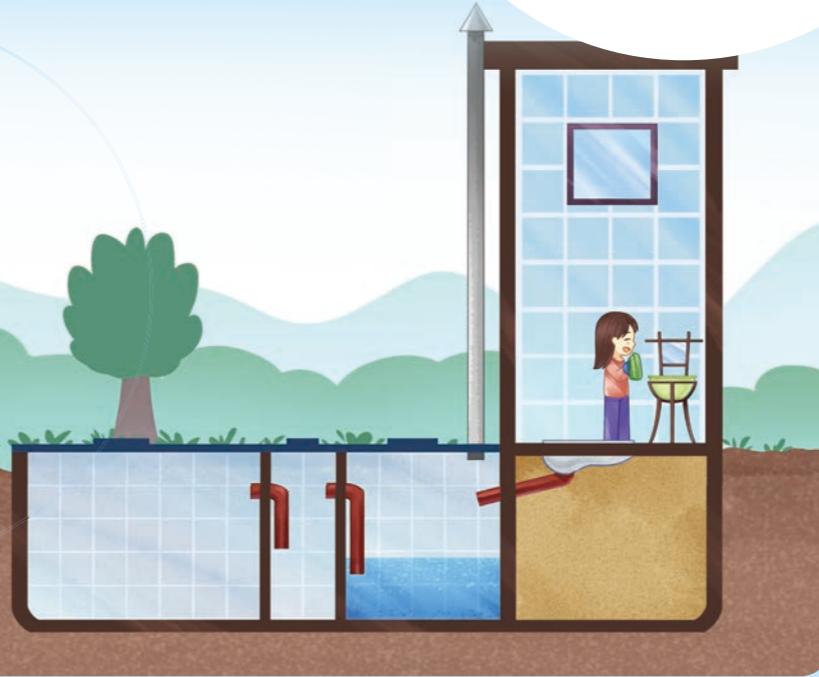


China Agricultural Press



PICTORIAL HANDBOOKS FOR IMPROVING
THE RURAL LIVING ENVIRONMENT

Improving Rural Toilets – A Pictorial Handbook



农业农村部规划设计研究院
ACADEMY OF AGRICULTURAL PLANNING AND ENGINEERING, MARA



联合国儿童基金会

Improving Rural Toilets

— A Pictorial Handbook



PICTORIAL HANDBOOKS FOR IMPROVING
THE RURAL LIVING ENVIRONMENT



China Agriculture Press
Beijing

Authors' Committee

Directors Hui Zhang Lianqi Jia
Members Yanqing Zhang Haibo Meng Yujun Shen
Qingdong Zhang Xufeng Wu

Authors

Chief authors Yujun Shen Jingtao Ding Huihui Wang
Other authors Haibo Meng Hongsheng Cheng Haibin Zhou
Yiman Jia Danyang Li Shengyuan Fan
Yawen Zhou Aiqin Zhang Xi Zhang
Jian Wang Juan Wang Qiongyi Cheng

Foreword

“One pit, two boards, three-foot mud walls and a four-sided enclosure.”

“Flies in summer and slippery ground in winter.”

These are people's impressions of toilets in a typical rural home across China. Unsanitary, inconvenient and dirty toilets affect the quality of life for rural inhabitants. And that is one of the reasons why new generations of migrant workers from rural communities who have lived a long time in cities are reluctant to return and why city people are unwilling to move to the countryside. The toilet is a livelihood issue representing a preferable level of civilization. Household toilets in rural areas reflect the level of development of a region and affect the health and thus life quality of household members. Improving toilets has become an important livelihood project eagerly sought out by rural residents widely concerned by the whole society.

The toilet issue is not a small matter but an important aspect of urban and rural life. Sanitation improvements should be promoted as an integral part of rural revitalization to enhance the quality of life of people living in rural areas. To this end, the Ministry of Agriculture and Rural Affairs has launched a rural ‘toilet revolution’. To encourage the upgrading of toilet facilities and the recycling of toilet waste, the Academy of Agricultural Planning and Engineering (AAPE), within the Ministry, has compiled this *“Improving Rural Toilets—A Pictorial Handbook”*.

The handbook introduces the development process of toilets and the treatment methods of rural toilet waste in a question- and-answer format. It promotes different types of toilet-improving technologies, construction requirements, waste-recycling technology and other practical knowledge. It is hoped that this handbook will help rural residents tackle toilet renovation and waste recycling in a systematic, comprehensive, scientific and accurate manner. And in so doing, they will contribute towards improving rural sanitation.

Feedback on the content of the handbook is welcome.

Authors
December 2021

Contents

Foreword

1 Something about toilets

1.1 When did Chinese people begin using a toilet?	1
1.2 What are the hazards of faeces and urine?.....	4
1.3 What are the uses for faeces and urine?.....	5

2 Toilet renovation in the countryside

2.1 Why is toilet renovation imperative in the rural areas?	6
2.2 What should rural toilet facilities look like?	8
2.3 What are the types of non-hazardous toilets?	9
2.4 What are the types of new toilets?.....	10

3 Household toilet with three-compartment septic tank

3.1 What are the characteristics of a household toilet with three-compartment septic tank?.....	11
3.2 How does a household toilet with three-compartment septic tank flush?	12
3.3 How does the three-compartment septic tank treat faeces in a non-hazardous manner?	13
3.4 How should a household toilet with a three-compartment septic tank be properly built?	14
3.5 How big should the three-compartment septic tank be?	18
3.6 How should the inlet and transfer pipes be set?.....	19
3.7 How should the household toilet with a three-compartment septic tank be managed?.....	20

4 Double-urn household toilet

4.1 What are the characteristics of a double-urn
--

household toilet?	22
4.2 How does the double-urn household toilet treat faeces in a non-hazardous manner?	24
4.3 How big should the double-urn septic tank be?	25
4.4 How should a double-urn septic tank be properly built?	26
4.5 How should a double-urn household toilet be managed?	27

5 Alternating double-pit household toilet

5.1 What are the characteristics of the alternating double-pit household toilet?	28
5.2 How does the alternating double-pit household toilet treat faeces in a non-hazardous manner?	29
5.3 How big should the alternating double-pit household toilet be?	30
5.4 How should the alternating double-pit septic tank be properly built?	31
5.5 How should the alternating double-pit household toilet be managed?	32

6 Integrated household flushing toilet with separate systems for faeces and urine collection

6.1 What are the characteristics of an integrated household flushing toilet with separate systems for faeces and urine collection?	33
6.2 How does the integrated household flushing toilet with separate faeces and urine collection systems treat faeces in a non-hazardous manner?	34
6.3 How big should the integrated household flushing toilet with separate faeces and urine collection systems be?	35
6.4 How should the integrated household flushing toilet with separate faeces and urine collection systems be	

properly built?	36
6.5 How should the integrated household flushing toilet with separate faeces and urine collection systems be managed?	37

7 Household toilet with biogas digester

7.1 What are the characteristics of a household toilet with biogas digester?	38
7.2 How does the household toilet with biogas digester treat faeces in a non-hazardous manner?	39
7.3 What are the types of household toilets with biogas digesters?	40
7.4 How big should the biogas digester for the household toilet be?	41
7.5 How should a household toilet with biogas digester be properly built?	42
7.6 How can the existing toilet be transformed into a household toilet with a biogas digester?	44
7.7 Are there any precautions when using a household toilet with biogas digester?	45
7.8 How should a household toilet with biogas digester be managed?	46

8 Integrated household flushing toilet with complete water supply and drainage pipeline

8.1 What is the integrated household flushing toilet with complete water supply and drainage pipeline?	47
8.2 What are the characteristics of the integrated household flushing toilet with complete water supply and drainage pipeline?	48
8.3 How does the integrated household flushing toilet with complete water supply and drainage pipeline flush?	49
8.4 How does the integrated household flushing toilet with complete water supply and drainage pipeline treat the sewage?	50

8.5 Are there any precautions when using the integrated household flushing toilet with complete water supply and drainage pipeline?	51
---	----

9 Integrated household flushing toilet with biological treatment

9.1 What are the characteristics of the integrated household flushing toilet with biological treatment?	52
9.2 How does integrated biological treatment equipment treat the sewage?	54
9.3 How should the integrated household flushing toilet with biological treatment be properly built?	55
9.4 How should the integrated household flushing toilet with biological treatment be managed?	56

10 Ecological toilet

10.1 What are the constitution and characteristics of the ecological toilet?	57
10.2 How does the ecological toilet treat faeces in a non-hazardous manner?	58
10.3 How big should the ecological toilet be?	59
10.4 How should the ecological toilet be properly built?	60

11 Toilet waste recycling

11.1 How should toilet waste be disposed?	62
11.2 How should dispersed toilet waste be collected?	64
11.3 How should toilet waste be composted?	65
11.4 How is toilet waste transformed into nutrient-rich water for farmland?	71
11.5 What are the ecological treatment methods of human waste?	77

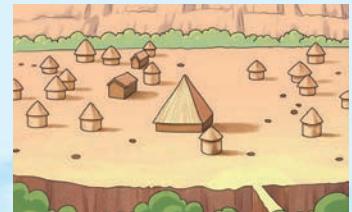


Something about toilets

1.1 When did Chinese people begin using a toilet?

In ancient times

Archaeologists found small pits where humans lived at a tribal site 5,000 years ago, in what is now known as of Banpo village in Shaan xi Province. After several rounds of authentication, it was finally determined that these small pits were simple toilets used in ancient times. This is considered the period when the ancestors became ‘civilized’, and these pits are considered the earliest toilets in China.



In slavery and feudal times

The toilet was first described in *Rituals – Ji Xi Li*, written in the Western Zhou Dynasty (1100 BC to 771 BC). It uses the phrase “slaves dig ground for toilets” to mean that ancient people dug the ground to make toilets. And when the pit was full, they ordered the slaves to fill it up and dig a new one. From the Xia, Shang and Western Zhou Dynasties to the early Qing Dynasty, toilets were named ‘hun’, ‘qing’, ‘yan’, ‘ce’, ‘qing’ and ‘shi suo’. And to avoid taboos, toilets had many nicknames, such as ‘she hou’, ‘xi ge’, ‘wo tou’, ‘mao si’ and ‘geng yi shi’ in the Tang Dynasty (618 to 906), ‘xue yin’ in the Song Dynasty (960 to 1279), ‘gong ce’ in the Ming Dynasty (1368 to 1644) and ‘gong tong’ in the Qing Dynasty (1644 to 1912).



Yan



Hun



Gong tong

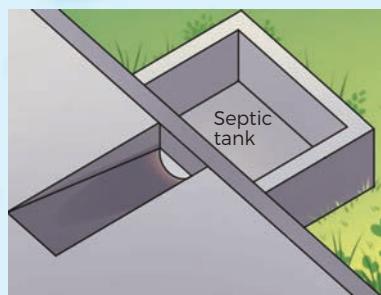
In the early days after the founding of the People's Republic of China

The ‘trench toilet’ is the first modern toilet that the Chinese people made. The design of a trench connected to a cesspool was popular in both urban and rural areas. It was not only convenient for people to excrete into but also to develop fertilizer within – killing two birds with one stone. But it also generated serious problems with bad smells, flies and maggots. At the founding time of the People’s Republic of China, a ‘patriotic sanitation campaign’ swept the country. People built toilets, managed faeces and eliminated pests, thereby greatly improving the sanitation level of toilets.



At the beginning of reform and opening up

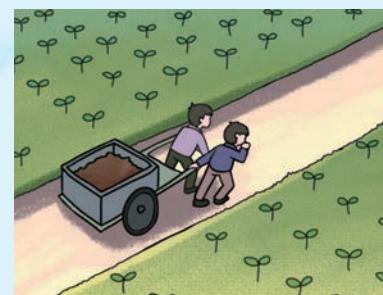
The government used the preparation for the 1990 Asian Games as opportunity to launch a massive toilet renovation campaign, which everyone called the ‘toilet revolution’. After a period of centralized reform efforts, China’s sanitation problem began to ease. At this point, people began to realize that the ‘smelly’ toilet was due to a design shortcoming.



Toilet pit and septic tank built with concrete bricks.



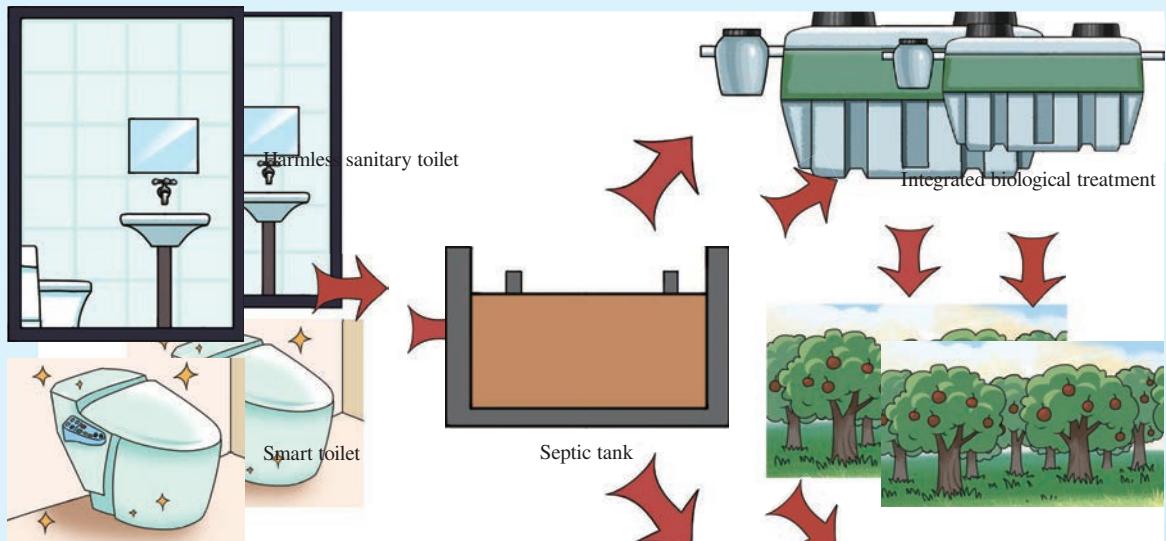
Regular cleaning of septic tank.



Toilet waste used as fertilizer for farmland.



In the 21st century



As China's new countryside construction and rural toilet renovation continued to advance into the twenty-first century, sanitation gradually improved, from the use of toilet pits to sanitary and non-hazardous toilets. In terms of toilet technology, energy conservation, environmental protection and resource recycling grew in significance, eventually becoming priorities. Water-saving household toilets, ecological household toilets and intelligent household toilets were introduced in rural areas, and the recycling of toilet waste attracted much attention. The toilet revolution in the countryside became a crucial component of the rural revitalization strategy and a requisite for building a prosperous society.



1.2 What are the hazards of faeces and urine?

Excrement contains many pathogens that are harmful to human health. It contains bacteria that may cause dysentery, typhoid, paratyphoid fever, cholera or food poisoning. It also can contain viruses that cause hepatitis A, hepatitis E or gastroenteritis. It can harbour parasites and their eggs, which can cause ascariasis, enterobiasis, bilharziasis, teniasis and other zoonotic parasitic diseases.

Under normal circumstances, pathogenic microorganisms can survive in the natural environment for several weeks to several months. Parasite eggs can even survive for several months to several years in untreated faeces. Therefore, excrement must be treated in a non-hazardous manner to prevent the spread of disease and epidemics.

Faeces and urine contain a large amount of nitrogen and phosphorus. Once discharged into water, they cause the eutrophication (the dense growth of plant life that leads to the death of animal life due to lack of oxygen) of the water and contaminate the water source. Water contaminated with faeces and urine can leak into the ground, raising the nitrate level of the groundwater. If it is not contained properly, it can increase the risk of digestive system tumours.



Hand – mouth – pathogen.



Fly – food – mouth – pathogen.

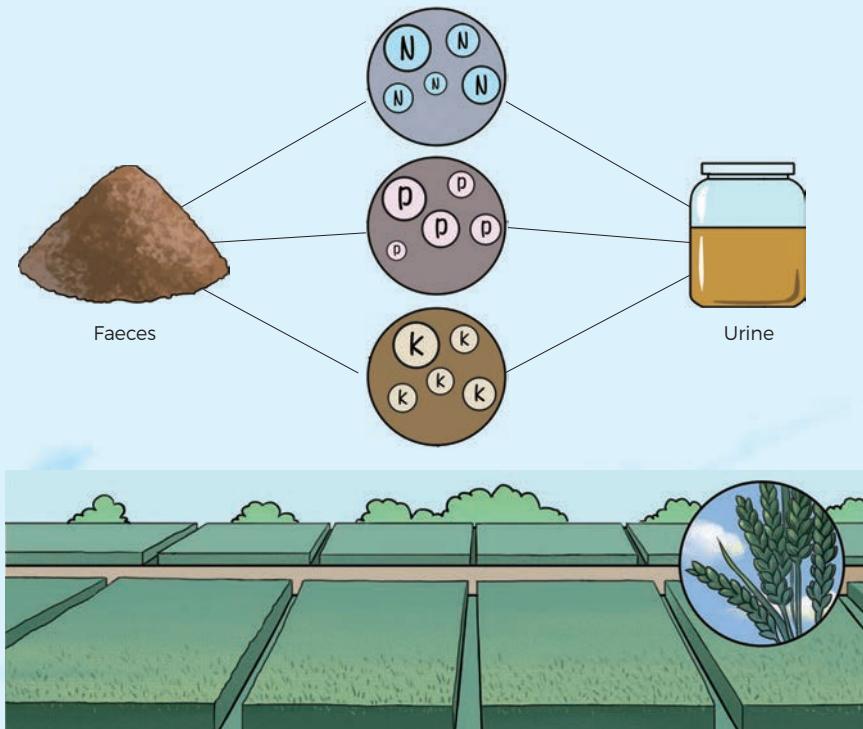


Soil – agricultural product – mouth – pathogen.



Water source – mouth – pathogen.





After non-hazardous treatment, excrement can be applied to farmland to produce organic products.

1.3 What are the uses for faeces and urine?

Faeces and urine are mixed together and widely used as fertilizer in rural areas of China. As a popular saying goes, “The growth of crops depends on faeces.”

The nutrient content of excrement is high. It contains high levels of nitrogen, phosphorus and potassium and a small amount of trace elements and inorganic salts, all of which are nutrients that crops need. One tonne of human faeces and urine is equivalent to 11–17 kilograms of urea and 3–6 kilograms of potassium dihydrogen phosphate.

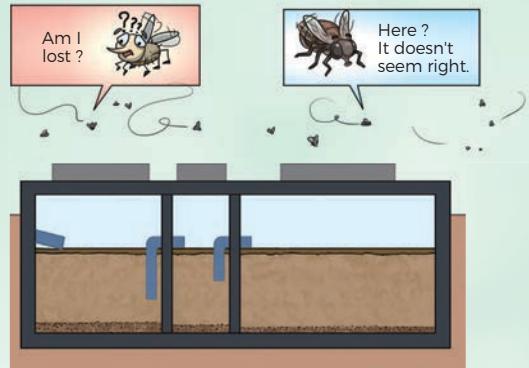
2

Toilet renovation in the countryside

2.1 Why is toilet renovation imperative in rural areas?

To contain the spread of diseases

Rural toilet improvement can control faecal and urine pollution and reduce mosquito- and fly-borne diseases. It can reduce the incidence of dysentery, typhoid, cholera, hepatitis, gastroenteritis and other diseases and interrupt the transmission of parasitic diseases, such as schistosomiasis, ascariasis and ancylostomiasis.



To improve living conditions

Once a toilet is upgraded in rural areas, it is followed by a sealing of the facility to block the impact of faeces on the environment, reduce the generation of odours and the breeding of mosquitoes and flies and to prevent and control the pollution of water sources. All these measures help to rid the dirty, messy and dangerous conditions caused by exposure to toilet waste and thus improve the rural living environment.



Improved quality of life



Civilized and sanitary.



Improved toilet conditions.



Rural toilet renovation



Improvement of flushing and handwashing facilities.



Neat yard.



Organic fertilizer.



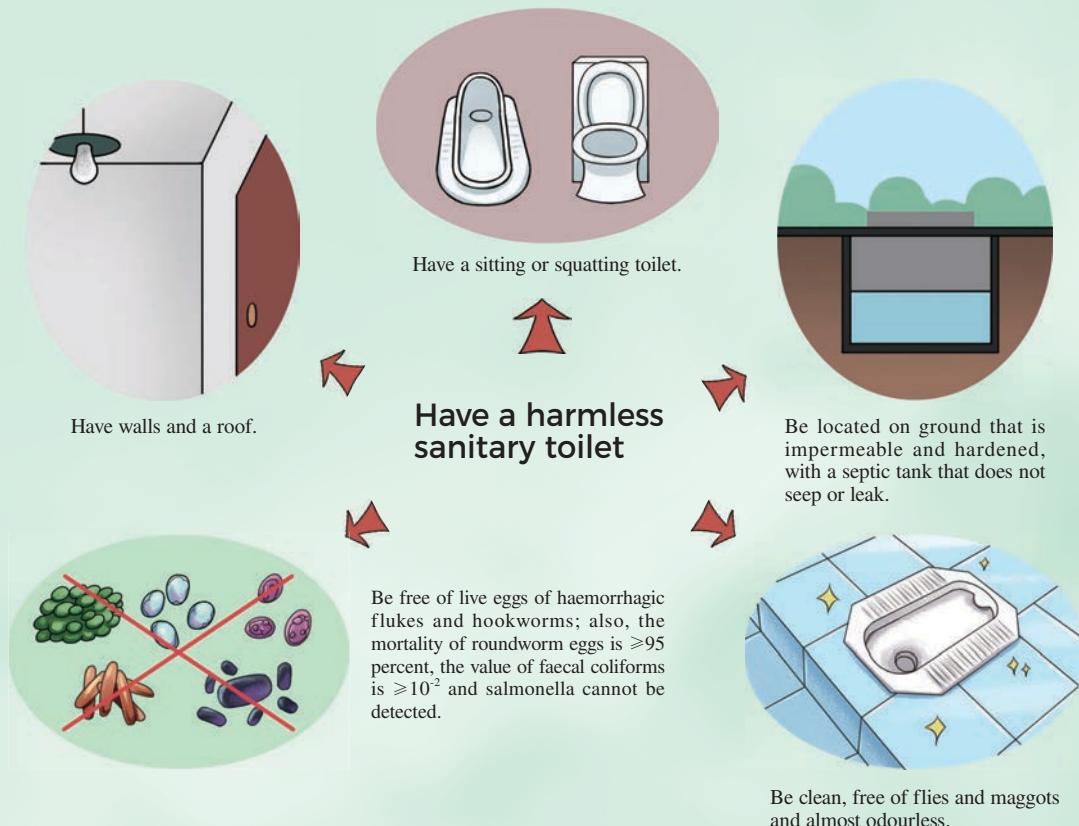
Agricultural products.

Production of
organic agricultural products.

The improvement of the sanitary conditions of toilets can improve the ease of excreting and the comfort of living. And the faeces can be used as organic fertilizer after non-hazardous treatment to produce high-quality agricultural products and improve the living standards of rural residents.

The use of sanitary toilets in rural areas can change some villagers' unhygienic habits and practices, improve their awareness of safe sanitation and good health and effectively control domestic pollution in the countryside.

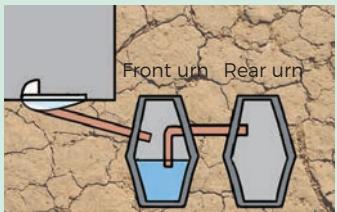
2.2 What should rural toilet facilities look like?



