

# Study on the behavior and overall planning of domestic hot water in Chifeng University

Ying Shuai<sup>1</sup>, Yaxin Zhang<sup>1\*</sup>, Xiaowei Li<sup>1</sup>, Qian Wang<sup>2</sup>, Yuchen Yang<sup>1</sup>, Qiang Li<sup>1</sup>, Zixuan Han<sup>1</sup> and Kunpeng Zhang<sup>1</sup>

<sup>1</sup> Departments of College of Physical and Intelligent Manufacturing Engineering, University of Chifeng, Chifeng, Inner Mongolia, China

<sup>2</sup> Division of employment and Entrepreneurship, University of Chifeng, Chifeng, Inner Mongolia, China

**Abstract.** Based on the statistics of the current situation of hot water in students' dormitories of Chifeng University, this paper summarizes the characteristics of male and female students' use of domestic hot water, obtains the relevant laws of university students' hot water use behavior characteristics, and puts forward the selection and layout of water heaters according to the water use rules, so as to solve the bottleneck problem of hot water use in our school.

## 1 Introduction

With the continuous expansion of college enrollment and the construction of a large number of students' dormitories, more and more attention has been paid to the problems related to students' dormitories. There are some foundations for the research of student dormitory in China. For example, in the book "overall design of university campus" edited by Xu Huijun, it is proposed that students' dormitories should pay attention to the importance of living environment, communication and learning; Luo Chenyun of Southeast University in his paper "a preliminary study on the design of university apartments", through the study of the living needs of college students, the spatial layout, indoor thermal environment and future development trend of different student apartments are divided. In the book of "energy saving technology for students", the book "energy-saving technology for students" in "chongqing" is introduced.

Chifeng College, approved by the Ministry of education of the people's Republic of China in 2003, is a full-time ordinary high school established by Chifeng National Normal College, Chifeng Education College, Chifeng Branch of Inner Mongolia Radio and Television University, Inner Mongolia preschool normal school and Chifeng health school. It has 58 undergraduate majors and some higher Vocational Specialties, and some of them are bilingual in Mongolian and Chinese. It has two professional master's degree authorization points of "education" and "cultural relics and museums". At present, there are 11927 full-time undergraduates, 1144 junior college students, 77 postgraduates and 120 international students, with 13243 students in total. With the development of the school and the increase of the number of students, Chifeng College is facing the reality of serious shortage of water resources and the increasing demand for water resources, so the conservation of resources and energy becomes more and more urgent.

\* Corresponding author: [zhangyaxin1981@126.com](mailto:zhangyaxin1981@126.com)

Therefore, the research on the behavior characteristics of students' domestic hot water use in Chifeng university is helpful for the targeted design of students' domestic hot water system, which will also be an important way to save water resources and energy.

## 2 Hot water use survey

### 2.1 respondents

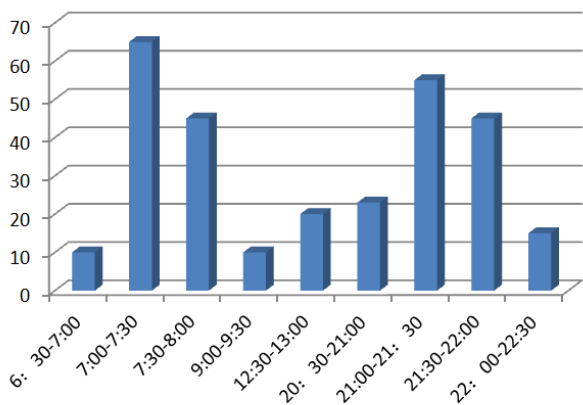
In this study, we chose No.6 building, No.8 building, No.5 building and No.9 building. 60 male students and 50 female students were randomly selected from different floors of each apartment building. The survey was conducted from November 20 to December 4, 2020, and the observation lasted for two weeks. At the end of November every year, the work in the school is in a relatively stable period in a semester, which can reflect the normal living conditions of students in the school, and has a typical water state in the dormitory area of the school.

