

# Analysis on the Current Energy Consumption of Heating In Rural Toilets in Tibet

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**Abstract:** In order to grasp the basic sanitation facilities, toilet renovation planning and progress, residents' toilet habits and willingness to renovate, and the maintenance status of renovated toilets in townships and rural areas of Tibet, and to understand the basic situation and toilet renovation planning of public toilets in townships and rural areas. This article selects independent public toilets in agricultural and pastoral areas of Tibet as the research object. In response to the problems of low indoor temperature and high heat consumption in township toilets, the construction and heating status of township toilets were obtained through on-site research. The heating characteristics of township toilet buildings were summarized, and typical buildings were selected for load characteristics analysis, providing a preliminary basis for the design of solar heating schemes in the future.

**Keywords:** Tibet region, Township toilets, Energy consumption status, Heating characteristics.

## 1. Introduction

This survey mainly adopts the following three research methods: data collection, resident interviews, and on-site research. a) Data collection: Firstly, through internet information retrieval, collect, summarize and organize policy and planning documents related to the toilet revolution in Nagqu City, Tibet Autonomous Region; Summarize the theoretical basis for the transformation of township toilets required for research. The second is to communicate and exchange with the local competent department for toilet renovation, understand the local development situation, obtain materials on the progress of relevant planning, construction, and implementation, and lay the foundation for

subsequent on-site research. b) Resident interviews: Conduct on-site interviews in selected rural areas, agricultural and pastoral areas, and pastoral gathering areas. One is to understand the objective basic situation of the village, the second is to listen in detail to the subjective thoughts of village cadres on the improvement of the living environment, and the third is to understand the specific needs of farmers for toilet renovation. c) On site investigation: A random sampling survey method is used in the area where the research object is located to conduct on-site investigations, visits, and household surveys. Take photos and record the construction status, enclosure structure, and heating methods of local township toilets. The on-site survey image is shown in Figure 1.



Figure 1. Site Survey Photos

## 2. Survey Data Analysis

### 2.1. Current Situation of Public Toilet Construction in Towns and Towns

A survey was conducted on the construction status and enclosure structure types of village public toilets, and the results are shown in Figure 2. A total of 16 villages were surveyed, of which 14 have public toilets, accounting for 87.5% of the total number of surveyed villages. 2 villages do not

have public toilets, accounting for 12.5% of the total number of surveyed villages. There are a total of 14 public toilets in the survey area, of which only 3 meet the requirements for the construction of harmless sanitary toilets, namely toilets that meet the basic requirements of sanitary toilets and are managed and maintained according to relevant regulations, accounting for 18.75% of the total number of public toilets; There are 5 public toilets that meet the construction requirements of sanitary toilets but have poor operation and maintenance effects, accounting for 31.25% of the total

number of public toilets; There are a total of 7 ordinary dry toilets that do not meet the requirements for sanitary toilets, accounting for 43.75% of the total number of public toilets. In addition, there is one public toilet with management personnel responsible for specialized cleaning and maintenance, accounting for 6.25% of the total number of public toilets, and this toilet is located in the Luoma Town Health Center in Nagqu City.

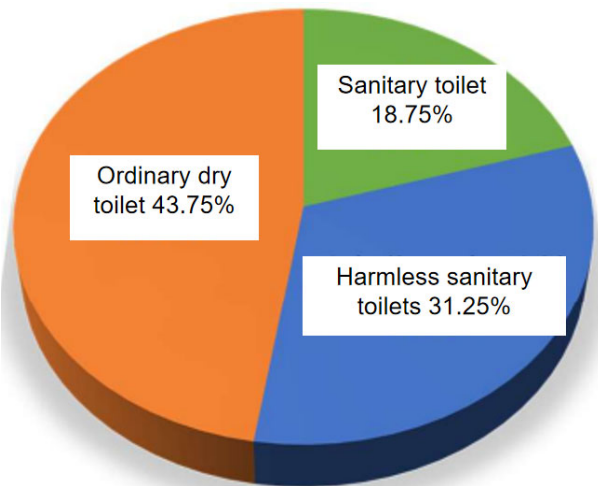


Figure 2. Construction of Sanitary Toilets

More than half of the surveyed public toilets have brick walls, accounting for 66.1%; The proportion of concrete walls is 16.9%; These are mostly new buildings, with insulation layers in the enclosure structure, resulting in better indoor insulation effects. However, there are still a few toilet walls made of stone and adobe, both accounting for 6.8% respectively. The reconstruction of these toilet buildings has not yet been completed. The envelope has a large heat transfer coefficient and serious indoor heat loss. The investigation of the building condition of the toilet enclosure structure is shown in Figure 3.