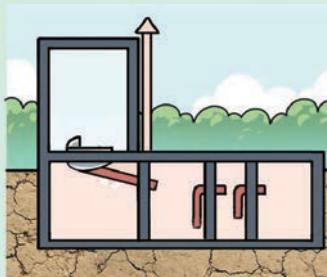
Simply put, rural toilets should be changed to non-hazardous sanitary toilets. The lavatory must have walls, a roof, a door, a sitting or squatting commode of a certain standard, hardened and impermeable ground and an leak-proof septic tank. It must be free of flies and maggots and remain basically odourless. The excrement can be treated in a non-hazardous manner to effectively reduce the infectiousness of any biological pathogens.



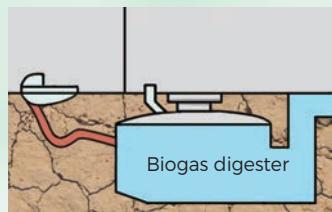
2.3 What are the types of non-hazardous toilets?



Dual-urn household toilet.



Household toilet with three-compartment septic tank.



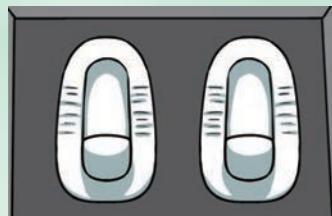
Household toilet with biogas digester.



Household toilet with separate faeces and urine collection systems.



Flushing household toilet.

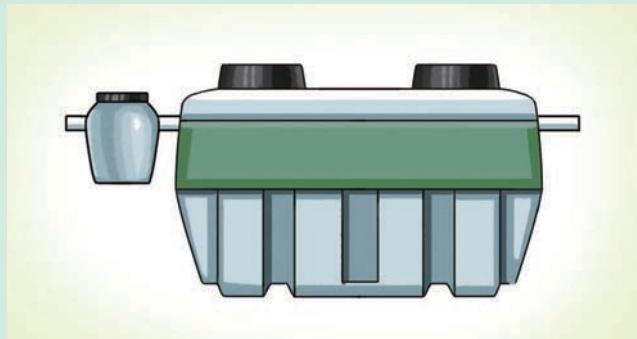


Alternating double-pit household toilet.

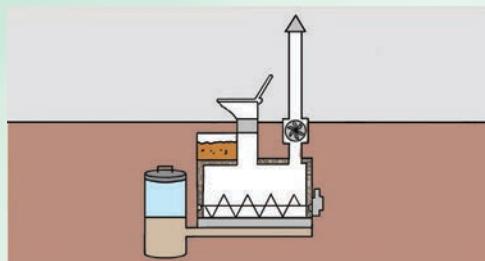
Non-hazardous toilets are classified several ways: household toilet with a three-compartment septic tank; double-urn household toilet; alternating double-pit household toilet; household toilet with separate faeces and urine collection systems; and flushing household toilet with complete water supply and drainage system and sewage-treatment facility.

2.4 What are the types of new toilets?

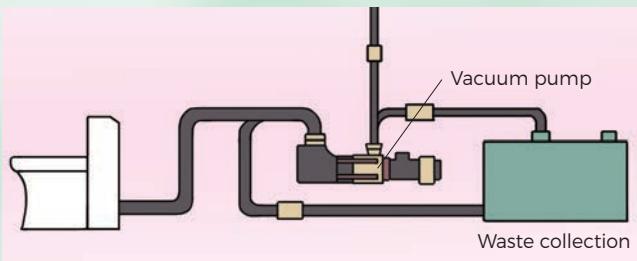
The new types of toilets are household toilets with integrated biological treatment that can treat all sewage and excrement together. Ecological toilets do not need to be flushed with water and can produce organic fertilizer. Vacuum self-suction water-saving toilets can be pressurized.



Household toilet with integrated biological treatment.



Ecological toilet that does not need to be flushed.



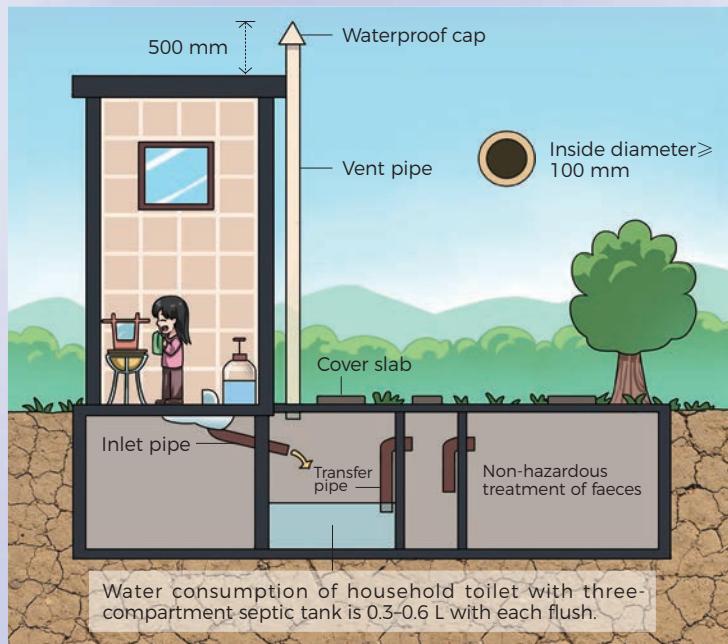
Vacuum self-suction water-saving household toilet.



Household toilet with three-compartment septic tank

3.1 What are the characteristics of a household toilet with three-compartment septic tank?

The household toilet with a three-compartment septic tank consists of the toilet room, a sitting or squatting toilet, flushing equipment and a three-compartment septic tank. Under the principles of faecal residue settlement and microbial degradation, the three-compartment septic tank treats faeces in a non-hazardous manner and can be widely used in rural areas without a water supply or a drainage pipeline network.

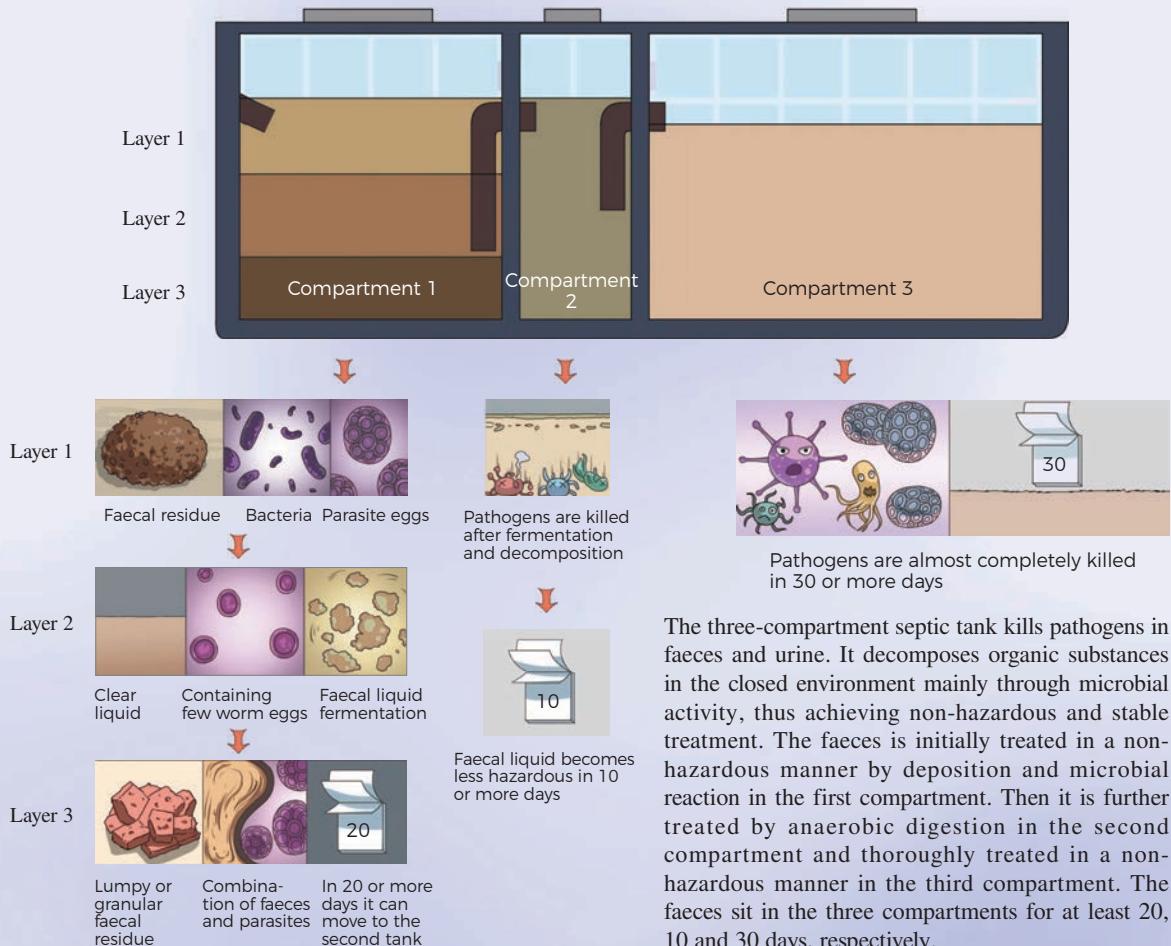


3.2 How does a household toilet with three-compartment septic tank flush?

A water-saving high-pressure flushing device is recommended. The device consists of a water tank, flushing pump, tank lid, foot pedal or button and outlet pipe. A high-pressure pump or stepping on the pedal or pressing the button causes the toilet to flush.



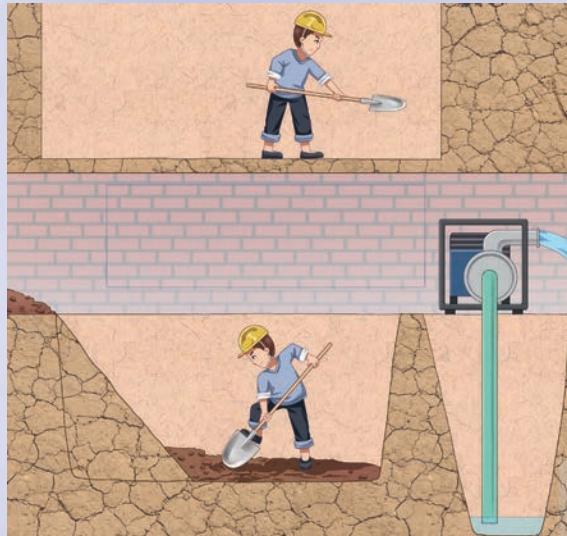
3.3 How does the three-compartment septic tank treat faeces in a non-hazardous manner?



The three-compartment septic tank kills pathogens in faeces and urine. It decomposes organic substances in the closed environment mainly through microbial activity, thus achieving non-hazardous and stable treatment. The faeces is initially treated in a non-hazardous manner by deposition and microbial reaction in the first compartment. Then it is further treated by anaerobic digestion in the second compartment and thoroughly treated in a non-hazardous manner in the third compartment. The faeces sit in the three compartments for at least 20, 10 and 30 days, respectively.

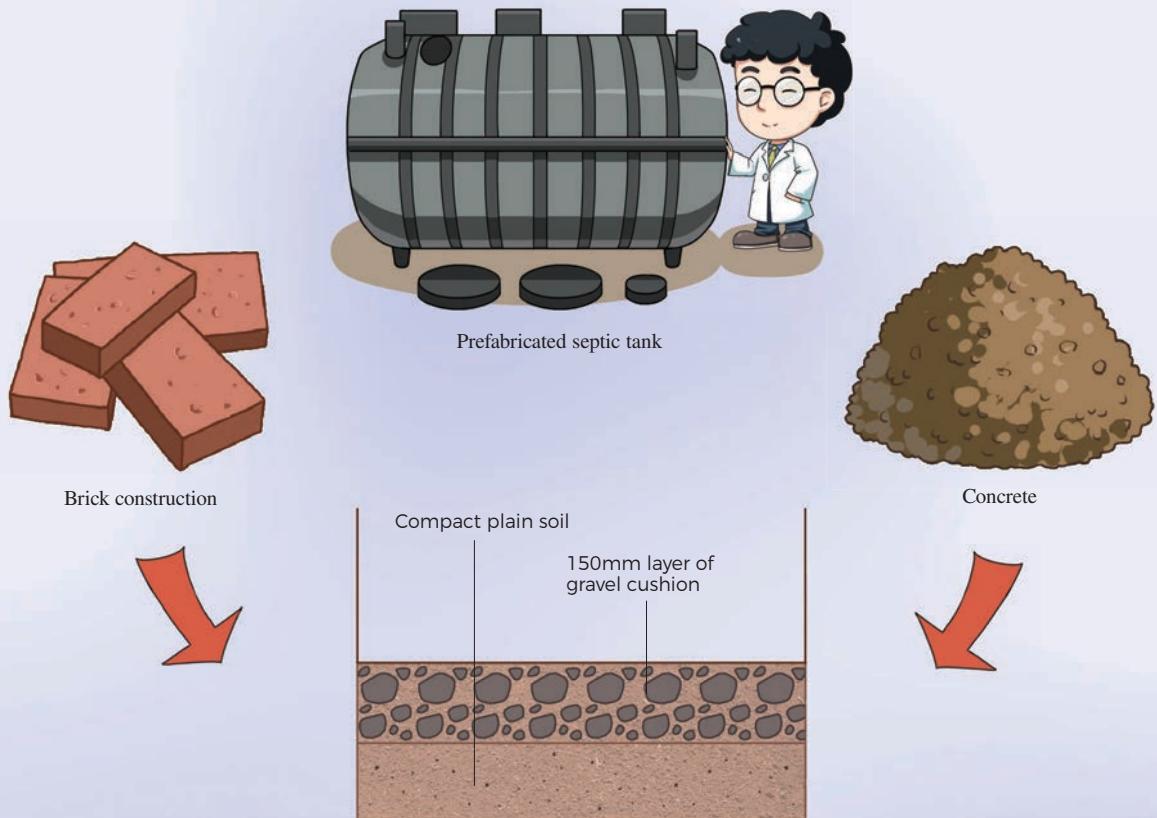
3.4 How should a household toilet with a three-compartment septic tank be properly built?

The three-compartment septic tank for a household toilet is mainly built from bricks or prefabricated components. The construction of a brick-structure septic tank mainly includes pit digging, foundation treatment, tank construction (installation) and water test. The key works are seepage prevention and the installation of the transfer pipe. After construction, the water test should be performed first before using the septic tank. A prefabricated septic tank can be installed.

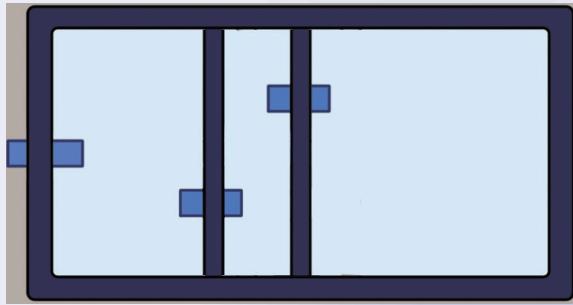


① **Pit digging:** In a plot of land with good soil quality, dig a pit vertically. Then lay the bricks closely against the pit walls. In a plot of land with poor soil quality or groundwater, dig a pit with a slight slope; the backfilling width should not be less than 150 millimetres. For both conditions, next dig a 2metres-deep sump (low space) near the pit in a plot of land with a high groundwater level and start the excavation after the water is completely drained. In cold regions at high altitudes, anti-freezing measures, such as deep burying and covering with thermal insulation materials, can be adopted to ensure stable operation.

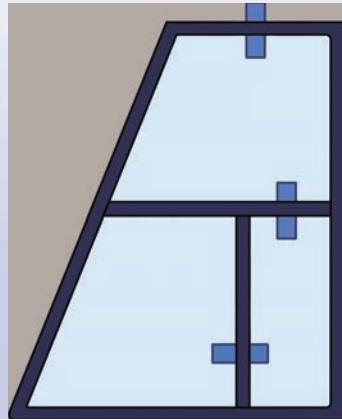
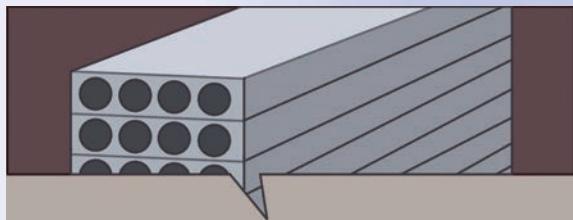




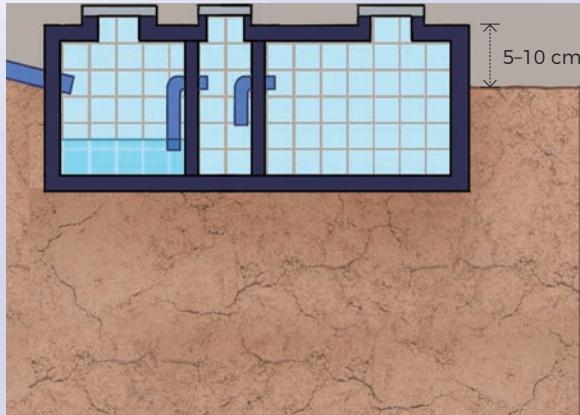
② Foundation treatment: The foundation must be compacted. Use a 50–100 millimetres-thick concrete cushion as the foundation to prevent equipment displacement and seepage due to any uneven settlement.



In a form like this Chinese character ‘目’

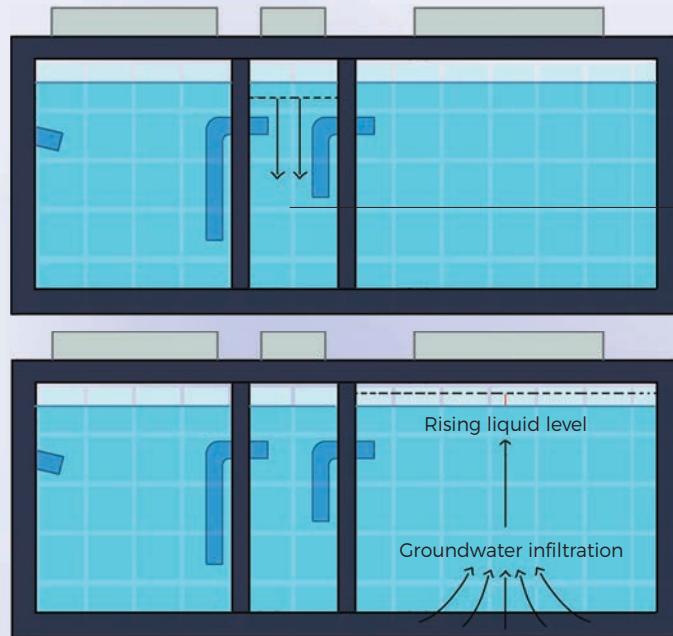


In a form like this Chinese character ‘品’



③ Tank construction (installation): When using a prefabricated three-compartment septic tank, check it for any damage in transportation or instalment and perform a water test when necessary. When using a cast-in-place tank, build the walls first according to the dimensions of the septic tank. Build two walls in the middle to create three compartments in the form of the Chinese character ‘品’ or ‘目’. Plaster the walls with concrete. Pay attention to the installation time and the position and direction of the inlet and transfer pipes. Backfill the foundation with plain soil, which can be mixed with 30 percent gravel or tile fragments. The top plate and top cover of the tank must be prefabricated to ensure sealing. The top of the septic tank should be 5–10 centimetres higher than the surrounding ground to prevent water from flowing into the tank.





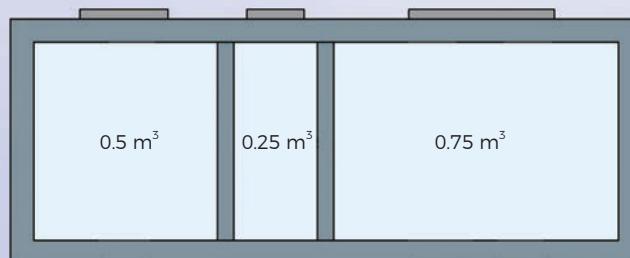
④ **Water test:** Perform the water test first after the completion of the septic tank. Fill the tank with water. If the water level drops more than 1 centimetres in 24 hours, there is seepage. Plaster the tank with cement paste containing anti-seepage powder one to two times. If the water level goes up, the groundwater level will be high and thus infiltrate the tank. Corresponding measures should be taken to prevent infiltration and floating.

3.5 How big should the three-compartment septic tank be?

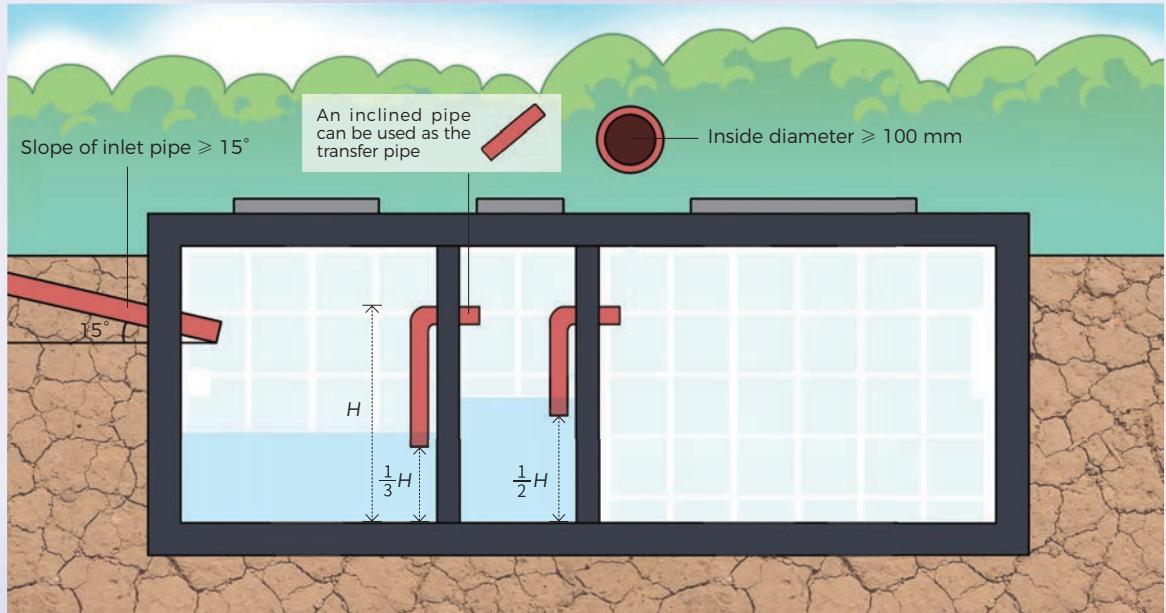
The volume ratio of the three compartments of the septic tank should be 2:1:3. For a family of four persons, a 1.5 cubic metres septic tank is needed. The volume of the first compartment is 0.5 cubic metres, the second is 0.25 cubic metres and the third is 0.75 cubic metres.



A family of four



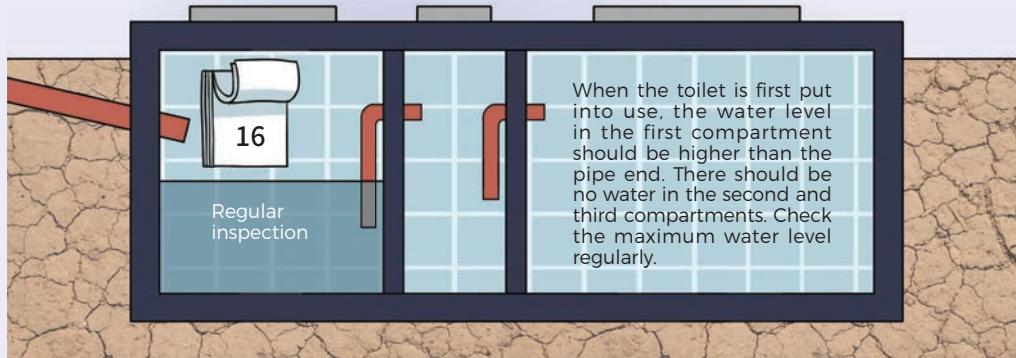
3.6 How should the inlet and transfer pipes be set?



