

Company Heineken

Case Title Selective recovery of ethanol and aroma compounds from alcoholic solutions Heineken

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Problem description

Heineken has been successful in developing and marketing non-alcoholic (0.0%) beer with great reception from the market. The non-alcoholic beer segment is expected to grow in the coming years because of the rising trend of awareness in health and wellness among the target market.

In the brewing industry, different techniques have been developed to produce non-alcoholic beers, including limited fermentation and ethanol removal. While limited fermentation generates final beverage with increased malty flavors and low user acceptance, ethanol removal leads to the decrease of beer-associated aromas.

In order to address the lack of beer aromas in non-alcoholic beer, we propose a (combination of) approach(es) to selectively separate beer-associated aromas from ethanol in beer and beer based products to improve the product with better beer-associated aromas. In order to simplify the discussion, we select EtOH (ethyl acetate) as low-boiling beer-associated aroma and *i*AmOH (isoamyl alcohol) and *i*AmOAc (isoamyl acetate) as high-boiling beer-associated aromas.

Approach

After careful literature research on selective recovery of aroma molecules from alcoholic solutions and intensive discussion with company representative, we identified feasible industrial approaches including, salting out, vacuum distillation, vapor permeation, adsorption and isolation with supercritical carbon dioxide. In the following analysis, we included combinations of techniques to address the problem. As parameters of feasibility, we considered the operation energy (cost) and effectivity to selectively isolate EtOAc, *i*AmOH and *i*AmOAc. An extra parameter was carefully considered, which is the amount of ethanol in the final recovery.

Promising solution(s)

We formulated three pipelines: pipeline 1 (salting out – distillation – distillation), pipeline 2 (distillation – adsorption) and pipeline 3 (distillation – distillation). Specifically, salting out should be performed by adding salt to increase water hydrophilicity and removal of alcoholic layer for further treatment. Distillation is used mainly to remove low boiling compounds from the feed material (EtOAc and ethanol) and high boiling compounds (*i*AmOH, *i*AmOAc and water). Second distillation is used to remove most of ethanol and concentrating EtOAc in limited amount of ethanol. Adsorption to hydrophobic resin was considered as a well-known solution to isolate organic compounds.

Conclusion

Based on energy cost and recovery efficiency, we recommended pipelines 1 and 3 to be explored in greater detail from feasibility, efficiency and investment costs. In addition, we recommended specific parameter to be improved from the classical isolation on hydrophobic adsorption.