

The enactment of thermal efficiency standard for domestic gas appliances and its foreground of Implementing in Chongqing *

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Abstract: This paper analyses the principles we should obey and the problems we should be confronted with when thermal efficiency standards for instantaneous gas water heaters and gas ranges are enacted. It is considered that enactment of thermal efficiency standards for domestic gas appliances could intensify economization on domestic gas utilization and marked economic and environmental benefits could be generated consequently.

Keywords: gas, gas appliances, thermal efficiency, energy conservation

1. Preamble

A huge scheme of natural gas's exploring and application is under through in China, main measure to carry out it is the project of west-east gas transmission, key project of the 10th 5 years plan. It aims to enhance gas's proportion in Chinese energy consumption, because current situation of this proportion is backward. Based on statistics of 1998, gas energy occupied approximately 2.1% of all energy, while the average of this proportion was 23% in the world. The goal of intensive project of gas exploring and application is to elevate the gas's proportion to 8% or so by 2010. We can foresee that the scale of gas application in China will expand sharply.

Enlarging the scale of domestic gas application is necessary to boost the gas application of China, that should be a project with priority in China. Basis to formulate this policy lies in the importance of domestic energy in improving people's living environment and reducing living energy's influence to environment

Currently, domestic gas of China concentrate in the scope of urban residences, roughly 200 million users, gas consumption is over 9 million tons of oil equivalent (1Kg of oil equivalent=41800KJ). Within next 10 to 15 years, this quantity will rise 5~6 times.

At the same time of extending domestic gas application, efficiency of utilizing domestic gas can not be ignored. Crux of this matter is to enhance thermal efficiency of domestic appliances.

According to this circumstance, Chongqing attempted to work out the thermal efficiency standard for chief domestic gas apparatus-domestic instantaneous gas

water heaters and gas ranges. On that basis, restrict the thermal efficiency of gas water heaters and gas ranges and assess their energy economization. It will efficiently impel relevant institutions in China make more effort on elevating thermal efficiency of domestic appliances.

2. Status quo of thermal efficiency standards for domestic gas appliances in China

In the aspect of energy utilizing efficiency of domestic gas appliances, most restrictions of standards and regulations are derived from correlating technical standards of various gas appliances. In these standards, corresponding index of thermal efficiency was posed, but the index is lack of binding force in energy saving, manifested as:

1) Relatively low index of thermal efficiency. For instance, domestic gas ranges should have a thermal efficiency no less than 55%, for instantaneous gas water heaters no less than 80%. These indexes are easy to attain, and very likely to be exceeded. Data from advanced countries proved that, at least higher by 10%.

2) In relevant standards, index of thermal efficiency is not the most important index. Those can not attain it are classified as products with defect, rather than unqualified product, still able to be marketed.

3) No ban to the energy-hungry products. Some currently widely used products, such as storage-type gas water heaters, with a thermal efficiency less than 70%, an apparent energy hungry product, already manufactured and vended in large amount without any restraint of correlating technical standards.

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*Supported by U.S. Energy Foundation.

4) Domestic gas is a potential consuming field of gas fuel in China. With the rapid growth of consumption, if the energy conservation problem of domestic gas appliances is not solved, it will result in massive squander of gas, hence cause drain on resource and damage to environment to China, a country short of gas fuel.

3. Practice of establishing local standard of thermal efficiency for domestic gas appliances

3.1 Relevant principles for enacting standard

In order to coordinate implementation of *The Law on Energy Conservation of the People's Republic of China*, enhance energy utilizing efficiency of instantaneous gas water heaters, spur manufactures to improve their energy saving technology, Resource Conservation and Comprehensive Utilizing Department of Chongqing Economic Committee, Standard Department of Chongqing Quality & Technology Supervision Bureau together raised the plan of enacting Chongqing local standard—"energy conservation standard for instantaneous gas water heaters". This standard was taken into 2002 plan of revising and enacting Chongqing local standards. July 2003, passed experts from Chongqing Quality & Technology Supervision Bureau's assessment, and issued August 1st 2003.

The enactment of this standard provided technical foundation for elevating domestic gas appliances' energy utilizing efficiency in Chongqing and carrying out energy conservation of instantaneous gas water heaters.

In the process of compiling The prescribing energy efficiency value & energy conservation appraisal value for instantaneous gas water heaters standard, in-depth research was launched to work out how to objectively assess energy utilizing of instantaneous gas water heaters under current technical condition. Meanwhile, established principles to be conformed with when drafting the energy efficiency standard.:

1) Objectively assess the energy utilizing condition of existing instantaneous gas water heaters, and make thermal efficiency the solo index to reflect instantaneous gas water heaters' energy utilizing efficiency.