Inlet pipe: A polyvinyl chloride (PVC) plastic pipe connecting the toilet to the septic tank should have an inside diameter of no less than 110 millimetres. And the angle between the pipe and the horizontal line should not be less than 15°.

Transfer pipe: Generally, an L-shaped pipe or inclined pipe is set in a staggered position. The distance between the lower end of the transfer pipe between the first and second compartments and the bottom should be one third of the highest liquid level in the first compartment. And the distance between the lower end of the transfer pipe between the second and third compartments and the bottom should be one half the highest liquid level in the second compartment. The upper end should be at the upper limit of the maximum liquid level.

3.7 How should the household toilet with a three-compartment septic tank be managed?



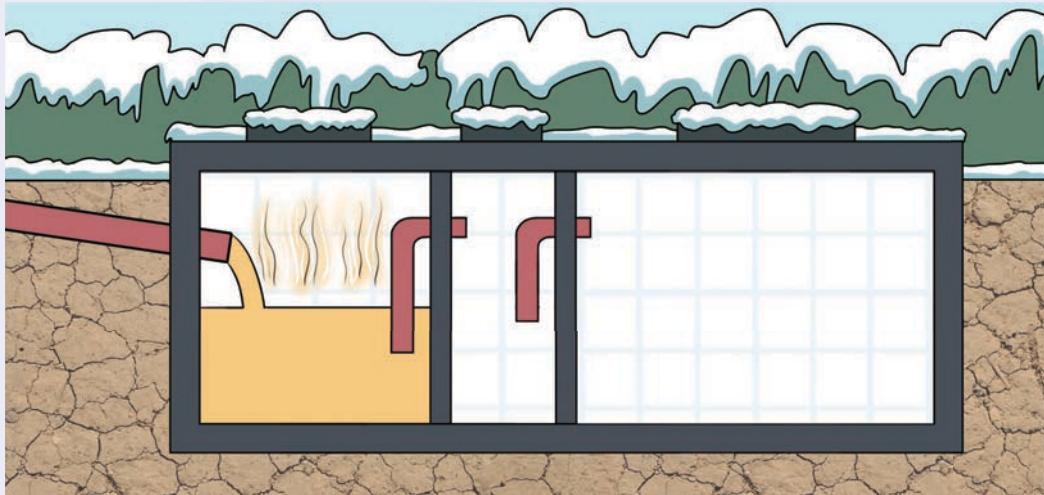
Do not drop waste, such as toilet paper and sanitary napkins, into the toilet.



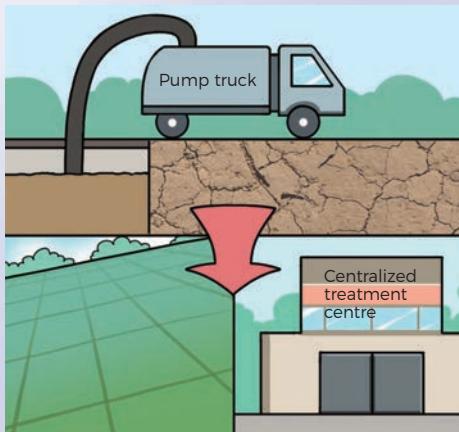
Prevent shower and laundry water from entering the septic tank if the toilet waste will be reused in farmland.

The household toilet with a three-compartment septic tank should be used and maintained in a safe, stable and water-saving manner. Check the initial water level when the toilet is first put into use. Do not drop other waste into the toilet, and keep washing water from entering the septic tank. Clean the tank regularly to prevent environmental pollution.





When there is excess sludge in the toilet in cold regions during the winter, clean it with warm water to keep the inlet pipe clear.



Faeces can be pumped out from a septic tank for centralized treatment



Do not drop firecrackers or cigarette butts into the septic tank.

4

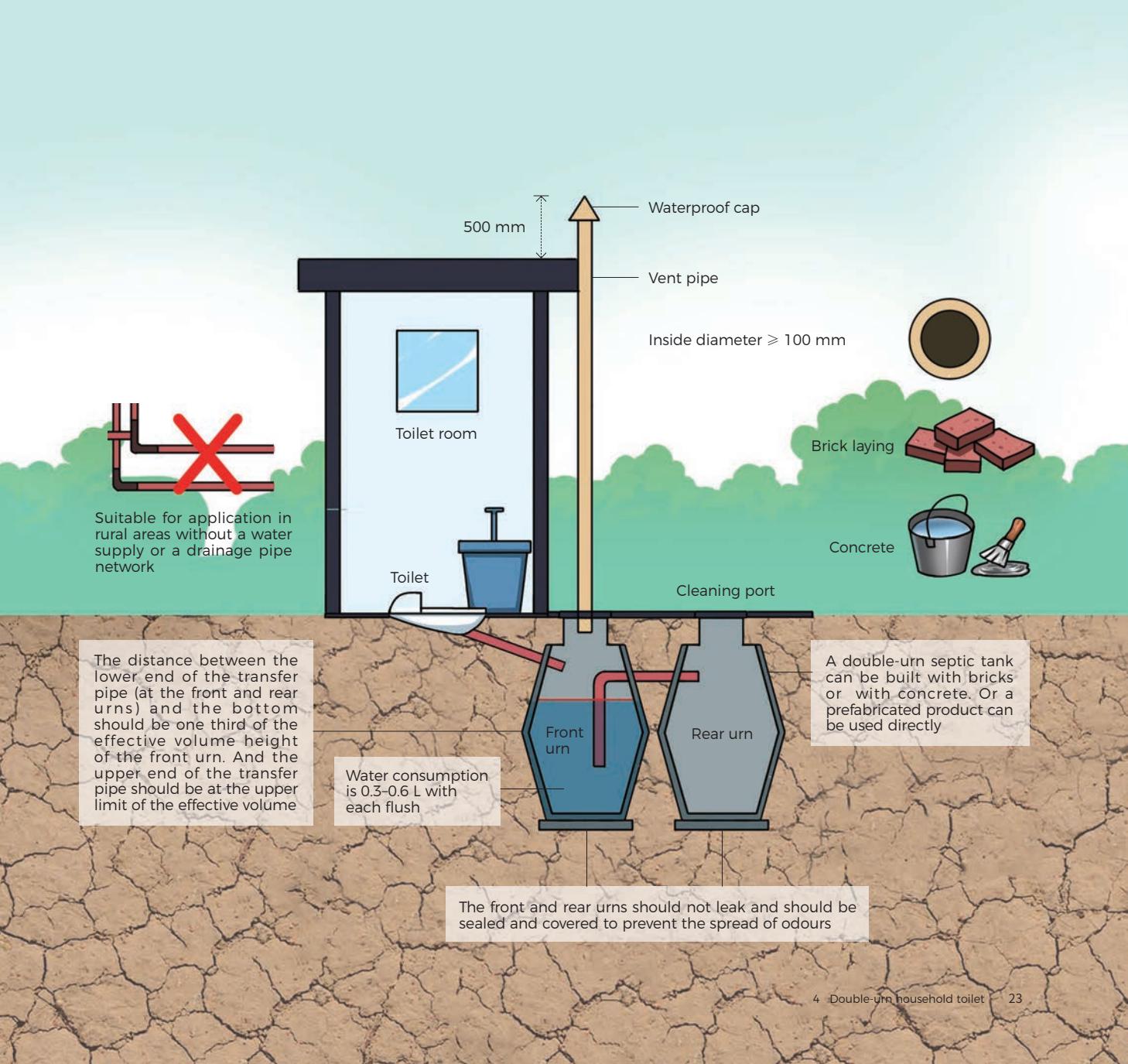
Double-urn household toilet

4.1 What are the characteristics of a double-urn household toilet?

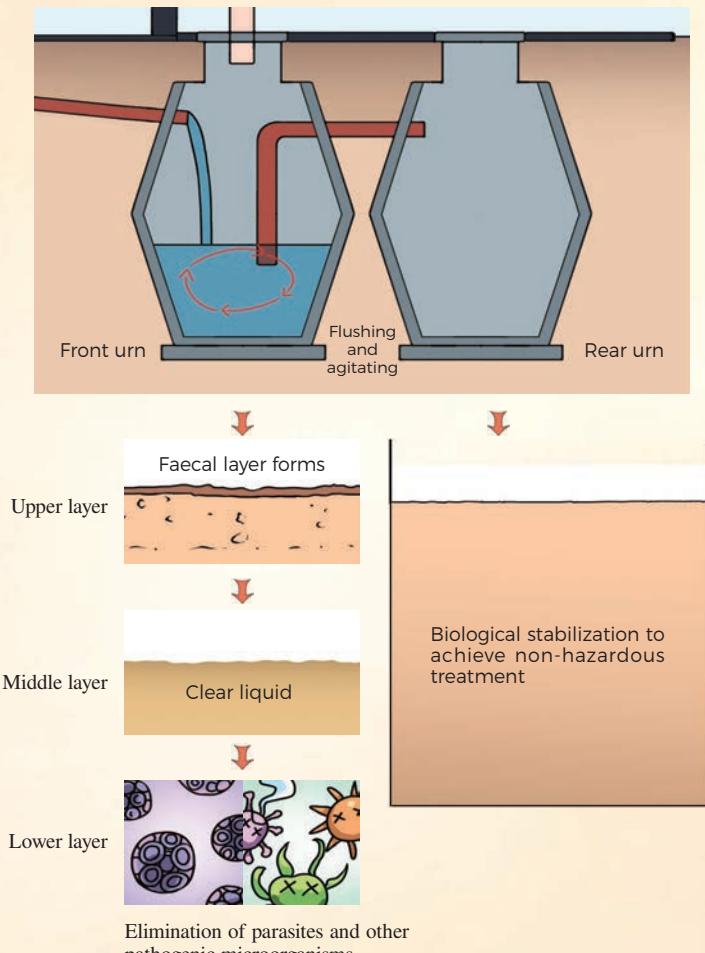


The double-urn household toilet consists of a front urn, (sitting or squatting) toilet, rear urn, toilet room and vent pipe. The double urns (double compartments) consist of two closed septic tanks connected by a transfer pipe. The elimination of pathogens, such as parasite eggs and enteropathogenic bacteria in the faeces, is realized through the anaerobic fermentation and decomposition of the faeces in the urns.





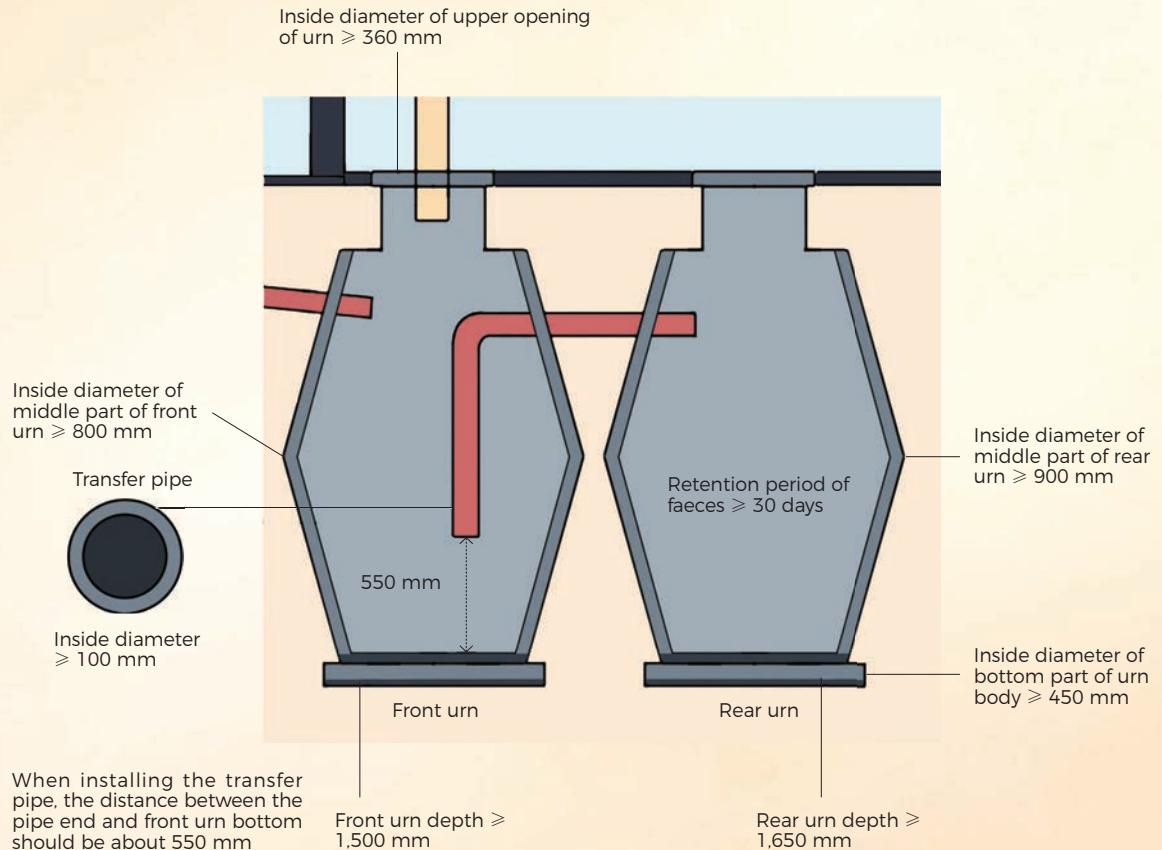
4.2 How does the double-urn household toilet treat faeces in a non-hazardous manner?



In the double-urn septic tank, waste is stored in the closed environment. Bacteria, viruses and parasites (eggs) are eliminated or removed by anaerobic fermentation and precipitation to achieve non-hazardous treatment.



4.3 How big should the double-urn septic tank be?



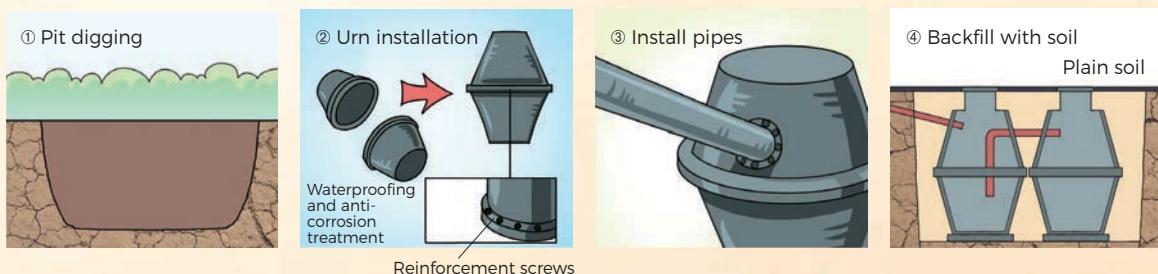
4.4 How should a double-urn septic tank be properly built?

A double-urn septic tank is mainly built from bricks or prefabricated components. The construction of a brick-structure septic tank mainly includes pit digging, foundation treatment, tank construction (urn installation) and a water test. The key works are seepage prevention and the installation of the transfer pipe to prevent the urn from being displaced. After construction, the water test should be performed first before using the septic tank. A prefabricated septic tank can be installed as required. In cold regions at high altitudes, anti-freezing measures, such as deep burying and covering with insulation materials, can be adopted to ensure stable operation.

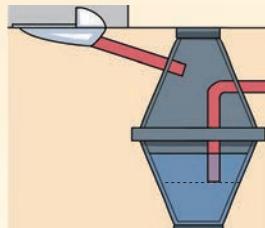
Brick-structure septic tank



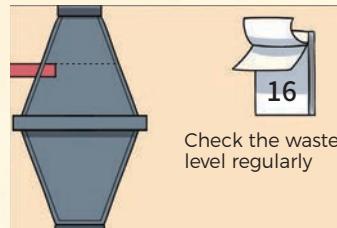
Prefabricated septic tank



4.5 How should a double-urn household toilet be managed?



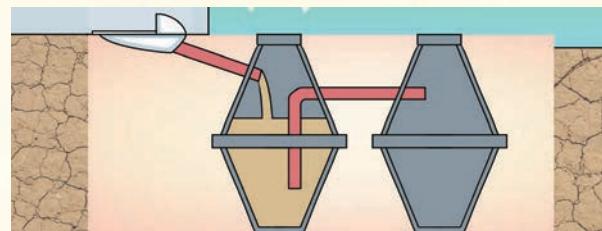
The water level should be higher than the pipe inlet in the front urn when using the toilet.



The maximum water level should be higher than the pipe outlet in the rear urn.



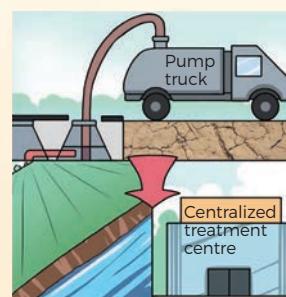
Do not drop other waste into the toilet or toilet pit.



When it is cold, clean the urns with warm water to clear the pipes.



Prevent shower and laundry water from entering the septic tank.



A pump truck removes faeces from the rear tank.

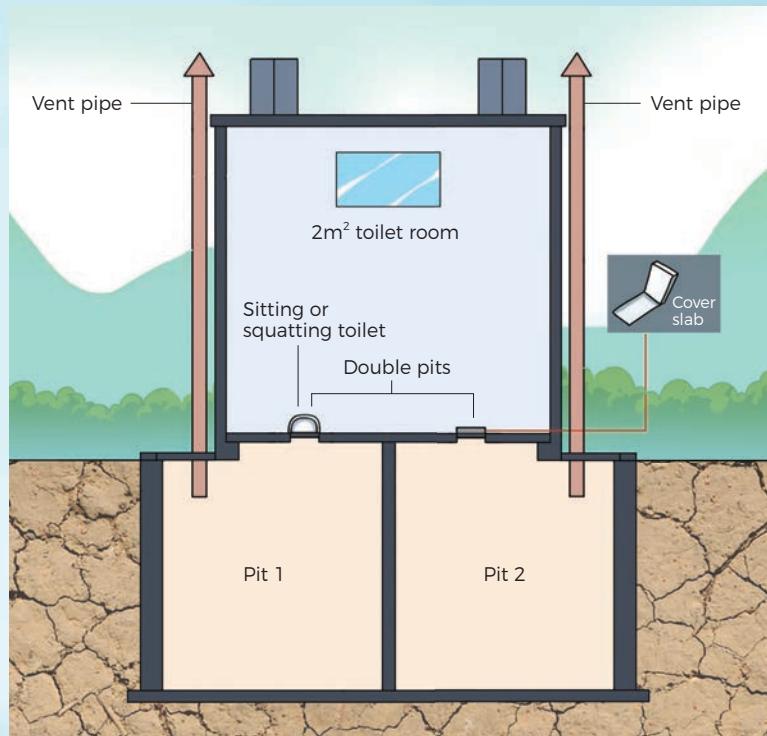


Do not drop firecrackers or cigarette butts into the tank.

5

Alternating double-pit household toilet

5.1 What are the characteristics of the alternating double-pit household toilet?

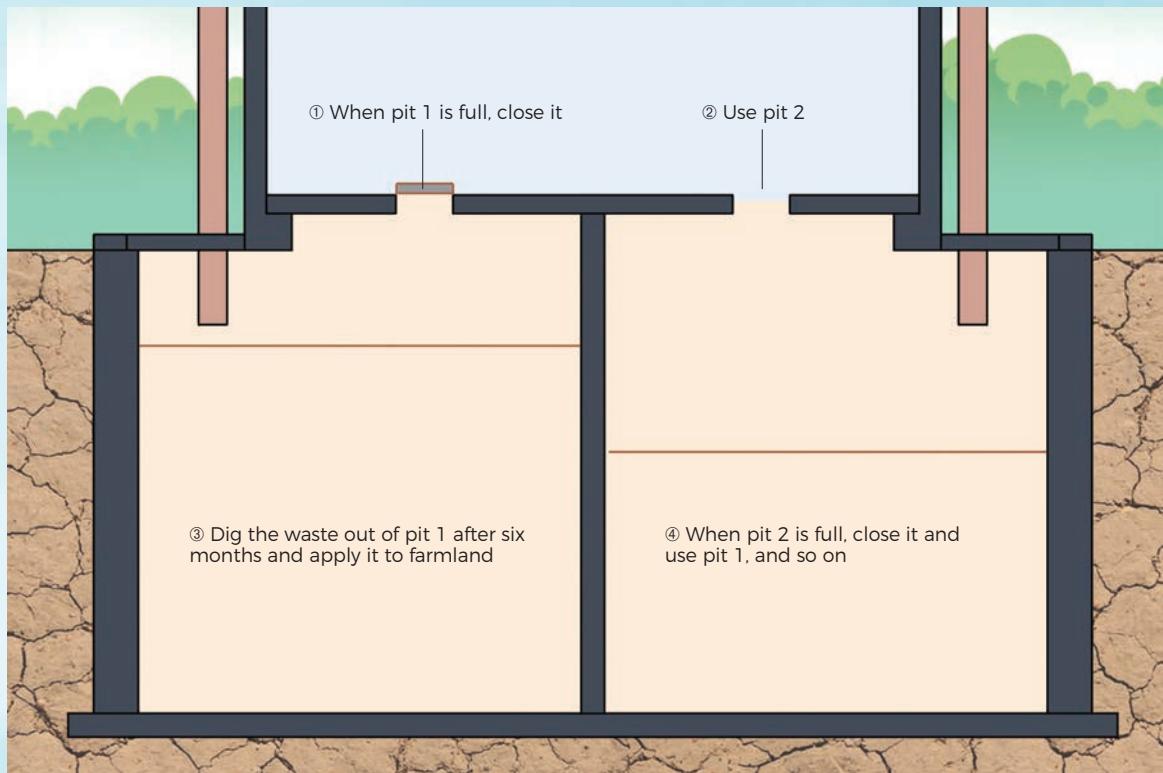


The alternating double-pit household toilet consists of a toilet room, toilet and septic tank. The alternating double-pit septic tank treats faeces in a non-hazardous manner mainly through microbial activity. Characteristics of the alternating double-pit household toilet are two pits of the same volume and two rectangular squatting openings on the upper prefabricated slab cover. The openings are closed with cover slabs after they are used. Each faecal pit has one vent pipe, and the toilet room is built over the two pits. This type of household toilet is more often used in dry and cold regions at high altitudes.



