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High-Tech Low Power Space Toilet and Waste Management System

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***Abstract*—The main Question in the space is how do astronauts go to the bathroom? The most basic human biological processes becomes challenging off-planet due in part to the lack of gravity. During the first Space Shuttle mission in 1981, astronauts had to unclog the smelly toilets, making for a messy scene. Frozen urine flushed from the Russian Mir space station damaged the station's solar panels over time, reducing their effectiveness by around 40 percent. The solution for this problem is to design reliable and convenient space toilet for astronauts. In this paper I covered various solutions to the problems like (i) work in both microgravity and lunar gravity, (ii) accommodate female and male crew, (iii) be easy to use and maintain, with low noise, low odor, and fast turnaround time, (iv) allow for transfer of collected waste to storage or external vehicle disposal. The design that I have Suggested here would (i) capture and contain urine, feces, vomit, diarrhea, and menses, (ii) Stabilize urine, (iii) accommodate simultaneous urination and defecation, (iv) accommodate the needs of 2-4 crew members for 15-20 days, (v) accommodates the use of toilet hygiene products, (vi) clears previous waste content prior to next use, (vii) defines how often the collections system must be replaced or disposed of in the mission. The toilet will work on low power about 100 watts per day for pumps and common components (like Sphincter, valves, etc.) I firmly believe that human beings should always make progress and development. Human beings are made for progress. And one day, I believe, we will form human habitat in different planets, and we must be ready for that today.**

***Keywords*—Space, space toilet, toilet, space missions.**

I. INTRODUCTION

The design named *"High-tech Low Power Space Toilet and Waste Management System"* is very useful in the condition of microgravity and in moon gravity. This toilet is easy to use and most important is its portability. That feature made this very special.

This toilet has 3 small parts, those are:

1. Toilet (main)
2. Track (pipes)
3. Container

1. Toilet (main): The toilet is small, foldable, and portable as I mentioned. This (main toilet) can be folded in circular, cubical, or rectangular shape. Because of this property, the toilet can fit at any place i.e. there is no necessity to create a separate compartment to put a toilet. It requires less space as well as it has less weight so it can easily pick up and travel anywhere. This has a foldable butt-stand that can open and close by folding. (Butt-stand is for supporting the buttocks). The Structure is made as that way the anal cavity is synchronized with the toilet hole/cavity and not overall butt evacuated. That is for comfort.

2. Track (pipes): The track (pipe) is also the main part of the space toilet. The Track joint toilet to the container. Track/pipes are not so long and are adjustable so one can adjust the toilet as per his/her choice. I designed different track for space toilets. That these pipes have further (internal) parts: 1) Descending colon 2) Rectum. In my design, I include the most interesting thing and that is Sphincter. These pipes are one-way pipes i.e. waste flows only in one direction and couldn't flow backward.

3. Container: Container used to store the excreted waste materials that come from the toilet through the track and process it. I designed the container especially for waste management purpose i.e. the excreted waste material comes from the toilet that will get form/shape of cubes or cookies. I designed especially the container part innovatively. It comes with the waste management system automatically. I will explain this waste management system separately in the next section. Container has a pressure chamber for waste collection.

There is one more part for urine passage. That urine passage is attachable to the main toilet. It can help an astronaut to do two things at the same time i.e. urine and toilet like we do it on the earth. This attachment can possible with magnets or electromagnets. There will be a suction system. This toilet can attach or put on any surface like a stool or chair etc. That property made it so easy to use and portable. Another specialty is to fold the main toilet in the shape of a circle or cube. The reason is portability and can fit anywhere. In the spacecraft, the biggest problem is the small space and we have to fit all the necessary equipment and other things that's why the portability that I kept in mind for this project. This helps in traveling with no loss.

II. EASE OF USE

1. Fix the position
2. Attach the toilet to buttocks
3. Fix the movable around thighs

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4. Vacuum start
5. Attach urine passage nozzle (if necessary)

These are the steps for using a space toilet.

it is easy to maintain or low maintenance needed because of fewer components.

It is portable that's why is convenient to use.

I design the track that joint the toilet with the container in a different way. The track design includes the following internal parts:

1. Sphincter
2. Evacuated pipe
3. Multiple internal opening and closing
4. Descending colon
5. Rectum.

- The sphincter is an important part of the toilet track. It is a circular part situated at the starting of the track. It allows the waste flow from only one direction to the other direction. It never flows backward. Sphincter controls the passage of liquid and solid (any type of waste). During the contraction of the sphincter/circular part, the opening associated with the sphincter closes.

