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Publication year: 2019

Publisher: Biomass Technology Centre, Swedish University of Agricultural Sciences

Conference information: 27th European biomass conference & exhibition, 190527-190530, Lisbon, Portugal

Cyclone drying of hydrothermally treated sludge at bench scale

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Introduction

Drying is an energy-intensive and slow operation. Industries face pressure to realise a more circular economy from their waste streams. Hydro thermal carbonisation (HTC) provides a means of improving the sustainability of important industrial processes such as pulp and paper manufacturing.

Methodology

Drying behaviour of sludge and other biomass is determined using a bench-scale cyclone dryer whose design geometry can be optimised (Figure 1). Experimental parameters include inlet air velocity, air temperature, material feeding rate and geometry of the cyclone itself.

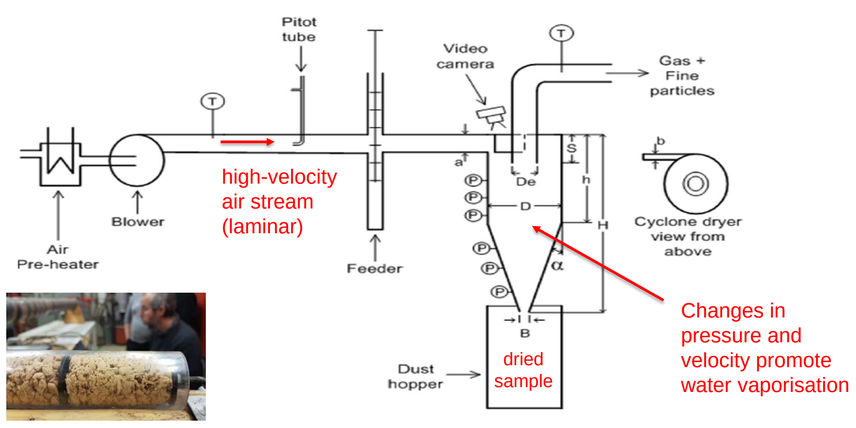

Figure 1. Overview of the bench-scale cyclone dryer [1]

Figure 2. Single-cell protein before and after drying. Particle size reduction takes place through wall collisions and there is a separation of particles into a course and fine fraction.

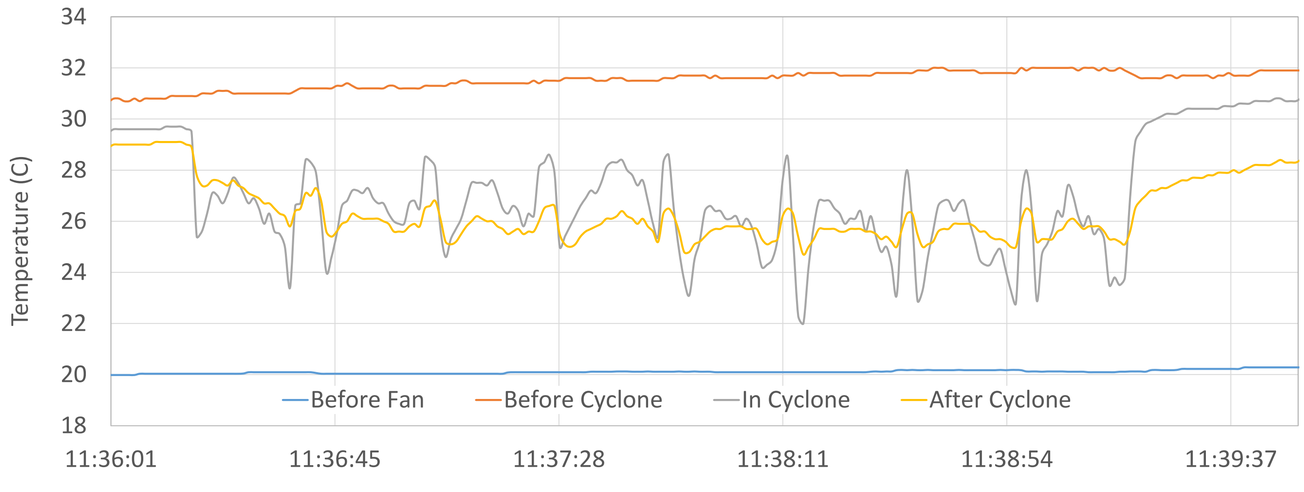

Figure 3. Cyclone dryer experimental data showing temperature distribution (no heating)

A high velocity air stream, along with changes in pressure and velocity in the cyclone, promote water vaporisation.

Hydro Thermal Carbonisation

HTC treatment of pulp and paper mill bio-sludge was performed at RISE Processum AB (Örnsköldsvik, Sweden) using a continuous eight-litre reactor (200°C, 18 bar and 165 min.).

Table 1. Proximate and ultimate analysis of bio-sludge untreated and after HTC treatment

Sludge	Ash (%)	Volatiles (%)	Fixed C (%)	HHV (MJ kg^{-1})	LHV ar (MJ kg^{-1})	C (%)	H (%)	N (%)	O (%)	Cl (%)
Untreated	32.00	-	-	15.45	14.39	38.20	4.90	3.50	20.90	0.04
HTC 200°C	38.76	52.25	7.18	11.34	-	33.76	3.78	0.96	22.38	0.36

Results

The average drying rate using the cyclone (31°C air temperature) was 5 % min^{-1} (wet basis) for hydrothermally treated sludge having initial moisture content of 50% (wet basis).The rate of bio-sludge drying using cyclone dryers primarily depends on inlet air velocity and temperature and can be hundreds of times greater than in convective fixed-bed dryers [1].

Acknowledgments

The authors wish to thank Markus Segerström at the SLU's Biomass Technology Centre, Gunnar Westin at Processum AB and Chuan Wang at Swerim AB for their kind assistance. This study was carried out through the OSMet S2 Project, Utilisation of Organic Sludge in Metal Industry (funded by Vinnova), and the Swedish Bio4Energy Strategic Research Environment.

[1] Grimm et al. Drying recycled fiber rejects in a bench-scale cyclone: Influence of device geometry and operational parameters on drying mechanisms. Fuel Processing 167: 631-640 (2017).
[2] Mäkela et al. Pretreatment of recycled paper sludge with a novel high-velocity pilot cyclone: Effect of process parameters on convective drying efficiency. Applied Energy 131; 490-498 (2014).

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