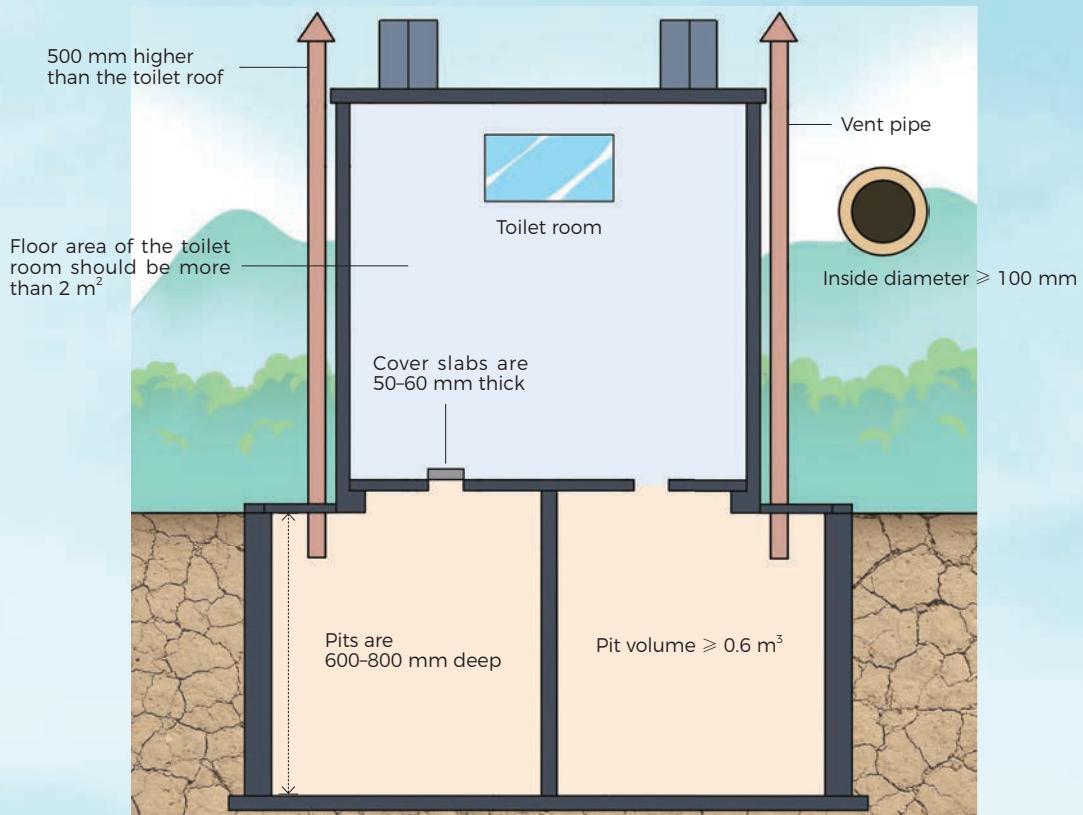
5.2 How does the alternating double-pit household toilet treat faeces in a non-hazardous manner?

The alternating double-pit septic tank kills pathogens in the faeces in a closed environment mainly through microbial activity, achieving non-hazardous treatment. Pit 1 is used first. After this pit is full, it is closed, and pit 2 is put into use. The faeces in pit 1 can be cleaned after six months. If it must be cleaned before six months, the faeces should be composted for non-hazardous treatment. The two pits are used alternately. After using the squatting toilet, a proper amount of plant ash, slag or chopped stalks is sprinkled to cover the waste in the pit.

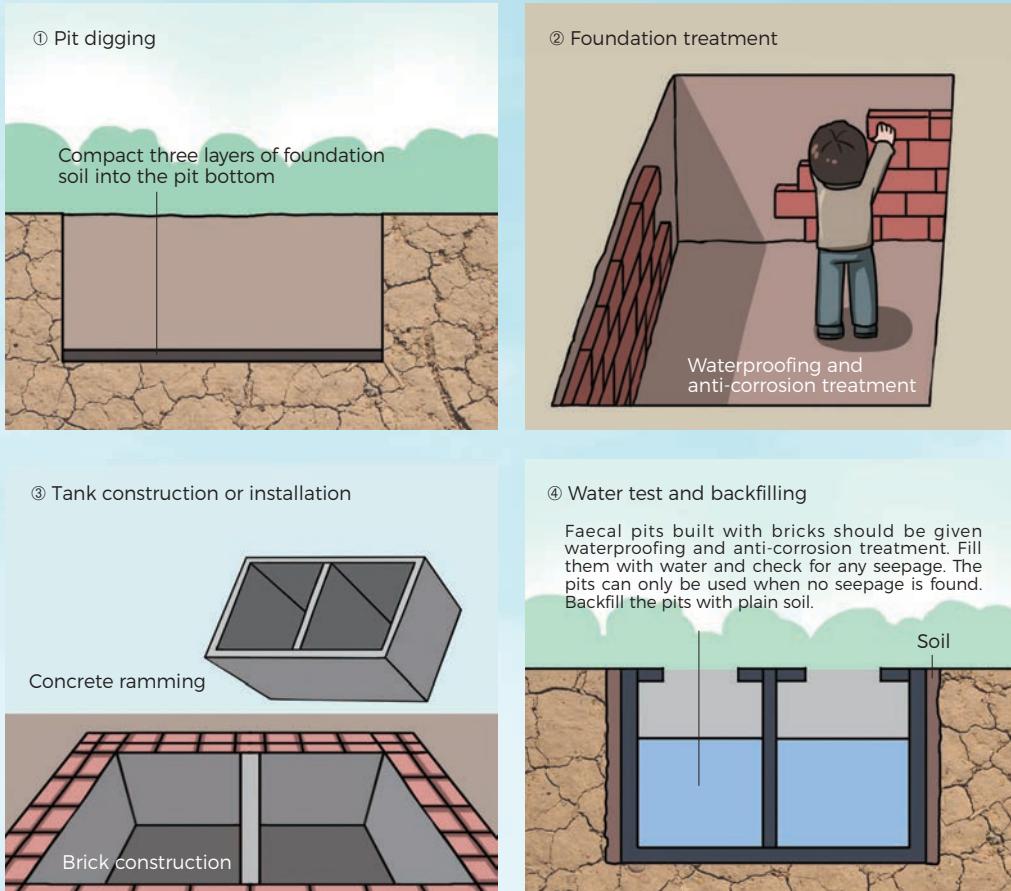


5.3 How big should the alternating double-pit household toilet be?

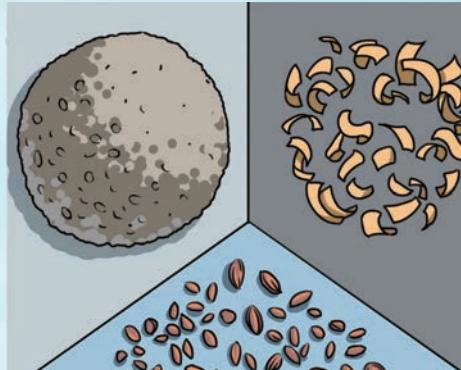
A family of four persons requires an alternating double-pit household toilet, with the volume of each pit at nothing less than 0.6 cubic metres. There should be a 300×300 millimetres square outlet on the back wall of each pit.



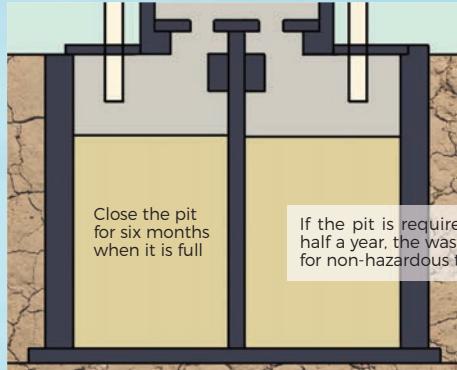
5.4 How should the alternating double-pit septic tank be properly built?



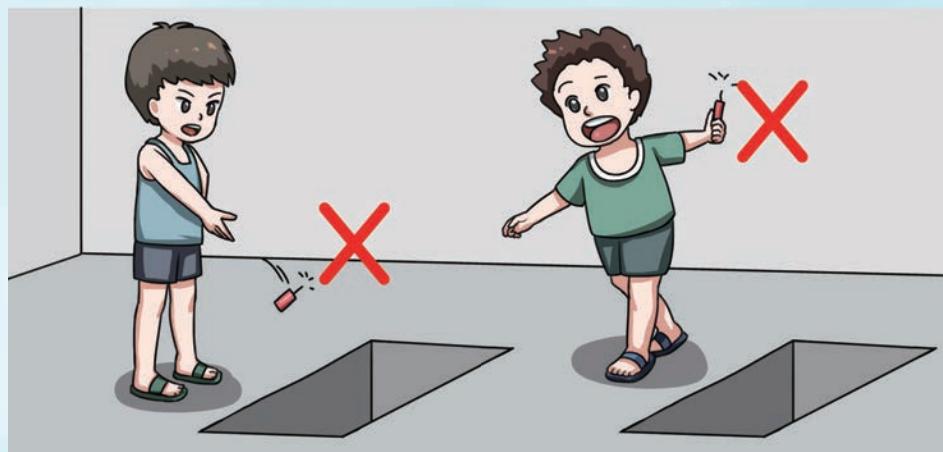
5.5 How should the alternating double-pit household toilet be managed?



Cover faeces with dry and fine soil, sawdust or straw after using the squatting toilet.



Only one faecal pit should be used at a time.



Do not drop firecrackers or cigarette butts into the pit because it could cause the flammable gas to ignite.



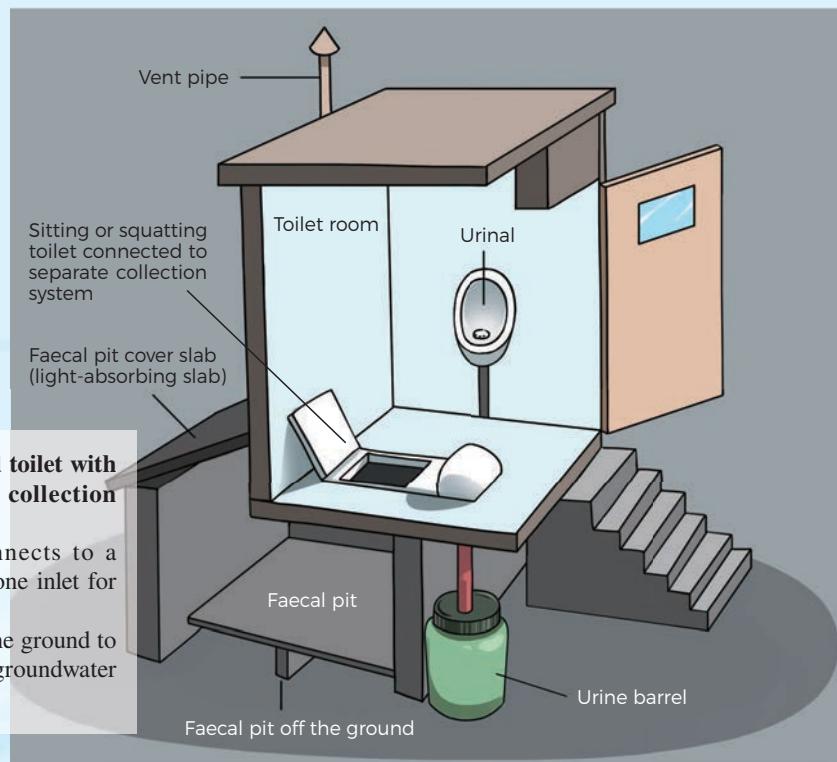
Integrated household flushing toilet with separate systems for faces and urine collection

6.1 What are the characteristics of the household flushing toilet with separate systems for faeces and urine collection?

The household toilet with separate system for faeces and urine collection consists of a toilet room, sitting or squatting toilet connected to a separate collection system, urine barrel, faecal pit, faecal pit cover slab (light-absorbing slab) and vent pipe. Its overall structure is designed to be overground. It is suitable for arid regions.

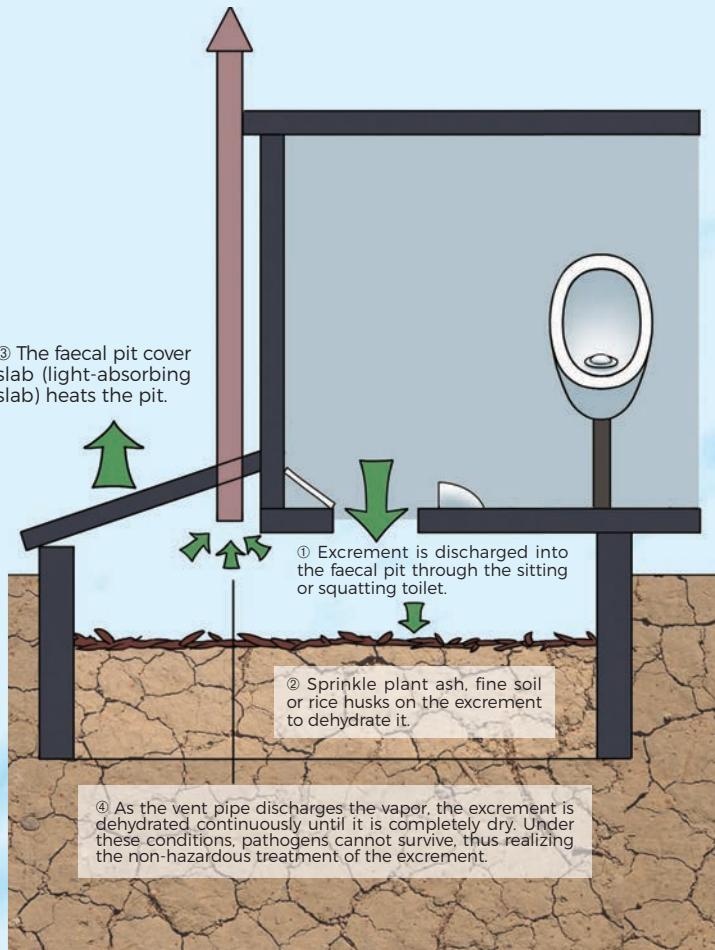
Characteristics of household toilet with separate faeces and urine collection system

- ① The squatting toilet connects to a collection system that has one inlet for faeces and one for urine.
- ② The faecal pit must be off the ground to prevent the infiltration of groundwater and moisture.



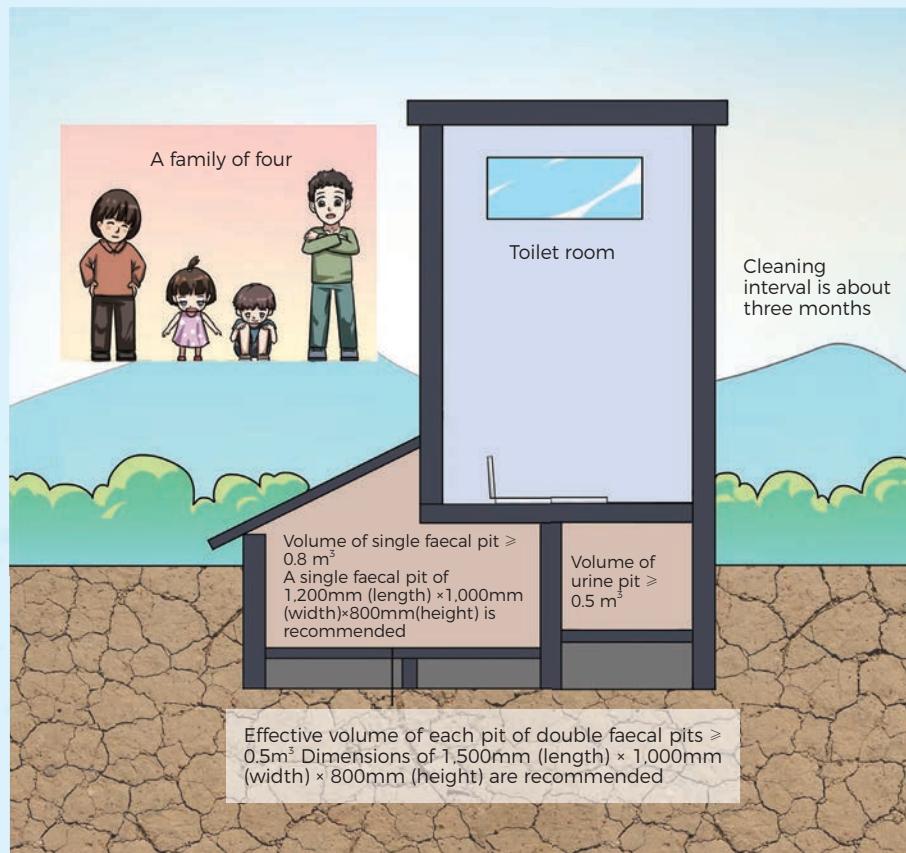
6.

The household toilet with a separate systems collects and treats faeces and urine separately via the dedicated squatting toilet. The excrement is discharged into the faecal pit through the excrement inlet. The urine flows into the urine barrel through the urine inlet. The user then sprinkles plant ash, fine soil, stalk powder or rice husks on the faeces to dehydrate it to some extent. As the faecal pit cover slab (light-absorbing slab) heats the faecal pit and the vent pipe discharges the vapor, the excrement is dehydrated continuously until it is completely dry. Under these conditions, pathogens cannot survive, which leads to the non-hazardous treatment of the excrement.



6.3 How big should the integrated household flushing toilet with separate faeces and urine collection systems be?

For a family of four persons, the effective volume of a single faecal pit cannot be less than 0.8 cubic metres. The effective volume of each pit of double faecal pits cannot be less than 0.5 cubic metres. And the volume of the urine pit cannot be less than 0.5 cubic metres.



6.4 How should the integrated household flushing toilet with separate faeces and urine collection systems be properly built?



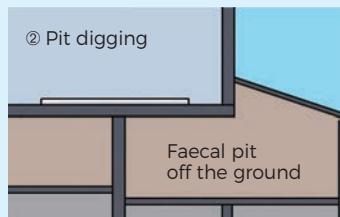
Select a dry place with sufficient sunshine in the yard to build the toilet. The light-absorbing slab should face south.



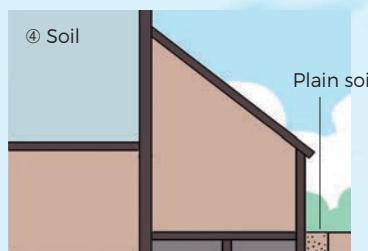
A faecal pit built with bricks should be given waterproofing and corrosion-resistance treatment. After curing and drying, fill the pit with water to check for seepage. The pit can be used only when no seepage is found.



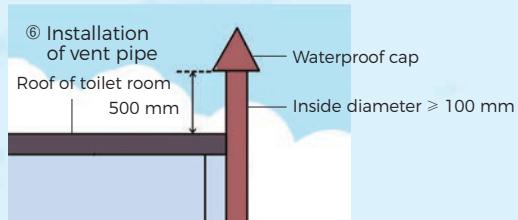
The faecal pit is installed with a light-absorbing slab that should be made of a metal plate with both sides painted black and have a slope of about 45°.



The faecal pit is off the ground and given waterproofing and other weatherproofing treatment to prevent the infiltration of groundwater and moisture.



Backfill the faecal pit with plain soil.



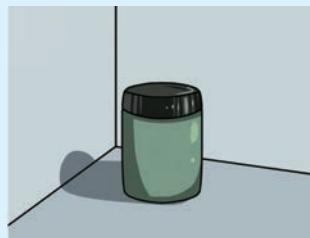
The top of the vent pipe should be 500 millimetres higher than the roof edge of the toilet room. The inside diameter should be ≥ 100 millimetres. The top of the vent pipe must have a waterproof cap.



6.5 How should the integrated household flushing toilet with separate faeces and urine collection systems be managed?



Clean any urine and excrement stains, and sprinkle covering materials regularly to keep the toilet clean.



There must be a barrel to store covering materials in the toilet room, maintained with sufficient covering materials for use.



When the urine barrel or faecal pit is full, clean it in a timely manner.



Prevent laundry water and shower water from entering the pit.



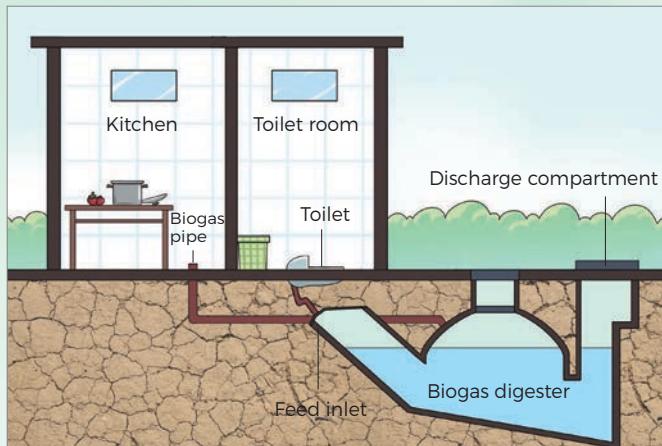
Prevent firecrackers, cigarette butts and feminine hygiene products from entering the pit.

7

Household toilet with biogas digester

7.1 What are the characteristics of a household toilet with biogas digester?

The household toilet with a biogas digester connects the toilet and biogas digester via a pipe to produce biogas by fermenting faeces, thereby realizing the non-hazardous treatment of waste. It consists of overground and underground parts. The overground part includes a toilet room, squatting toilet, movable biogas digester cover and biogas pipe. The underground part includes an inlet, discharge compartment and household biogas digester.



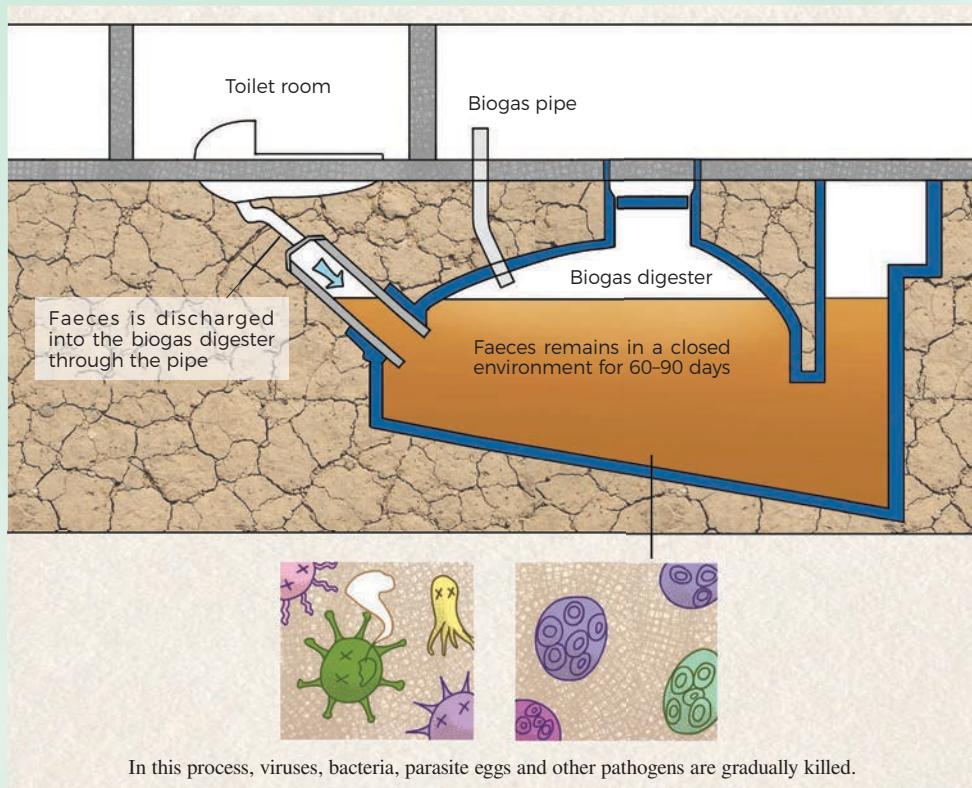
Characteristics:

- ① The integration of the toilet and biogas digester can address the difficulty in storing faeces as well as the supplying of biogas and fertilizer to effectively ease the shortages of clean energy and fertilizer in rural areas.
- ② It reduces the cost and decreases the time needed for excrement cleaning (once every year or two years).
- ③ It improves environmental hygiene because the biogas digester is capable of sterilization, deodorization and killing worm eggs, effectively improving dirty, messy and dangerous toilet environments in rural areas.
- ④ It has wide application scope because it can be used in villages that already have household biogas digesters or that are suitable for the construction of household biogas digesters.

