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Context and Objectives

In Reunion Island, 65%, 13.7% and 21.4% of household wastes are landfilled, recycled and composted, respectively. Significant environmental burdens are caused by current waste management (WM). Indeed, a new WM strategy ensuring energy recovery by gasification of residual household wastes (RHW) will be implemented. Before waste treatment, its characterisation is a primordial action [1,2].
The present work aims at analyzing the **physico-chemical properties** of different waste compositions.

Materials and Methods

In this work, direct analysis method is used. Before sampling, 3 mixtures of waste have been established (Fig. 1) based on local context and data from the last waste characterisation campaign in Reunion conducted by ADEME in 2019. RHW-1 and RHW-2 represent respectively the typical RHW without fine particles and the typical RHW. The waste sampling steps began with the collection of mother samples which represent a RHW produced in one week and are from waste storage site and selected dumpsters on the campus of the University of la Réunion. The mother samples are manually sorted into 10 categories such as: putrescible, paper, cardboard, composite, textile, sanitary textile, plastic, combustible, non-combustible and fine particles. Then, a 1 kg sample of each proposed mixture is sent to the laboratory. For the physicochemical characterization of RHW, we have drawn inspiration from the French and European standards that have been put in place as far as possible.

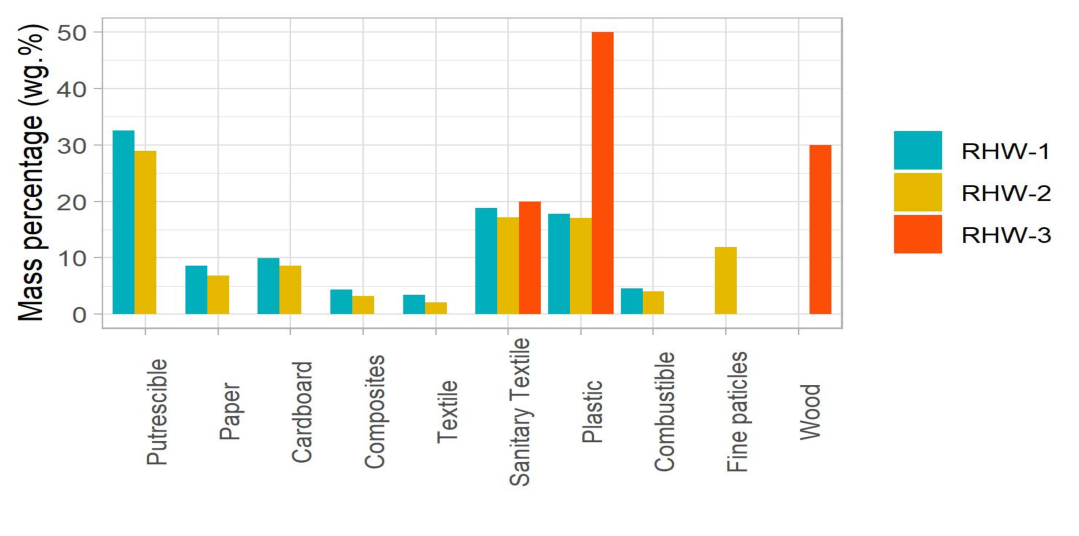

Fig. 1: The different composition of the samples

Results and Discussion

Proximate and ultimate analysis

The result of proximate analysis show that, with 11.9 and 10.5 MJ/kg respectively, the LHV of RHW-1 and RHW-2 are indeed low compared to other types of solid wastes, which generally have higher LHV such as RDF and MSW (12.1-22.5 MJ/kg) [3]. Moreover, RHW-3 have acceptable LHV (16.77 MJ/kg) compared to LHV of RDF found in the literature [3]. According to Fig. 2, RHW-3 has the highest LHV due to the high proportion of plastic in the mixture which leads to a high VM content. The considerable proportion ($< 50\%$) of putrescible, paper and cardboard in RHW-1 and RHW-2 is the origin of their low calorific value. Furthermore, the presence of fine particles in RHW-2 leads to an increase in oxygen (Fig. 3) and moisture content (Fig. 2), which results in a decrease in LHV. According to the ultimate analysis (Fig. 3), RHW-1 and RHW-2 have higher oxygen content due to high proportion of putrescible, paper, cardboard and fine particles.

