

# Technical data sheets for urine diversion as an ecosan component - a GTZ contribution to ecosan information sharing

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## INTRODUCTION

With the quick spreading of the ecological sanitation concept, an increasing number of ecosan projects were implemented and a series of different technologies were tested and proven at the operational level. It now becomes more and more crucial to establish technical reference for ecosan project planners and implementers and to spread information on the available ecosan technologies and their current state of development. To cover these needs, the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) has elaborated a series of data sheets looking at specific ecosan technology modules (GTZ 2005). One of the data sheets is presenting an overview on urine diversion technologies (GTZ 2005a).

Urine diversion is principally a collection system of separating human urine at the source before it mixes with faeces. This is achieved with specially designed toilets and urinals, piping systems and storage containers. The collected urine, loaded with essential plant nutrients, can then be further processed and used as a local fertiliser in agricultural production, thus closing the nutrient cycle. By separating urine from faeces, separate treatment options can also ensure a more manageable faecal fraction and reduce potential odours. The technological options available for urine diversion and collection include many different designs of urinals and toilets connected to a collection container via drain pipe or channel. In the data sheets for urine diversion technologies, current proven technology alternatives and their cost, applications, operation and maintenance, weakness and advantages are summarised and lists of products and producers are included as well.

### Urine diversion toilets

The urine diversion toilet differs from an ordinary toilet as it attempts to collect the urine separately from the faeces for potential reuse applications.

*The urine diversion flush toilet.* The urine diversion flush toilet has a partition in the toilet bowl isolating a bowl for urine in the front, and a bowl for faeces in the rear. Some designs allow for each bowl to be flushed separately. The collection of undiluted urine is also possible.

*The urine diversion waterless toilet.* The urine diversion waterless toilet is a very simple configuration adapted to a drop toilet whereby the urine is captured in a bowl in the front of the toilet and drained off to a storage container or leaching pit. The waterless toilet requires no water for flushing the faecal fraction, although small doses may be used to flush the urine. *Vacuum sewerage.* Urine diversion as a component of vacuum sewerage systems is still very much in development. A pilot project in Berlin, Germany is under test.

Toilet designs vary considerably in complexity and application potential resulting in a wide range of prices. Urine diversion flush toilet prices range at present from 400 to 675 EUR. Urine

diversion waterless toilet and squatting plate cost between 8 to 750 EUR.

### **Waterless urinals**

The motivation of introducing waterless urinals is to reduce the consumption of water resource and avoid urine dilution. Low flush urinals with little dilution are also available.

*Simple and low cost urinals.* Simple and low cost urinals, for example slab urinals are simply a small channel in the defecation slab, where the urine is collected and drained away. The low cost version often has no stench barrier, and a considerable amount of the urine can evaporate causing odour problems. Prefabricated plastic urinals consist of a plastic bowl with an outlet. It is wall mounted and the urine can be collected directly under the bowl in a container or it can be connected by hose to a holding tank elsewhere.

Several types of stench barriers for waterless urinals have been developed in order to reduce odour problems. Urinals with four types of trap are available:

*Membrane stench trap.* In urinals with a membrane stench trap, the stench barrier consists of a thin rubber tube. The urine passes through this membrane, which then closes when the urine flow stops and effectively seals the urine outlet, preventing smell. These membrane stench traps are available in low cost plastic types produced in South Africa or in more expensive stainless steel types produced for the European market.

*Liquid stench trap.* In urinals with liquid stench trap the urine passes through and blocked by a liquid odour lock made of mineral oil or aliphatic alcohols that are heavier than urine. The sealing liquid is environmentally friendly and for the most part biodegradable.

*Electromagnetic float trap.* In urinals with electromagnetic float trap the urine passes into the cylindrical inner part of the pan and from there to the overflow chamber, whereby the float rises and seals the inlet opening against a flexible sealing lip. When the urine in the overflow chamber reaches a certain level it flows into the drain of its own accord. Every time the urinal is used an electromagnet draws the float down again to ensure complete emptying of any residual urine. Instead of using a magnetic device driving by electricity,

*Hydrostatic float trap.* Urinals with hydrostatic float trap are also newly available. When there is urine the float sinks down after it is pressed by the urine received above and therefore the channel is open and urine flows in. When the urine in the overflow chamber reaches a certain level it overflows. The float trap will move up and close again. It is designed in a way that the float will move downwards even when the pressure from urine received is very small, to ensure that no urine is blocked and leaved outside.

