# REMOVAL OF ALCOHOL FROM BEER BY REVERSE OSMOSIS AND BATCH DISTILLATION

Author: Gareth Stephenson with Chris O'Malley | School of Engineering

## Introduction

Beer is a popular beverage worldwide, typically containing 3-6% v/v of alcohol [1, 2], and in recent times there has been an increased demand for low or non-alcoholic beers [3]. There four main existing methods to achieve lower alcohol beers: fermentation-free brewing, dilution procedures, alcohol removal/de-alcoholisation and restricted alcohol fermentation. The best method varies depending on the most highly desired parameter for the final beer, such as: flavour profile, % ABV or total annual cost of running the process. The primary focus of this research was to obtain a de-alcoholised beer, whilst also recovering the separated alcohol for further use, with particular focus on flavour of the de-alcoholised beer.

## Method

Reverse Osmosis (RO)

- The Alfa Laval TestUnit M20 was used to trial the de-alcoholisation of beer via RO diafiltration method using Alfa Laval RO90 membranes.
- Modifications were made to optimise transmembranar pressure, temperature and beer quality by diafiltration with distilled permeate.

Batch Distillation

- Experiments were conducted using a 30L Grainfather Connect pot still with temperature control. A Still Spirits Turbo 500 Copper Condenser was used packed with copper saddles.
- Temperatures and reflux were manipulated to investigate effect on de-alcohlisation.