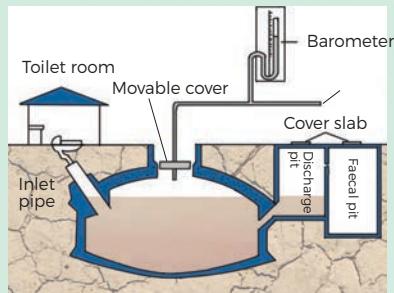


7.2 How does the household toilet with biogas digester treat faeces in a non-hazardous manner?

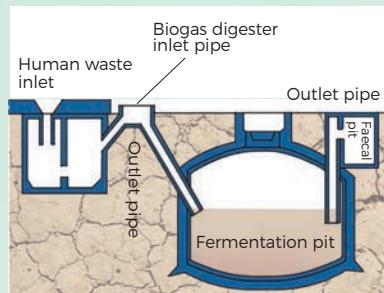
The household toilet with a biogas digester kills pathogens in the faeces in a closed environment mainly through microbial activity, achieving non-hazardous treatment.



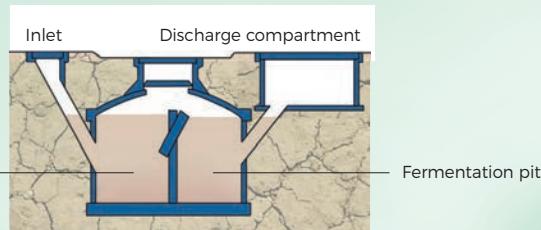
7.3 What are the types of household toilets with biogas digesters?



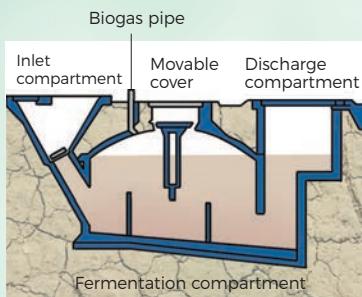
Three-pit biogas digester



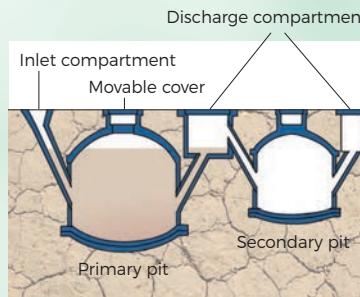
Human waste pre-treatment biogas digester



Two-compartment biogas digester



Meandering biogas digester

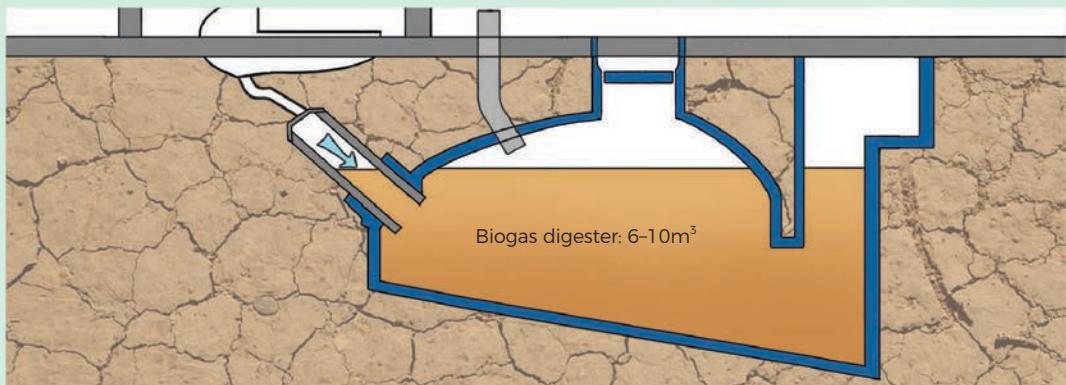


Two-stage fermentation biogas digester

There are five types of household toilets with biogas digesters: one with a three-pit biogas digester, one with a human waste pre-treatment biogas digester, one with a two-compartment biogas digester, one with a meandering biogas digester and one with a two-stage fermentation biogas digester.



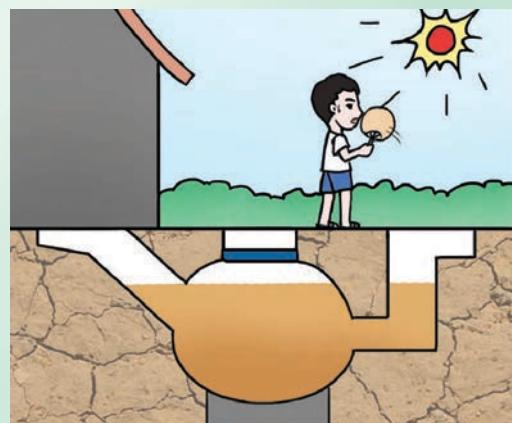
7.4 How big should the biogas digester for the household toilet be?



Generally, a 6–10 cubic metres biogas digester is needed.



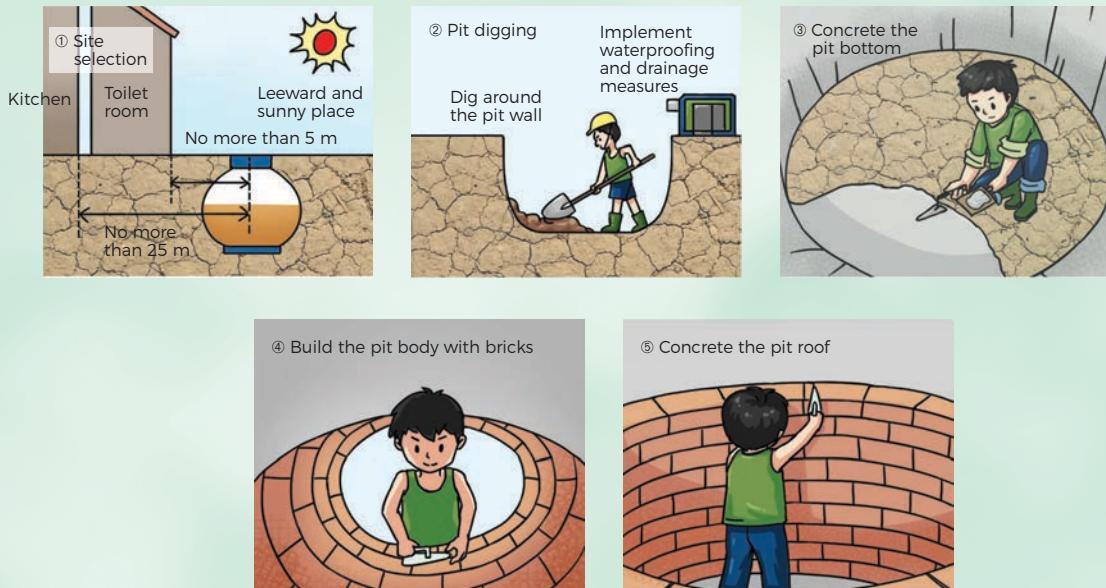
The average volume of a biogas digester is 8–10 cubic metres in the north.

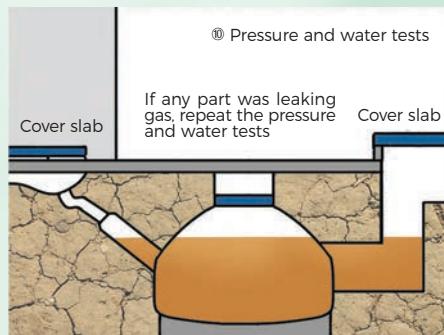
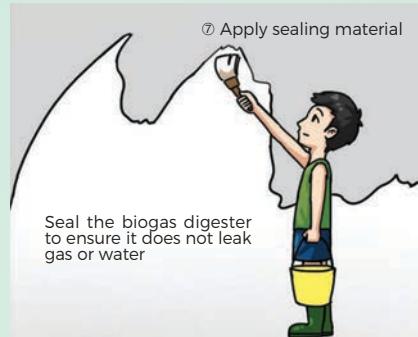
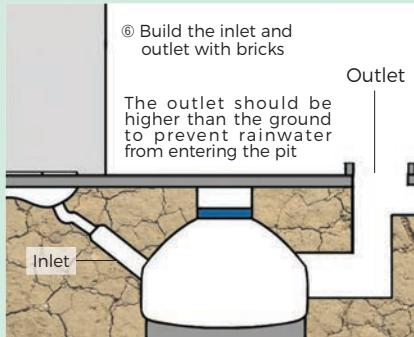


The average volume of a biogas digester is 6–8 cubic metres in the south.

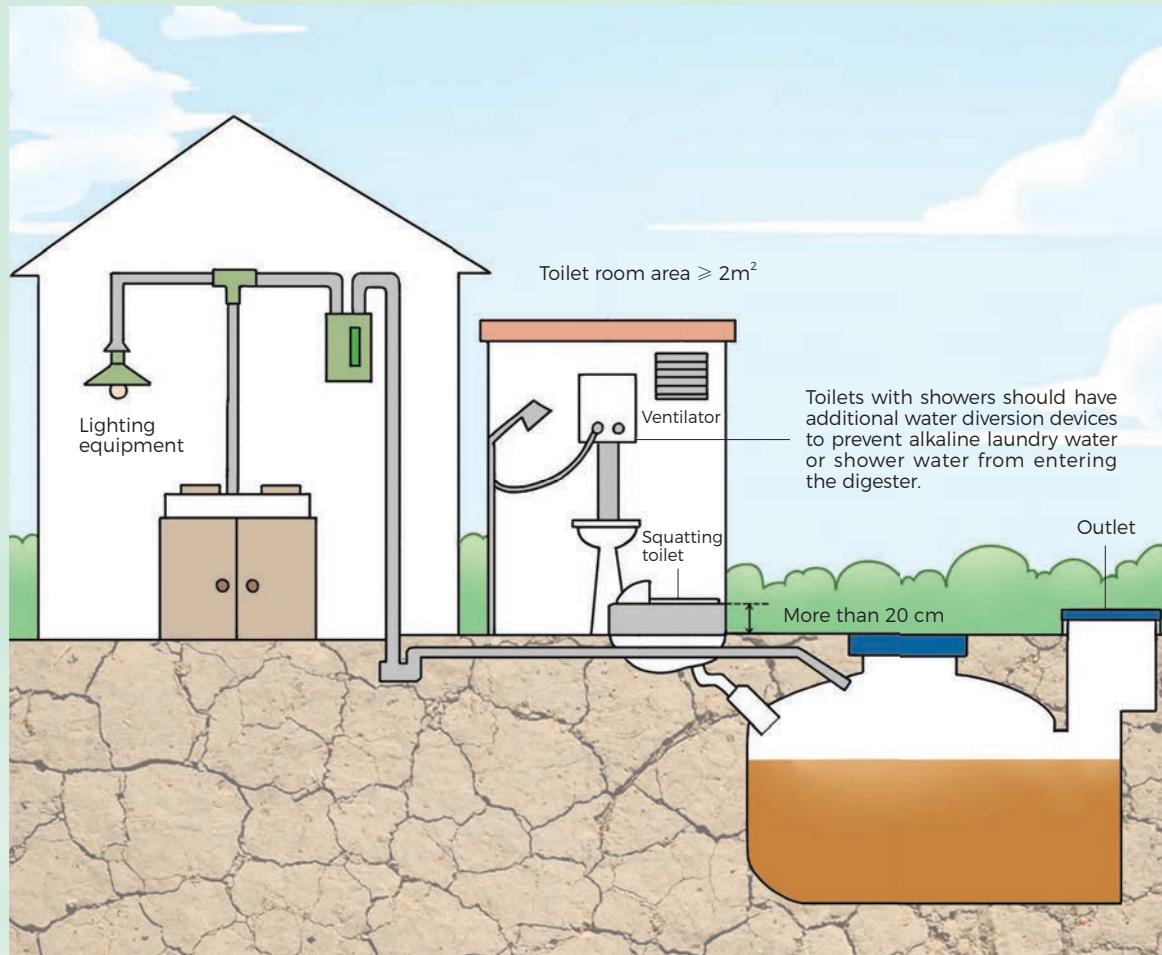
7.5 How should a household toilet with biogas digester be properly built?

The construction of a household toilet with a biogas digester involves 10 steps: site selection, pit digging, pit bottom concreting, pit body masonry, pit roof concreting, inlet and outlet masonry, applying sealing material, building the toilet room, installing the toilet and testing the water and pressure. It can only be built by professional technicians. The water and pressure tests should be performed in accordance with the requirements of Specifications for Quality Inspection and Acceptance of Anaerobic Digester.





7.6 How can the existing toilet be transformed into a household toilet with a biogas digester?

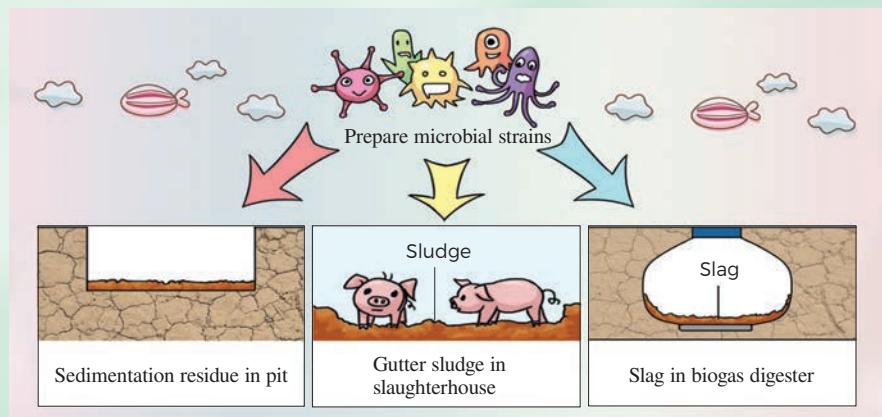
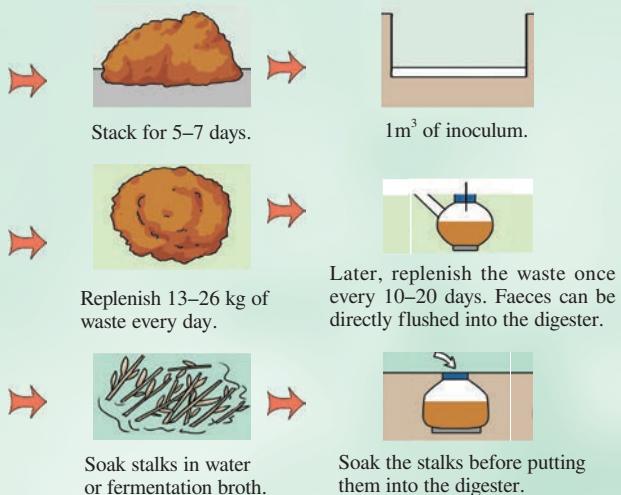


7.7 Are there any precautions when using a household toilet with biogas digester?

Prepare 2 cubic metres of human and animal faeces (stack it for 5–7 days; poultry excrement cannot be directly used as the raw material for initiation) and guarantee that all faeces has not been sterilized by chemical agents. In addition, prepare 1 cubic metres of inoculum, which is a microbial substance.

After a household toilet with a biogas digester is first put into use, replenish 13–26 kg of waste every day to improve the biogas output. Thirty days after the toilet is put into use, replenish the waste every 10–20 days. Faeces can be directly flushed into the digester.

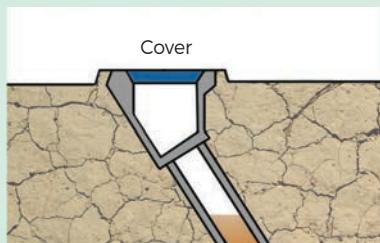
If dry stalks are used, cut them up, pulverize them or soak them in water or fermentation broth. Then stack them for 5–7 days.



7.8 How should a household toilet with biogas digester be managed?

Be careful when using a household toilet with a biogas digester:

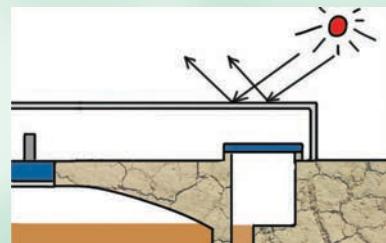
- ① The inlet of the biogas digester must be covered to prevent humans and animal from falling in.
- ② Do not allow fire or embers near the outlet of the biogas digester or near the mouth of the biogas pipe. Otherwise, the biogas will expand fiercely and the digester will explode.
- ③ The outdoor pipeline should be protected against direct sunlight to prevent weathering and ageing, which will cause biogas leak. Do not make a fire within 5metres of the biogas digester.
- ④ Do not stack heavy items, such as bricks and stones, or flammable and explosive articles, such as firewood, near the biogas digester.
- ⑤ Do not operate the biogas digester without any protective measures.



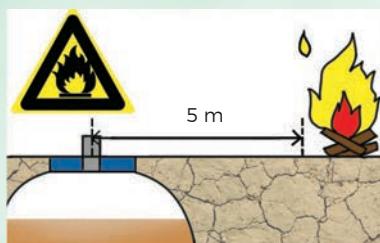
The inlet must be covered.



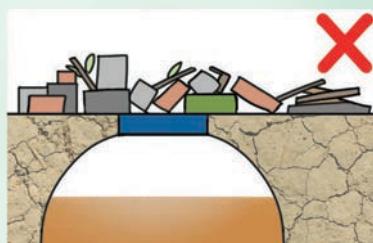
Do not allow fire or embers near the outlet or near the mouth of the biogas pipe.



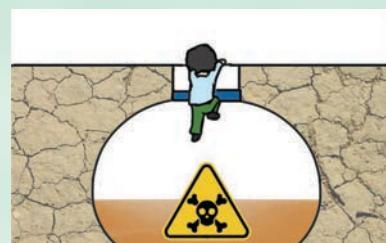
Protect against direct sunlight.



Do not make a fire within 5metres of the biogas digester.



Do not stack heavy items near the biogas digester.



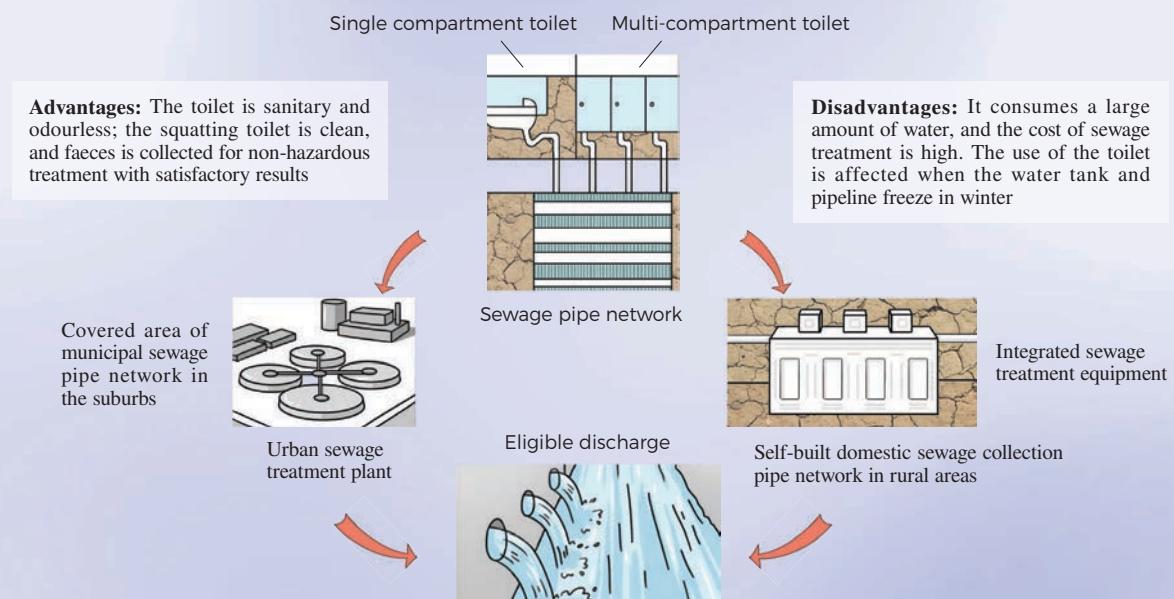
Do not operate the biogas digester without taking any protective measures.



Integrated household flushing toilet with complete water supply and drainage pipeline

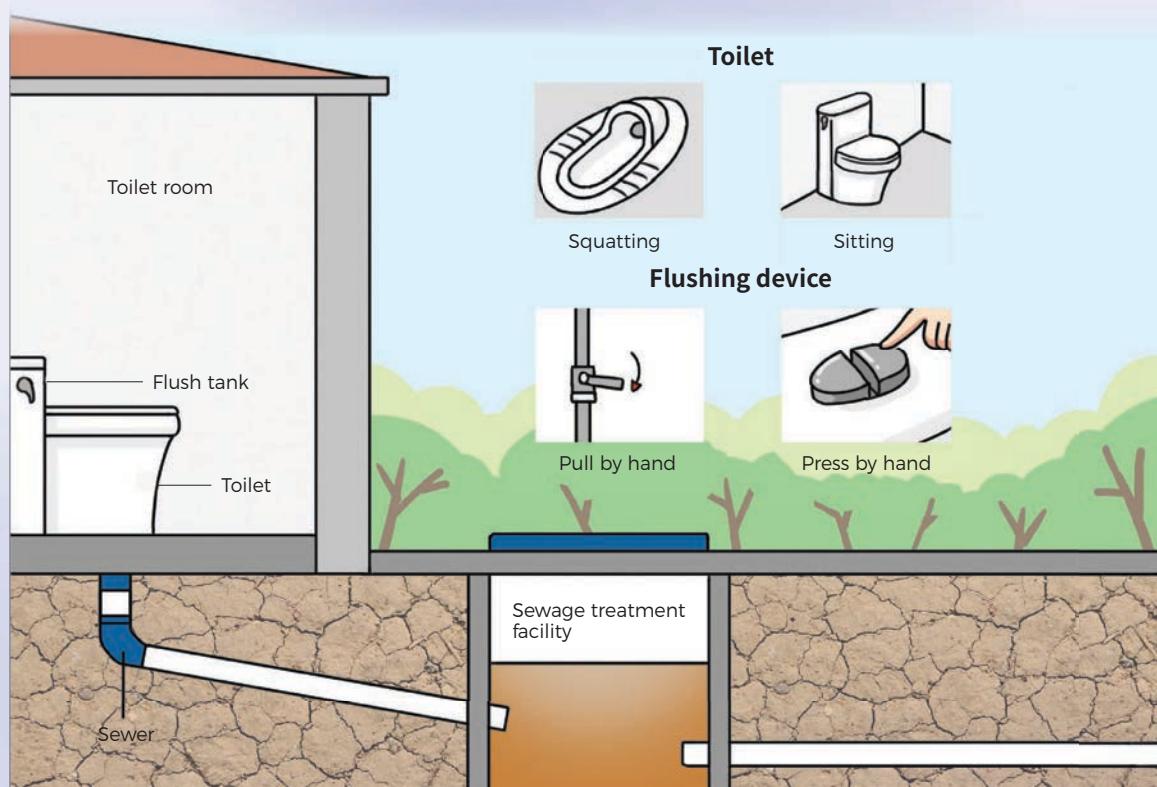
8.1 What is the integrated household flushing toilet with complete water supply and drainage pipeline?

The integrated household flushing toilet with complete water supply and drainage pipeline is widely used in urban households and residential buildings in urban areas. In recent years, this household toilet has become popular in rural areas due to urbanization influences. The construction site of a household toilet with complete water supply and drainage pipeline must have access to the municipal water supply. Generally, it is designed and constructed in synchronization with the construction of new residential buildings.



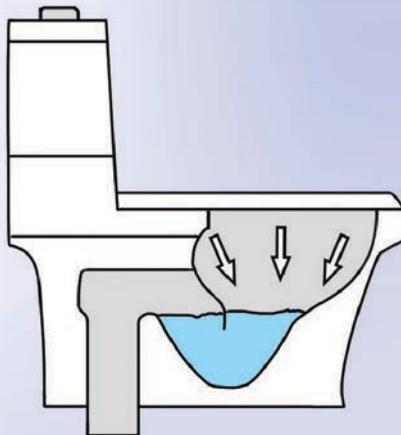
8.2 What are the characteristics of the integrated household flushing toilet with complete water supply and drainage pipeline?

