Drying characteristics of VIP faecal sludge

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Summary

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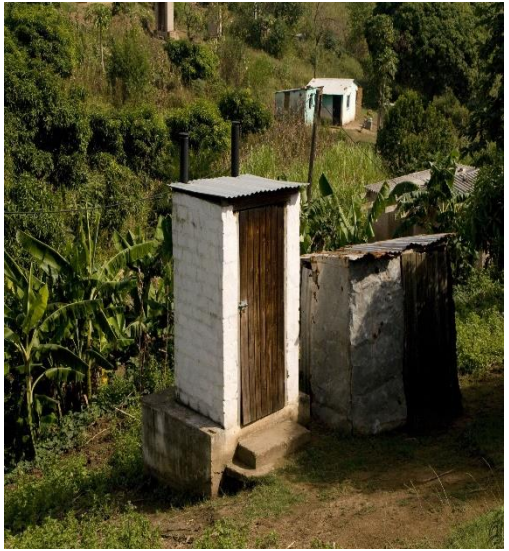


Overview

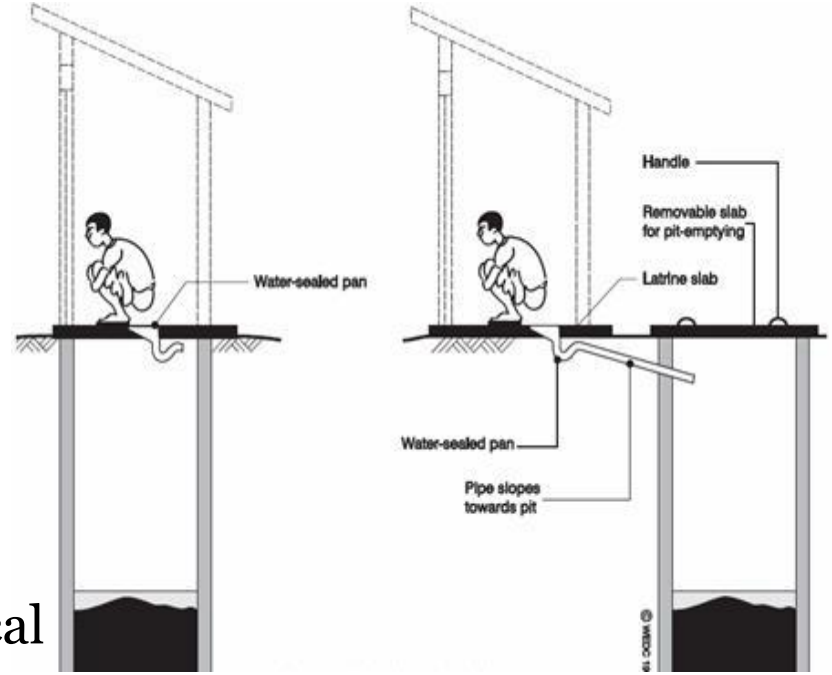
- Bill and Melinda Gates Foundation (BMGF) Grantee

- BMGF vision – enhance global healthcare and reduce poverty

- Reinvent The Toilet Challenge (RTTC)

Sanitation challenges

- 2.5 billion don't have access to basic sanitation
- Most rely on onsite sanitation
- Emptying of pits and the disposal of the contents pose a major problem to the local municipalities



Common disposal route

- Agriculture
- Landfill
- Waste water work

Estimated excretion of nutrients per capita in different countries based on diet

Country	Nitrogen [kg/cap.yr]	Phosphorus [kg/cap.yr]	Potassium [kg/cap.yr]
China	0.5	0.2	0.5
Haiti	0.3	0.1	0.3
India	0.3	0.1	0.3
South Africa	0.4	0.2	0.4
Uganda	0.3	0.1	0.4

Research on possible processes of Faecal sludge

- Gasification
- Combustion
- Pyrolysis
- Drying
- Hydrothermal carbonization
- Anaerobic digestion
- Composting