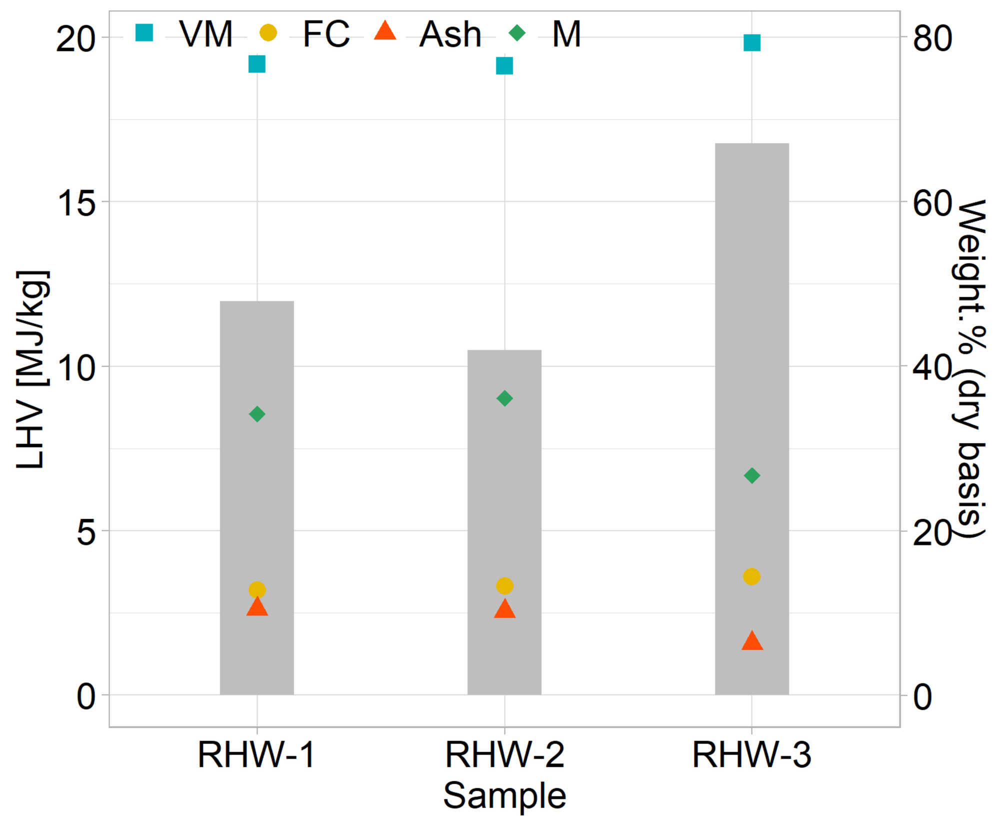

Fig. 2: Proximate analysis of RHW

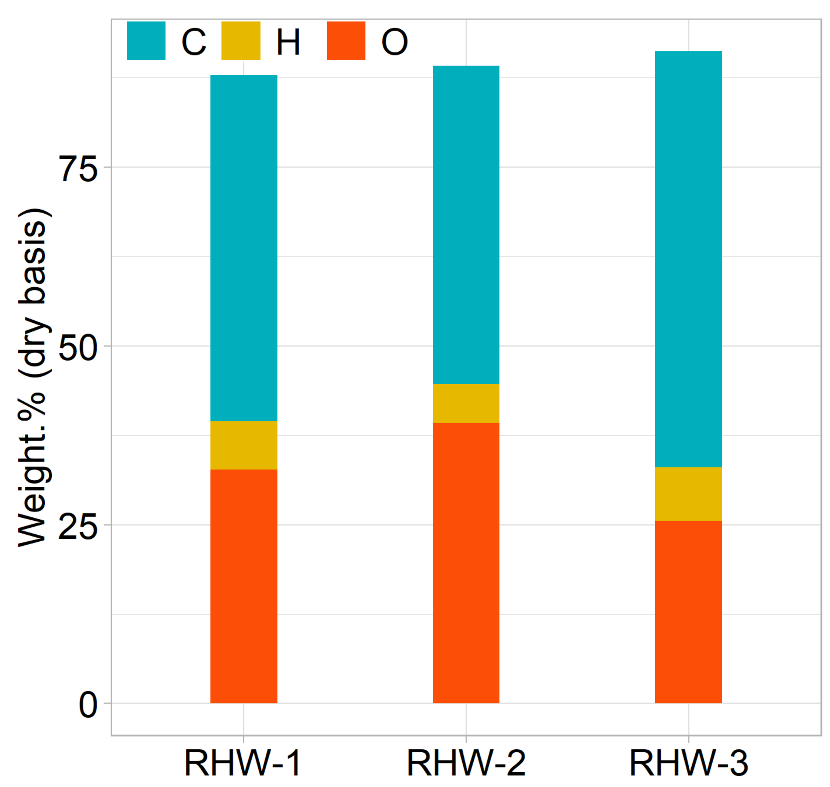

Fig. 3: Ultimate analysis of RHW

Fig. 4 shows the N, S and Cl content of the analysed samples. In gasification process, the high content of chlorine ($NaCl$ and PVC), N and S in the waste is the cause of the formation of: NH_3, H_2S and certain chlorinated products (HCl and Cl_2) and a source of emission of dioxins and furans [4]. As illustrated in Fig. 4, the 3 samples have low S