The integrated household flushing toilet with complete water supply and drainage pipeline consists of a room, toilet, flushing tank, sewer and sewage treatment facility. It is generally built in the home, and its area varies according to unit type. A squatting toilet or ceramic toilet is commonly used. The sewer consists of a branch pipe for each household and a main pipe for the unit. Faeces is flushed into the branch pipe and converge into the centralized treatment facility via the main pipe for non-hazardous treatment.



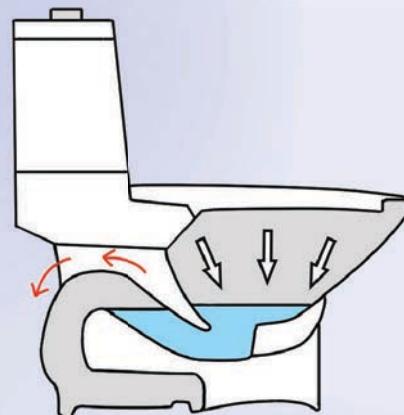
8.3 How does the integrated household flushing toilet with complete water supply and drainage pipeline flush?

There are two types of flush toilets: the flush type and the siphonic type. The flush toilet discharges faeces with the momentum of flowing water. It has a relatively large faecal outlet and a steep slope. The siphonic toilet draws faeces and water into the bend through the siphonage of water and discharges it via the drainage pipe. The water in the toilet trap blocks the passage of gas from the sewer and septic tank, preventing odours from escaping into the room.



Flush toilet

Loud flushing noise, big pipe,
small curvature



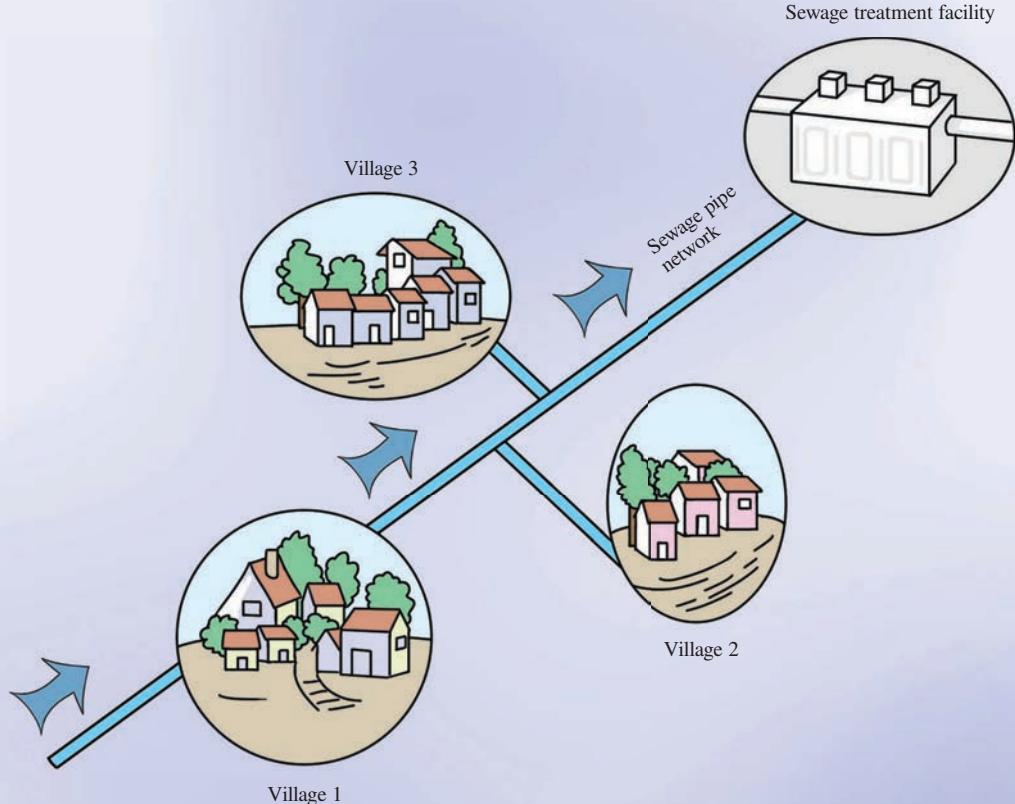
Siphonic toilet

Quiet flushing noise, small
pipe, big curvature



8.4 How does the integrated household flushing toilet with complete water supply and drainage pipeline treat the sewage?

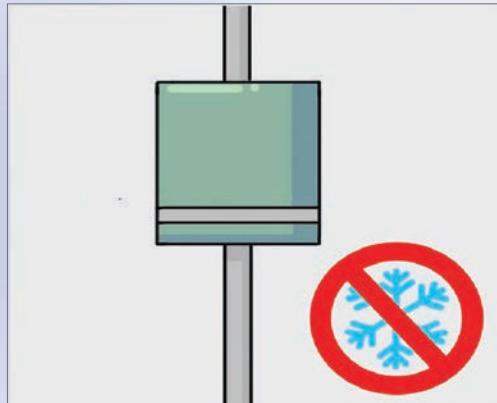
Toilet waste can converge with domestic sewage or be treated separately. Villages in the suburbs can be connected to municipal pipe networks. Densely populated villages in plains areas can use a centralized sewage treatment station, while villages with a dispersed population can use household sewage-treatment equipment.



8.5 Are there any precautions when using the integrated household flushing toilet with complete water supply and drainage pipeline?



Do not drop other waste inside.



Prevent the water tank and pipes from freezing.



Close the lid before flushing.



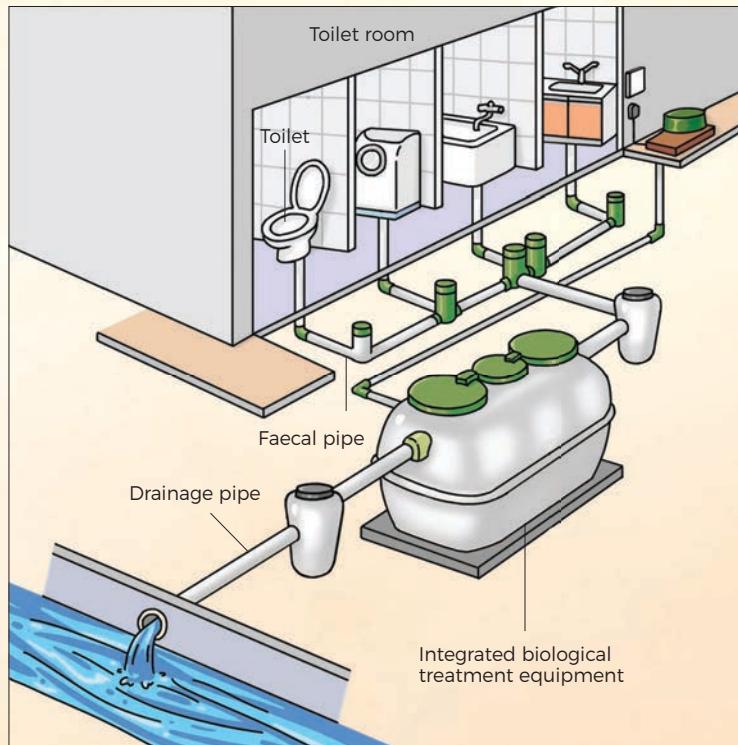
Clean the toilet regularly to keep it hygienic.

9

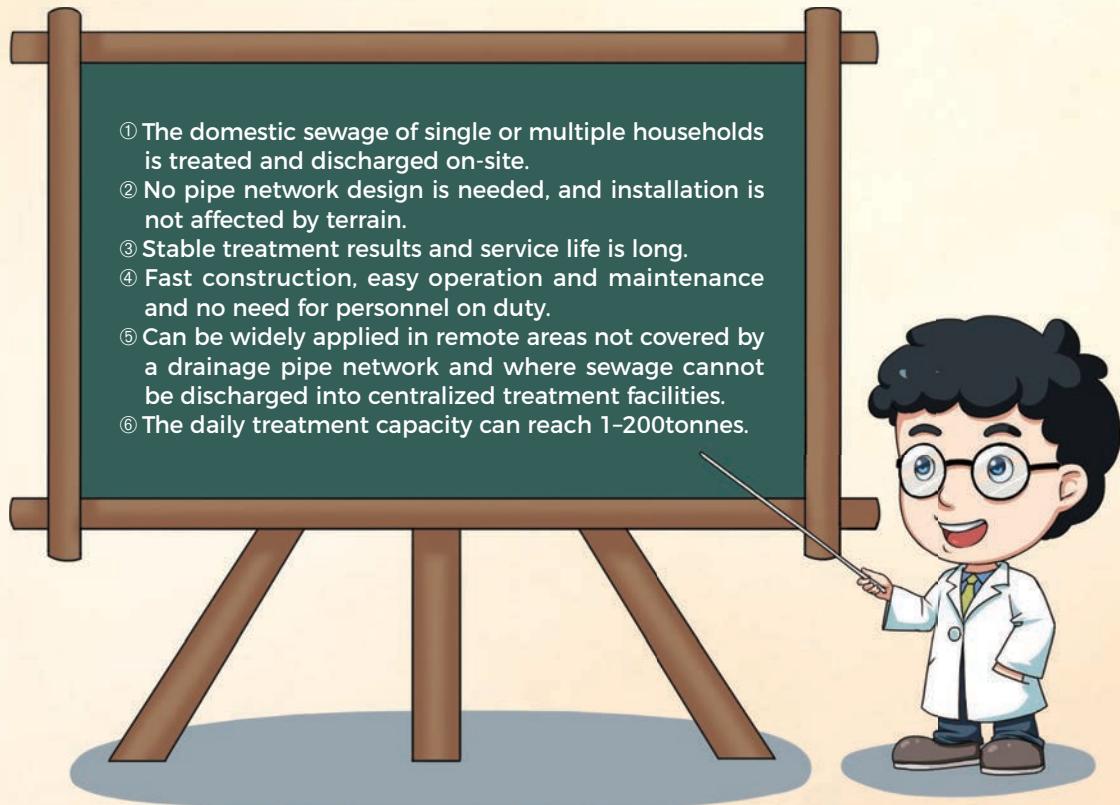
Integrated household flushing toilet with biological treatment

9.1 What are the characteristics of the integrated household flushing toilet with biological treatment?

The integrated household flushing toilet with biological treatment consists of a toilet room, toilet, faecal pipe, integrated biological treatment equipment and a drainage pipe. A flush toilet with a flushing volume of less than 6 litres per time can be used. Shower water and laundry water can be treated simultaneously. After precipitation, microbial activity, secondary precipitation, sterilization and other processes, the chemical oxygen demand and total nitrogen of the discharged water can reach the Grade I(B) standard.

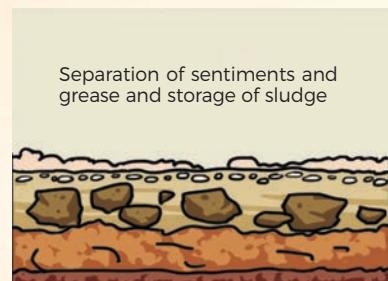


Characteristics of household toilet with integrated biological treatment

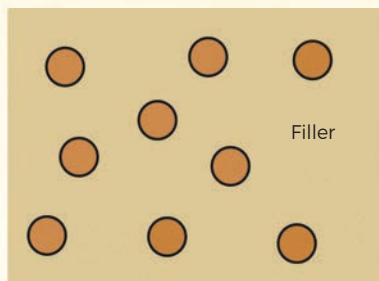


9.2 How does integrated biological treatment equipment treat the sewage?

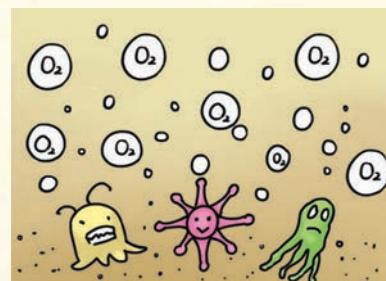
Integrated biological treatment equipment is equivalent to a small sewage treatment plant. Its processes mainly include precipitation and filtration, microbial activity, secondary precipitation and sterilization.



Precipitation and filtration



Anaerobic reaction



Aerobic reaction



Chemical agent

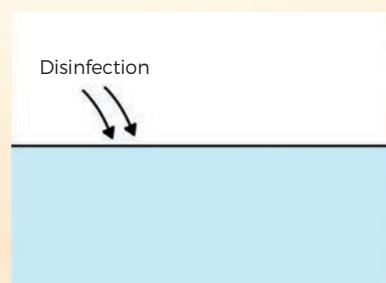


Electrolytic flocculation

Enhanced phosphorus removal



Secondary precipitation

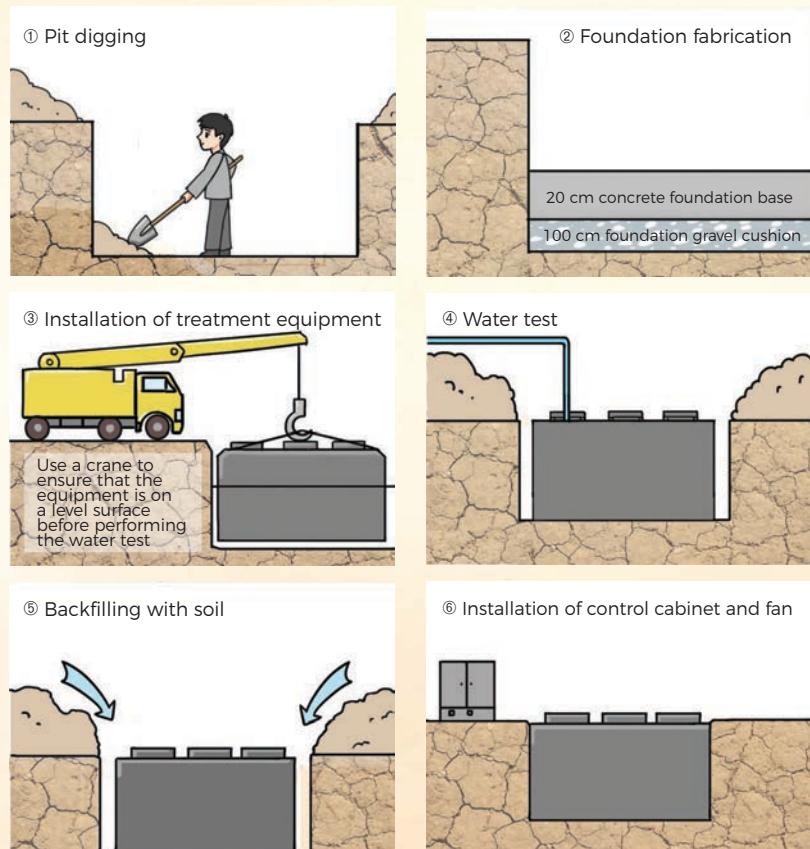


Sterilization



9.3 How should the integrated household flushing toilet with biological treatment be properly built?

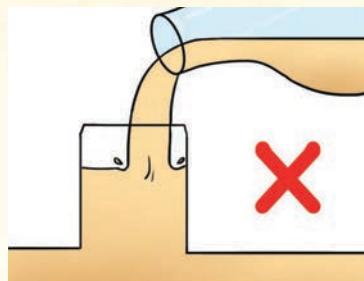
The construction of a household toilet with integrated biological treatment involves foundation pit digging, foundation fabrication, installation of treatment equipment, water test, backfilling with soil and then the electrical installation. The size of the foundation pit is determined according to the dimensions of the equipment. The foundation and backfilling should be firm enough to ensure that the equipment is not displaced.



9.4 How should the integrated household flushing toilet with biological treatment be managed?



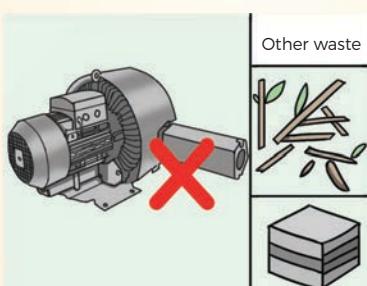
Prevent foreign matter from blocking the pipeline.



Do not pour cooking oil inside.



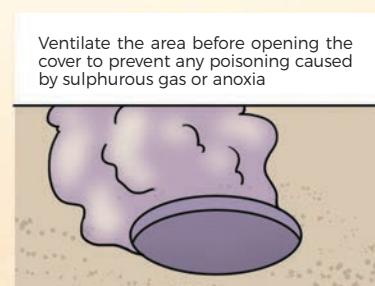
Do not pour disinfectant inside.



Prevent the aerator from causing fire and electric shock.



Prevent people from falling in.

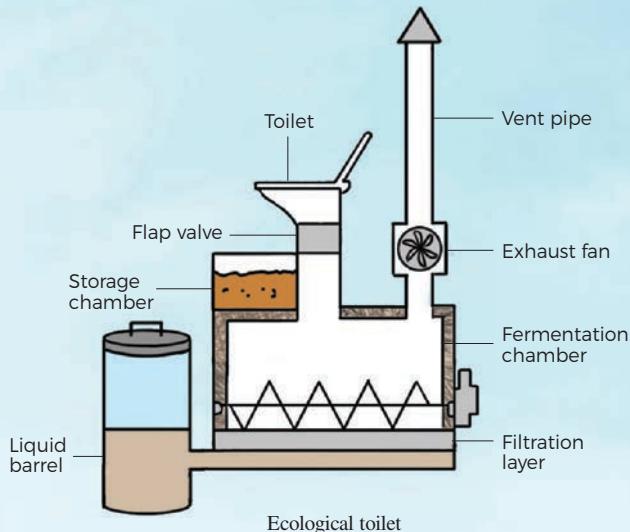


Prevent anoxia or poisoning when opening the cover.



10 Ecological toilet

10.1 What are the constitution and characteristics of the ecological toilet?



Characteristics of an ecological toilet:

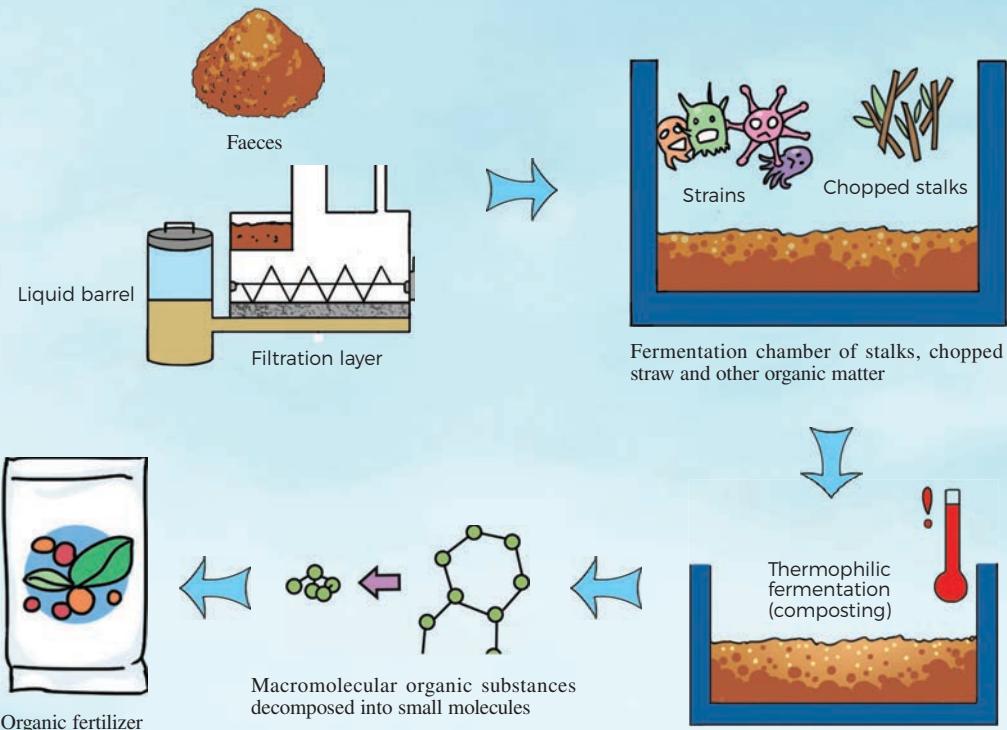
- ① No need for water; odourless; pathogens are eliminated by biological treatment.
- ② Highly adaptable and operable without a power supply.
- ③ Use of existing agricultural and forestry residue for composting, such as stalks, sawdust, rice husks, leaves and branches.
- ④ Turns waste into organic fertilizer.



The ecological toilet is a kind of toilet that does not need to be flushed with water and does not pollute the environment. It highlights the ideas and functions of waste self-purification and recycling. It mainly consists of a toilet, fermentation chamber, flap valve, storage chamber, liquid barrel and vent pipe. It is suitable for arid regions.

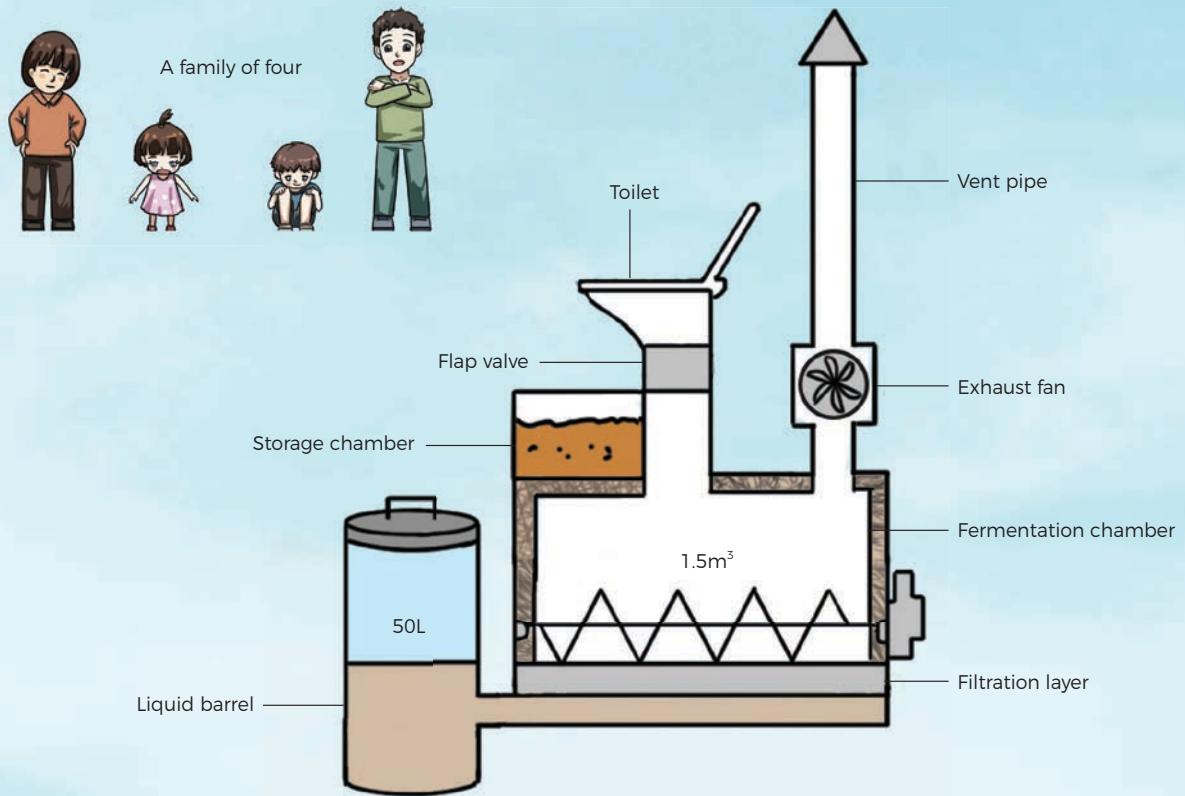
10.2 How does the ecological toilet treat faeces in a non-hazardous manner?