Advantages of drying

Drying

- Volume reduction
- Mass reduction

} Lower transport costs

- Pathogen free product → safer handling

- Increase of calorific value → increase of combustion efficiency

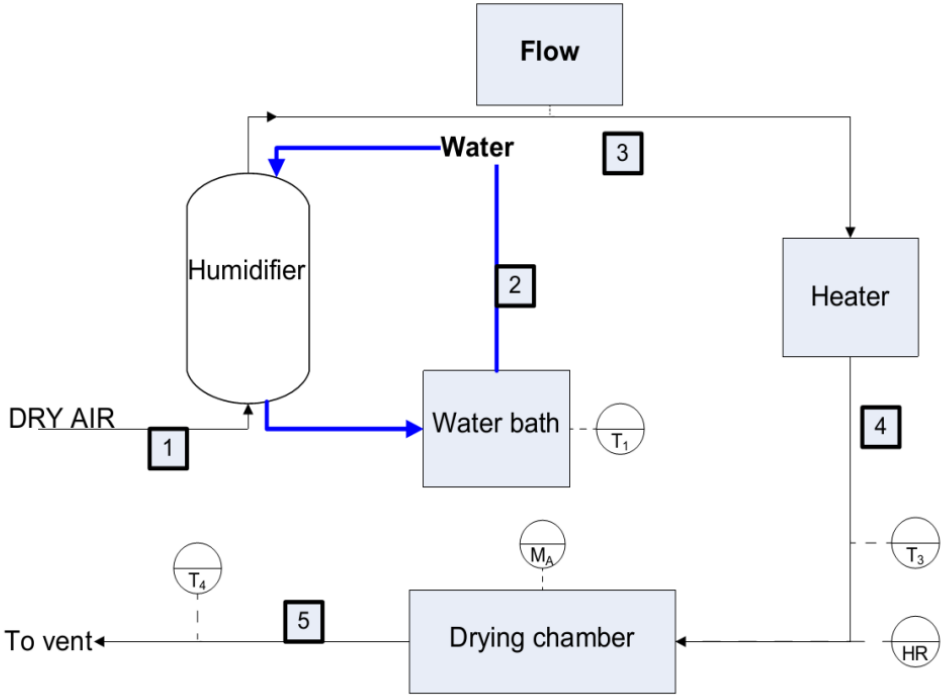
Objectives

Investigating effect of the drying air temperature, air flow rate and air relative humidity on :

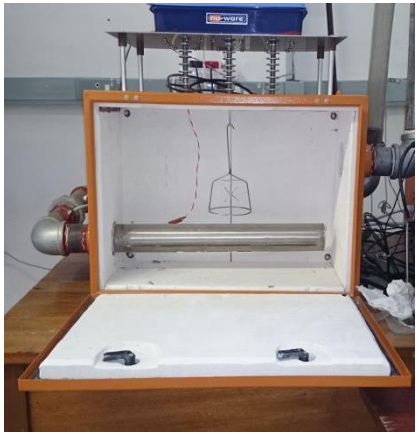
- Drying characteristics – Drying curves
- Thermal characteristics – Calorific value
- Inorganic nutrient analysis – NO_3^- , P , K