content, RHW-1 has the highest N content and RHW-3 has high Cl content because of plastics present in the mixture.

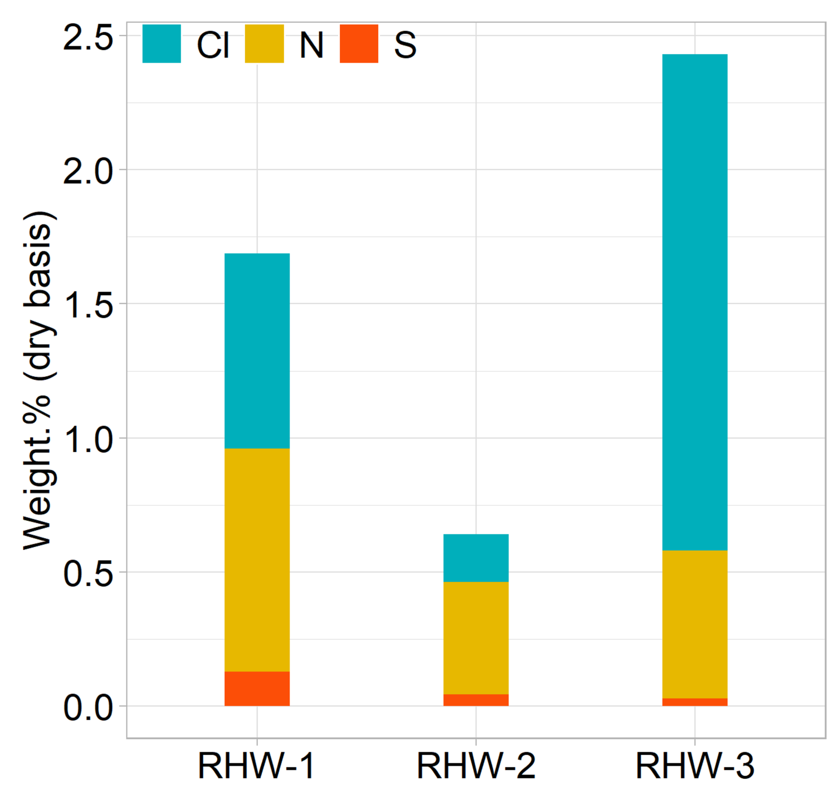

Fig. 4:Inorganic element content of RHW

Van Krevelen diagram

From Fig. 5, the H/C and O/C atomic ratios of the residual wastes show that RSHW-2 is among the biomasses with low calorific values while RHW-1 is outside the biomass zone. Moreover, due to its composition rich in plastics and baby nappyies, RHW-3 is closer to lignin than to biomass.

