EFFECT OF CIRCULATION FLOWRATE ON THE PERFORMANCE OF A SPIRAL FINNED CRYSTALLIZER

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INTRODUCTION

Concentration Process Technologies

Evaporation

Reverse Osmosis

Freeze Concentration
FREEZE CONCENTRATION

**SFC**
Small ice crystals in the suspension in mother liquor.
Difficult separation of ice crystals.
Involves SSHE – the most expensive heat exchanger (expensive capital cost).
More unit operations – more capital cost.

**PFC**
A single of ice block of ice crystal.
Easy separation of ice crystal (flushing / draining).
Does not involve SSHE.
Less unit operations (no filtration and washing unit) – lower capital cost.
PROBLEM STATEMENT

Different kinds of PFC system:
- To increase quality
- To increase quantity

Weaknesses:
- Low productivity
- Consists of many equipments
- Too long of process time
- Formation of foam in the pipes

A new design of PFC system will be developed.

Heat transfer plays an important role in the production of ice crystal

Spiral fin
- Provide highest surface area & optimum flow characteristic
- Enhance heat transfer

The newly designed spiral finned crystallizer was investigated in PFC with the effect of circulation flowrate
To investigate the newly designed spiral finned crystallizer in PFC with the effect of circulation flowrate.

The effect of circulation flowrate was experimentally evaluated from the viewpoint of both effective partition constant (K) and recovered solute (Y).
MATERIALS

Solution • 6 %Brix glucose solution

Coolant • 50% (v/v) ethylene glycol solution
The new crystallizer is named as spiral finned crystallizer.
This crystallizer is in a cylindrical shape and is attached with rectangular shaped fin.
Fin is positioned at the inner wall of the crystallizer in a spiral form.
The spiral fin was built in this crystallizer for the purpose of making bigger contact surface area.
By addition of the spiral fin, surface area is increased to 107.73%.
Cooling jacket covers the crystallizer for cooling purpose.
In order to minimize heat transfer from the environment, the crystallizer is insulated by polyurethane foam.
EQUIPMENT

- Spiral finned crystallizer
EXPERIMENTAL SETUP
EXPERIMENTAL PROCEDURE
EVALUATION OF SYSTEM EFFICIENCY

- Effective partition constant ($K$)

$$ K = 1 - \frac{\log(C_O/C_L)}{\log(V_L/V_O)} $$

- Recovered solute ($Y$)

$$ Y = \frac{C_L m_L}{C_O m_O} $$
RESULT AND DISCUSSION

• Effect of circulation flowrate

- The result obtained means that with higher circulation flowrate, the more pure ice crystal and high concentration of concentrated solution were produced.
- The recovered solute increased over the circulation flowrate.
- At 3000 mL/min, the best value of $K$ and $Y$ have been yielded which are 0.35 and 0.96.
- This shows that the higher circulation flowrate is preferable for efficient PFC by the spiral finned crystallizer.
RESULT AND DISCUSSION

- **Effect on PFC performance**

Spiral fin plays a role in the PFC system to enhance its performance.

Adding spiral fin to the crystallizer in the PFC system increase the surface area.

It can be a possible solution for productivity enhancement in PFC system.

Spiral fin appears as an interesting way to improve heat transfer in PFC process especially to overcome productivity limitations.
CONCLUSION

Circulation flowrate of 3000 mL/min was discovered to result in the lowest K value and highest Y value during the process.

Concentration of glucose solution by using the spiral finned crystallizer was found to be feasible.

The results show the feasibility of the system and give an excellent idea of the operating conditions that can be used to concentrate glucose solution.