- The evacuated pipe is the part of the track that absorbs the waste material with the pressure handling. It is an important phase of the toilet in microgravity, lunar gravity, and mini gravity. This pipe sucks the waste material from the track. It is very convenient for the crew members.

- Multiple opening and closing in the track provide extra protection for the toilet. By using this method the waste never comes back and there is no tension of regular maintenance.

- The descending colon is used in microgravity and lunar gravity. By use of this colon, the waste flows descend and collected by the container. The rectum is the final portion of the track. The waste that comes from the toilet that passes by this rectum. This can slightly longer to connect to the waste container. The rectum acts as a temporary storage site for the excreted waste.

Working (Toilet to the container):

- Very first, when the crew member wants to go to the toilet then they can take the main toilet and open it.

- After the opening, the main toilet attaches to the rump and the sphincter synchronizes with the anus.

- When waste comes out from the anus, the sphincter opens and waste enters into the track.

- Toilet has the butt-stand, that supports the buttocks.

- Thereafter the waste comes in the track/pipe through the sphincter(passage valve).

- After that, the waste comes through the evacuated pipe and further passes through the pipe.

- The waste passes through multiple openings/sphincters. This helps the waste flow unidirectional. the waste cannot come upside/backward once passes through the sphincter.

- Then the waste passes through the descending colon. That makes the wast flow easily.

- After coming through the pipe/track the waste passes through the rectum that placed at the end of the track/pipe.

- The pipe is adjustable that's why it is easy to handle the toilet to the crew members.

- After this overall process waste enters the container.

After the entry of the waste in the container, the waste processed as follow:

1. Collection: In this process, the waste collected from the rectum i.e. track and passes through the absorption chamber. The entry of a collection chamber also has a sphincter. This process occurred at the beginning of the container.

2. Absorption: After the waste passes from the collection chamber, it comes in the absorption chamber. In this chamber, all the moisture and odor contents absorb and dry out the waste. This process is done by using electric Furness or maybe direct sunlight. the waste is dry out entirely and sends to the shaping process in the shaping chamber

3. Shaping: The waste, after, passes from the absorption chamber and comes in the shaping phase. in this device/chamber, the dried waste then gets shape like a cube or cookie(like dung cake).

4. Storage container: After this entire process, these cookies have placed in a dry chamber for long term storage. This process gives convenience to store the excreted waste in a better form

I design a special waste management system for the toilet. The power for this can be obtained by the solar power system. Those cookies are can be used for further work or as fuel.

This toilet is durable and has a fast turnaround time.

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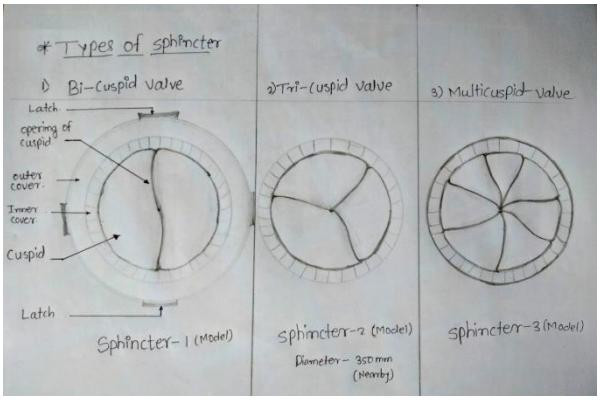


Sphincter/cuspid valve

As I mentioned earlier that my design contains various new parts like sphincters, pressure chambers, rectum, discrete ducts, etc. These parts have the tendency to hold and flow the liquid, urine, feces, vomit, diarrhea, and menses unidirectional.

For the liquid and urinal part also the same solution as for the solid waste that as follow:

- The collector collects the waste and send it to the container. It has two pressure chambers.
- The pressure chamber is connected to the track and to the sphincter.
- The sphincter/cuspid is an important part of the toilet track and pressure chamber. It is a circular part situated at the starting of the track. It allows the waste flow from only one direction to the other. It never flows backward. Sphincter controls the passage of liquid and solid(any type of waste). During the contraction of the sphincter/circular part, the opening associated with the sphincter closes.
- This helps capture and contain liquid waste.