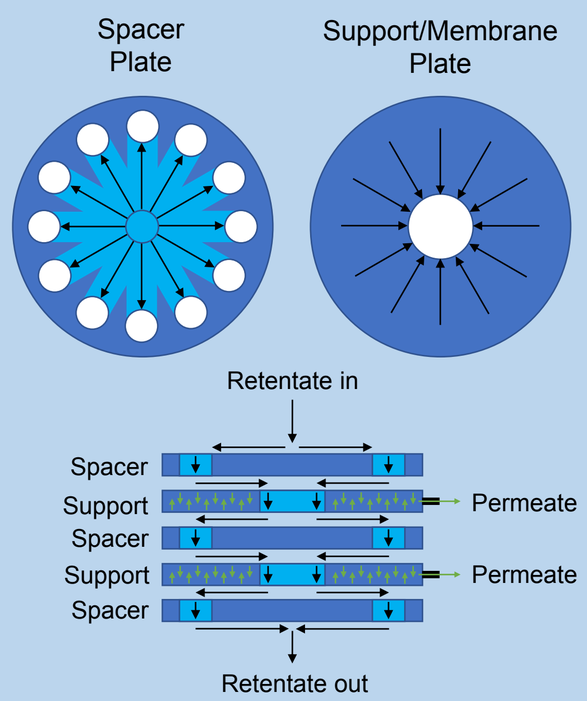



Figure A – Permeate and retentate flows through RO membrane module

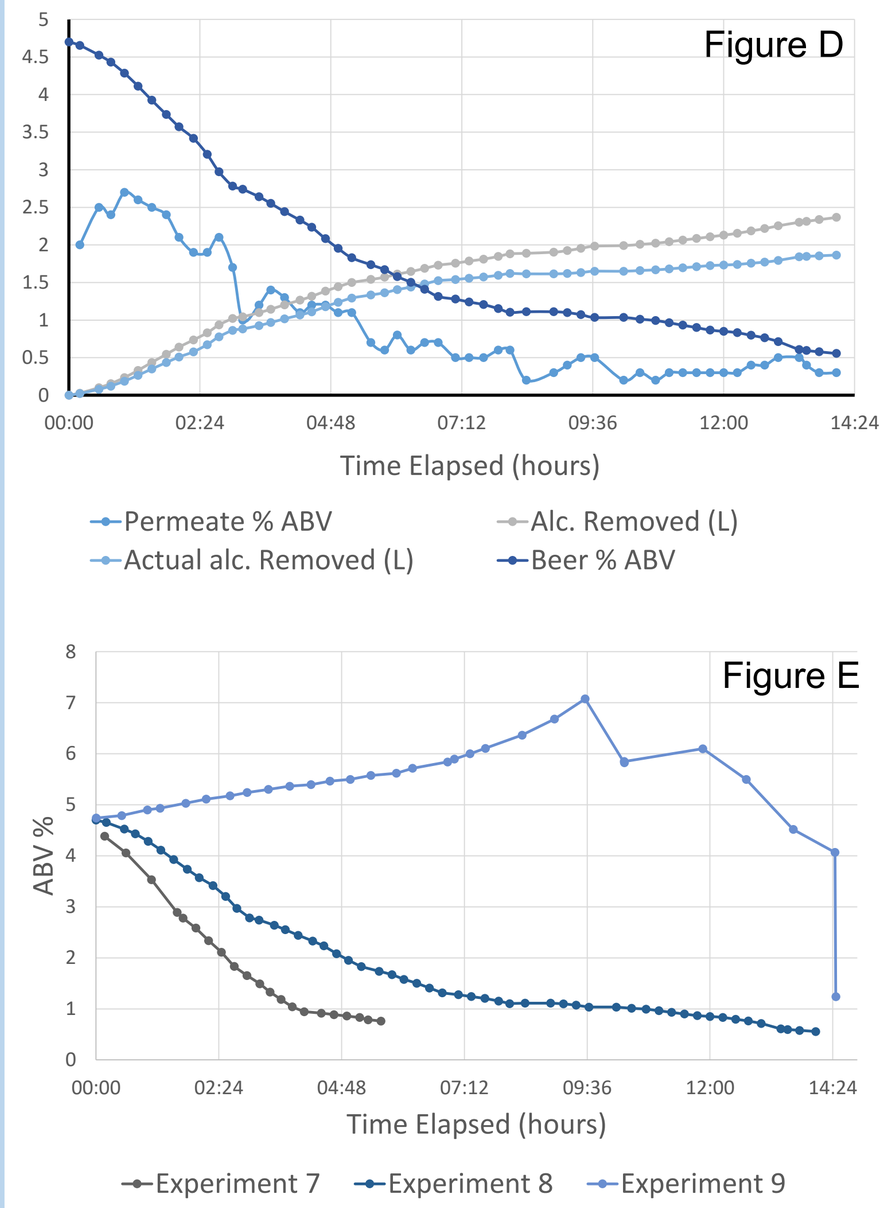
## Results and Discussion

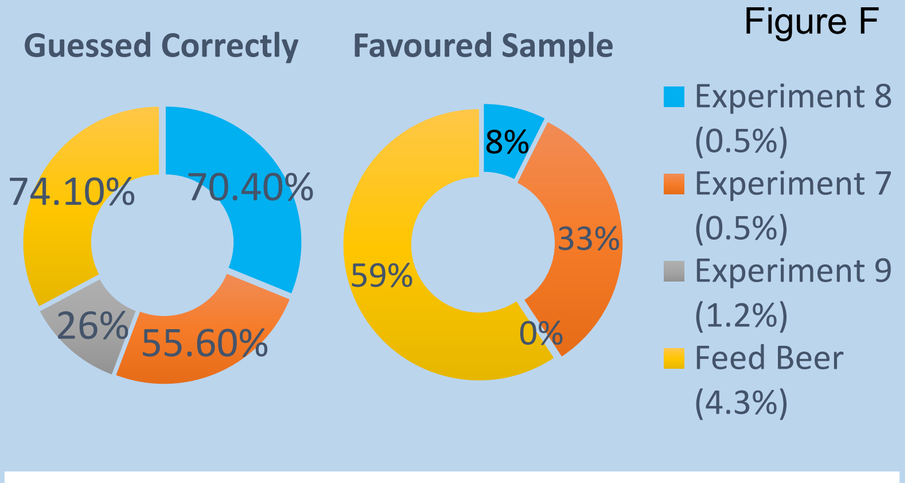
1) Reverse Osmosis (RO)