Materials and methods

Material and methods



Humidifier



Drying chamber

Thermal and chemical analysis

Bomb calorimeter

Caloric value

Spectroquant

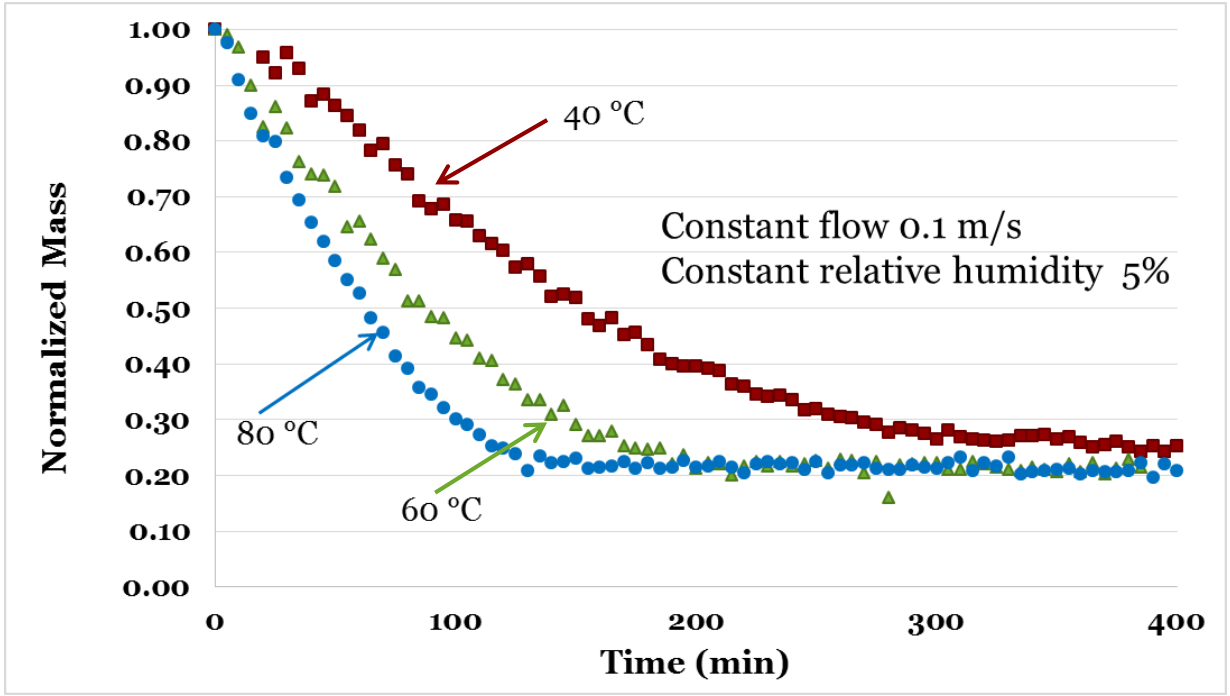
Nutrient concentration

Experimental Results

Important terminology

- Equilibrium moisture content, M_e
- Moisture ratio, $\text{MR} = \frac{M - Me}{M_0 - Me}$
- Constant rate drying period
- Falling rate drying period