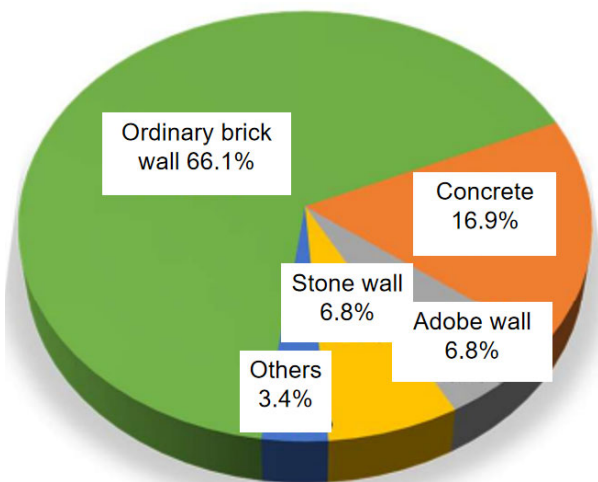


Figure 3. Building condition of enclosure structure

## 2.2. Application of Heating Method Technology

A survey was conducted on the heating situation and heating technology types of township public toilets, and the results are shown in Figure 4. Due to the advantages of flexible control, convenient installation, and simple maintenance, independent heating systems have been widely

used in independent buildings such as public toilets, with about 90% of public toilets adopting the form of independent heating systems. Among them, household air conditioning, as the most common heating appliance, still has the highest proportion of application in public toilets, with about 35.4% of public toilets using air conditioning for heating; About 29% of public toilets use direct electric heating (electric heating film, electric heating); Air source heat pump is an efficient, energy-saving, clean and safe heating equipment that includes two heating methods: hot water and hot air. About 16.1% of public toilets use air source heat pumps as heating sources, with 80% of air source heat pumps using hot air and 20% using hot water; Compared with conventional energy heating technology, solar heating systems have the advantages of energy conservation, low-carbon, and green environmental protection. However, due to their large equipment investment, complex operation and management, and the need for auxiliary heat sources, only about 9.7% of public toilets use active solar heating systems. Part of the public toilets located near the gas pipeline route adopt household use of cow dung stoves for heating, using cow dung or coal as the heat source. In public areas outside the toilet area, the cow dung stove radiation system is used as the heating terminal. However, due to the need to meet certain site selection requirements, the application proportion is only about 3.2%. Compared with household heating, central heating is a more economical, energy-saving, safe and environmentally friendly heating form. However, only 6.5% of public toilets use municipal central heating because of the high cost of municipal heating pipe network interface and large quantities of work.

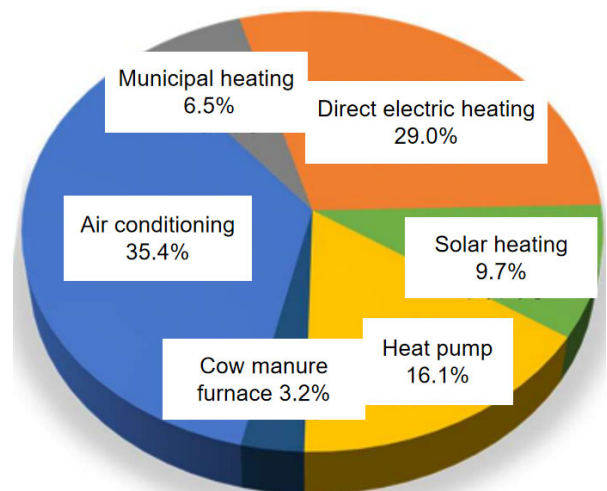
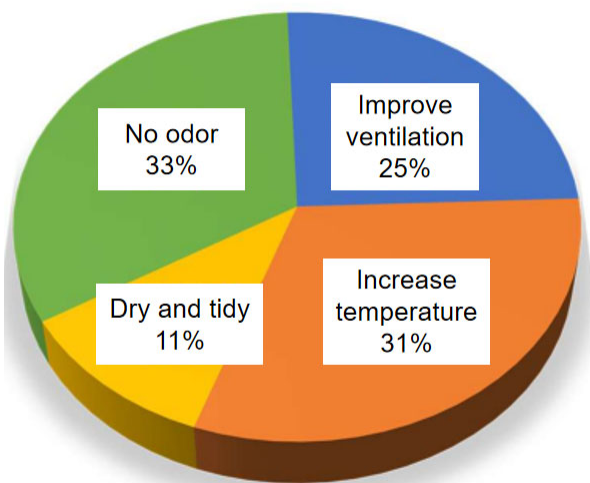


