Status Report: Impact of Gas Quality Variation on Gas Appliances in Japan

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Background

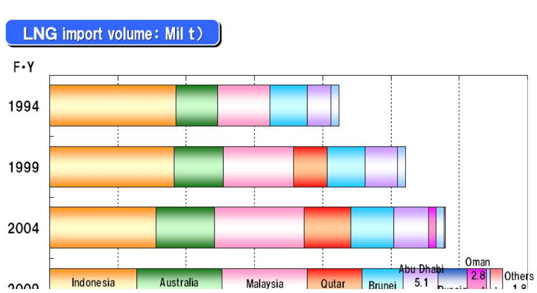
As the risk of fluctuation in utility gas quality increases due to the introduction of third party access and biogas injection into pipeline, gas companies in Japan have heightened their vigilance over maintaining the standard calorific value of gas supply to secure the safe operation of gas appliances at their industrial and residential customers.

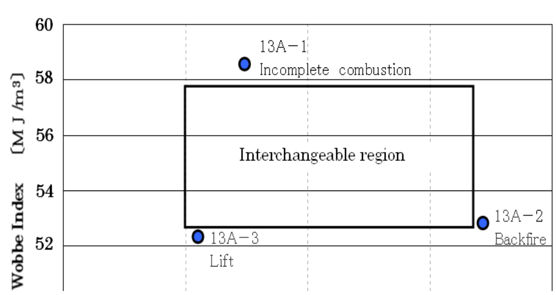
Starting in 1970's, the Japanese gas industry worked on the unification of gas heating value through switching of gas supply from coal/oil derived gas to natural gas imported as LNG. Now switching has been completed with the calorific values almost unified; 98% of customers using a high-calorie gas called 13A and 2% a low-calorie gas called 12A mainly supplied by direct pipeline from domestic natural gas field in the country. The similar unification effort can be seen in Europe establishing EASEE in March 2003 with the aim of integrating the gas market in the region.

Meanwhile, the Japanese gas industry has been developing and marketing gas appliances as tools to promote the usage of the standardized gas in the country as the gas demand expanded over the years and procurement sources became more diversified (Fig.1). The appliances are designed to run on gas of the specification stipulated in Gas Business Act in Japan. The recent examples of such devices include fuel cells and micro CHP.

In recent years, there were two developments in the Japanese gas market which requires the pipeline-owning gas companies to make finer adjustments of supply gas heating value due to incoming gas of various qualities: market liberalization and environmental conversation. The gas market liberalization in Japan has opened up the pipeline owned by gas utilities to new third party gas retailers to send their gas through the pipeline, which might have a different specification from that of gas sent by the gas utilities. As awareness of environmental conservation increases in the country, the gas companies in Japan has started to inject bio-methane which is highly purified from raw biogas into their pipeline under the amended regulation obliging them to promote the usage of biogas in the country, which also has different calorific value from that of utility gas.

Under these circumstances, the Japanese gas companies have established their own provisions for gas supply and has set the terms and conditions for quality of gas to be received from outside to maintain the quality of supply gas on the standard level for the gas appliances at their customers. This report explains the current status of gas quality issues in





Japan and measures taken by gas utilities to secure the quality standard.

Aim and method

Since the specifications of supply gas in Japan are very similar to each other, this report examines the supply gas specifications of a representative utility of the country, Osaka Gas. The specs were established for the purpose of standardizing supply gas quality and are also applied to the quality of newly introduced gases such as third party's gas and biogas injected into pipeline. The supply gas conditions of Osaka Gas, shown in Table.1 below, stipulate such gas quality.