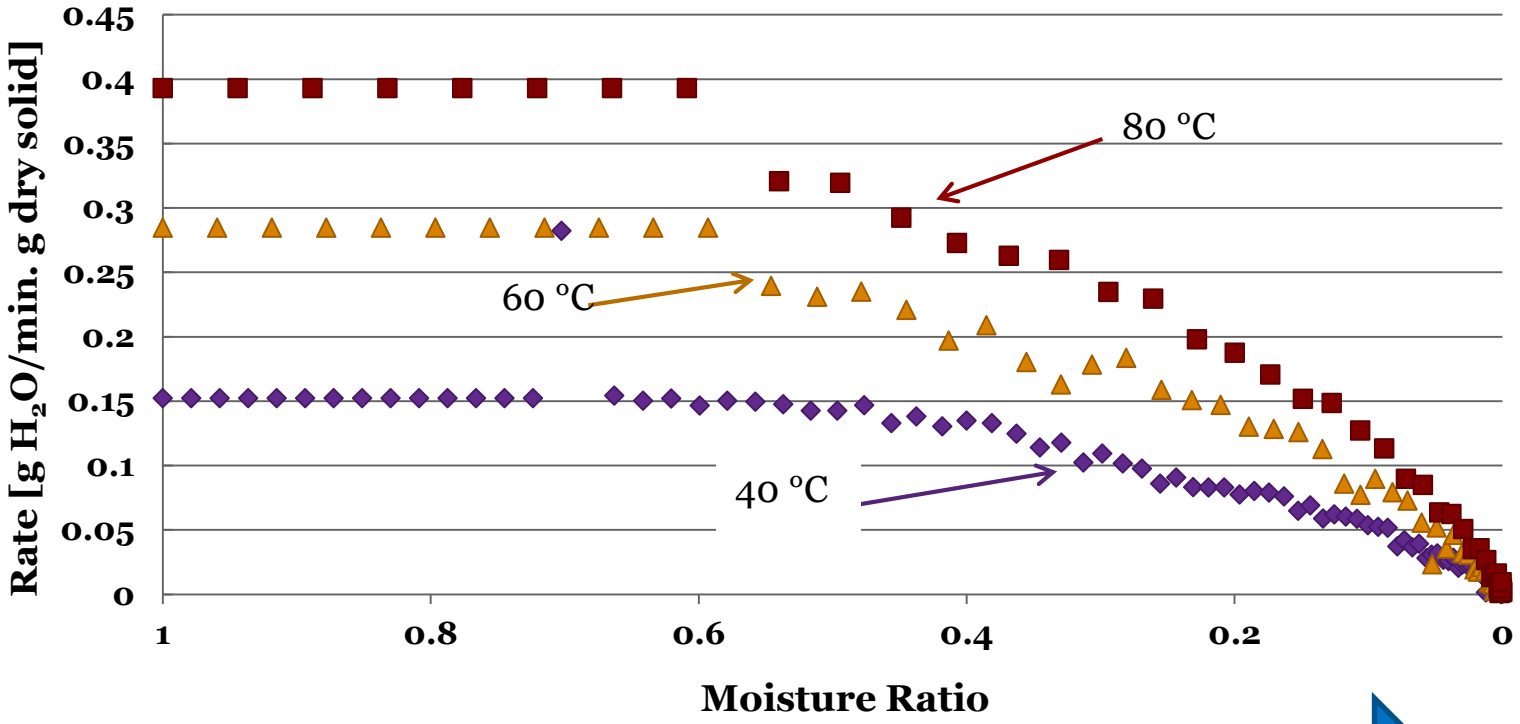
Effect of air temperature



Drying times

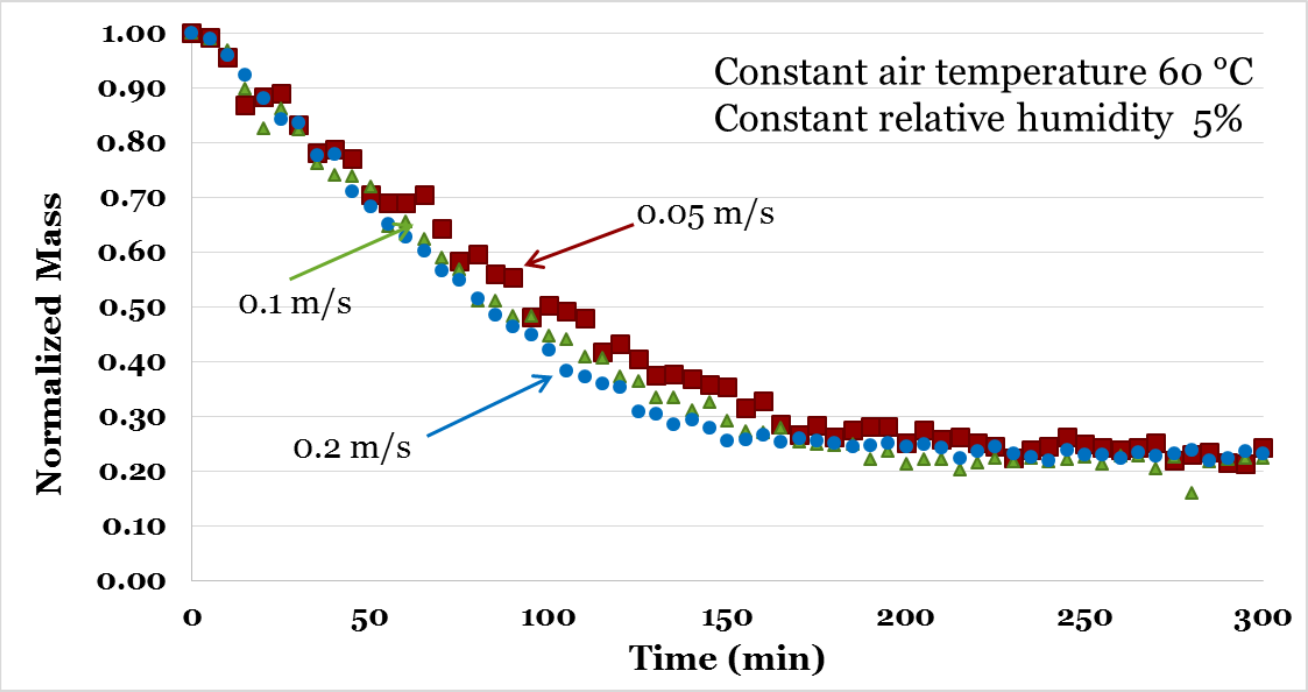
- 40°C – 5 hrs
- 60°C – 3 hrs
- 80°C – 2.5 hrs