2) Fully respect the authority of thermal efficiency index in instantaneous gas water heaters' technical standard, economize energy by limiting the thermal

efficiency value of instantaneous gas water heaters.

3) The establishment of prescribing thermal efficiency index in the standard should enable 80% instantaneous gas water heaters and gas ranges in the market to meet the requirement.

4) No more than 20% instantaneous gas water heaters and gas ranges in the market can reach the appraisal index of energy conservation.

5) No regulation of thermal efficiency indexes can hinder the achievement of safety indexes.

6) The standard should clarify the prescribing value of thermal efficiency's influence on qualification of products.

3.2 Method to determine thermal efficiency index in the standard

Via analysis on the change of thermal efficiency cause by the alteration of gas water heaters and gas ranges' working conditions, following basic results can be obtained:

1) The alteration of gas appliances' working condition will change the thermal efficiency to some extent.

2) Since the testing condition of the first inspection may not be the least favorable status of all working conditions, its thermal efficiency value does not totally reflect the actual value of the water heater's thermal efficiency; when it comes to gas ranges, the first test substantially chose the medial status of all working conditions, therefore, its thermal efficiency value generally represents the average thermal efficiency of the gas range;

3) The maximum thermal efficiency of gas water heaters usually appear when the temperature difference between cold and hot water is 25 °C, change of efficiency with other single conditions like gas load and rate of water flow does not follow any obvious regular pattern; maximum thermal efficiency of gas ranges appear under the heating condition of minimum heating load to maximum pot diameter and water volume;

4) For any instantaneous gas water heater, there're extreme working conditions, represented by the maximum and minimum value of the temperature difference between hot and cold water. Under extreme working condition, there's 4~6% negative deviation of the thermal efficiency from its maximum value. And for any domestic gas range, there're also extreme

working conditions, with a negative deviation of 50%;

5) It's not able to comprehensively and scientifically attain the purpose of energy conservation by restricting the instantaneous gas water heaters and gas ranges' energy utilizing level, if solely restrict the energy utilizing situation of instantaneous gas water heaters and gas ranges by their thermal efficiency value of the first inspection.

Therefore, in the process of enacting the standard, mean thermal efficiency value was adopted as foundation of appraisal index to evaluate the actual thermal efficiency. The definition of mean thermal efficiency is the average of the thermal efficiency of first inspection and the minimum thermal efficiency under extreme working conditions. To use the minimum thermal efficiency under extreme working conditions is due to there are 2 extreme conditions, although they all locate in low thermal efficiency area, but they're distinct. For example, conditions for minimum thermal efficiency of different water heaters, some are working condition of maximum temperature-rise, some are minimum.

3.3 prescribing thermal efficiency value & energy conservation appraisal value

3.3.1 prescribing thermal efficiency value for gas appliances

The so-called prescribing thermal efficiency value is the value that gas appliances' thermal efficiency should attain. Thermal efficiency value of the first test is the basic index of prescribing thermal efficiency for instantaneous gas water heaters and gas ranges.

1) In the technical standards for instantaneous gas water heaters and gas ranges, values that thermal efficiency of first inspection should reach were illustrated clearly, respectively, 80% and 55%. Thus, in the enactment of thermal efficiency standard, "prescribing value of thermal efficiency" must be or higher than 80% and 55% respectively, this does not contradict technical standards.

2) The standard should provide clearly that prescribing thermal efficiency is the index to determine whether instantaneous gas water heaters and gas ranges are qualified when the standard is applied.

3.3.2 energy conservation appraisal value for gas appliances

As a significant index to assess the energy effect situation of products, this standard stipulated the

approach to calculate some classifications of products' experimental thermal efficiency.

Sampling products should accord demand of correlating standards and if testing methods are not provided in those standards, employ methods in this standard.

Main foundation to set energy conservation appraisal value is the data of samples acquired from the Quality Testing Station for Gas Appliances. According to gas water heaters, among the whole 71 samples, up to 40% have a thermal efficiency of first test achieving 88%, but consider the derivation of mean thermal efficiency and experimental thermal efficiency, the mean thermal efficiency can not achieve 88% if the thermal efficiency of first inspection is only 88%. As a matter of fact, only 13 samples reach 88%, less than 20% of all samples. Assuming experimental thermal efficiency of gas water heaters no less than 88% as energy conservation index is reasonable.

3.3.3 Energy conservation assessment of gas appliances

As authorization to product, thermal efficiency of gas appliances fulfilling prescribing thermal efficiency value only is not enough. So-called energy conservation assessment means test and judge to decide whether the gas appliances that can be deemed to be energy saving products achieve the thermal efficiency index of energy conservation appraisal value.

