Foam separation of biosurfactants

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Introduction

Surfactants, surface active amphiphilic molecules, have a broad spectrum of applications, from everyday tasks such as washing the dishes to advanced oil recovery operations. The global market for surfactants is approximately 8 million tonnes per annum with a total value of £ 7.1b[1]. The majority of this demand is met with surfactants obtained from non-renewable oil-based feedstocks. An alternative route of surfactant production exists in nature in the form of microbes capable of producing surfactants. Microbially produced biosurfactants are characterised by both their chemical composition and microbial origin[2] and can perform many tasks for which traditional petrochemical or oleochemical surfactants are currently used. Biosurfactants have also found utility in fields such as environmental bioremediation , food-processing and pharmaceuticals[3]. An interesting example of a biosurfactant is the heptapeptide surfactin, a metabolite of *Bacillus subtilis* BBK006. Surfactin is highly surface active and exhibits antibacterial, antiviral and antitumor behaviour[4].

A significant proportion of the production costs of biosurfactants are incurred during downstream processing. Standard separation techniques such as microfiltration are costly when applied to typical bioproduct process streams, i.e. large volumes, with a low product concentration. The development of novel separation techniques which reduce the cost of biosurfactant production, such as Foam Fractionation, is key to increasing the biosurfactant market.

Foam fractionation theory

Foam Fractionation is a low cost adsorptive bubble separation method, which is used to enrich and partially separate solutions of surface active species[5]. As sparged gas bubbles rise through the liquid pool surface active molecules adsorb to the liquid gas interfaces. At the top surface of the liquid reservoir foam, which is richer in the adsorbed species than the liquid in the reservoir, is formed which constantly overflows from the top of the system. The overflowing foam is collapsed and enriched liquid known as foamate is obtained.

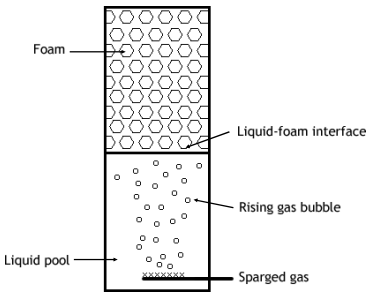

Figure 1 – Foam Fractionation column.

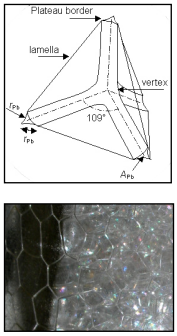

Figure 2 – Polyhedral foam cell and foam.

An analogy can be made between foam fractionation and distillation, and the familiar concept of an equilibrium stage applied to foam column design

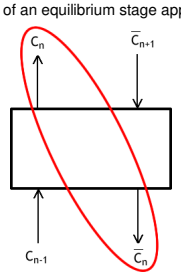

Figure 3 – Equilibrium stage.

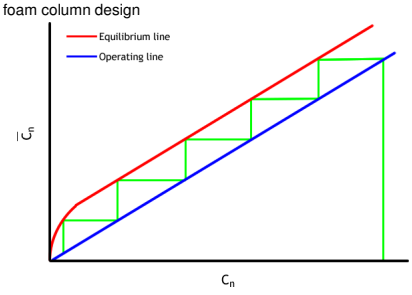

Figure 4 – McCabe-Thiele diagram for a fractionation column.

References

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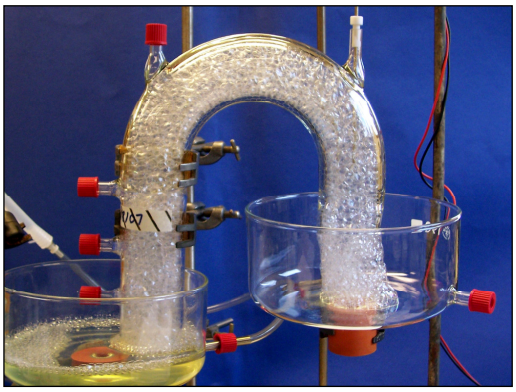


Figure 5 –Foam Fractionation apparatus

Methodology

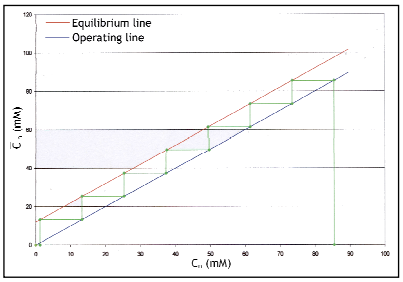
Foam Fractionation experiments were carried out using the equipment shown in figure 5, with the addition of a reflux line. A ??mM cetyl pyridinium chloride (CPC) solution was used as the feed. Foam was generated using two different air flowrates, 1.0 L min^{-1} and 1.5 L min^{-1}, and the foam column was operated under total reflux.

CPC concentration measurements.

Steady state.

Equilibrium line

Results



Enrichments of ~?? of a solution of CPC were achieved using Foam Fractionation.

The number of equilibrium stages depends on air flowrate, 7 stages for 1.0 L min^{-1} and 5 stages for 1.5 L min^{-1}

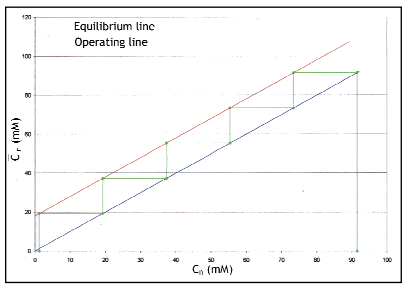


Figure 6 –McCabe-Thiele diagrams for air flowrates of 1.0 L min^{-1} (Top) and 1.5 L min^{-1} (Bottom).

Conclusions

Foam Fractionation with reflux of CPC solution was carried out, and enrichments of ?? were obtained.

The number of equilibrium stages in the foam column was found for two different operating conditions using a McCabe-Thiele diagram. This data can be used to improve process design and achieve greater product enrichments.

Acknowledgements:

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