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Air Drying of Dewatered Biogas Digestate and the use of Dried Product as Bulking Agent

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Outline

- Introduction
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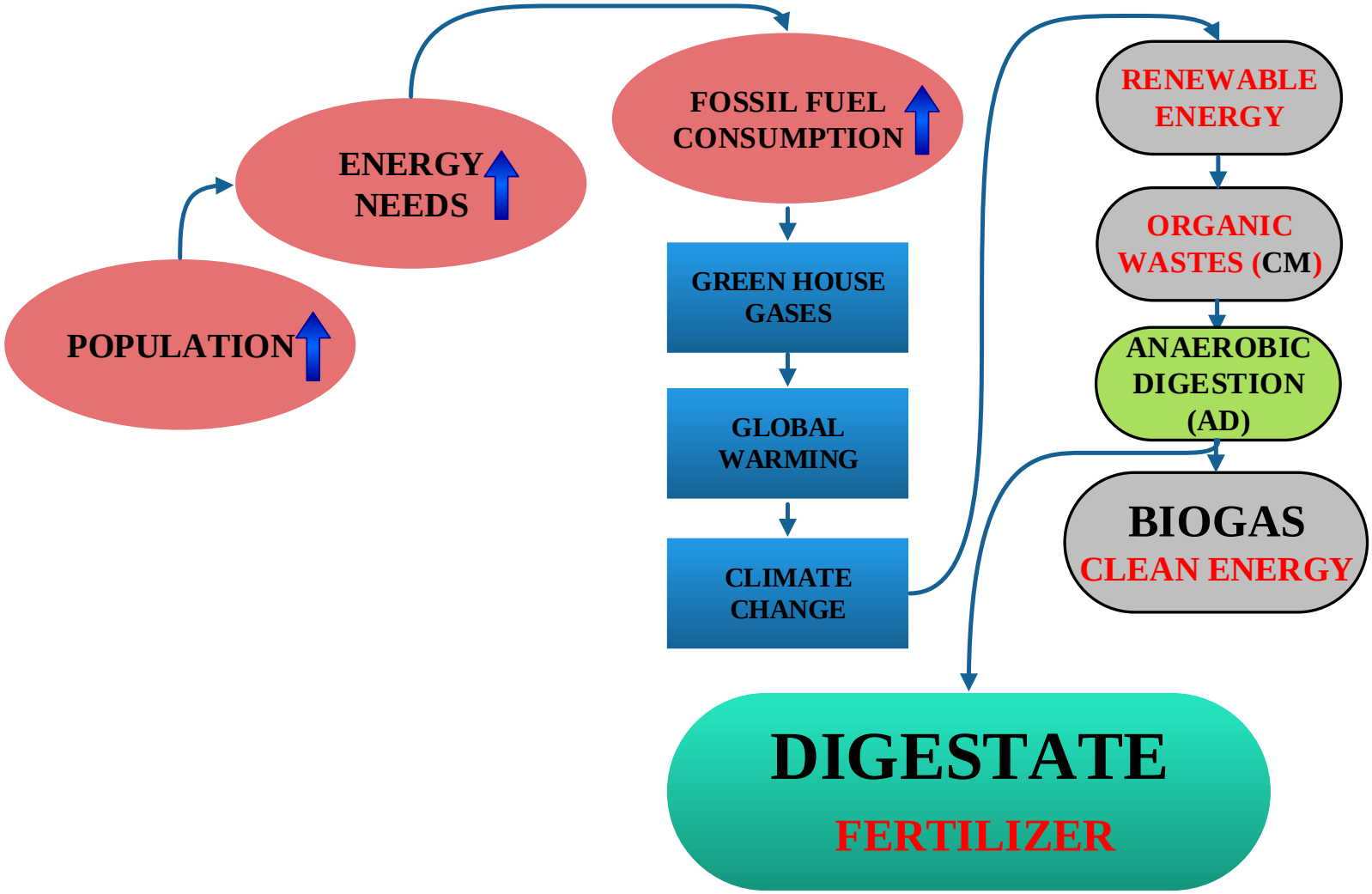
- Results and Discussions
- Conclusions

Introduction



Introduction

- Biogas is a promising alternative fuel for sustainable and renewable energy production.
- Along with biogas, digestate is produced and has to be managed properly.
- It has fertilizer potential when used in agricultural applications
- Dewatered digestate is composed of organic matter and enhances soil quality such as porosity, water-nutrient catchment capacity.

