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Waste Mining: How Today's Plumbing Engineers Can Design for Tomorrow's Piped Urine Systems

Separating urine from the waste stream could provide practical solutions to some of the problems caused by the materials in our wastewater. While widespread use of such technologies most likely won't occur until far into the future, most of the buildings we design and build today will be in operation for decades. What can we do in today's plumbing system design to prepare for these future systems?

It is now possible to design buildings with many different gravity systems, such as primary rainwater, secondary rainwater, black water, graywater, air-conditioning condensate, acid waste, and more. Should we start thinking about a separate piped system for urine? What are some of the special issues concerning piped urine systems?

Drinking water entering and flowing through the plumbing system in a building is a relatively clean liquid that we can consume without worrying about it harming our health. However, when clean, drinkable water flows into the drain, it mixes with a cocktail of harmful substances. Typical building plumbing systems combine organic, chemical, solid, and chemical wastes into one waste stream and send it to the wastewater treatment facility, where it is cleaned and sent back to natural waterways. Many people now are realizing that we are asking municipal wastewater treatment systems to do too much. This is why we need to look at separating our waste streams in our buildings.

HERE IS THE CONCEPT

According to the Novaquatis research project in Switzerland performed by Eawag Aquatic Research and detailed in the report "A New Approach to Urban Water Management," there are advantages to separating the urine flow in a building. The advantages are more apparent when you consider municipal-level waste systems, in particular the wastewater treatment facility and area waterways.

The report states that most of the nutrients in wastewater are from urine. About 80 percent of the nitrogen and 50 percent of the phosphorus in a wastewater stream is from urine. However, only 1 percent of the total volume of the wastewater stream is urine. These nutrients can have toxic effects, such as causing excessive ammonium, algae growth, and phosphorus in natural waterways. Unfortunately, precipitating phosphorus and converting ammonium to nitrate so it can be removed later in the wastewater treatment plant are expensive processes.

Those living in coastal communities, in particular in Florida's Gulf Coast, know about the red tide, which is algae blooms in the ocean. It is uncertain whether high levels of nitrogen actually cause red tides, but nitrogen can exacerbate the problem. Nitrogen in waterways previously was traced to agriculture; however, in the last few years, farmers have reduced the amount of nitrogen they use that runs off into natural waterways.

Another problem comes from residential fertilizers and turf irrigation, which also wash nitrogen into natural waterways. This is another reason to use efficient irrigation systems or plants that do not require irrigation and chemical use, but that is a topic for another day.

The nitrogen from wastewater treatment facilities is thought to be another source of the nitrogen that enters waterways. As stated, one of the major sources of this nitrogen is urine from building occupants.

Urine can cause other problems when it is mixed in the waste stream. Some reports have found trace pharmaceuticals in water sources because our bodies do not process all the pharmaceuticals we ingest, and they pass into the waste stream via our urine. Because the urine content in the waste stream is small and the amount of pharmaceuticals is even smaller, trace pharmaceuticals are difficult to remove from the larger waste stream at the wastewater treatment facility. Separating and treating urine before it enters the waste stream reduces the cost and effort of removing it from the waste at the treatment facility.

NASA faced this issue when developing the plumbing systems for Sky Lab, the Shuttle, and the International Space Station, and the Russian Federal Space Agency researched it in their MIR space station program. They discovered that it is easier, safer, and more efficient to separate waste streams at the source and treat them individually. In the Space Station, solid waste is collected and brought back to Earth, while urine is treated and reused. Several space toilets were designed with a urinal to separate the urine from the solid waste.

The Novaquatis study looked at using nitrogen and phosphorus to produce fertilizer. The process would be the

same as that used at wastewater treatment plants, except on a smaller scale. These nutrients would be converted to agricultural uses, and the micropollutants such as pharmaceuticals would be removed from the larger waste stream.

HOW WOULD WE DESIGN THE SYSTEM?

In buildings with urinals, the waste piping from the urinals could be diverted to a separate system. How would urine be separated at the water closet?

NEW PLUMBING FIXTURE

The Novaquatis study investigated water closets using NoMix technology, which have two compartments. The front compartment collects urine, while the back compartment operates like a conventional toilet. This way, one fixture can separate the urine from the main waste stream.

TREATMENT SYSTEM

The next problem is what to do with the urine after it is separated. Novaquatis is working on a system that will collect the urine in holding tanks and treat the urine on site. Another method is to collect the urine and move it off site for treatment.

SPECIAL DESIGN CONCERNS WITH URINE

When urea from urine is degraded by bacteria, the pH rises, which leads to crystallization. It was thought with waterless urinals that no salts or crystallization would occur with undiluted urine. However, the opposite occurred, and blockages in the fixture and piping occurred when the urine was only slightly diluted or completely undiluted. The blockages can be reduced with the use of rainwater in the system to dilute the urine. The problem with this solution is that the size of the rainwater storage tank must be increased.

Researchers have investigated undiluted systems where urine is collected at the fixture, but this would require redesigning the NoMix water closet and waterless urinal. Such a system would increase maintenance for a project and may not be practical.

PROCESSING

Several ways to process urine are available. One way is a simple one-step biological process. This process could be used in rural settings where the urine must be stabilized to prevent the release of ammonia when fertilizer is applied to the ground. In metropolitan areas where fertilizer is not used, a more complex chemical process can be used to protect the natural waterways from excessive nutrient loads.

TRANSPORTING

Another issue is how to transport urine if a treatment system is not on site because using trucks to transport the tanks may not be practical. One concept is to use the existing municipal waste piping distribution system. It could be possible for many facilities to discharge the urine waste into the sewer network at one time, creating a "wave" of urine to the treatment facility, which would be set up to receive the urine and process it at all at once.

AGRICULTURAL USES FOR URINE

Treated urine can be used in fertilizers due to the nutrients found in it. However, on average our bodies do not retain 60 to 70 percent of the ingredients in medicines, which is excreted in our urine, and urine-based fertilizer should not contain these micropollutants. Added treatment processes can remove most of these materials from urine, but not all. At what level is it acceptable to have these materials in fertilizer that will be used on food products? Many feel that this is a small problem compared to the larger benefits of removing urine from natural waterways.

There have been problems in the past with using sewage sludge on agriculture, so the industry must prove to farmers and consumers that this process is different. More testing will have to be done before this idea is ready for the market.

TECHNOLOGY MATURITY

It is important to note that this technology is not yet mature and ready for plumbing engineers to install in buildings. The technology is still in the laboratory stage. Tests have to be conducted, models run, and standards developed before the complete system is ready.

WHAT ABOUT TODAY?

Most of the buildings we design today will be in operation for years. While piped urine system technology is not yet available, we can do other things in building design today.

For instance, urinals could be installed with a separate piped system that connects to the waste system where it exits the building. Low-flow (1-pint) flush fixtures could be used to dilute the urine to reduce clogs in the piping. The urine line could be routed through a mechanical space before it connects to the waste main. This way, a future collection system could be installed in the mechanical space when the technology is ready.

In conclusion, many new technologies are not ready for use in our buildings today. However, design techniques such as installing a separate piped urine collection system can be used today so future building operators and owners can install the systems when the technology is ready. PSD

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