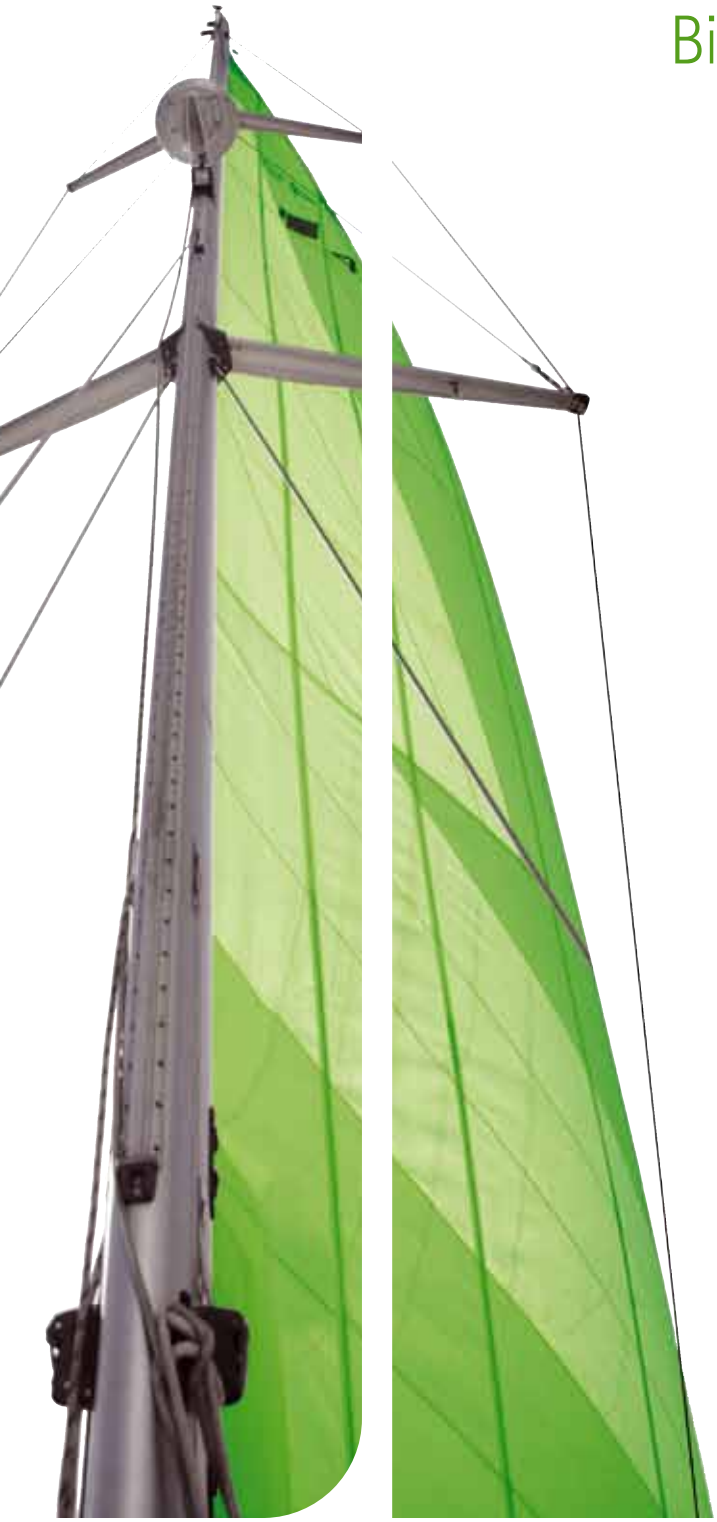

Bio-Butanol as high energy additive for fuels

An economic and innovative new method to extract butanol from fermentation broths via the Ionic Liquid DMIM TCB (1-decyl-3-methyl-imidazolium tetracyanoborate)

Ethanol is currently used as an additive for various petroleum-based fuel formulations, even though it exhibits some deficits related to the long term compatability with these fuels. Ethanol is a polar solvent which will accumulate water, resulting in an undesired phase separations and high corrosivity. Butanol has properties which make it a suitable ethanol replacement, having a higher energy content in addition to a significant improvement of mixing properties with conventional fuels.

