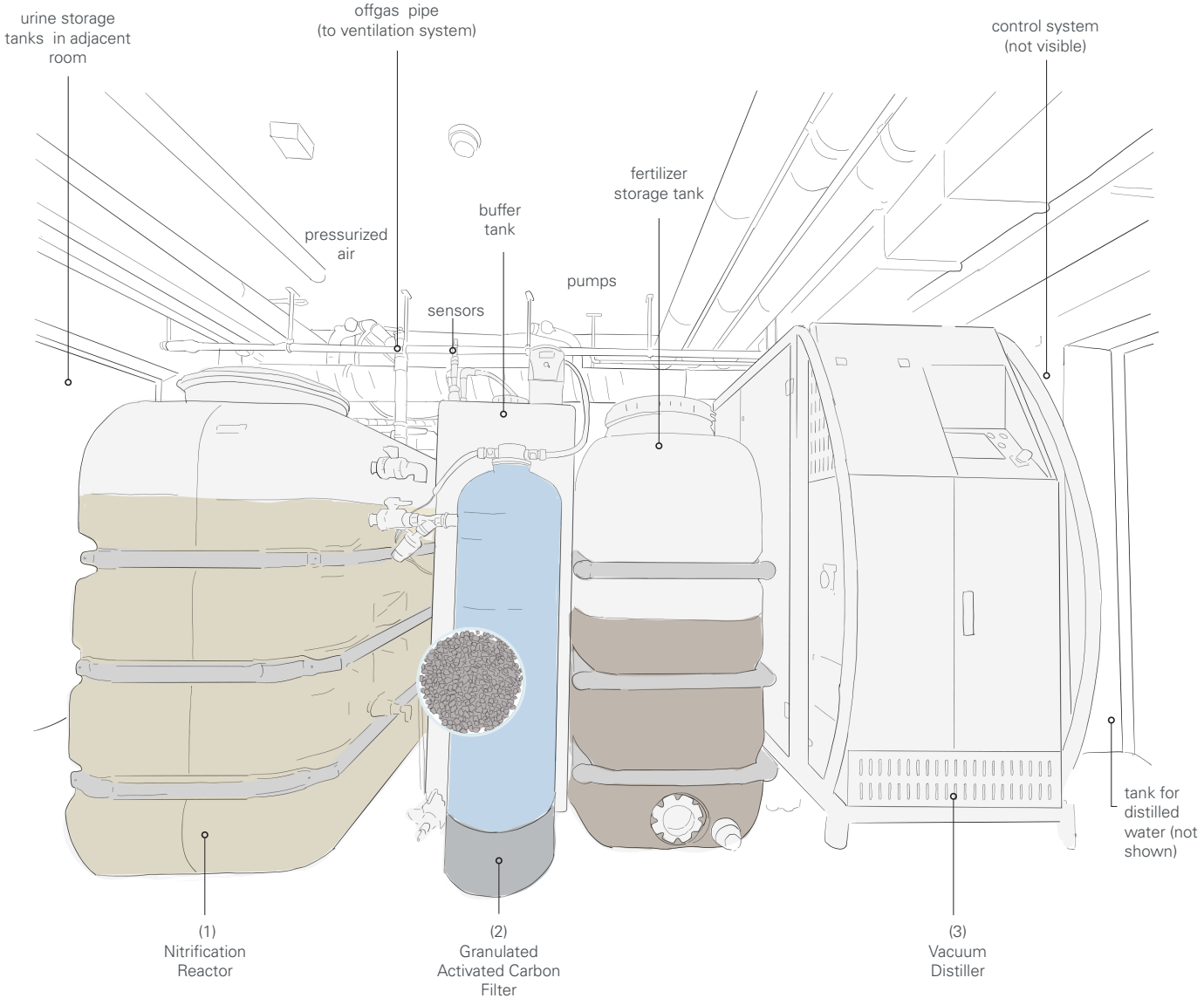
T.3 NITRIFICATION-DISTILLATION

TECHNOLOGY



Nitrification-distillation of urine, also referred to as the VUNA process, is a treatment and complete nutrient recovery technology that converts urine into a liquid nutrient fertilizer through (1) biological treatment in an aerated reactor for the stabilization of carbon and nitrogen compounds, (2) activated carbon filtration for the removal of micropollutants and (3) vacuum distillation for the concentration (down to 5-10% of the original volume) and hygienization of the stream. It is a relatively high tech solution, best suited to treat urine flows of at least 500L/day (roughly 350 p.e.). The core of the treatment is the aerated bioreactor in which microorganisms aerobically degrade organics and convert ammonium to nitrate (a process known as nitrification), with residence times between 5-10 days.

The technology can be implemented in (and potentially retrofitted into) large "nutrient hotspot" buildings to alleviate the burden of N & P removal on municipal wastewater treatment. The produced fertilizer solution contains macro- and micronutrients that can be used in agriculture.

INPUT STREAMS

- U Urine
- YW Yellow water

TARGET OUTPUT(S)

- Liquid Fertilizer

FORUM CHRIESBACH

Dübendorf, Switzerland | 2006

Treatment of urine from three neighboring buildings

Forum Chriesbach includes urine-diverting flush toilets, urine piping, and a storage and treatment room at the underground level, where the VUNA process was developed and optimized. In 2021, two additional campus buildings with urine-diverting flush toilets were connected via piping to the treatment room. In 2022 the treatment system was renewed and scaled to treat the increased volumes of urine. The system treats ~400L/d in a mechanical room of ~50 m².