Figure 4. Application of Heating Technology in Public Toilets

## 3. Residents Expect Projects to Improve Thermal Environment

A total of 96 permanent residents were selected from the surveyed townships and regions for a questionnaire survey. A total of 91 sets of valid data were obtained, with a valid questionnaire rate of 94.7%. Among the survey personnel, there were 42 males (46.2%) and 49 females (53.8%). The survey subjects have all lived here for a long time and are expected to be able to accept the local climate and environment. During the research process, village residents were asked which areas they hope to improve in terms of indoor thermal environment comfort in the future, and the results are shown in Figure 5.



**Figure 5.** Looking forward to improving the thermal environment project

Among them, 30 people, accounting for 33%, expect toilets to be odorless and odorless; 23 people, accounting for 25%, expected to improve ventilation; 28 people, accounting for 25%, are expected to increase their temperature; There are 10 people who expect the toilet to be relatively dry, accounting for 11%. Based on the results obtained, it can be inferred that residents prefer to increase the temperature of toilets and remove odors.

#### 4. Conclusion

With the steady progress of the national "Toilet Revolution" special action, public toilets have achieved significant improvements in terms of quantity layout and functional facilities[1]. However, there are still obvious problems in the design and maintenance of rural public toilets in the Nagqu area of Tibet, which further lead to high heating energy consumption, low thermal comfort, and poor environmental quality in public toilets[2]. So based on this survey of a large number of rural public toilets, it was found that there are still several issues with township toilets:

a) Poor basic conditions and mixed quality of toilet renovation

With the continuous development of the toilet revolution, modern rural toilets are widely popularized. However, due to factors such as local natural conditions, economic level, ethnic customs, and policy implementation, there are significant differences in the promotion of toilet reform in different regions[3]. Based on the research results, although a number of sanitary toilets with modern facilities have been built, there are still a number of traditional dry toilets and poorly functioning or idle public toilets after renovation. These toilet enclosure structures mostly use single-layer brick walls directly, and some toilets are even soil and stone walls, or even semi open. These building enclosure structures cannot meet the current standard requirements and cannot meet the indoor insulation requirements, resulting in extremely poor indoor comfort in winter.

b) Single and outdated heating methods

From the research results, it can be seen that nearly half of

rural toilets still do not have heating, and the heating method of heated toilets is relatively single. Most toilets only use household air conditioning or electric heating for heating, without considering local conditions, which is neither energy-saving nor environmentally friendly. Some toilets use municipal heating network and gas heating methods, while only a small number of newly built toilets use heat pump heating[4]. Considering the climate characteristics of the Nagqu region in Tibet, the outdoor temperature can reach below  $-25^{\circ}\text{C}$  in winter, and the heat pump has extremely low efficiency or stops operating in low temperature environments, which cannot meet the temperature requirements for toilet use and causes resource waste. In addition, according to research results, only a small number of newly built public toilets use solar heating, and the proportion of new energy heating methods is relatively small, which does not meet the requirements of "clean heating" tailored to local conditions.

c) Low temperature and poor ventilation

According to the analysis of research results, the ventilation and temperature of public toilets are important indicators for evaluating the thermal environment of toilets. It is generally believed that the current situation of public toilets cannot meet the expectations of thermal comfort and hygiene. Due to the characteristics of public toilets, the entire room is filled with a large amount of air pollutants and microbial bacteria. If the room is closed and the air is not ventilated, it is easy to breed bacteria and cause a decrease in indoor air quality. Therefore, a large amount of ventilation is required. Most cleaners lack relevant management standards and operating procedures, and the phenomenon of using natural ventilation is common, which cannot timely eliminate odors to the outside, thereby affecting the indoor environment[5]; According to research results, only a small number of toilets use heat recovery devices, while most public toilets use simple mechanical exhaust fans. In winter, when the outdoor temperature is low, a large amount of heat energy will be lost with the exhaust, resulting in a significant decrease in heating efficiency.

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