Driven by the intrinsic benefits of butanol versus ethanol, Merck KGaA, Germany, in close cooperation with the University of Dortmund, has developed an innovative downstream process involving the extraction of butanol from biomass fermentation broths.

By using advanced materials like the Ionic Liquid DMIM TCB, we have realised a process for the efficient and selective extraction of butanol from aqueous fermentation broths. In direct comparison with oleyl alcohol (OA), the benchmark extractant for the recovery of butanol, DMIM TCB out performs by a number of measures. In contrast to OA, DMIM TCB recovers both butanol and acetone, drawing out two value streams from a single process. The negligible vapour pressure of DMIM TCB means that the final removal of butanol + acetone can be accomplished cleanly and completely through a distillation step. Furthermore, the new butanol extraction process will improve the overall process safety as it does not incorporate any unnecessary use of volatile solvents.

Check out the flip side for further technical details related to this new butanol extraction process. We look forward to discussing the business opportunities DMIM TCB brings you.

MERCK

Non-volatile media for extraction of butanol

"Bio-Butanol" is an alternative fuel generated by micro-organisms designed to convert biomass into butanol. But with limits of 1% on the amount of butanol these micro-organisms can tolerate, extraction is the only economical means of isolating butanol from the fermentation broth. DMIM TCB has an excellent capacity for butanol and is polar enough to offer sufficiently high selectivity of butanol over water (Figure 1). Ionic liquids made with other anions just cannot compete with the capacity of TCB for butanol. And because DMIM TCB is a non-volatile Ionic Liquid, the recovery of butanol by distillation leads to a high purity product.

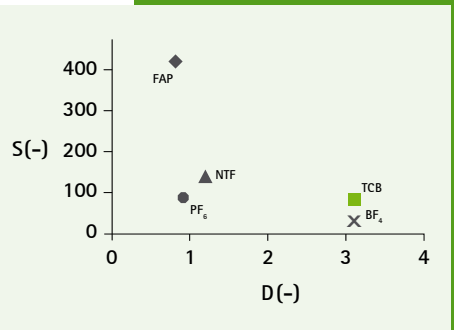

Figure 1:
Ionic Liquids based on the TCB anion outperform all other ionic liquid systems. D: Distribution coefficient of butanol in the ionic liquid phase of an ionic liquid-aquous biphasic mixture. S: Ratio of butanol to water in the ionic liquid phase.

Recover two value streams, not just one

Acetone is generally produced as a side product in the production of butanol. Traditional media for the extraction of butanol, such as oleyl alcohol, leave the acetone behind, lost to the environment through evaporation. (Figure 2) DMIM TCB extracts both the butanol and the acetone, which can then be separated at the final distillation stage. Simultaneous recovery of butanol and acetone prevents the unwanted and wasteful release of a volatile but valuable by-product.

Faster Downstream Process Time

Extraction of butanol using such conventional media as oleyl alcohol is complicated by long phase separation times. DMIM TCB is polar enough to drag out the butanol, but doesn't have the hydroxyl functional groups present in alcohols which form the strong hydrogen-bond networks which complicate and retard separations.

With DMIM TCB, you get an innovative material which can revolutionise your butanol extraction processes by enabling:

- Reduction of down-stream process times due to faster mixing-settling
- Increase of economical benefit via co-extraction of acetone
- Improvement of energy balance due to fewer distillation steps to recover butanol

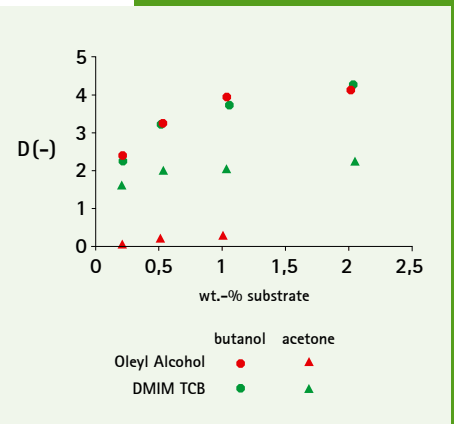

Figure 2:
Oleyl alcohol can extract butanol from an aqueous mixture of butanol (2%) and acetone (1 %), but it leaves the acetone behind. With DMIM TCB, you get efficient extraction of both high value products.

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