Specifications of sphincter:

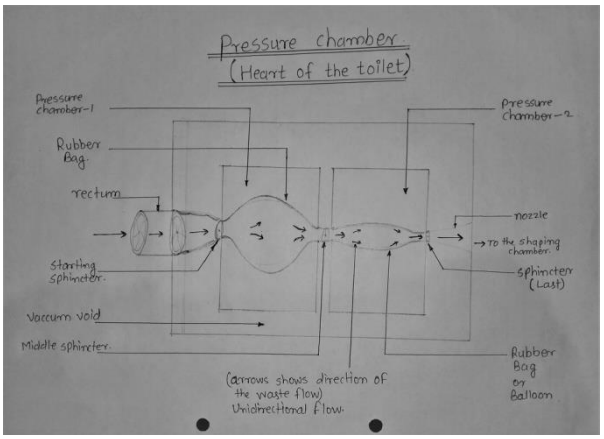
1. The sphincter is the one side opening valve.
2. It is round-shaped.
3. It has a small cuspid valve that allows liquid or solid to flow only in one direction.
4. All the cuspid valves can be open on one side. This cannot open by another or opposite side.
5. These valves can be Bi, tri, or multicuspid.
6. A valve opens or closes incumbent on differential pressure on each side of the chamber.

"The pressure chamber is

the heart of the space toilet."

Working of pressure chamber:

1. There are two pressure chambers. One is for the collection of the waste and the other is for sending the waste to the container or the further process.
2. When the Collection pressure chamber is operated or depressurized, then the sphincter/cuspid valve opens. When the valve gets open, the waste comes in the pressure chamber-1.
3. After that, the pressure chamber-2 depressurize, and pressure chamber-1 gets pressurized. The sphincter of pressure chamber-1 is closed and simultaneously the sphincter of pressure chamber-2 gets open.
4. Because of this simultaneous action and reaction pair, waste collected and sent to the container.
5. Like the Heart, this chamber works, and waste flows from only one direction to another.



Pressure chamber

The collector has two pressure chambers. One is for the collection of waste and the other is to send the waste material to the container. The pressure chamber has a balloon-like part that helps to collect the waste easily and efficiently.

For the maintenance of the toilet, only the chamber(balloon) needs to replace only if it is necessary.

The urine nozzle is detachable, that's why there is no problem for simultaneous urination and defecation. This nozzle can attach to the toilet for both purposes. The attachment achieved by electromagnet/magnet. So if necessary, one can do only urination by detaching the nozzle. The nozzle is personal or separate for each crew member.

It clears previous waste content prior to the next use. Maintenance is easy and convenient. This toilet has proper use, storage, reuse, and clean technology.

The collection system designed a very sophisticated manner. very less often the collection system is replaced or reused. Because of the removal of the moisture content and dry out

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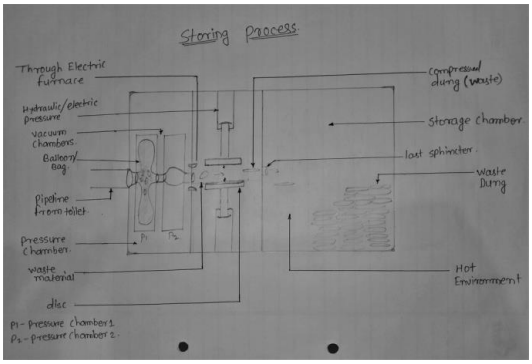
the waste, the waste becomes light; the volume also reduced by this method. that is why it is very convenient to replace, reuse, or dispose of the system. The dried-out waste(dung) cakes or cookies could be reuse as fuel or any other use in the mission.

Safety measures

The*"-tech Low Power Space Toilet and Waste Management System " is* durable and easy to handle. At the event of system failure, the waste wouldn't interfere in the work of the crew. That's why I design powerful waste management of the space toilet.

The handling of the toilet is very easy as well as very sufficient because of the management system of the space toilet. There will be no problem for the crew members to handle the waste. They will do it very sufficiently and conveniently (easily) in a situation like a system failure.



Waste management system and storage.

The waste is in that form, that the crew will easily handle this. For a better understanding of my design, we look at a waste management design data as follows:

1. Collection
2. Absorption
3. Shaping
4. Storage container

- In this process, the waste collected from the rectum i.e. tracks and passes through the absorption chamber. The entry of a collection chamber also has a sphincter. This process occurred at the beginning of the container. After the waste passes from the collection chamber, it comes in the absorption chamber. In this chamber, all the moisture and odor contents absorb and *dry out the waste*. This process is done by using electric Furness or maybe direct sunlight. the waste is dry out entirely and sends to the shaping process in the shaping chamber. The waste, after, passes from the absorption chamber and comes in the shaping phase. in this device/chamber, the dried waste then gets shape like a cube or cookie(like dung cake). After this entire process, these cookies have placed in a dry chamber for long term storage. This process gives convenience to store the excreted waste in a better form.

The power for this can be obtained by the solar power system. Those cookies are can be used for further work or as fuel.

That is why crew handling of waste materials during maintenance or system use is minimized automatically. And the waste is safe to handle (in various situations). And the maintenance is easy.