### 2.2 survey methods

According to the characteristics of dormitory management in Chifeng College: from 6:00 a.m. to 22:30 p.m. every day, the hot water consumption and waiting time of male and female students are investigated. After counting and analyzing the change of water consumption at different time points in the dormitory building, the characteristics of water consumption in male and female apartments are sorted out.

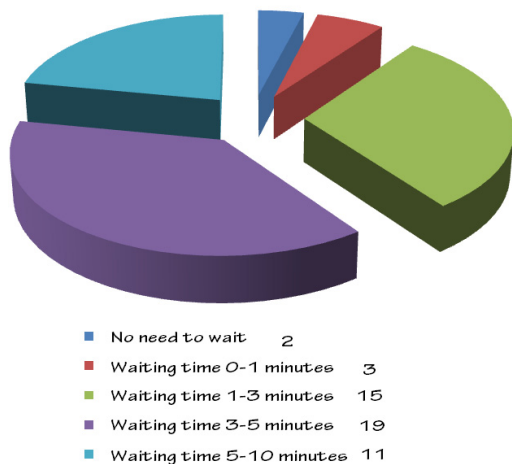
### 2.3 findings

According to the survey results, there is a significant difference between boys' hot water consumption from Monday to Friday and holidays, while girls' hot water consumption does not change significantly from Monday to Friday and holidays. The reason is that female students work and rest relatively regularly, and boys' self-discipline is poor. The characteristics of water use are as follows.



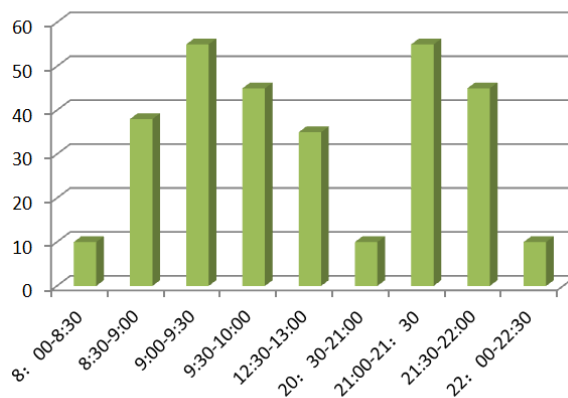
**Fig. 1** hot water usage pattern of 60 boys in class day

The hot water consumption of 60 boys every day is shown in Figure 1. It can be seen from the figure that the peak water consumption occurs at 7:00-8:00 and 21:00-22:00, which is the time for boys to get up and go to bed, so the hot water consumption is large. There were small water consumption peaks at 6:00-7:00, 9:00-9:30, 12:30-13:00 and 22:00-23:30. 6: From 00:00 to 7:00, some self-discipline students began to get up to wash water; from 9:00 to 9:30, this was the second big class, and lazy students began to get up and wash water. 12: From 30:00 to 13:00, this period is to return to the dormitory after lunch and start drinking water or reserve water for class in the afternoon. In other periods, water consumption is very low, only sporadic students use hot water.



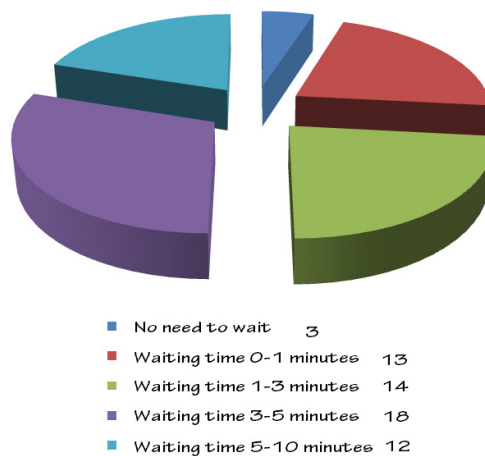
**Fig. 2** waiting time of 60 boys using hot water in peak hours on class day

The waiting time of 60 male students using hot water during the peak period is shown in Figure 2. In the six peak periods of water consumption, only two people do not need to wait for water drawing; three people wait within one minute; 15 people wait for 1-3 minutes; 19 people wait for 3-5 minutes; and 11 people wait for 5-10 minutes. It can be seen that in the peak period of using hot water on school days, half of the students need to wait for more than 3 minutes when taking water.



