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Biodegradable and sustainable antifoam based on modified cellulose.

The aim of this project was the development of a biobased and biodegradable antifoam. A sugar factory uses a substantial amount of antifoam during beet sugar production. Most commonly those consist of fossil or silicone raw materials. Despite the growing demand for sustainable and biodegradable, plant-based alternatives, their foam-breaking performance remains inadequate compared to commercial products. The joint project “BIO-DEFOAM” aims to develop a sustainable and effective alternative to the fossil-based antifoams. Cellulose is a renewable and sustainable raw material. The possibility to functionalize cellulose is already being utilized in the chemical industry, making it one of the most consumed renewable polymer. A first batch of antifoam was produced by Frauenhofer IAP based on the syntheses given in the literature (Z. Hu et al. ACS Sustainable Chemistry & Engineering 5 (2017), 5018). Antifoaming capacity of the nanocrystalline cellulose functionalised with tannic acid were tested in a wide range of applications. Especially during the sugar test at elevated temperatures (70°C/158°F), the nanocrystalline cellulose antifoam performed very well, even comparable to commercial products from Struktol (Figure 1. Nano I). Further modifications of the cellulose have been synthesized and tested for their antifoaming capabilities. In a first step the nanocrystalline cellulose was replaced by cheaper micro- & macrofibre cellulose. Secondly, the functionalization with different vegetable oil was tested, in order to eliminate critical chemicals and ease upscaling into industry size (Figure 1. Nano II). The antifoaming capabilities of those formulations with different combinations of cellulose and methods of functionalization can be found in Figure 1. The graphic displays the foam generation in mL by fumigation of air into a solution consisting of water, sugar and saponin. It can be seen, that the bio defoamer based on macro cellulose and functionalized by esterification performs as well as the already commercially available product STRUKTOL SB 2433. The antifoaming capacity of selected bio defoamers based on modified cellulose was found to be in the range of already available products based on fossil raw materials. It remains to be seen if an industrial implementation of the bio defoamers can be viable.

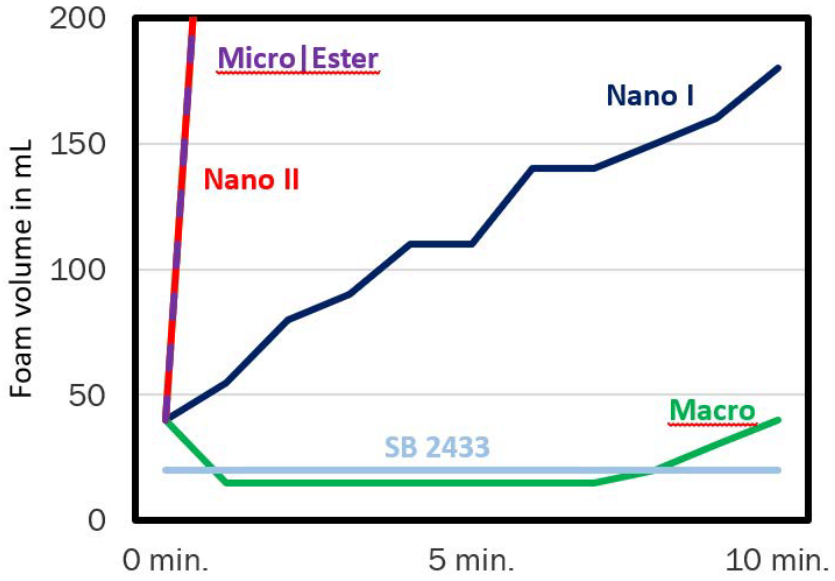

Figure 1: Foam volume over time in a sugar laboratory test. Results of selected cellulose formulations and STRUKTOL SB 2433.