Drying of olive mill wastewater for material recovery

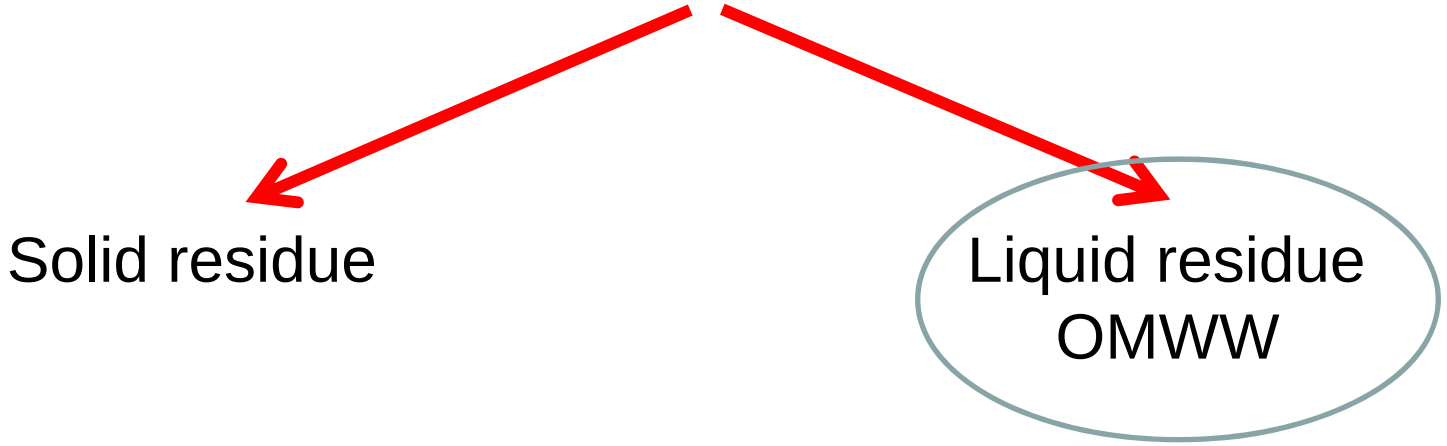
P. Dutournié, M. Jeguirim, L. Limousy,

6th International Conference on Sustainable Solid Waste Management, Naxos, 13/06/2018

Introduction

- Olive oil industry → by-products and wastes
- Different extraction techniques

→ 3-phase system (Tunisia, Greece, Italy, ...)



Introduction

OMWW (Water ~ 80%, salts and organic compounds)

→ Discharged and stored in natural open-air basins

→ soil and sub-soil contamination by percolation

→ during drying, a crust (plastic consistency) covers the surface and inhibits mass transfer of water, oxygen, ...

→Sterile soil, ground water and rivers contamination

Introduction

Eco-frendly alternatives...

→ Soil improver (in small amounts)

→Water recovery for irrigation, ...

→Fuel preparation (high energy content)

→ drying

→ OMWW

→ after impregnation on a biomass

Aim of this work

Comparison of drying opportunities

→ OMWW

→ after Impregnation on Sawdust (IS)

→ after Impregnation on WoodChips (IWC)

In terms of
kinetics, solid by-products, water recovery, ...

Experimental section

Experimental drying tests

→ Air temperature and flow rate controlled

→ Study of 2 sample thicknesses (3 mm and 3 cm)

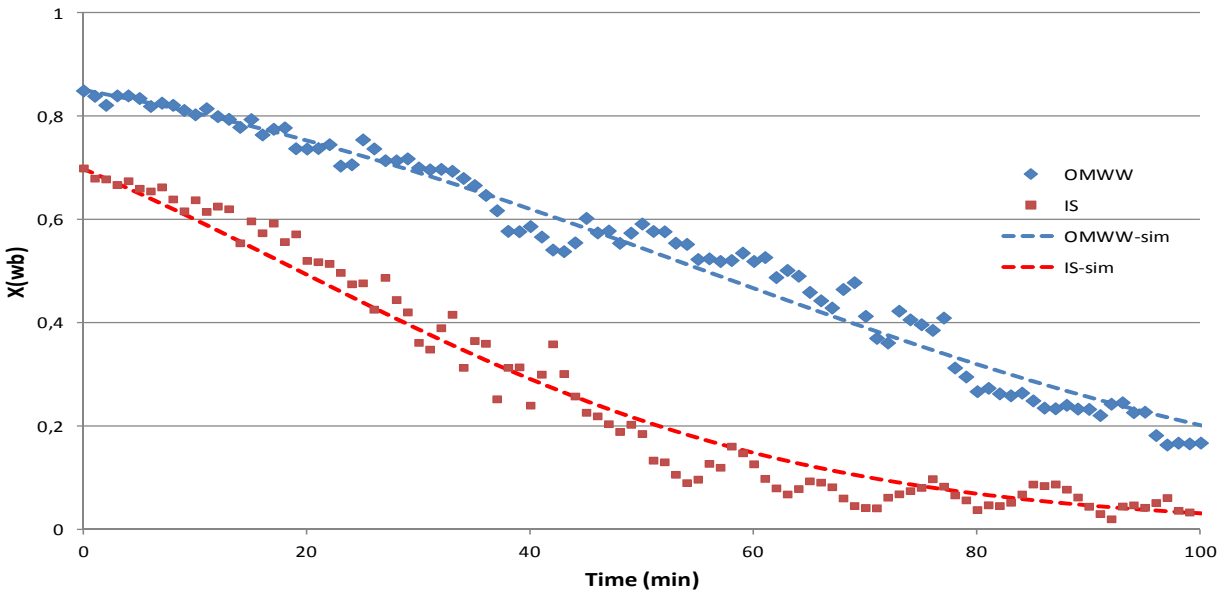
→ Continuous mass recording,

→ Condensation of water in a condensing boiler body cooled by a cooling unit, sampling for analyses of water for reuse purpose

