23 April 2021

TECHNOLOGY FACT SHEET

Thermal drying

The purpose of thermal drying is to reduce the volume and mass of the digestate.
Thermal drying relies on evaporating water by heating up the product by means of heat transfer from another medium (e.g. air, steam, heated oil). Preferably the heat is residual heat from the CHP.
When a drying step is added, the dry matter content can be increased to 95-95% and during drying, a germ-count reduction also occurs. Every type of digestate has specific drying characteristics. Also air velocity, pressure and temperature will have an influence on the drying process (de Vogeleer 2009).

There are many drying digestate systems on biogas plants in Europe and the predominant systems used are: belt dryers, fluidized bed dryers and indirect dryers (Bamelis 2016; Buckwell et al. 2014; Drosg et al. 2015).
One type of classification can be made based on the contact between the heated medium and the product:

Direct dryers (a.k.a. convection dryers) directly use the evaporation energy of the heat medium, which can be heated air or even flue gasses. During and after drying, the heated air/gasses will contain many volatile components (like ammonia) and dust originating from the drying of the product.

Indirect dryer (a.k.a. conduction dryers) dry the product by transfer of heat through a surface (i.e. a heat exchanger), meaning that the heat medium does not come into direct contact with the product (Bamelis 2016). The heat medium can be a hot liquid (e.g. thermal oil, hot water) or gas (e.g. steam).

Depending on the chosen medium, there may or may not be a need for the extension of the contact surface. Each type of medium has its own advantages and disadvantages (personal communication Waterleau, 2016):

Hot water is often immediately available from cooling or production processes. Because of the lower temperature, a larger contact surface is required and a high flow. The heat exchange is about 20 ° C.

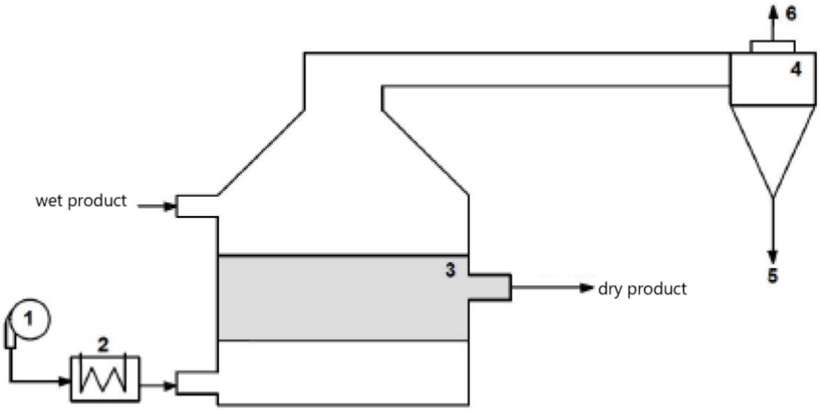
Steam ensures that a high temperature heat exchange is possible, limiting the required contact surface and flow. However, this medium places some restrictions on construction because of the higher pressures involved.

Thermal oil combines a high temperature and heat exchange at relatively low pressure. Like steam, a smaller contact is surface required, yet it requires a higher mass flow compared to steam.

The main advantages of working with an indirect dryer (such as the Hydrogone®) are that due to the lack of direct contact between hot gases and dry dust, a safer process is created. The dryer is airtight, so that work can be carried out below the explosion limit. In addition, the systems are characterized by a high evaporation rate (large contact surface) and a high efficiency (both thermal and electrical). Maintenance of this type of installations is also limited, because there are few moving parts. The investment cost is a disadvantage. Moreover, this type of dryer can only be used profitably from a certain scale size.

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no. 730400. (www.systemicproject.eu).*

Fluidized bed dryer



Scheme of a fluidized bed dryer. 1) fan 2) air heater, 3) drying chamber, 4) cyclone, 5) dust, 6) exhaust air. Source: (de Vogeleer 2009)

In a fluidized bed dryer, the product to be dried is placed on a perforated, gas distributor plate (the "bed") in a vertical cylinder shaped drying chamber, through which the heat medium (air of flue gasses) is sent (0.2-3 m/s) from below.

Pressure drop across the bed increases as the fluidizing gas velocity is increased. At a certain gas velocity, the bed is fluidized when the gas stream totally supports the weight of the whole bed. This increases the contact surface with the heat medium.
The temperature in the dryer can range from 100-800°C (Bamelis 2016; Ceulemans and Schiettecatte 2013).

Advantage of this type of dryer include low residence time (a few minutes), high rate of moisture removal, high thermal efficiency (70-85%), easy material transport inside dryer and ease of control.

Limitations include high pressure drop, poor fluidization quality of some particulate products, nonuniform product quality for certain types of fluidized bed dryers, erosion of pipes and vessels, entrainment of fine particles, attrition or pulverization of particles, and agglomeration of fine particles (Law and Mujumdar 2015).