Effect of air temperature on rate curves



Increasing temperature increases drying rate

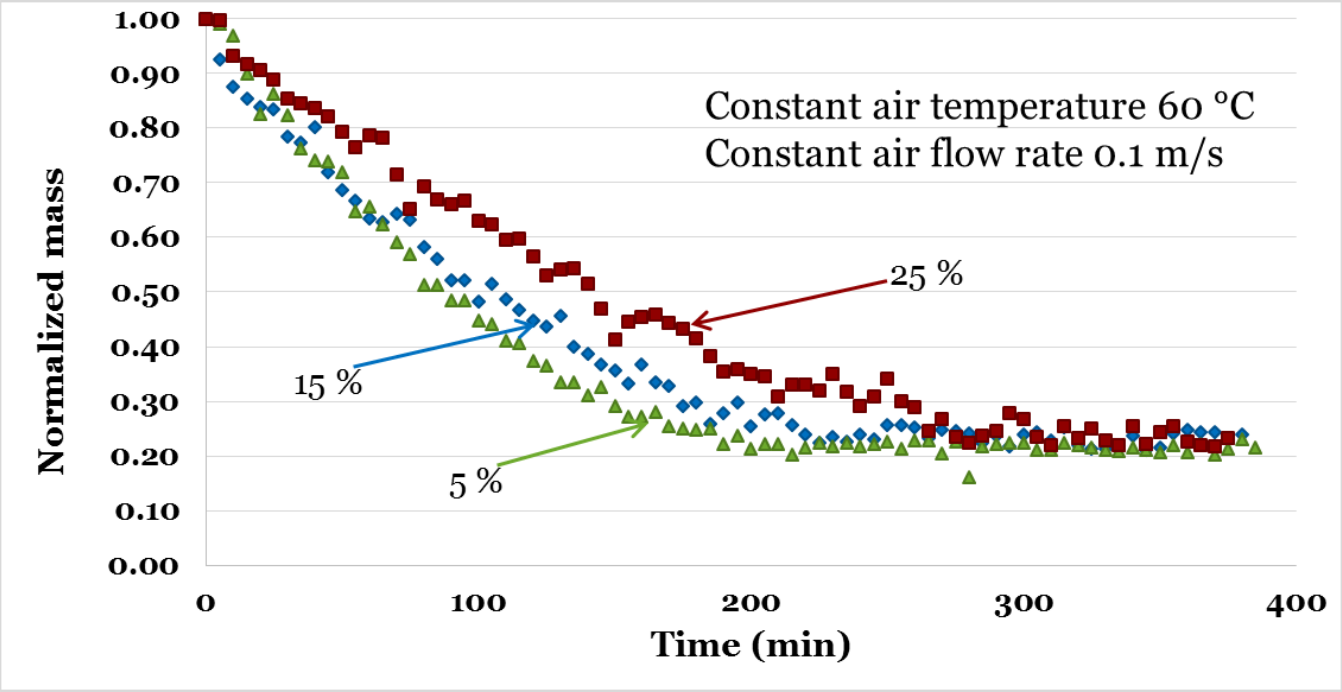
Effect of air flow



Drying time

- 60°C – 3 hrs

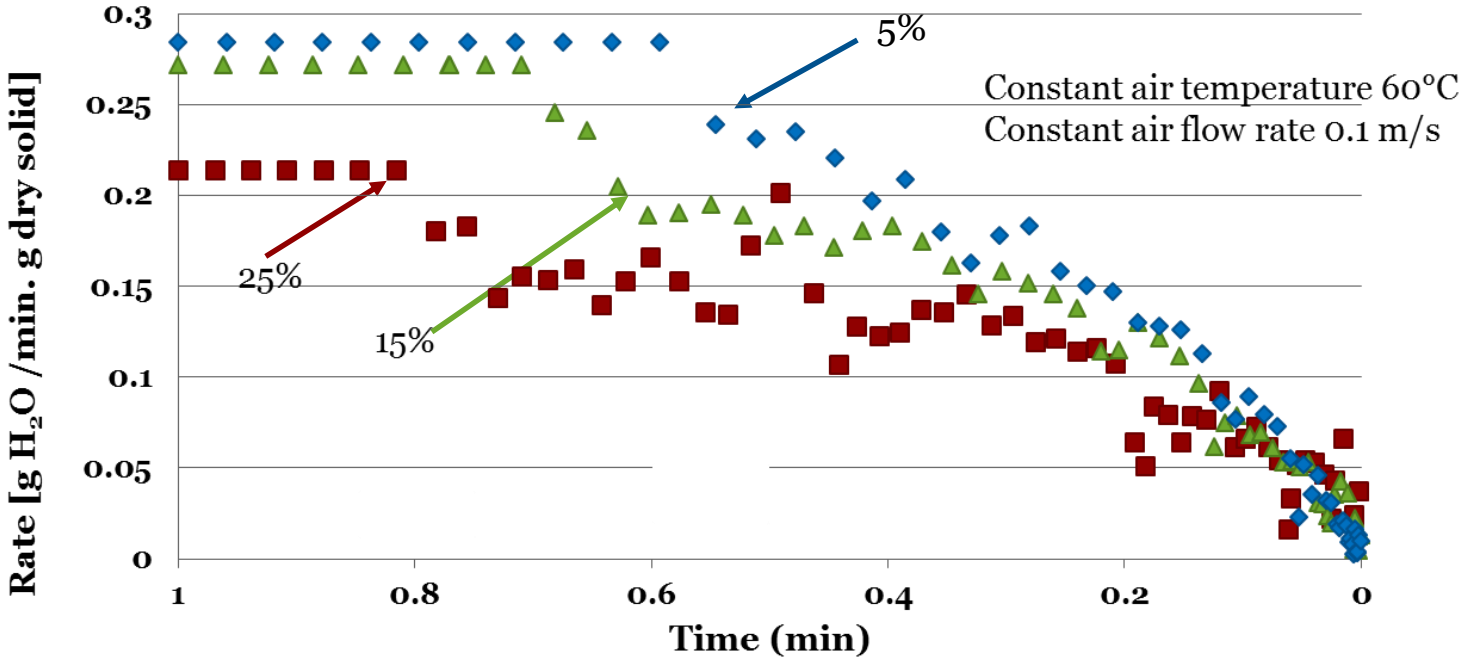
Effect of air humidity