→ After drying → heat value of solid by-products

Experimental results

Drying tests (60°C, 1 m/s) -- samples 3 mm thick

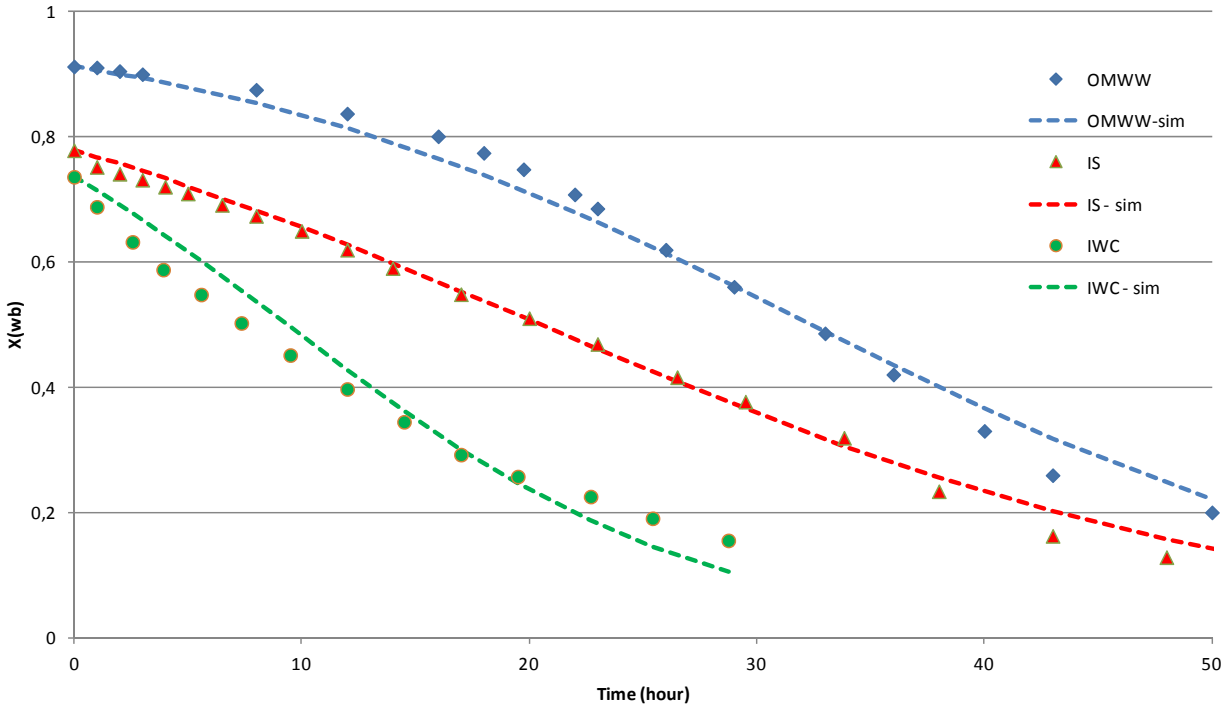


Drying kinetic IS > OMWW

Drying kinetic modelling (Henderson and Pabis) → X(db)=a exp(-kt)

Experimental results

Drying tests (60°C, 1m/s) samples 3 cm thick



Drying kinetic (IWC) > OMWW > IS

Results (3 cm) ≠ 3 mm

Experimental results

Drying tests (kinetic results)

Assuming a pure diffusive transfer → 1D unsteady model

→ For long drying period $X \approx X_0 \exp(-\pi^2 D_{eff} t/e^2)$

samples	k (3 mm) (s-1)	D_{eff} (3mm) (m^2/s)	k (3 cm) (s-1)	D_{eff} (3 cm) (m^2/s)
IS	7.2 E-4	1.2 E-9	1.7 E-5	1.6 E-9
OMWW	5.2 E-4	0.8 E-9	2.0 E-5	1.8 E-9
IWC	-		3.1 E-5	2.8 E-9

Diffusive coefficient in agreement with data available in the literature for convective drying of wood by-products, food products or wet olive husk.

Experimental results

Drying tests - conclusion

- Impregnation of OMWW on biomass is interesting

- For a quick and effective drying need of:

  → Thin layer,

  → Regularly turn the matter

Water recovery

Recovery rate (~ 70 % of evaporated water)

		pH	ρ (µs/cm)
OMWW native		4.8	9730
IS		3.9	238
IWC		3.8	267
OMWW		3.9	293

Water recovery

Standards of water quality for irrigation

	France	Tunisia	Results
SM (mg/L)	< 15	< 30	~ 0
COD (mg/L)	< 60	< 90	In progress
Escherichia C. (CFU/100 mL)	< 250		~ 0
Conductivity (µS/cm)		< 7000	< 300
pH		6.5 – 8.5	~ 3.9

→ Additional analyses (COD, HPLC, µGC, ...) → identification of organic compounds in solution (in progress)

By-product → fuel preparation

OMWW → after drying → plastic crust adhers to the box

Recovering of matter → almost impossible

By-product → fuel preparation

After drying → IS, IWC easily recovered.

The box is clean → organic oily matter is adsorbed in sawdust or in wood chips

LHV = 16.4 (S) → 18 $MJ.kg^{-1}$ (IS)

Densification or pelletizing possible

Promising combustion tests

Conclusion

Eco-frendly alternatives to OMWW discharge and natural storage are viable

→ Drying of impregnated material can be optimised

→ After condensation, water can be used for irrigation purpose (after pH adjustment)

→ After drying, solid by-products can be densified and used as fuel or as soil improver

Thank you for your attention