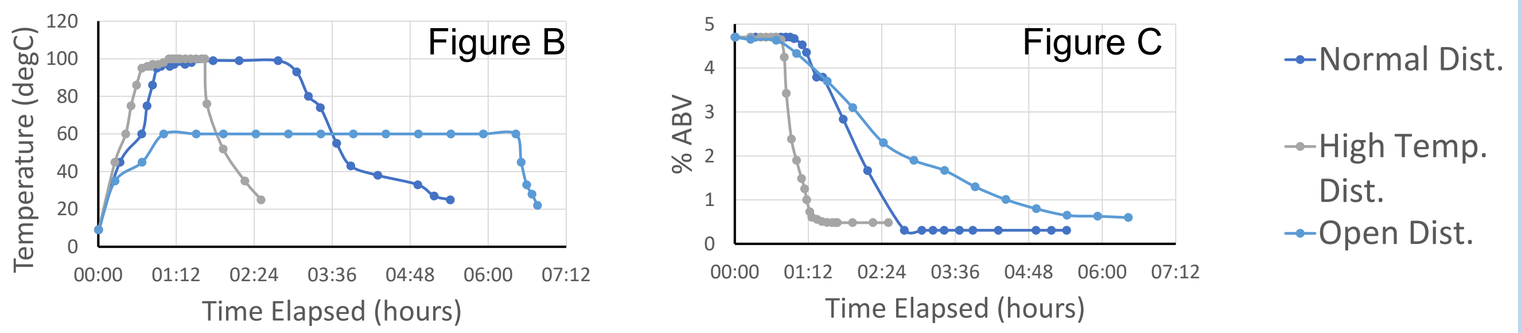
- Initial experiments conducted without strong hermetic seal which produced a stale, foul-tasting beer with some inconclusive results.
- Three experiments conducted with strong hermetic sealing, results illustrated in Figure E.
- Beer %ABV was estimated throughout runs using known alcohol content of permeate. Figure D represents this change over duration of experiment, with adjustment for slightly alcoholic distilled permeate used in diafiltration.
- Permeate flux increased with temperature, also rejecting more ethanol until osmotic pressure difference mitigated transmembranar differential pressure.
- A Taste panel determined original Lab Session Feed Beer was the best, see Figure F. Exp. 7 (shortest duration) was the favoured de-alcoholised beer while Exp. 9 was least favoured (longest duration).

2) Batch Distillation

- All three runs yielded a beer within or close to de-alcoholised tolerance (Figure. C)
- No hermetic sealing caused beers to taste off and quickly oxidise to a stale condition.
- Duration of experiment had little effect on taste and heat degradation of flavour compounds occurred at operating temperatures above 60°C (Figure B).




## Conclusion

- In both methods, reduction in alcohol level is a function of experiment duration.
- Increased duration of RO has negative effect on flavour due to rejection of flavour compounds as well as ethanol.
- Combination of reduced filtration and subsequent dilution with water yielded highest quality de-alcoholised beer.
- >1atm batch distillation unsuitable for de-alcoholisation of beer – consider vacuum distillation with strong hermetic sealing.
- Further research recommended to investigate rejection of aromatic compounds against RO duration and %ABV of retentate.

## References

[1] Hardwick, W.A., *The properties of beer*, in *Handbook of brewing*, W.A. Hardwick, Editor. 1995, New York : M. Dekker: New York. p. 551-586.
[2] Bamforth, C.W., *Nutritional aspects of beer—a review.* Nutrition Research, 2002. **22**(1-2): p. 227-237.
[3] Mangindaan, D., K. Khoiruddin, and I.G. Wenten, *Beverage dealcoholization processes: Past, present, and future*. Trends in Food Science & Technology, 2018. **71**: p. 36-45.
[4] Falkenberg, A.J.W., *Removal of Alcohol From Beer Using Membrane Processes*, in *Department of Food Science*. 2014, University of Copenhagen: Copenhagen. p. 94.

FIND OUT MORE →→→

View PDF