

Particle emission characterization when incinerating halogen- and sulfur- containing nanowaste using a lab scale tubular furnace operating at 1100°C

C. Dutouquet¹, L. Meunier¹, A. Joubert², R. Boudhan², S. Durécu³, L. Le Coq², O. Le Bihan¹

¹INERIS Parc Technologique, Alata BP2, 60550 Verneuil En Halatte France

²IMT Atlantique, GEPEA CNRS BP 20722, 44307 Nantes cedex3, France

³TREDI, Séché Environnement, BP 20199, 54505 Vandœuvre-lès-Nancy, France

Keywords: incineration, nanoparticles, 1100°C, halogen, sulfur

Associated conference topics: 1.9, 1.10, 2.1,

Presenting author email: Christophe.dutouquet@ineris.fr

Nanotechnology is said to be the industry of the 21st century. The production of nanoproducts keeps growing at a rapid pace. In November 2016 in France, the 4th annual declaration on imported, distributed and manufactured nanoscale substances reported a total number of registrations four times that of year 2013. Consequently, the need to anticipate how to deal with these products at each step of their life cycle is more and more necessary. Nanowaste management including product incineration is to be investigated to assess the impact it could have both on human health and the environment. The growing number of registrations of nanoscale substances clearly demonstrates that the amount of nanowaste to be processed in waste treatment plant will increase in years to come. Though to date French and European regulations relative to nanowaste management do not exist, recommendations may at least be delivered to minimize possible impact on the environment and human health. Data on nanowaste incineration are still scarce, which motivates considering this question to better understand the phenomena at stake.

Little is known yet about nanowaste incineration and the ensuing fate of nanoparticles. In addition, literature is scarce. A previous project led by our consortium supported by the French Agency for Environment and Energy Management (ADEME) and denominated NanoFlueGas (grant N°1181C0088) was dedicated to this topic. The results revealed first that nanoparticles were released in the raw fumes when incinerating nanowaste at 850°C in a lab-scale furnace specially fitted to comply with incineration constraints (Le Bihan 2014). Second, it was shown that bag filter nanoparticle collection efficiency was higher than 96 % (Boudhan 2017).

In this context, the Nanowet project supported by the ADEME agency was set up to complement the existing studies. It focuses this time on the treatment of halogen- and sulfur- containing nanowaste by elevated temperature incineration (1100°C). The objective is threefold, namely to assess the influence of (i) high temperature on the whole process (ii) the effect of the presence of acid gases in the fumes on particle emission and (iii) the wet scrubber technology installed in the waste treatment plant on nanoparticle capture efficiency.

Three wastes were selected and characterized for this project:

- PDMS waste obtained from polyorganosiloxane polymerization processes containing 24.4% dwt of SiO₂

nano-fillers (waste previously studied in the framework of NanoFlueGas project);

- Soft PVC waste originating from flexible PolyVinyl Chloride production and containing 36% dwt of Cl and nano-fillers mainly composed of TiO₂;

- Resin waste stemming from soiled strong acid cation exchange resins of sulfonic type exhibiting 15.4% dwt of S and free of nano-fillers.

A lab scale horizontal tubular furnace operating with a temperature of 1100°C is utilized at INERIS nanosafety laboratory for the Nanowet experiments. Compliance with the combustion requirements when incinerating products were carefully checked namely: a temperature of 1100°C in the post combustion zone, gas residence time of at least 2 seconds in the post combustion zone, oxygen content and gas turbulence high enough.

Four series of experiments were carried out. The first three implied the incineration of each waste one after the other. The last series involved the incineration of a mix of the three wastes. It should be noted that at least four incineration experiments were carried out for each series.

Several instruments were implemented to monitor gas and particulate emission:

- A Horiba PG-350 was utilized to monitor the combustion process through CO₂, O₂, CO and NO temporal follow-up

- A FTIR allowing real-time monitoring of noxious gases such as HCl and SO₂

- A DMS500 was used for time-resolved monitoring of particle emission according to size distribution

- A MPS allowing collecting particles on a TEM grid for a differed morphological and elemental analysis of the collected particles

- A SEM analysis of the residue (morphology and elemental composition)

Eventually, the obtained results make it possible determining the fate of the nanoparticles considering the influence of the gases such as HCl and SO₂ and the impact of the mix of the three nanowastes.

This work was supported by ADEME under research grant N°1581C0096.

Le Bihan O. *et al.* Summary of the NanoFlueGas ADEME Project - Convention n° 1181C0088 (2014) 7p

Boudhan R., *et al.* Waste and Biomass Valorization (2017) 1-7