Table1

Items	Standard	Note
Standard calorific value	45MJ/m^3N	To follow the definition of the standard calorific value of the gas business law.
Range of calorific value	44.2～46.0MJ/m^3N	The height and the lowest difference of 24 hours must be 1MJ/m3N or less.
Wobbe Index	52.7～57.8	To calculate from the content ratio of the gas elements.
Combustion Velocity	35～47	To calculate by the method described in the gas business law
Specific Gravity	Less than 1.0	The specific gravity of air is defined as 1.0
H_2S	1.0mg/m^3N or less	
Total S	Less than 5.0mg/m^3N	To exclude the sulfur content included in the odorizer
Ammonia	Not detected	
Conc. Odor	12～16mg/m^3N	To use the same odorizer as Osaka Gas Co.,Ltd uses.
Conc. H_2	4vol%or less	
Conc. CO	0.05vol%or less	
Conc. O_2	0.01vol%or less	
Conc. N_2	1.0vol%or less	
Conc. CO_2	0.5vol%or less	
Temperature	0℃～40℃	
Others	separate consultation	Dew point of hydrocarbons Moisture Knocking Index Oil and trace element Olefin Benzene etc
Pressure	Below the highest pressure of the injection point of the grid	To secure pressure necessary for handing over the amount of the biogas purchase contract from upper point of the equipment that controls gas quantity or pressure .

Result

All the gas equipment is designed to create excellent combustion as long as combustion velocity is within the interchangeable region as shown in Fig.2. This high quality of combustibility was achieved through testing gas of three different specifications and restrictive conditions for elements involved in combustion.

The specification calls for a standard list of items. The amount of impurities including Total S, H_2S, and ammonia must be less than certain levels to prevent corrosion of gas burner or fuel pipes. Moisture must be also kept low to stave off corrosion of gas piping and appliances. To ensure good performance of fuel cells and Hydrogen generator, the concentration of O_2 and CO_2 must be limited while that of H_2 is also restrained to achieve high performance of gas-engine-driven CHP and GHP. For industrial customers, N_2 has a significant impact on atmospheric metal treatment, and the concentration needs to be controlled as well.

Another key factor to control CHP performance is Knocking Index, shown in Note for Others in Fig.2. Osaka Gas uses its own index called OGKI, which is calculated based on the concentrations of Hydrogen and C_2-C_4 hydrocarbon components.

Other characteristics that affect the combustion quality are gas calorific value fluctuation and its speed. They must be kept under close control because they have significant impact on the quality of products such as fluorescent lamps and glassware. The heating value fluctuation must be kept within 1MJ/day, and it will otherwise require an installation of a Wobbe controller to the appliance.

Conclusion

In the Japanese gas industry, the quality of gas is closely monitored and adjusted when necessary to maintain the constant supply of standardized gas to consumers in accordance with the gas supply rules and provisions set by gas utilities.

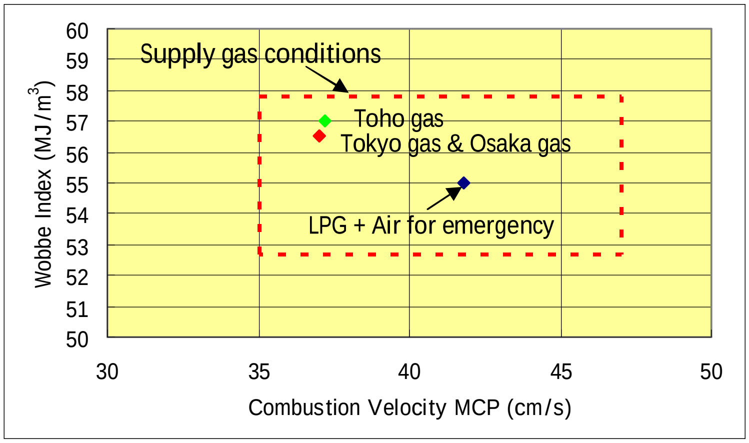


Fig. 3

This is especially essential for industrial customers to run the state-of-the-art gas appliances requiring fine gas quality control to maintain high quality products.

As Fig 3 shows, in an emergency such as great east Japan earthquake, gas industry might supply LPG + Air instead of natural gas. But major gas companies supply very similar quality gas.

In recent years, the hurdle to achieve the target has become higher due to the new developments in the gas industry including the introduction of third party access and biogas injection into pipeline. In the near future, the gas utilities may have to deal with new types of unconventional gases such as shale gas and coal bed methane as their supply gas. In case they cannot modify the calorific value of such gases to the current level, they must introduce a solution to the problem, such as installing Wobbe controllers to the gas appliances at the industrial customers' sites.