# POLYMER STATIC DEVOLATILIZATION: EXPERIMENTAL CHARACTERIZATION AND MODELLING

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Polymer devolatilization is an industrial process in which low-molecular weights components such as unreacted monomer, solvents, water, and various substances, which are often collectively referred to as “volatiles”, are removed to comply with various regulations, to improve the polymer’s properties, or for a variety of other reasons. Devolatilization of a polymer is a complex process involving the transport of volatiles to a polymer-vapor interface, the evaporation of the volatiles at the interface, and their subsequent removal by a vacuum system. In addition to simple diffusion of the volatiles to the polymer-vapor interface, devolatilization progresses in many cases through a foaming mechanism, in which bubbles containing vapor of the volatiles to be removed are formed within a polymer melt. To effectively reduce the concentration of volatile contaminants, a wide variety of devolatilizing equipment is used, which may be broadly classified into static and rotating devolatilizers.

This PhD activity focuses on the study of the static devolatilization equipment, aiming to understand its fundamentals, in order to properly design and scale-up a static devolatilization plant.

Static equipment relies on gravitational forces to transport the polymer through the devolatilization zone, whereas in rotating machinery the melt is conveyed by its contact with moving elements. Accordingly, the viscosities that nonrotating devolatilizers may handle are much lower than those processed in rotating equipment. In static devolatilization, volatile components (monomers, oligomers, solvents, stripping agents) are removed only by evaporation from a falling film, strand, or foam of a polymer melt. No dynamic apparatuses, e.g. extruders, kneaders, etc. are used for surface generation and heat transfer.

Currently, the driving parameters, that hide behind the static devolatilization process, have not been related to process efficiency yet.

The first year of the PhD was mainly centered on literature study, devolatilization fundamentals comprehension, CFD simulations aimed at fluid dynamics investigation (Fig. 1) and preliminary volatile sorption measurements for thermodynamic and kinetic characterization of the process [1].

The core activity of this PhD is the construction of a lab-scale static devolatilizer (Fig. 2), which will be performed during the PhD second year, with the goal of understating the effect of foaming on volatiles removal, as well as fluid dynamics and mass transfer within the devolatilizer. CFD simulations will be developed alongside, trying to implement mass transfer and bubble nucleation models to the already established 3D fluid dynamics simulations.

Indeed, in many industrial processes the volatile components are continually removed from molten polymer through bubble nucleation, bubble growth, and rupture in a contiguous gas phase. The presence of bubbles within the liquid drastically influences fluid dynamics and active surface for mass transfer. Thus, foaming is a crucial stage in the devolatilization process.

In the third and last year of the PhD, the scale-up problem will be addressed. The objective is to understand the scaling rules from laboratory to pilot scale and consequently, up to industrial scale. In order to achieve that, devolatilization tests will be carried on a pilot size static devolatilizer.

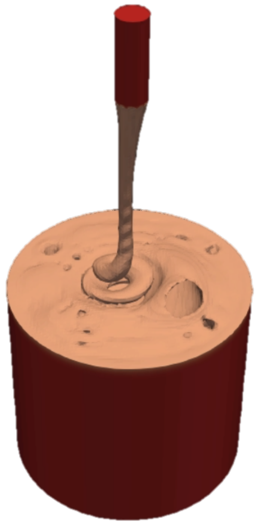

*Figure 1 - CFD simulation of devolatilizer filling*

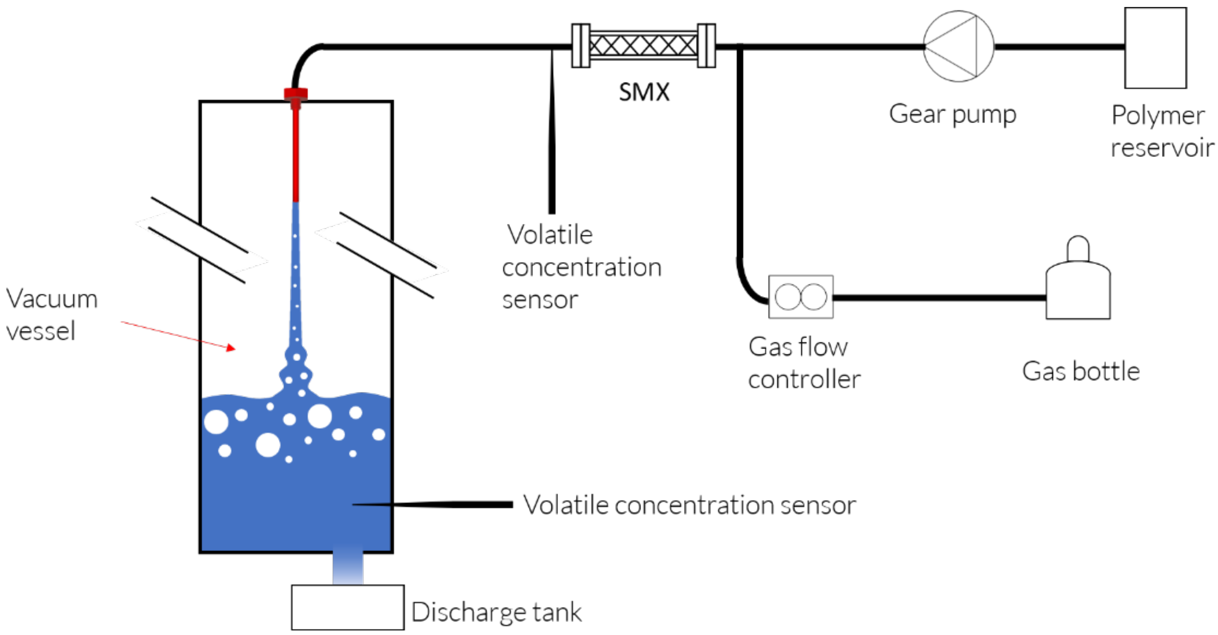


*Figure 2 - Lab-scale devolatilizer*

*References:*

[1] D. Tammaro, L. Lombardi, G. Scherillo, E. Di Maio, N. Ahuja, and G. Mensitieri, "Modelling Sorption Thermodynamics and Mass Transport of n-Hexane in a Propylene-Ethylene Elastomer," *Polymers (Basel).*, vol. 13, no. 7, p. 1157, 2021, doi: 10.3390/polym13071157.

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