Faeces and urine collected in an ecological toilet both enter the fermentation chamber. The urine flows into the liquid barrel through the filtration layer, and the faeces is evenly mixed with stalks or other organic matter by a mixer and then decomposed into organic fertilizer by compound microorganisms. At the same time, pathogens are killed through thermophilic fermentation, or composting. After the urine is purified in the filtration layer, it flows into the liquid barrel and can be discharged or used to flush the toilet or irrigate farmland.

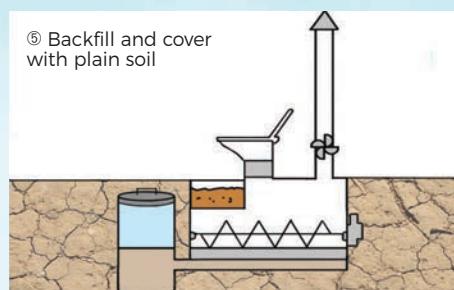
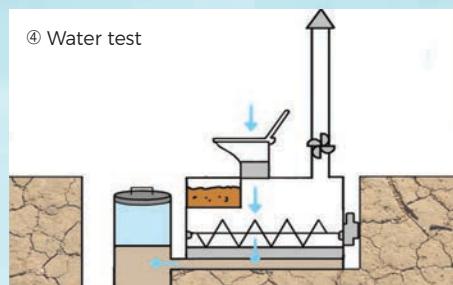
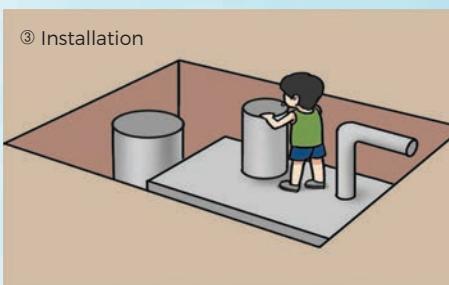
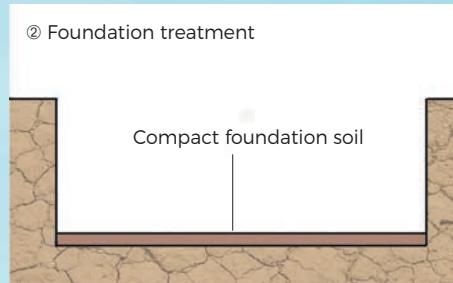


10.3 How big should the ecological toilet be?

For a family of four persons, the volume of the fermentation chamber should be 1.5 cubic metres. The length should be 1.5 metres and the width and height should each be 1metres. The volume of the liquid barrel cannot be less than 50 litres.



10.4 How should the ecological toilet be properly built?



Precautions when using an ecological toilet

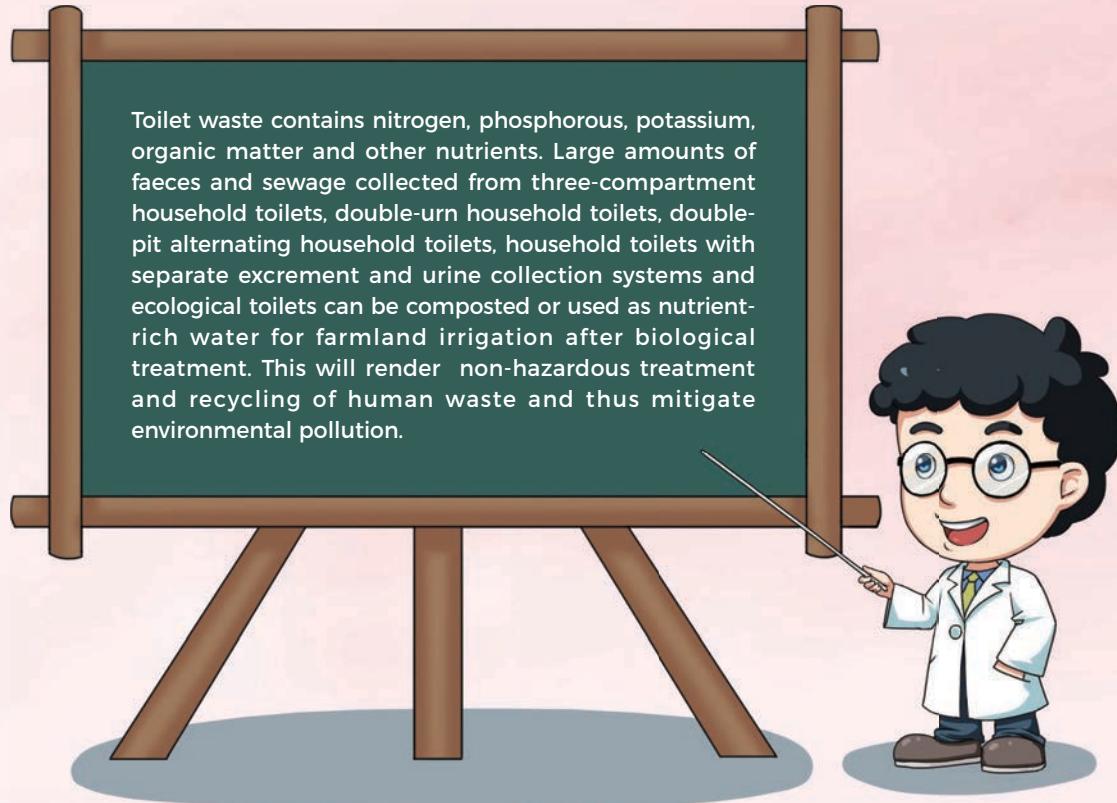
- ① Rainwater and domestic sewage are prohibited to throw.
- ② Women's articles and diapers are prohibited to throw.
- ③ The covering materials should be crushed to less than 10 centimetres.
- ④ Clean up on time and keep it clean and hygienic.
- ⑤ The cleaning period is at least 1 month.



11

Toilet waste recycling

11.1 How should toilet waste be disposed?

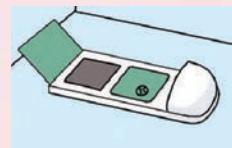




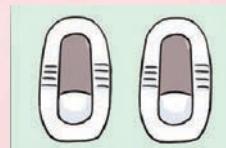
Household toilet with three-compartment septic tank



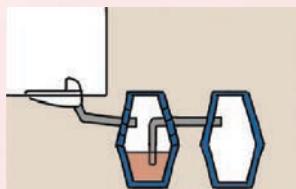
Flushing household toilet



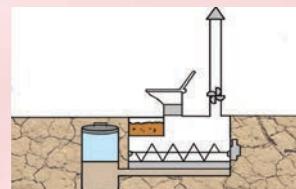
Household toilet with separate faeces and urine collection systems



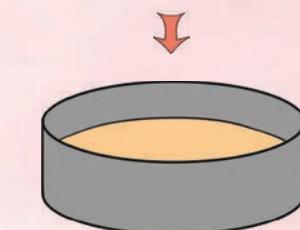
Alternating double-pit household toilet



Dual-urn household toilet



Ecological toilet



Liquid waste and sewage

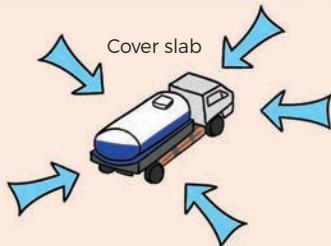


Solid waste



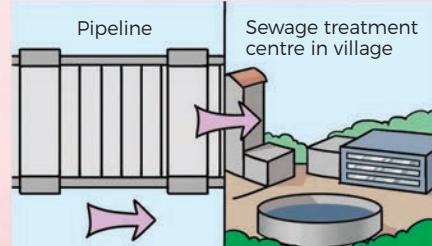
Farmland

11.2 How should dispersed toilet waste be collected?



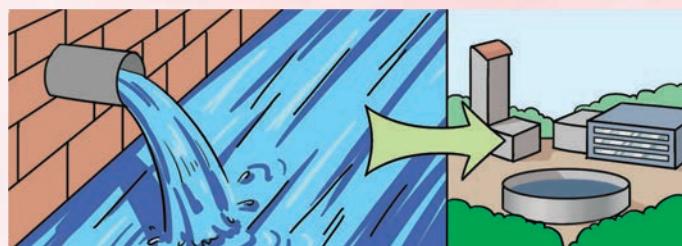
Distributed collection and on-site treatment mode

For villages with a small population, small amounts of human waste, dispersed households and complicated landscape with difficulty accessing the centralized municipal pipe network or for which the investment for accessing the pipe network is higher than that of treatment facility construction, waste can be collected and treated on-site.



Centralized collection and in-village treatment mode

For villages with a large population and many households, with large amounts of human waste, that are not covered by the municipal pipe network, waste can be collected via pipelines and treated in a centralized manner in the village.



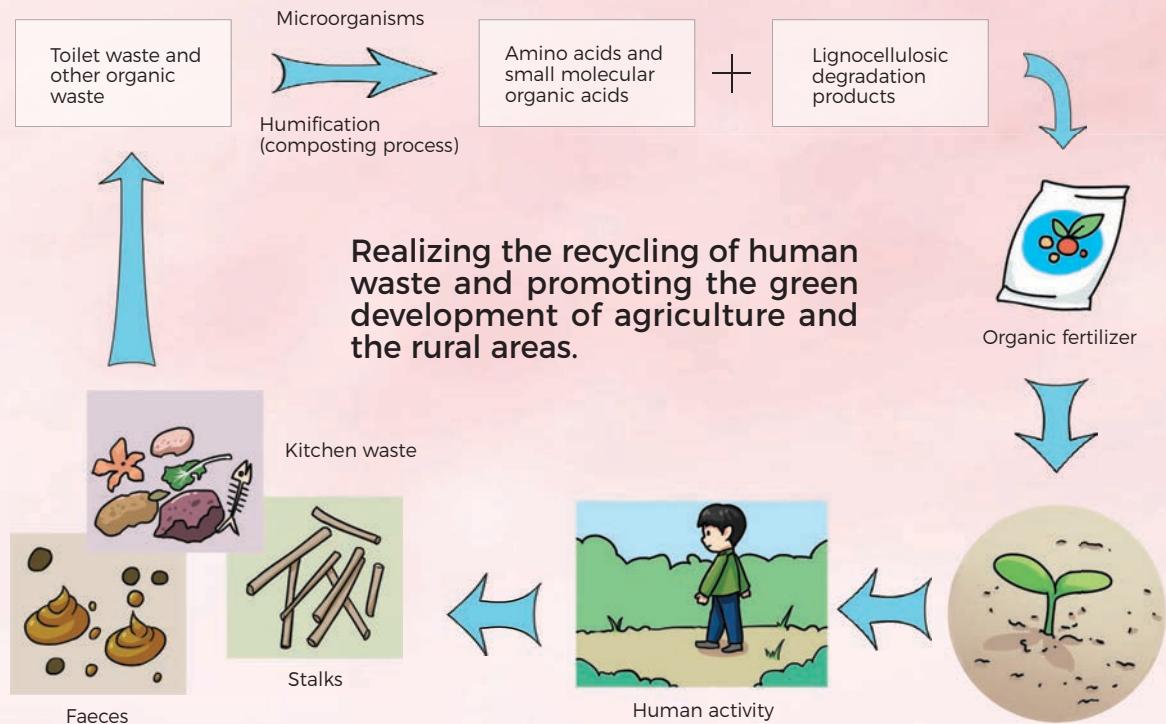
Centralized collection and municipal treatment mode

For villages in the suburbs, waste can be collected and discharged to the nearest municipal drainage system for centralized treatment.



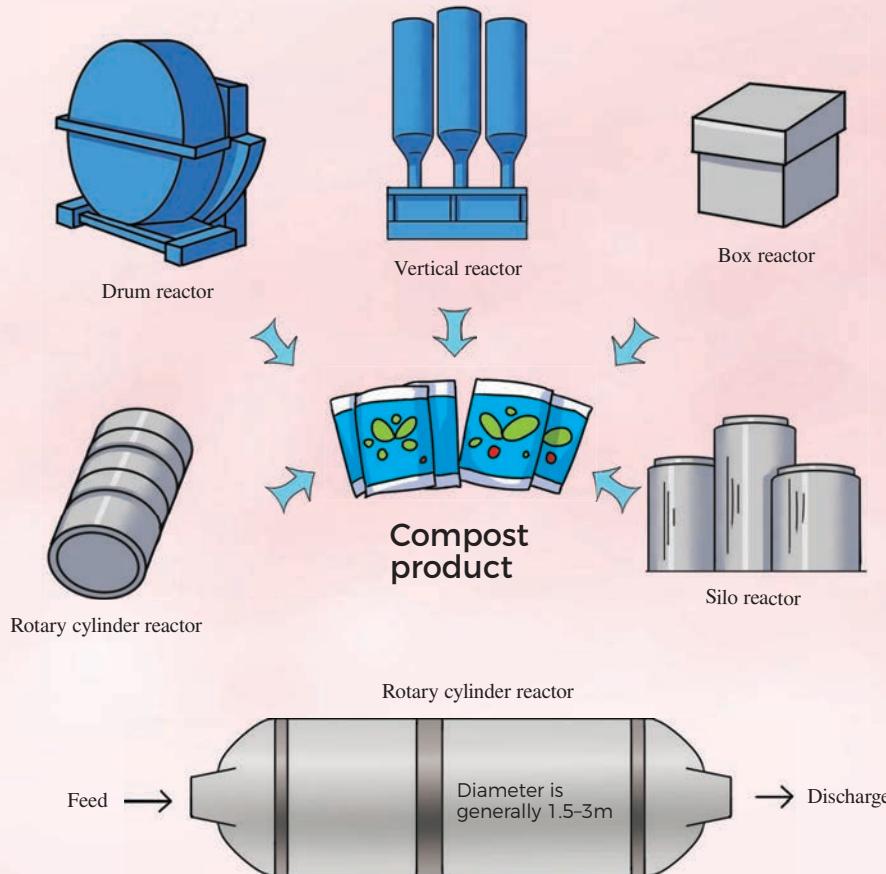
11.3 How should toilet waste be composted?

Composting, also known as aerobic fermentation, is the process of mixing toilet waste with stalks, rotten leaves, kitchen waste and other putrescible (capable of decaying) waste in a certain ratio and transforming the organic waste into organic fertilizer through microbial activity in aerobic and ventilated conditions. According to the openness of the system, composting technology is classified into three categories: open (stacked open-air composting), semi-open (such as trough workshop composting) and closed (such as reactor composting) systems.



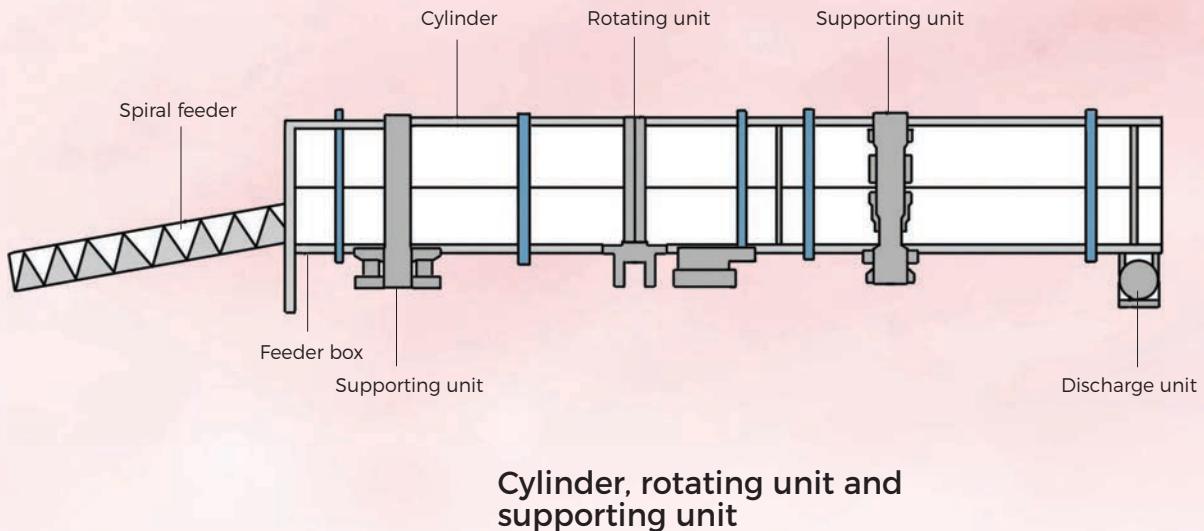
I . Reactor composting

Reactor composting is a process in which organic waste, such as toilet waste, is transformed into a compost product through the fermentation of microorganisms by manually controlling the moisture, the carbon-to-nitrogen ratio, the ventilation and other conditions in a container (such as a drum, silo, box, tunnel or reactor). Composting reactors include cylinder, silo, box, vertical and drum reactors.



II . Characteristics of reactor composting

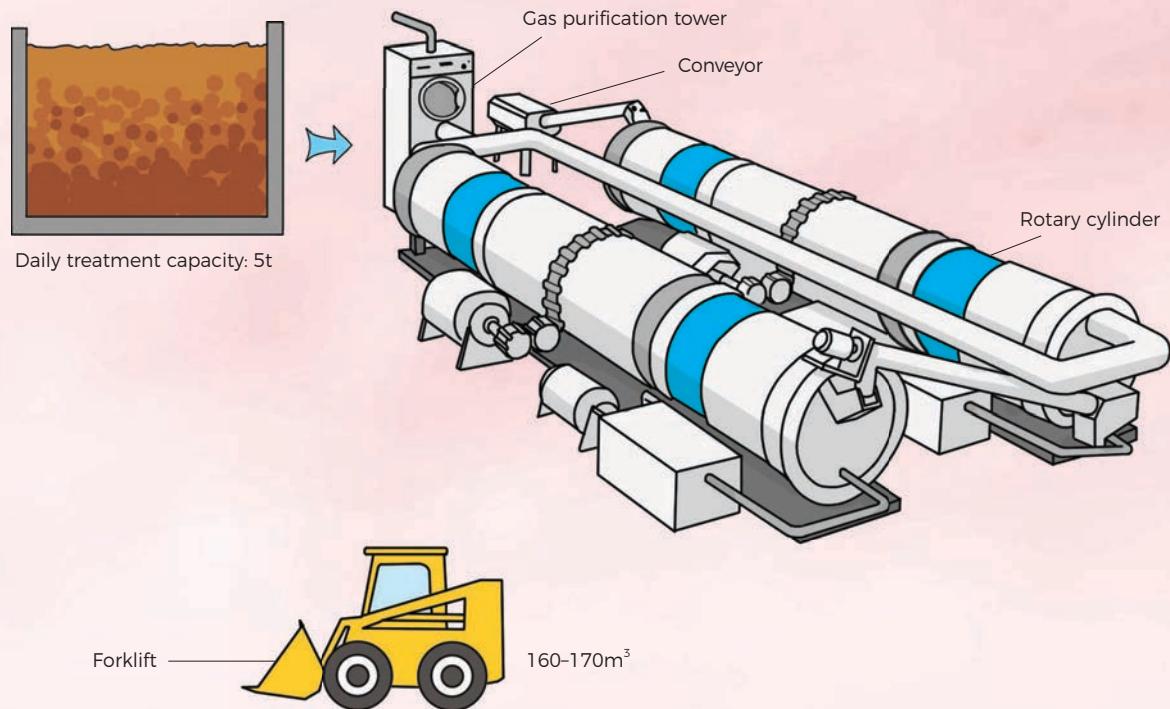
The closed reactor composting process is mainly used for the on-site treatment of organic solid waste from small and medium-sized farms. The main advantages of this process are its short fermentation cycle, small footprint, no need for auxiliary materials, good insulation and energy efficiency, highly automatic and easy to control odours. The main disadvantages are its low treatment capacity, high investment and excess equipment required for large projects.



III . Building a reactor composting facility

A reactor composting facility does not require a plant building. Only the ground where the reactor is installed should be hardened.

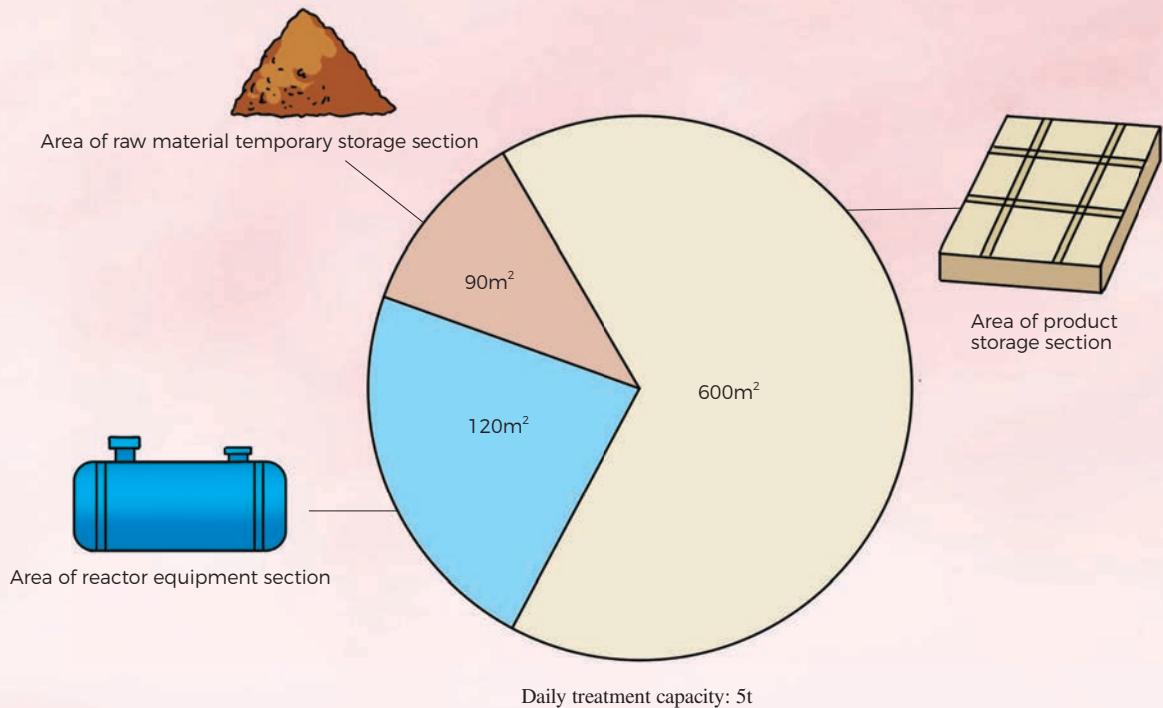
If the daily treatment capacity is 5 tonnes, a rotary cylinder reactor with a volume of 160–170 cubic metres, forklift or conveyor, gas purification tower and other facilities are needed.



IV . Area required for a reactor composting facility

The area of a reactor composting facility requires a temporary storage section for the raw material, a reactor equipment section and a product storage section. The reactor equipment section is the main occupied section, while the raw material temporary storage section and product storage section can be designed according to the required treatment capacity of toilet waste.

For a rotary cylinder composting reactor with a daily treatment capacity of 5 tonnes, the area of the reactor equipment section should be 120 square metres. The raw material temporary storage section should be 90 square metres, and the product storage section should 600 square metres.



V . Precautions for reactor composting

Do not mix stone, glass, iron pieces and other foreign matter into the raw materials.