Low tech urinals are very inexpensive. Self-built urinals can be made from a simple plastic container, which should be thoroughly washed before use to ensure a high quality if collected urine. Prefabricated plastic urinals produced in South Africa, cost around 30 EUR/bowl without a stench trap. High tech urinals are more expensive and require maintenance.

### **Piping and storage**

When the urine is separately collected by a urine diversion toilet or urinal, then a piping system normally consisting of two separate pipes for urine and faeces and at least one storage tank are required. In area where wet anal cleansing is practised, a third pipe may be required. The storage tank serves a temporary storage and sanitisation as well.

The costs of piping system range from very low (hose; around 1 EUR / meter) to expensive (prefabricated wastewater pipes; around 20 to 30 EUR / single pipe) to very expensive (pipes

with micro-structured wall surfaces). The cost of holding and storage tank depends on the system; they can be either very cheap or quite expensive. A plastic container (maximum 15 EUR) or a barrel (200l around 30 EUR) is not as expensive as a balloon tank used in Sweden.

### **Application, operation and maintenance**

Toilets and urinals are typically constructed of ceramic, concrete, fibreglass or plastic. Drain pipes and tubing are normally made of durable plastics such as polyethylene. Storage containers may be constructed of rubber, plastic or concrete. Metal components should be avoided as urine may react and corrode them.

If the urine is to be used in a larger municipal scale, the urine should be stored before reuse in order to achieve an adequate hygienic quality. If it is stored for one to six months without the addition of any new urine then the a safe application can be guaranteed. A high temperature, low dilution, high pH levels and inert materials for piping and storing promote sanitisation of the urine. In small, household systems, the urine may be directly reused until 4 weeks before the harvest of the crops.

Blockages of pipes through precipitation are known of conventional sanitation systems and have in some cases also been reported in urine diversion systems. Here, the blockages were mainly limited to the u-bend of low-flush urine diversion toilets, the rest of the piping system was generally found little or unaffected. Precipitates can be cleared with a mechanical snake or caustic soda. The piping can also be flushed if necessary with normal water pressure or by jet cleaning. In order to minimise precipitation, easily exchangeable traps, and non-dilution of the urine by water, as precipitation is greatly accelerated when the ammonia and phosphorous ions react with magnesium and calcium ions contained in hard water.

Urinals should be cleaned regularly. The detergent and how much water to be used depends on the desired quality of the collected urine. Specific maintenance operations should be adapted to each type of stench trap.

### **Strengths and weaknesses**

Urine separation systems

- Enable a highly hygienic and efficient collection and safe reuse of urine with 60-90 % urine collection efficiency.
- Reduce water consumption up to 50% compared to conventional flush toilet, which can also result in energy saving in the wastewater treatment and the production of fertiliser.
- Normally require an initially higher investment. The operation and maintenance cost and the level of skill for construction required depend on the type of technology selected.
- Blockages may be problematic in the drain of some flush toilets, but preventive measures can be taken accordingly.
- The barrier liquid from high-tech urinals and the daily use of anti bacterial detergent may have impact on agricultural fields when applied along with the urine. The effects is not yet known.
- Diversified technologies and products are available to meet different cultural, economic, technical and climatic situations, such as water availability, sanitary habit and financial capacity. They can be built on the existing system or new construction. Special attention should be made to ensure the users' acceptance of the technology used.

### **CONCLUSIONS**

Urine diversion system enables urine and faeces separation at source before mixing, therefore

urine and faeces can be handled separately and specifically, which ensure a more manageable faecal fraction and reduce potential odours. The data sheets of urine diversion cover different available technical options in regards to urine and faeces separated collection, including the urine diversion receptacles, piping and storage container, as well the cost, applicability, operation and maintenance, pro and cons of. Lists of typical products and their producers are also given as reference. They provide a strong overall reference for the practitioners, enabling them to indentify the most appropriate technologies to meet their objectives.

## REFERENCES

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