4. Prediction on effect of Chongqing local standard's implementation

Chongqing is one of the cities with largest quantity of natural gas consumption in China, Chongqing Quality & Technology Supervision Bureau published the 2 local standards, The prescribing thermal efficiency value & energy conservation appraisal value for domestic instantaneous gas water heaters, The prescribing energy efficiency value & energy conservation appraisal value for domestic gas ranges in Aug. 1st 2003. The former one will be carried out formally Oct. 1st 2003. And Jan. 1st 2004 for the later one. The implementation of the 2 endemic standards will bring positive influence to energy economization of domestic gas utilization, and supply practicing reference for the state to draw up similar standards.

4.1 Estimated demand for natural gas of Chongqing

According to the forecasted result of domestic gas

scale of Chongqing by experts organized by Chongqing Economic Committee, the growth of demand for natural gas in Chongqing in the next 20 years is amazing, and the quantity is colossal.

The consumption of domestic gas of Chongqing in 2002 was $4.69 \times 10^8 \text{ m}^3/\text{a}$ ($1.67 \times 10^{10} \text{ MJ/a}$), anticipate that the annual growth rate will be 10%, in that case, the estimated result of domestic gas consumption as follow:

Domestic gas consumption of Chongqing in 2007 $7.55 \times 10^8 \text{ m}^3/\text{a}$ ($2.69 \times 10^{10} \text{ MJ/a}$); 2010 $10.05 \times 10^8 \text{ m}^3/\text{a}$ ($3.58 \times 10^{10} \text{ MJ/a}$); 2020 $19.59 \times 10^8 \text{ m}^3/\text{a}$ ($6.99 \times 10^{10} \text{ MJ/a}$);

Commercial gas consumption of the city : 2007 $4.5 \times 10^8 \text{ m}^3/\text{a}$ ($124.2 \times 10^4 \text{ m}^3/\text{d}$), 2010 $7.3 \times 10^8 \text{ m}^3/\text{a}$ ($199.9 \times 10^4 \text{ m}^3/\text{d}$), 2020 $16.3 \times 10^8 \text{ m}^3/\text{a}$ ($447.9 \times 10^4 \text{ m}^3/\text{d}$)

4.2 Means to implement the standard and forecasted direct results

Chongqing has advantageous situation to apply thermal efficiency standard to domestic gas appliances.

Firstly, Chongqing Quality Testing Station for Gas Appliances, which is attached to Chongqing Quality & Technology Supervision Bureau, is a statutory institute for test of quality. All products vended in Chongqing should pass its examination, index of thermal efficiency is only one of many testing items, Implementation of item added by the standard can be realized on existing facilities;

Secondly, the consummate structure of organization in Chongqing does avail to implementation of energy conservation restriction. Department of Economization on Resource and Energy Utilization of Chongqing Economic Committee and Chongqing Quality & Technology Supervision Bureau are of Administrative duty, they're of necessity and facility to harmonize the mechanisms and provide administrative restriction, implement energy conservation assessment of gas appliances and affirmation of energy saving products via Chongqing Center of Economization on Energy Utilization, Chongqing Supervising Center of Energy Utilization, and Chongqing Quality Testing Station for Gas Appliances.

The energy saving confirmation of domestic gas appliances can further regulate the market of domestic gas appliances (instantaneous gas water heaters and gas

ranges) in Chongqing, enhance efficiency of utilization of thermal energy.

For Chongqing market of domestic gas, Implementation of thermal efficiency standard for gas appliances will bring appreciable effect of energy saving.

Count based on current thermal efficiency with an enhancement of 10%, quantity of saved energy respectively are: 2007 $0.775 \times 10^8 \text{ m}^3/\text{a}$ ($2.69 \times 10^9 \text{ MJ/a}$); 2010 $0.005 \times 10^8 \text{ m}^3/\text{a}$ ($3.58 \times 10^9 \text{ MJ/a}$); 2020 $1.959 \times 10^8 \text{ m}^3/\text{a}$ ($6.99 \times 10^9 \text{ MJ/a}$);

The effect of economization of 2020 equivalent to building a hydro power station of $2.2 \times 10^5 \text{ KW}$, the economical benefit can not be overlooked.

5. Conclusion

1) There's sufficient reason to concern the energy conservation of domestic gas, because the outcome of energy conservation is reducing consumption of coal directly, and the discharge caused by domestic energy utilization which is controlled by that has the most direct influence on people.

2) The publishing and implementation of Chongqing local energy conservation standard for domestic gas appliances (instantaneous gas water heaters and gas ranges) will play an important part in the economization of natural gas in Chongqing, and bring tremendous economical and environmental benefits.

3) The enactment of Chongqing local energy conservation standard for domestic gas appliances will promote the state to attach more importance to this matter, if the national government enact the same standard, it would generate greater economical and environmental benefits.

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