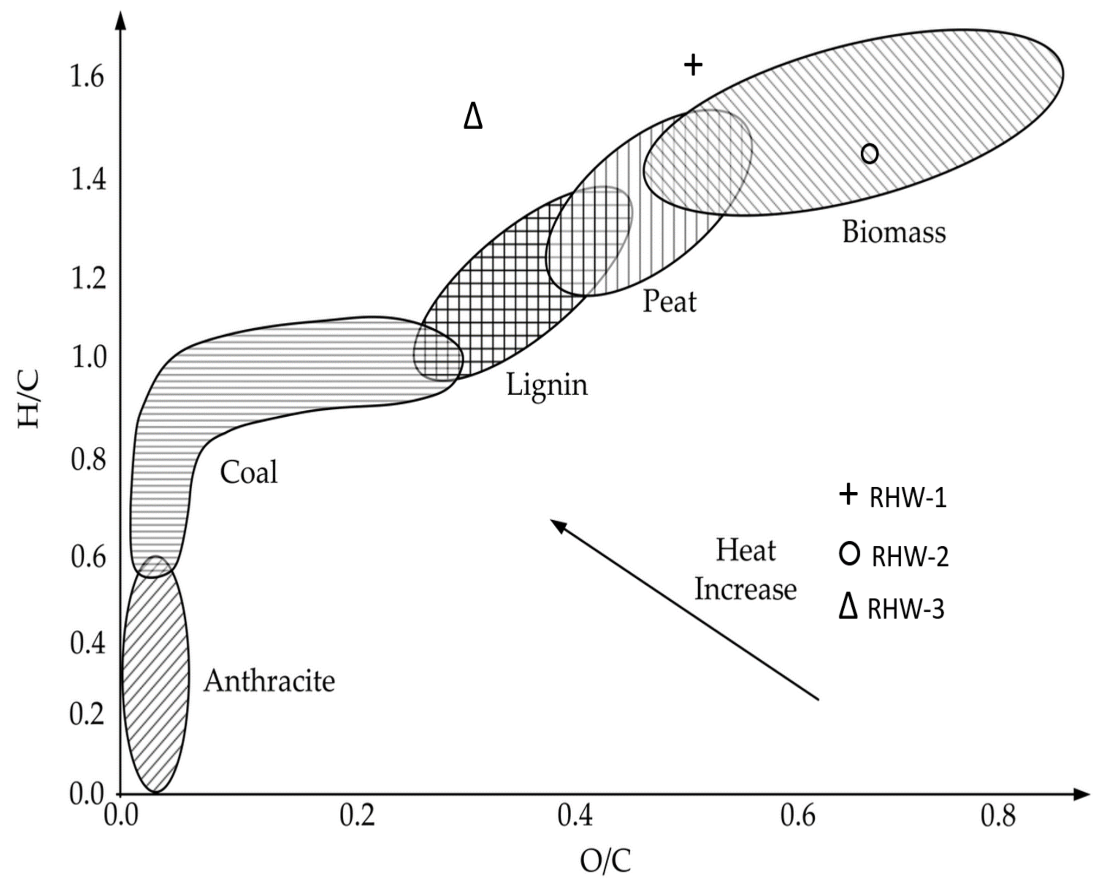

Fig. 5: Representation of the H/C and O/C atomic ratios in the Van Krevelen diagram

Conclusion and perspectives

To conclude, typical RHW (RHW-2) in Reunion has a low LHV and a high oxygen and moisture content. Its gasification will probably produces more CO and CO_2, lower H_2 and chlorinated products concentrations compared to syngas produced by typical RHW without fine particles (RHW-1). The removal of fine particles leads to an increase in the calorific value and decrease in oxygen and moisture content. Furthermore, RHW-3 has the highest LHV and lowest oxygen content, its gasification is likely to yield more hydrocarbons and more dioxin and furans due to its high Cl content. However, the mixture is interesting for heat production. Future surveys should focus on:

- the use of the collected physico-chemical characterization data to **model gasification**;
- **pretreatment** of RHW in order to improve the fuel quality such as: density, higher heating value, carbon and ash content and fixed carbon

Nomenclature

C	:	carbon
Cl	:	chlorine
FC	:	fixed carbon
H	:	hydrogen
LHV	:	lower heating value
M	:	moisture
MSW	:	municipal solid wastes
N	:	nitrogen
O	:	oxygen
RHW	:	residual household wastes
S	:	sulfur
VM	:	volatil matter

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