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Hydrothermal dehydrochlorination of PVC waste in subcritical and supercritical conditions

Aim

This thesis aims to explore the feasibility of PVC waste dehydrochlorination in water in subcritical and supercritical conditions and investigate the effect of the process parameters on the products and dehydrochlorination efficiency, with a focus on HCl as a utilizable product.

Justification

PVC waste is widely acknowledged as one of the more challenging categories of plastic wastes due to their limited end-of-life options. Most conventional methods of waste treatment result in products such as HCl or chlorinated organic molecules, thereby requiring specialized equipment that withstand corrosion and separation steps to remove the toxic chlorinated products. Thus far, a variety of methods have been adopted to deal with these challenges, including a separate dehydrochlorination step to remove the corrosive HCl products before further processing.

For the purpose of dehydrochlorination, several factors are of importance, including the simplicity and industrial applicability of the process, environmental factors, the nature of the organic by-products, and the possibility to separate the produced HCl as a valuable product. These factors have resulted in various methods for such process. Hydrothermal dehydrochlorination utilized water as a clean solvent to remove the chlorine from PVC, thus forming HCl as a product. This could take place both in subcritical and supercritical conditions with differences in the efficiency and the chemical profile of the products. Due to the simplicity, independence from toxic solvents, and the possibility of HCl valorization, this method has proved itself as an attractive substitution to the alternatives.

Most of the research on PVC is focused on pure or virgin plasticized PVC. However, it appears that research on waste streams is somewhat lacking in this field. That is in spite of the fact that PVC is often a highly modified plastic with sometimes more than half of its weight comprised of plasticizers and additives and is usually accompanied by other contaminants such as insulation materials or metals. The additives in PVC products could interfere with HCl production or make its separation more challenging. This makes it crucial to study the effect of such contaminations on the processes concerning PVC.

This thesis aims to fill the gap in the knowledge on PVC waste streams and the applicability of hydrothermal treatment as a feasible method on this feedstock. Furthermore, thanks to the value in HCl valorization, the economic feasibility of most PVC treatment processes rely on its successful separation as a marketable product. Therefore, it will be the main focus of this study to attempt producing HCl without the use of neutralizers. Moreover, the chemical composition of byproducts for further downstream processes will be studied and the effect of process conditions on them, as well as the HCl production will be measured.

Program

- Literature review on the concept of hydrothermal decomposition of PVC at both sub- and supercritical conditions.
- Initial monitoring of the effect of conditions on HCl production (using titration mainly).
- Designing experiments at different conditions for both pure and waste PVC with respect to their HCl production as a function of temperature, pressure, and loading.
- Identifying and quantifying the byproducts using chromatography methods.