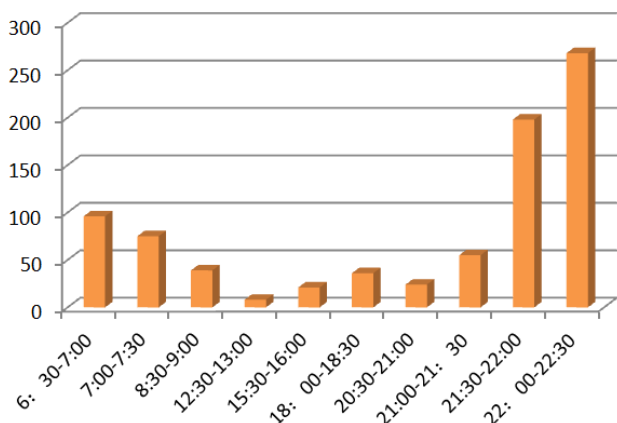
**Fig. 3** hot water use rules of 60 boys every day during holidays

The hot water consumption of 60 boys every day on holidays is shown in Figure 3. It can be seen from the figure that the peak water consumption occurs at 8:30-10:00 and 21:00-22:00, which is the time for boys to get up and go to bed, so the hot water consumption is large. There were small water consumption peaks at 8:00-8:30, 12:30-13:00, 20:30-21:00 and 22:00-23:30. On holidays, boys generally get up late, except for a few students, a large number of students start to get up after 8:00; from 12:30 to 13:00, this period is after lunch, when they go back to the dormitory to start drinking water; in other periods, the water consumption is very small, only sporadic students use hot water.



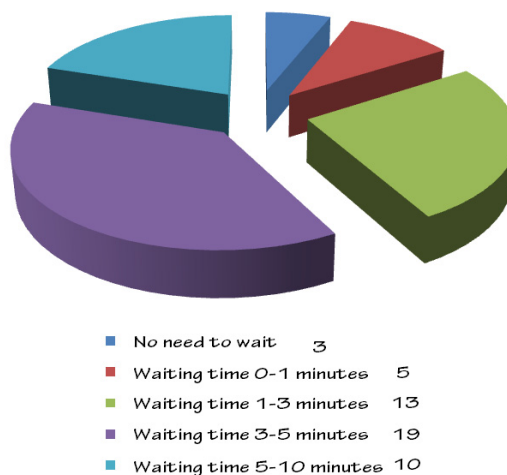
**Fig. 4** waiting time of 60 male students using hot water during peak hours on holidays

The waiting time of 60 male students using hot water during the peak period is shown in Figure 4. In the six peak periods of water consumption, only 3 people do not need to wait for water drawing; 13 people wait within 1 minute; 14 people wait for 1-3 minutes; 18 people wait for 3-5 minutes; and 12 people wait for 5-10 minutes. It can be seen that during the peak period of using hot water in holidays, the average waiting time is less than the class day, but 25% of the students still wait more than 5 minutes.



**Fig. 5** daily hot water usage of 50 girls

However, the average water consumption of each student is much higher than that of boys. The daily hot water consumption of 50 female students is shown in Figure 5. It can be seen from the figure that the peak water consumption occurs at 6:30-7:30 and 21:00-22:30, which is the time for girls to get up and go to bed, so the hot water consumption is large. The data comparison between girls and boys shows that most girls finish washing earlier than boys and come to the classroom as soon as possible. There were small water consumption peaks at 8:30-9:00, 12:30-13:00, 15:30-16:00, 18:00-18:30 and 20:30-21:00. 8: From 30:00 to 9:00, the students who did not have the first class began to get up more intensively; from 12:30-13:00, this period was when they went back to the dormitory after lunch and began to drink water before the break; from 15:30 to 16:00, the stage of centralized water and laundry water before the fourth class; from 18:00 to 18:30, the girls went back to the dormitory after dinner to start drinking water before the break or hot water after class; 20:00-16:00 : 30-21:00, in the early stage of washing and gargling, the girls washed in advance to avoid the concentration of water.



