. Fig 4 shows the experiment and simulation results of temperature distribution in the gas holder from the top to the bottom. And for simulate temperature distribution stop charging-discharging technique was in use to obtain the heat transfer coefficient change. The heat transfer coefficient were used to simulate the pressure and temperature change inside pipe type gas holder during charge and discharging. The simulated results then compared with the experiment results and they showed good agreement. And in general usage pattern pipe holder has no problem about temperature fluctuation.

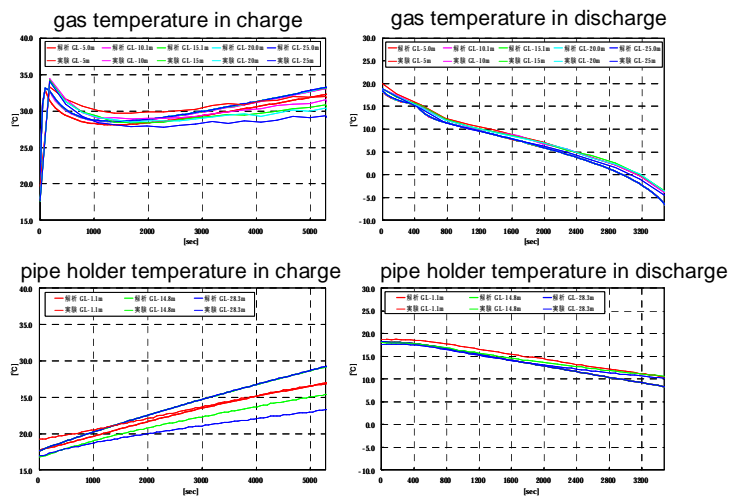


Fig4. Experiment and simulation results of temperature distribution

### CONCLUSION

To assure safety level for vertical buried pipe type gas holder, we have done earthquake resistance analysis and temperature fluctuation analysis. As a result of these analyses, it has high earthquake durability and little influence of temperature fluctuation.