SPECIFICATIONS

INFRASTRUCTURE

Nitrification - distillation can treat large volumes of urine in a relatively small space, usually in a dedicated technical room at ground or underground level so that the storage tanks can be fed by gravity piping. The system can also be placed in a technical building. If multiple buildings are connected to a single treatment station, gravity piping can be used if sufficient slope can be granted (2 - 3% slope). Alternatively, intermediate tanks and lifting pumps are needed to convey the urine to the treatment station (see).

Potential incentives for the implementation of urine diversion coupled with treatment by nitrification-distillation include (1) savings at wastewater treatment plants, particularly those operating at capacity, (2) returns on investment through sales of the fertilizer produced, and (3) water recovery from the distillation process.

OPERATION & MAINTENANCE

Operation and maintenance is carried out by the service provider or trained personnel. The process is automated, with a control system and a series of sensors, and can be monitored remotely.

Energy: Energy is required mainly for the distillation process, and a small amount is needed for aeration and for pumps (to pump solutions between processes).
Consumables: The granular activated carbon filter for micropollutant removal is designed to be exchanged 1-2 times/year.
Byproducts: Distilled water is the main byproduct of the treatment and can either be disposed of to sewer (it contains traces of ammonia) or treated further for water reuse.

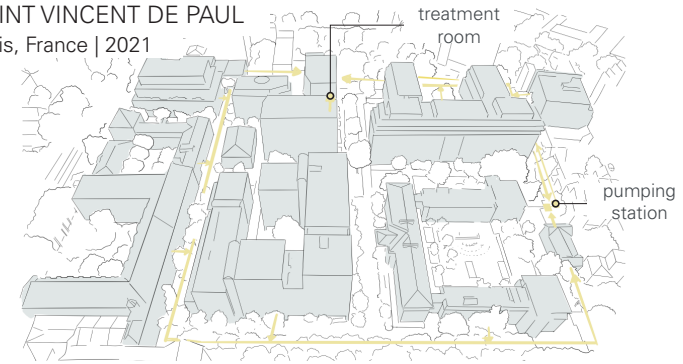
TARGET OUTPUTS

Nitrification-distillation produces a complete liquid fertilizer, with nitrogen (ammonium nitrate) phosphorus and potassium, and a broad range of micronutrients (e.g., iron, boron, zinc). The distillation step enables reuse in agriculture by hygienizing the solution and reducing its volume, facilitating its transport and application on field. Risk of ammonia volatilization during application is low thanks to the low pH (~4) and high solubility of ammonium nitrate. Fertigation, after dilution with water, is possible. The fertilizer has been authorized for sale in Switzerland, Lichtenstein, Austria and France.

SELECTED CASE STUDIES

SAINT VINCENT DE PAUL

Paris, France | 2021



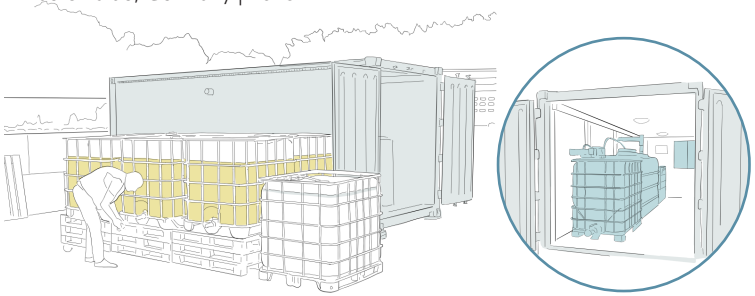
Urine diversion and treatment at neighboorhood scale

The renovated "eco-district" of Saint Vincent de Paul will include urine diversion on a neighbourhood scale to reduce the pressure on the municipal wastewater treatment plants discharging to the Seine. The urine piping system, consisting of three gravity pipes (spanning 500m) and one pressurized pipe with a pumping station, was built in 2021, before renovations and new construction. A treatment room in the basement will treat the collected urine from the urine diverting flush toilets and urinals. The fertiliser produced will be used by the parks and gardens services of the City of Paris.

YW → COLLECTION TANK → T.3 NITRIFICATION - DISTILLATION → distilled water

KREISWERKE BARNIM (ZIRKULIERBAR)

Eberswalde, Germany | 2023



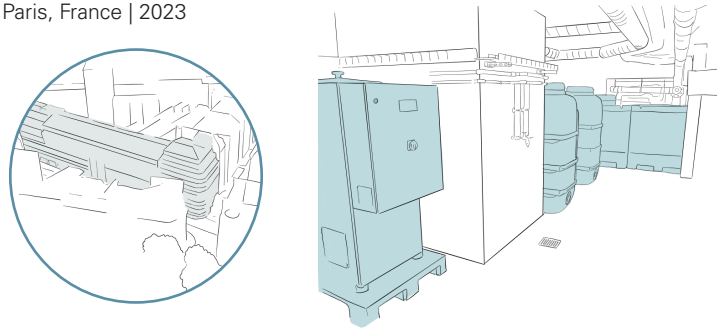
Nitrification-distillation of collected urine in centralized location

Urine collected from public composting toilets and waterless urinals is transported to a recycling center. The urine is stored in IBC tanks next to a shipping container which houses the technology. The produced liquid fertilizer will be used in field tests in nearby agriculture.

U → COLLECTION TANK → T.3 NITRIFICATION - DISTILLATION → distilled water

EUROPEAN SPACE AGENCY

Paris, France | 2023



Nitrification-distillation fit into newly refurbished office building

During the complete renovation of ESA's headquarters in 2023, urine diverting toilets and a dedicated urine piping system were installed. A nitrification-distillation system, set up in a technical room in the basement of the building, treats the yellow water from the building's 72 toilets and converts it into the liquid fertilizer known as "Aurin". The system is designed to process 200L/d.

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