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Assessing the recovery of dodecanol from alkyl polyglycosides (APG) using solvent extraction

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ABSTRACT

Dodecanol, known as lauryl alcohol, is commonly used in the production of alkylpolyglycosides (APG) by reacting dextrose with an excess of dodecanol in the presence of an acid catalyst. After the reaction is completed, the challenging part is the purification step, to separate unreacted dodecanol from APG to ensure the final product meets an industrial specification requiring less than 5% of the dodecanol residue. Current separation methods i.e., evaporation and distillation, require high energy and could deteriorate the product quality if it is not operated carefully. In this research, the extraction process was evaluated to separate the unreacted dodecanol without compromising the quality of the final product. The study investigates the effect of the solvent matrix, temperature and stirring speed for the extraction of dodecanol using a mixture of water with ethanol, propanol or toluene as a solvent matrix. The composition ratio of sample: solvent: water was fixed at 10:10:10 (in mL). The extraction temperature was manipulated between 60 °C and 80 °C and stirring speed was at 5 and 7 rpm. In addition, the extraction was also subjected to the ultrasonic frequency set at 9 Hz for 30 min and using toluene as a matrix solvent. Results show that higher extraction yield was obtained at low temperatures and stirring speed. By using a solvent matrix-toluene leads to the highest extraction yield of 15.02 w/w%. Applying ultrasonic during the extraction process increased the extraction yield to 32 w/w%, indicating that the ultrasonic has intensified the extraction process. In conclusion, the excess of dodecanol in the APG sample could be separated via an extraction process. This potential method allows an alternative separation technique at a low investment cost, energy saving and eventually meeting the APG's product specifications requirement.

1. Introduction

Alkylpolyglycosides (APG) are non-ionic, water-soluble, showing good surface-active surfactant properties. This surfactant is prevalently used to enhance foam formation in detergents and personal care products. Commonly, APG is prepared from renewable raw materials; usually, glucose derivatives react with an excess of fatty alcohols varying in chain length from C8 to C18, such as octanol, decanol and dodecanol, in the presence of an acid catalyst at elevated temperatures. These raw materials are bio-degradable, attributing to the non-toxic, non-irritating, excellent compatibility and foaming and surface activity of APG surfactants. The foaming capability, emulsification properties [1], skin compatibility, wetting and cleaning ability of APG surfactants drive their adoption across several industries such as pharmaceutical, textile, oil refining, personal care, cosmetics and household [2]. The synthesis of APG has been investigated for many years. The method invented by Emil Fisher was widely used 100 years ago [3]. Over the years, the Fisher method has evolved and innovated by utilizing various feedstocks and catalysts [4,5,6].

Generally, direct synthesis starts from the sugar and alcohol to constitute the end product, with the alcohol being used in stoichiometric excess. This blend is treated under vacuum in the presence of an acidic catalyst for about 7–8 h [7]. The acidic catalyst is neutralized with the base, typically sodium hydroxide (NaOH) when the reaction ends. The last step of the process is to separate the APG from the excess alcohol. The action is essential for the best quality control of the end product of APG with interfacial tension (IFT) approaching 0.01 dyne/cm or less. In most studies, this step is generally carried out by vacuum distillation, preferably thin film distillation at temperatures 150–180 ℃ [8]. However, it such a burden to the separation unit to control the quality of the product when less than 5% of unreacted alcohol is required. The present separation process also is quite expensive due to the high energy

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