**Fig. 6** waiting time of 50 girls using hot water at peak time

The waiting time of 50 female students in peak time of hot water use is shown in Figure 6. In the six peak periods of water consumption mentioned above, only 3 people did not need to wait for drawing water; 5 people were waiting within 1 minute; 13 people were waiting for 1-3 minutes; 19 people were waiting for 3-5 minutes; and 10 people were waiting for 5-10 minutes. It can be seen that the waiting time for girls to use hot water is more than 5 minutes.

### 3 Coverall Strategy



**Fig.7** layout of water heater in male dormitory



**Figure 8** layout of water heater in female dormitory

As shown in Figure 7-8, there is one boiler per floor in boys' dormitory and three in girls' dormitory, which still can't guarantee that students' waiting time will not exceed 5 minutes in peak period. If we adopt the way of adding water heater, it will not only cause energy waste, but also have great security risks when installing too many high-power electrical appliances in the dormitory. Therefore, the scheme of integration of quick heating and thermal storage water heater and timer is adopted.

According to incomplete statistics, the primary water supply of the quick boiling water heater is about 20L, and the primary water supply of the thermal storage water heater is more than 60L; the power of the fast heating water boiler is relatively large. Students' dormitories use water in wave band. Therefore, the time switch is adopted. During the peak period of water consumption (6:30-8:20 and 21:00) -At 22:30, the quick heating and heat storage water heaters work at full load without exceeding the circuit load (the heat storage water heater can work 20 minutes in advance, so that the students can store hot water before the peak use); when the water consumption is low (00:00-5:30), a heat storage water heater is used to save energy and meet the students' unexpected need for hot water at night; in other periods, a quick hot water heater is used Water heater (for drinking) + an intermittent heat storage boiling water device (for washing).

When the water heater breaks down, adjust the working time of other water heaters through the timer, so as to ensure the normal water demand of students while maintaining the water heater.

## 4 Conclusion

Students' dormitories are the main learning and living places for students' extracurricular time. However, the problems of poor environmental quality and serious energy consumption are often ignored. Therefore, it is necessary to introduce the design concept of energy conservation and environmental protection of green buildings into the design of College Students' dormitories. Based on the statistics of the current situation of hot water in students' dormitories of Chifeng University, this paper summarizes the characteristics of male and female students' use of domestic hot water, obtains the relevant laws of university students' hot water use behavior characteristics, and puts forward the selection and layout of water heaters according to the water use rules, so as to solve the bottleneck problem of hot water use in our school.

## Acknowledgments

This work was supported by Chifeng College Students' innovation and entrepreneurship training program in 2020 (DCXM2020014).

## References

1. Chen Jiamin. Evaluation and improvement design of green student apartments in Shandong Jianzhu University [D]. Jinan: Shandong Jianzhu University, 2008
2. Bertrand A, Mastrucci A, Schüler N et al. Characterisation of domestic hot water end-uses for integrated urban thermal energy assessment and optimisation. *Applied Energy*, 2017, 186: 152–166
3. Alcocer-Yamanaka V H, Tzatchkov V G, Arreguin-Cortes F I. Modeling of Drinking Water Distribution Networks Using Stochastic Demand . *Water resources management (S0920-4741)*, 2012, 26(7): 1779–1792
4. Deng Guangwei, Yan Da, an Jingjing, et al. Current situation investigation and energy consumption model research of residential centralized domestic hot water system, *water supply and drainage*, 2014, 40 (7): 149 – 157
5. Chongjie, Xue Yibing. Ecological student apartment [M]. Beijing: China Construction Industry Press, 2007 [6] Wang Shanshan, Hao bin, Chen Xilin, etc. investigation and Research on domestic hot water demand and energy consumption mode. *Water supply and drainage*, 2015, 41 (11): 73 – 77
6. Yang Liu, Chen Jing, Zhang Shaoliang, et al. Study on domestic hot water consumption quota of typical student apartment. *Water supply and drainage*, 2014, 40 (7): 157 – 161