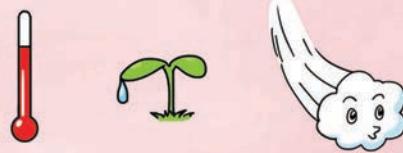


Stone

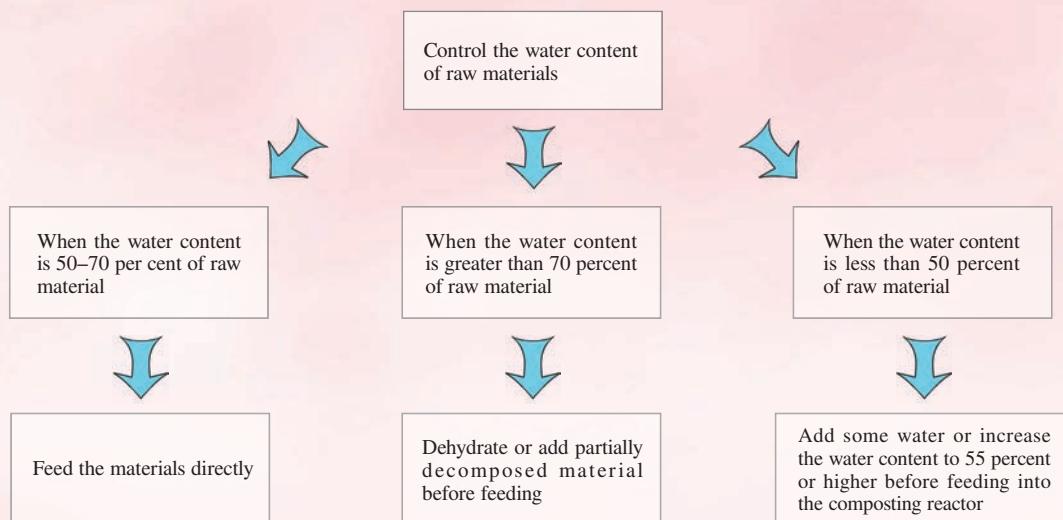
Glass

Iron pieces

Pay attention to temperature, moisture and ventilation.

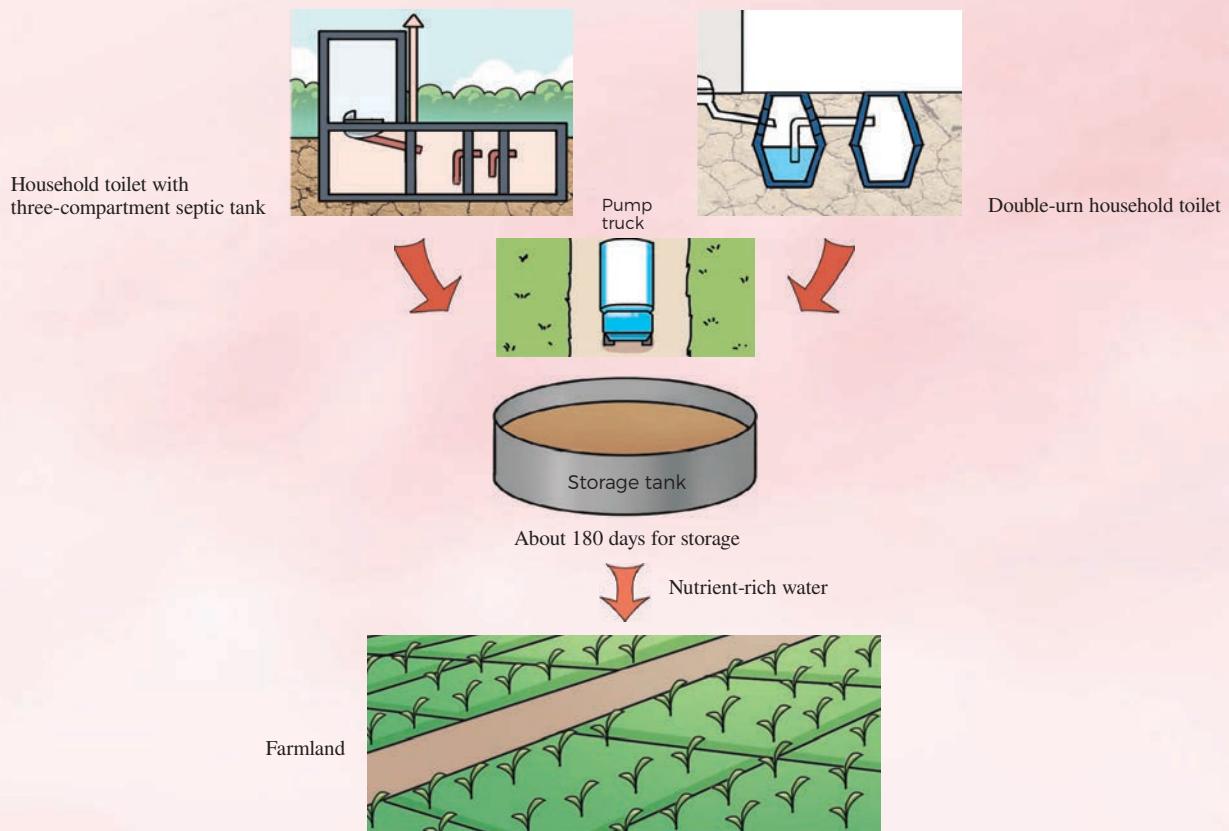


Follow the composting reactor instructions.



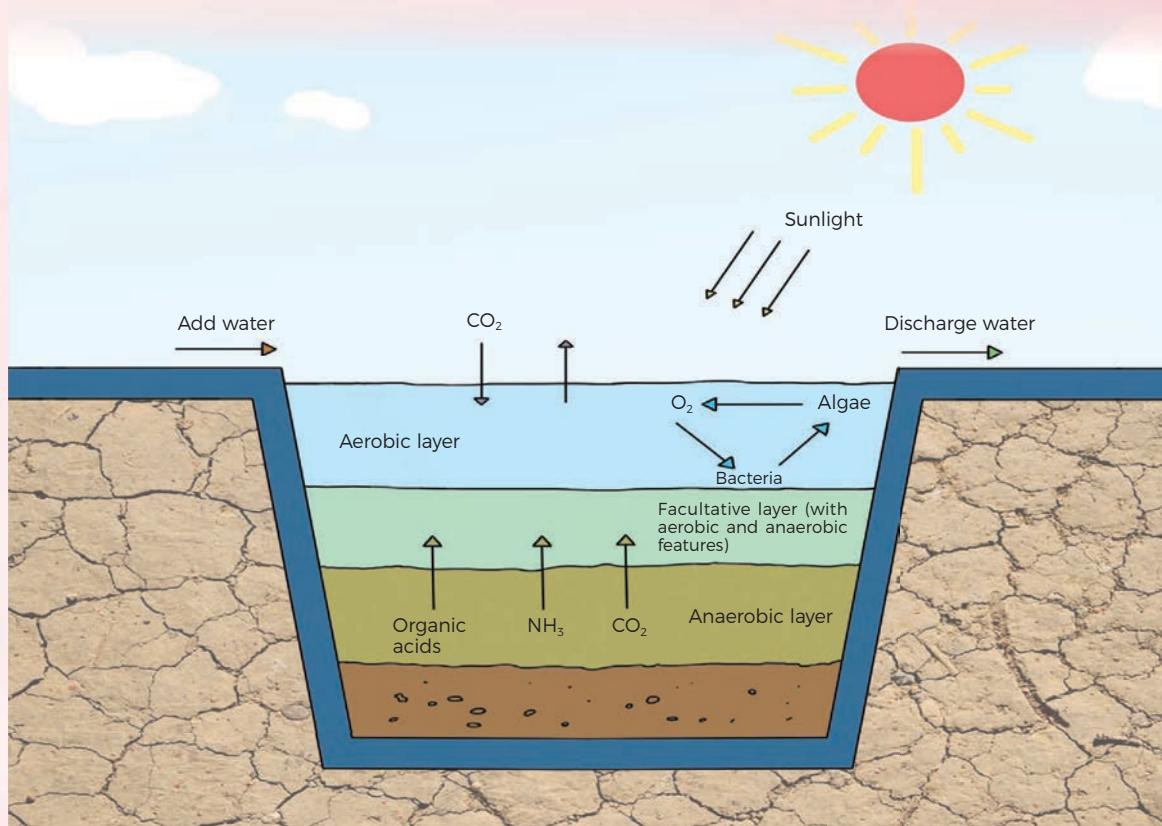
11.4 How is toilet waste transformed into nutrient-rich water for farmland?

For the three-compartment septic tank and double-urn toilets with large sewage output, toilet sewage can be stored after being collected and turned into nutrient-rich water for use as liquid organic fertilizer on farmland.



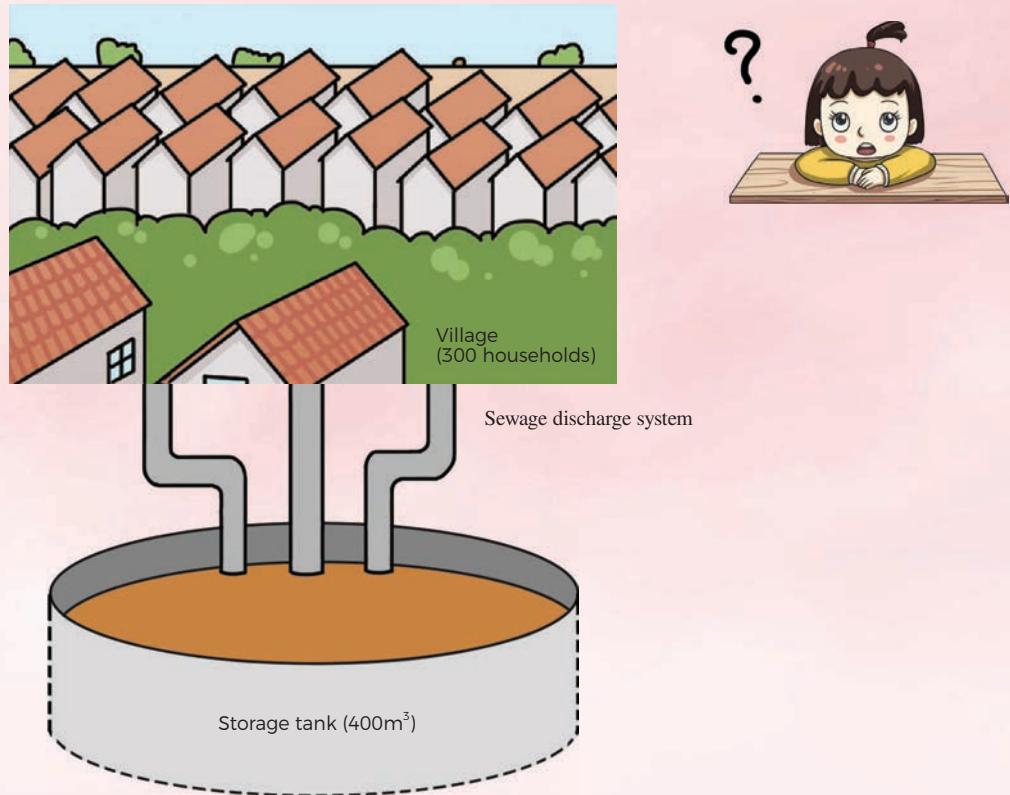
I . The principle of fertilizing farmland with nutrient-rich water produced from human waste

Toilet waste contains a high level of ammonia and nitrogen and a certain amount of pathogenic microorganisms. Due to the seasonality of crop fertilization and other reasons, toilet waste needs to be stored for a period of time. The organic substances in human waste are decomposed under microbial activity into stable decomposed products, in which bacteria, viruses, parasite eggs and other substances that are harmful to crops are killed and transformed into fertilizer that can be applied to farmland.



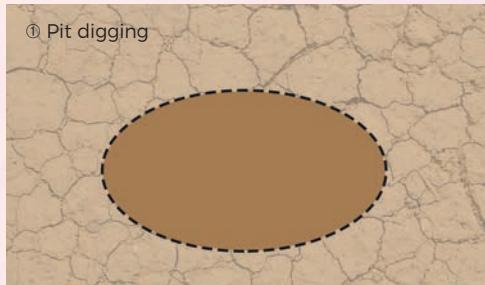
II . Size of a waste storage tank

The waste storage tank is designed according to the treatment capacity of toilet waste. For example, assume a village has 300 households and each household has four people on average. Each person produces 1.5 litres of urine on average every day, and human waste needs to be stored for 180 days. Thus, a 400 cubic metres waste storage tank is required.

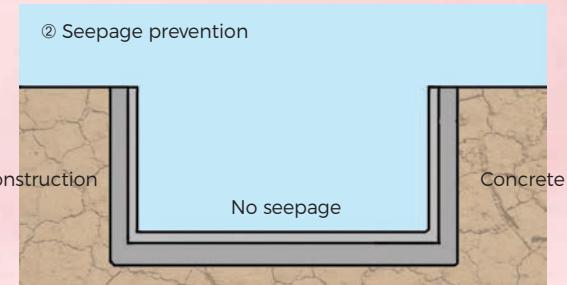


III . Building human waste storage tank

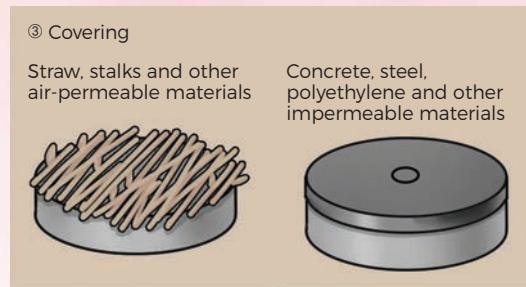
Covered storage method



Dig a pit according to the size of the required tank.



Design and construct the tank in strict accordance with the required processes. The tank should be solid, free of seepage and built with bricks or rammed with concrete.

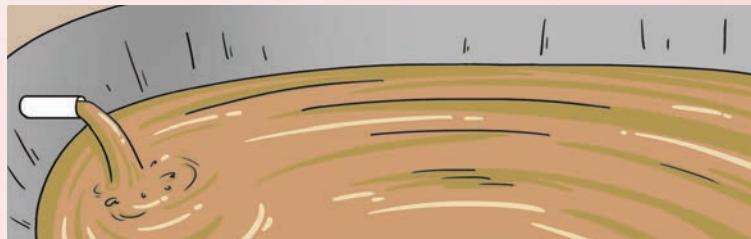


Cover with straw, stalks, concrete cover or steel plate according to the storage tank process.

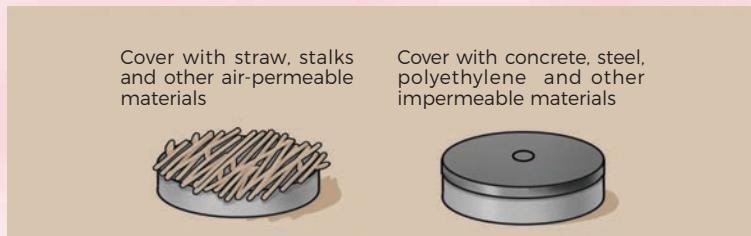


IV . Methods for human waste storage

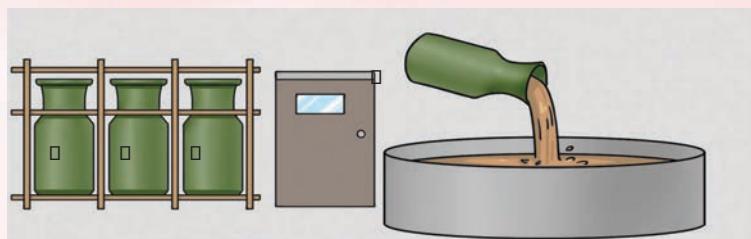
Human waste storage includes three methods: natural storage, covered storage and acidified storage. Natural storage generally emits a large amount of ammonia, while covered storage and acidified storage emit a small amount of ammonia.



Natural storage

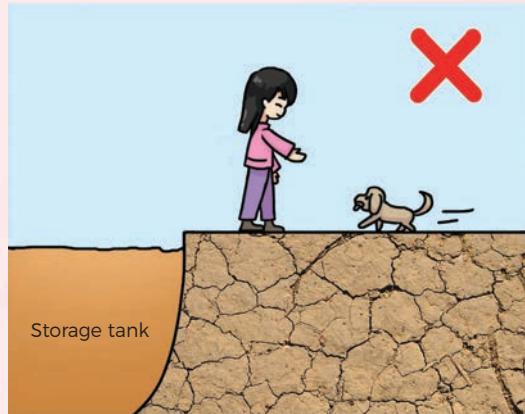


Covered storage



Acidified storage

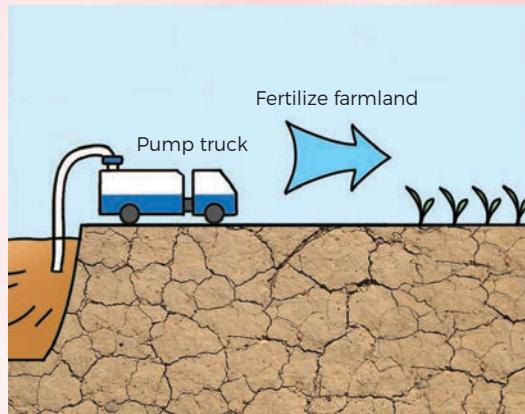
V . Precautions for human waste storage



Be careful.



Do not drop other waste inside.



Regular cleaning.



Scheduled maintenance.



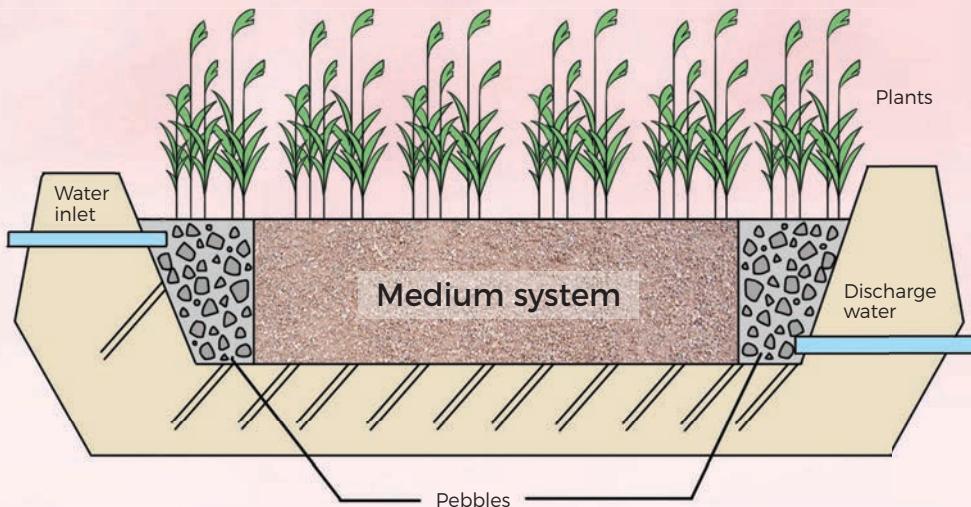
11.5 What are the ecological treatment methods of human waste?

Toilet waste can converge with domestic sewage or be treated separately. When the waste is discharged into the pipe network and treated with domestic sewage, the quality of the treated water should meet the relevant discharge standards.

When the toilet waste is treated separately, ecological treatment technology is preferred. The sewage is purified through filtration, absorption and decomposition under the combined action of the soil–plant–microbe system, then used to fertilize farmland if it meets the irrigation water standards. Common methods include the constructed wetland, stabilization pond and land treatment systems.

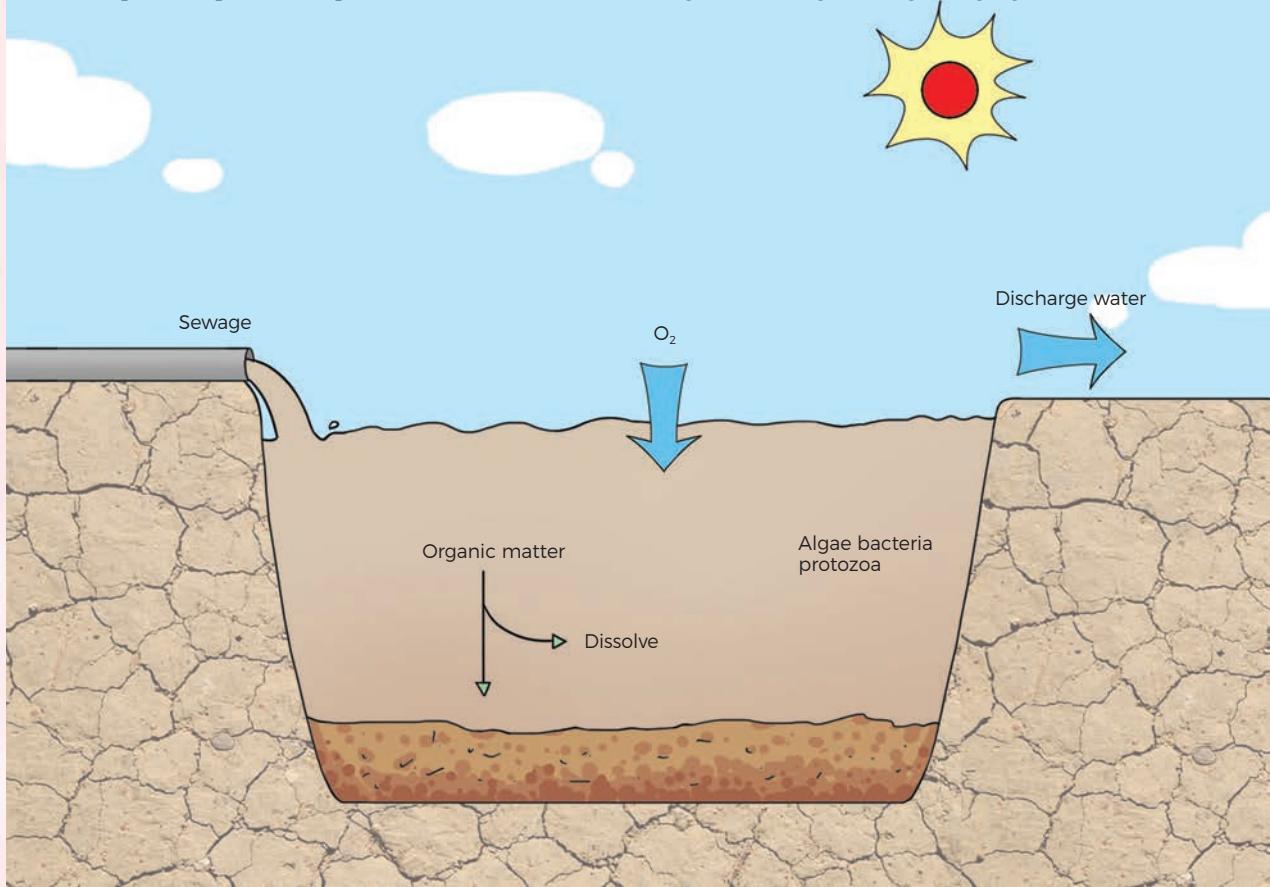
I . Constructed wetland treatment technology

The sewage is efficiently purified and recycled through filtration, adsorption, coprecipitation, ion exchange, plant absorption and microbial decomposition, based on a natural ecological system consisting of plants, soil and microorganisms. It is suitable for areas with surface runoff, waste land and a warm climate all year round.



II . Stabilization pond

The stabilization pond, also known as an oxidation pond, is a treatment facility that takes a pond as its main structure for purifying sewage using natural biological communities. According to the amount of dissolved oxygen in the pond water, the category of biological populations and function of the pond, a stabilization pond can be classified as an anaerobic pond, facultative pond, aerobic pond or aeration pond. These ponds are suitable for areas with available lakes, ponds, depressions, a pleasant climate and sufficient sunlight, which is good for growing algae.



III . Land treatment system

Sewage is batched on the land under artificial conditions using the purification capacity of the natural system. It is then purified by the soil–plant system under combined physical, chemical, biological and other actions.