Introduction

- Before field application solid fraction of digestate has to be separated from the liquid fraction.
- Screw or belt presses and centrifugal separators are commonly used for solid-liquid separation.
- Solid-liquid separators may achieve max. 30% dry matter
- After separation;
  - liquid part can be used as a dilution water in biogas plant
  - solid part can be considered as nutrient rich soil conditioner

Introduction

- To get a long-lasting digestate as a commercial product, its water content has to be reduced further.
- For this purpose, usually digestate is dried.
- The parameters affecting the drying operation are temperature, relative humidity, diffusion effect, thermal conductivity, porosity and velocity of the air.
- Increased porosity improves evaporation and heat transfer between air and water

Introduction

- To increase the porosity, in general, bulking agents are added to dewatered digestate
- Commonly used bulking agents:
  - agricultural residues (straw etc.)
  - sawdust
  - wastes with larger particle size
- Use of dried sludge as bulking agent is an applicable alternative
  - Cheap and easy to handle
  - Improves drying and airflow performance

Objectives

- To investigate the influence of porosity on air drying of biogas digestate
- To find the optimal mixing ratio (w/w) of dewatered to dried digestate in terms of energy requirement.

Materials and Methods

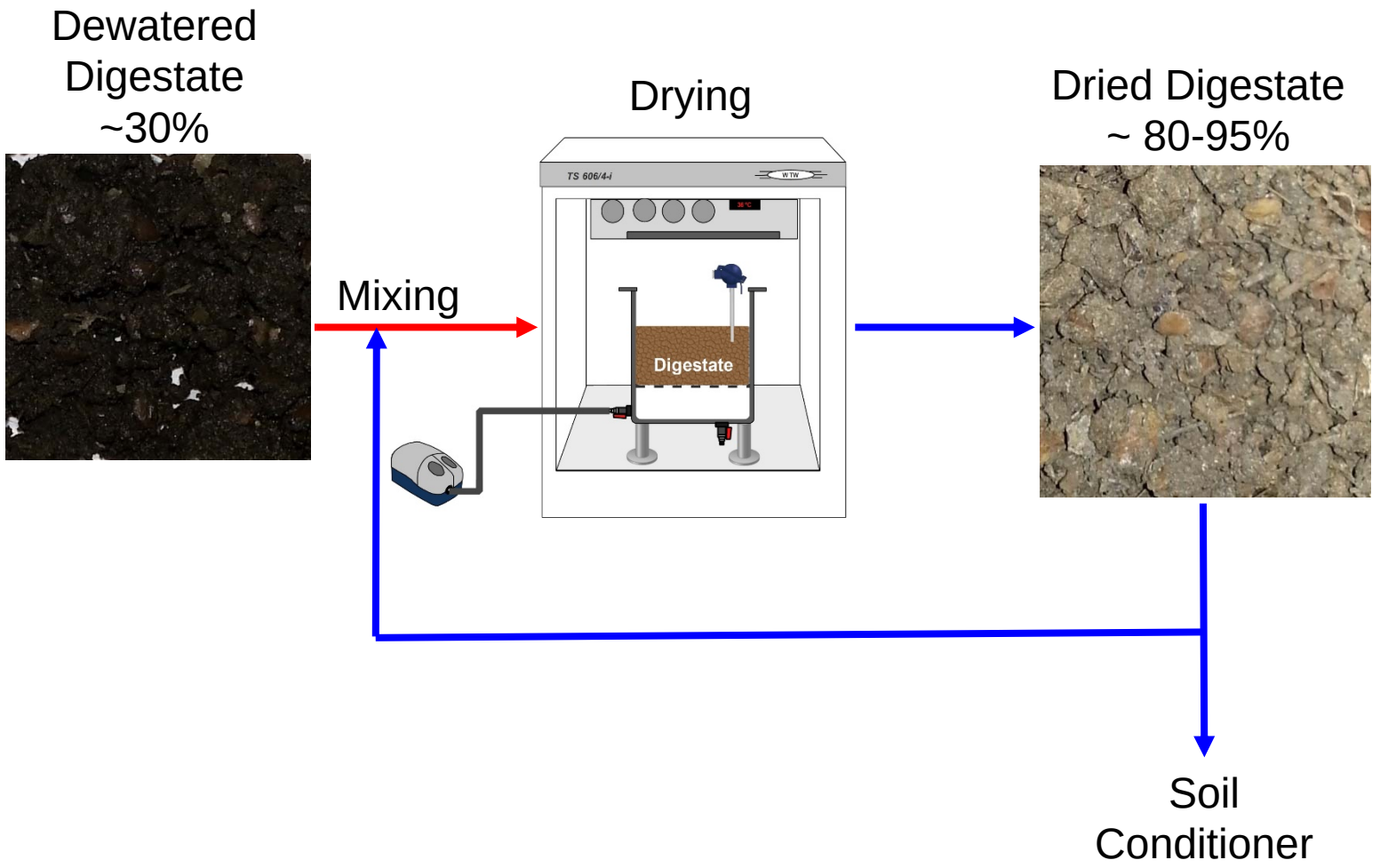


Figure 1. Flowchart of the study

Materials and Methods

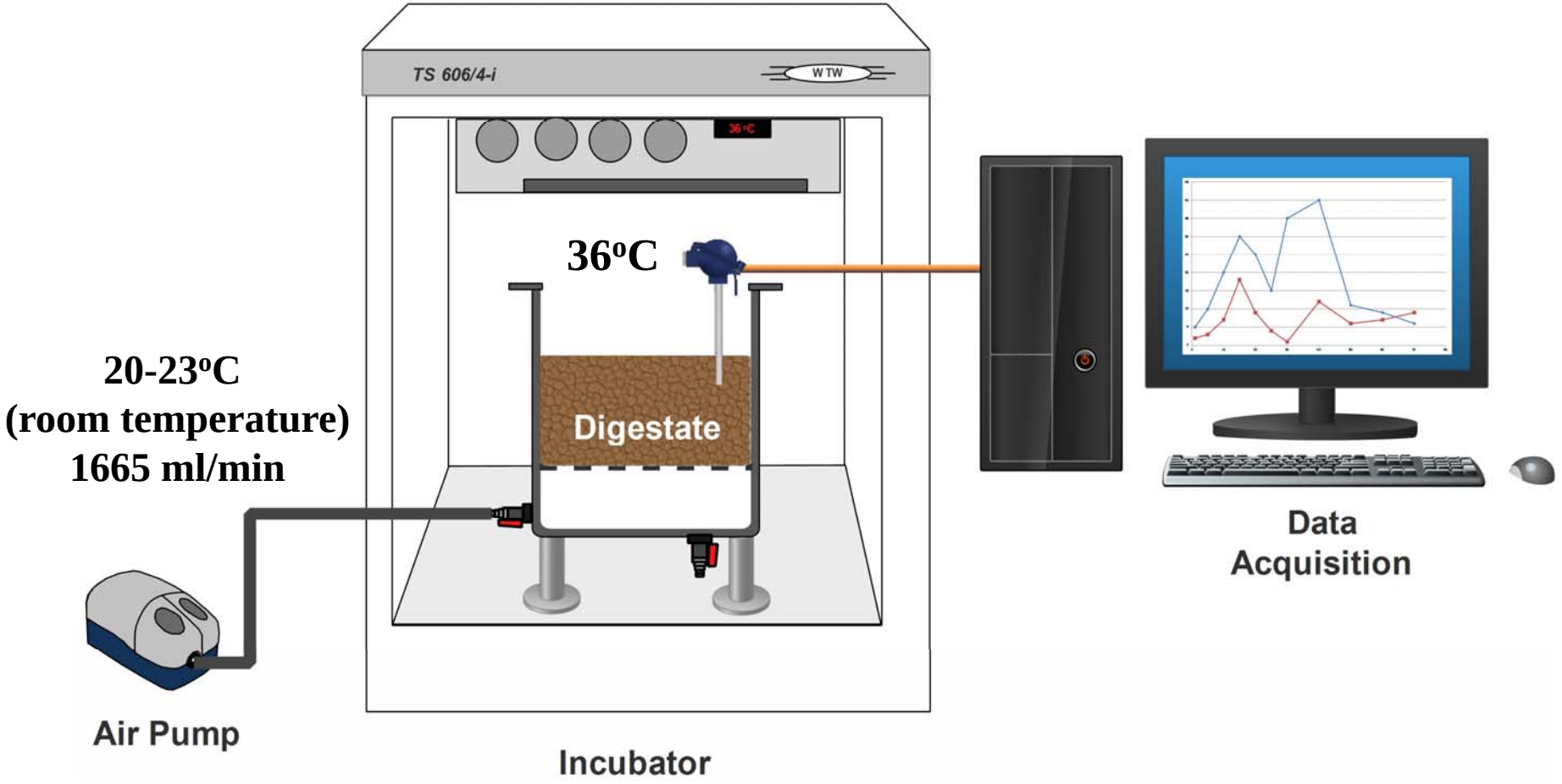


Figure 2. Experimental set-up used in air drying experiments

Materials and Methods

- Digestate was taken from a biogas plant located in Afyonkarahisar/Turkey.
  - Co-digestion of chicken manure and spent poppy straw.
  - Solid-liquid separation is performed by a screw press separator and a centrifugal decanter operating in series.

Table 1. The solids content of the dewatered digestate and the digestate mixtures used

Exp.#	Dewatered/ dried digestate ratio	$TS_{influent}$, %	$VS_{influent}$, %	$VS_{influent}/TS_{influent}$, %
1	1:0	28	13	46
2	6:1	37	17	46
3	4:1	42	19	44
4	2:1	50	23	47
5	1:1	62	29	47

Results and Discussions

- **Sole dewatered digestate drying took about 7 days to reach a dry matter content of about 95%.**
  - **Lack of sufficient porosity.**
  - **A bulking agent required to improve the porosity.**
  - **Formerly «dried digestate» used as a bulking agent.**

Table 2. Mixing ratios of the dewatered digestate and experimental results

Dewatered/ dried digestate ratio	TS_{in}, %	TS_{out}, %	Air consumed, L/g water evaporated	Drying rate, g-H_2O/m^2.day	VS_{out}/TS_{out}, %
1:0	28	95	57	3.73	47
6:1	37	82	56	3.76	46
4:1	42	89	55	3.85	46
2:1	50	90	47	4.55	44
1:1	62	94	70	3.03	47

Results and Discussions

- A minimum final dry matter content of 80% was selected to limit the regrowth and activation of the microorganisms.