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no. 730400. (www.systemicproject.eu).*

23 April 2021

Belt dryer/tunnel dryer

The belt dryer or tunnel dryer is a continuous dryer where the product is placed on a perforated band or grid, through which a fan blows hot air in counter current or vertically at air velocities of 0.3-2.5m/s.

Belt dryer. Source: Spiessens.be

This dries the product in the tunnel. It is important that the product is spread evenly on the belt, to prevent uneven drying and fire hazard.

The residence time depends on the size of the particles, the air velocity and the temperature and moisture content of the heat medium. The higher residence times (10-60 minutes) the product quality can easily be finetuned (de Vogeleer 2009).

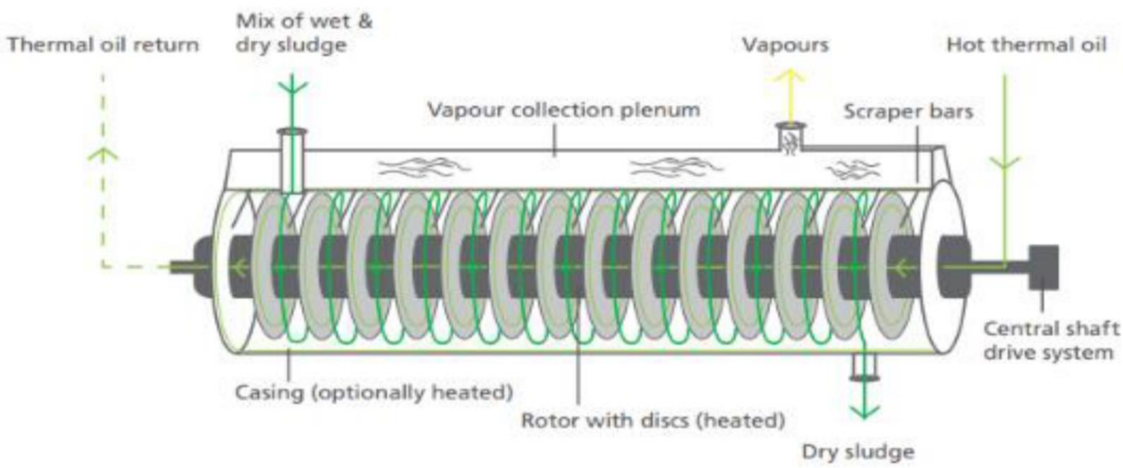
Advantages of the belt dryer are the possibility to also work on lower temperatures (30-400°C), meaning that other heat sources can also be used (radiation heat, heat from the cooling circuit of the heat exchanger, etc.)

Limitations are the lower thermal efficiency compared to the fluidized bed dryer (55-75%) and a higher air flow, because of lower temperatures.

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no. 730400. (www.systemicproject.eu).*

SYSTEMIC
Circular solutions for biowaste

Rotating disk dryer



Scheme of a Hydrogone® rotating disk dryer from Waterleau Engineering.

The rotating disk dryer is a continuous dryer that consists of a rotor on which discs are attached. Both the rotor and the discs are heated by means of steam, hot water or thermal oil.
The housing (jacket) around the rotor can also be heated (optionally). The product to be dried is mixed with dried product prior to entering the dryer to avoid sticking to the rotors.

Once introduced, the product is slowly propelled through the dryer by the combined movement of the rotating discs, the "swords" on the discs and the partitions in the dryer, with optimum heat transfer (Bamelis 2016).

Read more about the recovery efficiencies, energy requirements and costs in Chapter 2.2.6 of D 3.2 Final report on schemes and scenario's for nutrient recovery and Reuse.
www.systemicproject.eu/downloads →"project deliverables"

References

Bamelis, Lies. 2016. *Digestaat Op Maat: Inventarisatie Beschikbare Technieken*.

Buckwell, A., AN Uhre, A. Williams, J. Polakova, WEH Blum, and J. Schiefer. 2014. *Sustainable Intensification of European Agriculture*.

Ceulemans, Johan and Wim Schiettecatte. 2013. *WP2 Inventarisatie van Bestaande Technieken Voor Nutriënt Recuperatie Uit Digestaat En Mest*.

Drosg, Bernhard, Werner Fuchs, Teodorita Al Seadi, Michael Madsen, and Bernd Linke. 2015. *Nutrient Recovery by Biogas Digestate Processing*.

Law, Chung Lim and Arun S. Mujumdar. 2015. *8 Fluidized Bed Dryers*.

de Vogeleer, Gerlinde. 2009. "Technologieverkenning Industriële Droogtechnieken." 132.

*The H2020 EU-project SYSTEMIC (**Sy**stemic large **s**cale eco-innova**t**ion to advance circular **e**conomy and **mi**neral re**c**overy from organic waste in Europe) receives funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no. 730400. (www.systemicproject.eu).*