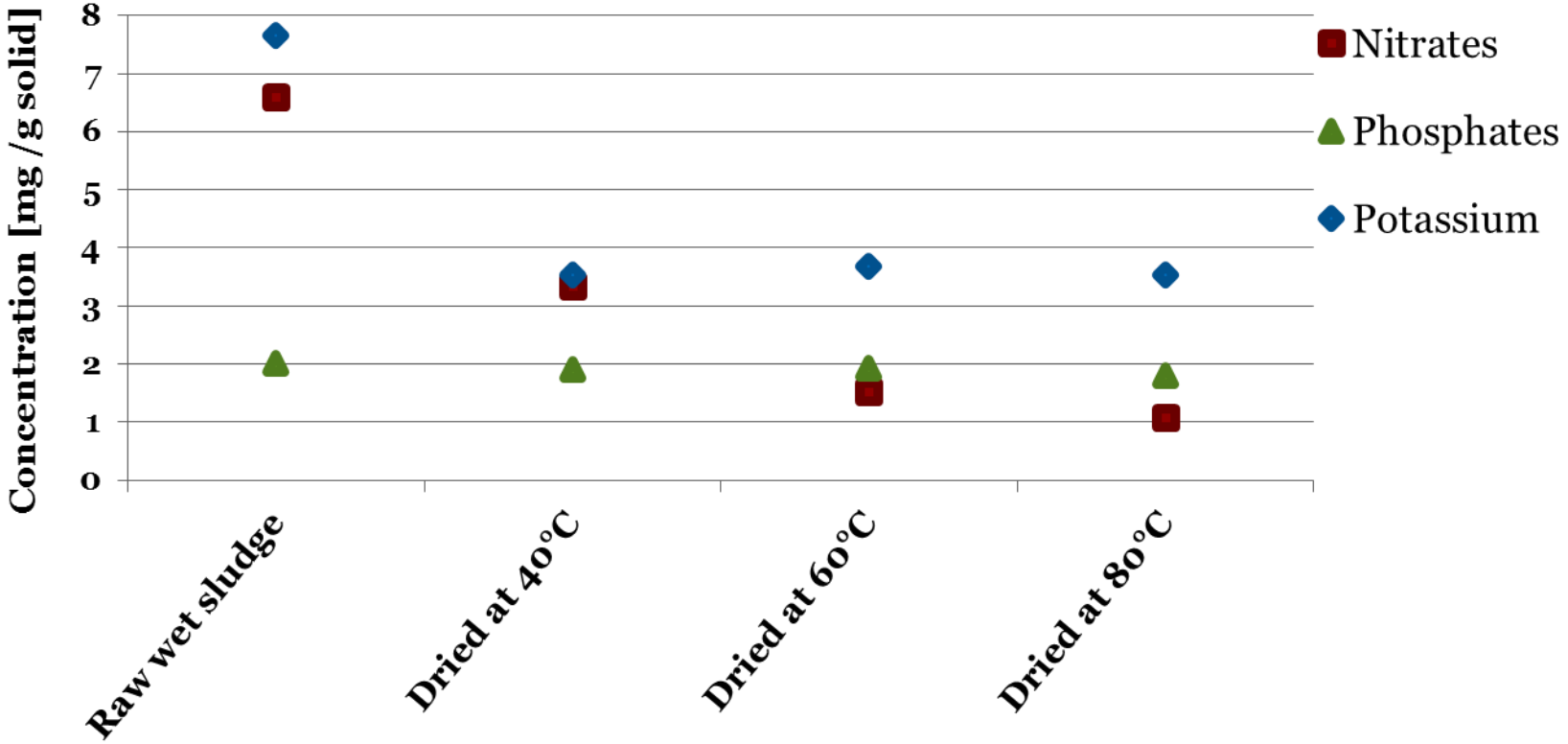
Drying times

- 5% – 3 hrs
- 15% – 4 hrs
- 25% – 5 hrs

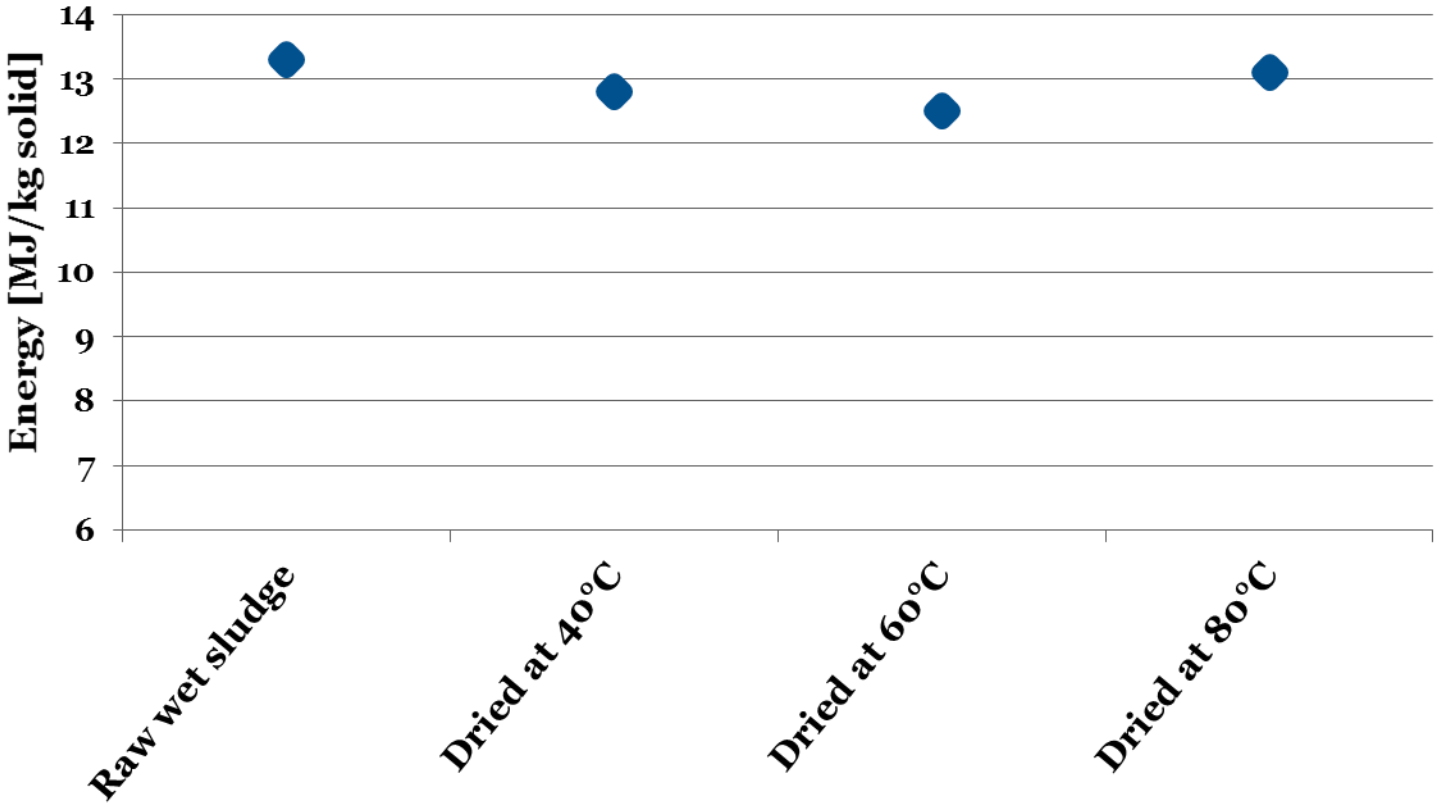
Effect of relative humidity on rate curves



Variation of nutrients with temperature



Effect of temperature on calorific value



Conclusions

Conclusions

- Air temperature and relative humidity have a significant effect on drying rate unlike air flow rate
- Nitrates and potassium concentrations decrease with increase in temperature
- The drying condition have not a significant effect on the phosphates concentration and caloric value

Work to be done

- Effect of initial moisture content
- Particle geometry and size
- Model and determine the variation of moisture effective diffusivity in the porous solid

Thank you

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