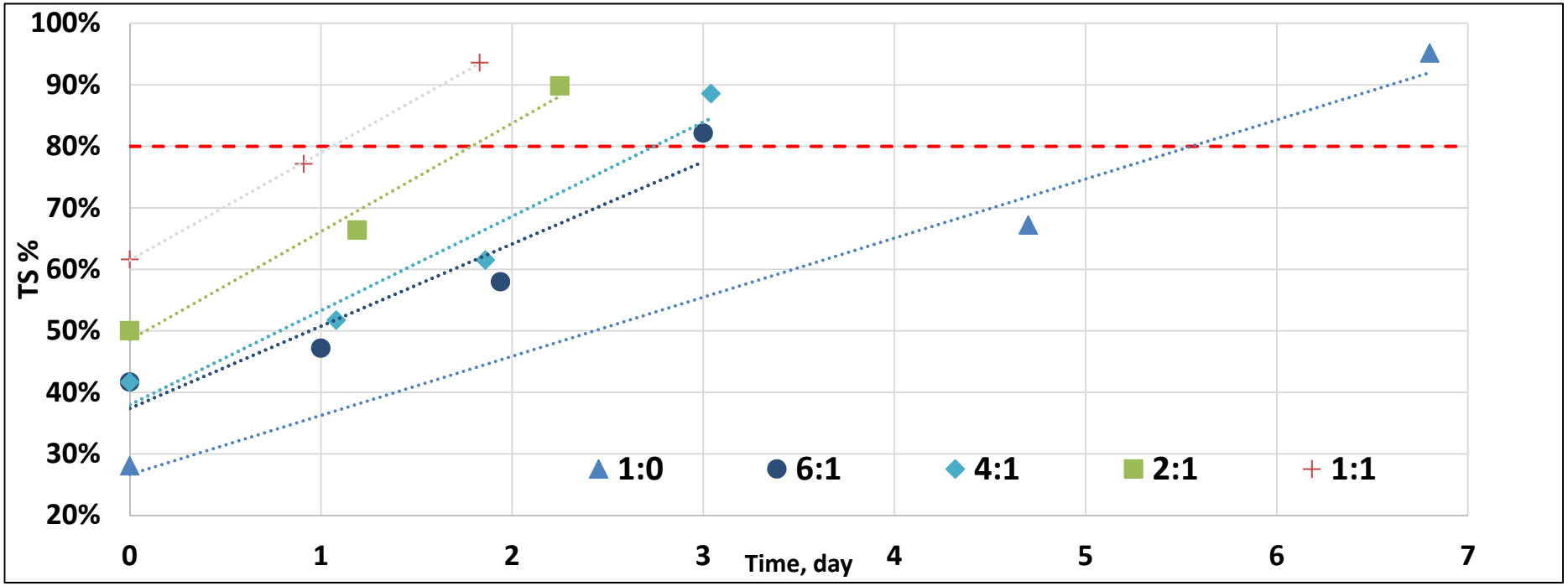


Figure 3. Variations of the total solids (TS) content with the time

Results and Discussions

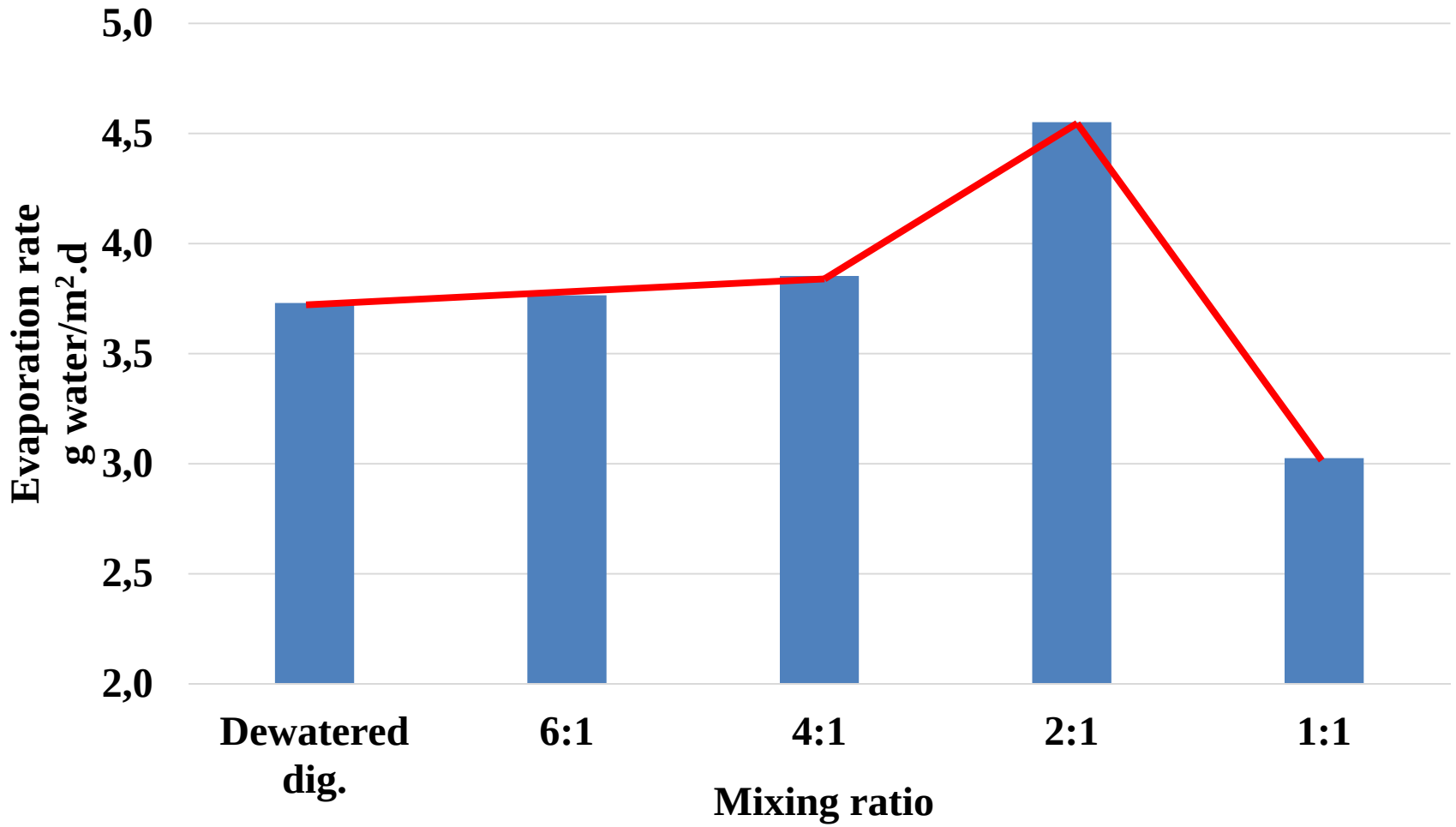


Figure 4. Evaporation Rates of experiments

Results and Discussions

- **Drying rate of 4:1 and 6:1 mixing ratios were very similar to the sole dewatered digestate.**
- **The lowest drying rate of 3.03 g water/m^2.day and the highest air consumption was obtained with the mixing ratio of 1:1.**
  - **High initial dry matter content reduced the thermal conductivity and thus restricted the effectiveness of aeration.**
  - **The increasing water content increases the thermal conductivity; increasing the porosity beyond a value may decrease the thermal conductivity.**

Results and Discussions

- **The highest drying rate, 4.55 g water/m^2.day, and the lowest air consumption was achieved with the mixingratio of 2:1.**
  - **Every 47 L of air supplied resulted in evaporation of 1 g of water.**
  - **Air could penetrate into the digestate mixture easier compared to the other sets, which resulted in increased evaporation rate.**

Conclusions

- Mixing (w/w) the dewatered and dried digestate at a ratio of «2:1» increased the drying rate due to increasing the porosity.
- However, the drying rate at a mixing ratio of «1:1» decreased to 3.03 g water/m^2.day due to decrease in thermal conductivity.
- The maximum evaporation rate of 4.55 g water/m^2.day was observed at a mixing ratio «2:1».

Conclusions

- The formerly dried product can be successfully used as a bulking agent in air drying of biogas digestate due to the
  - high efficiency
  - cost-effective
  - easy application
- By mixing the dewatered digestate with the dried one at a ratio of «2:1», the energy consumed for the final product decreased from 1.7 to 1.1 kWh/kg-dewatered digestate.

Results and Discussions

Dewatered digestate

Partially dried

Dried product

Figure 4. Photographs of air-dried biogas digestate

Thanks for listening…