COMBINED ION EXCHANGE AND MICROFILTRATION

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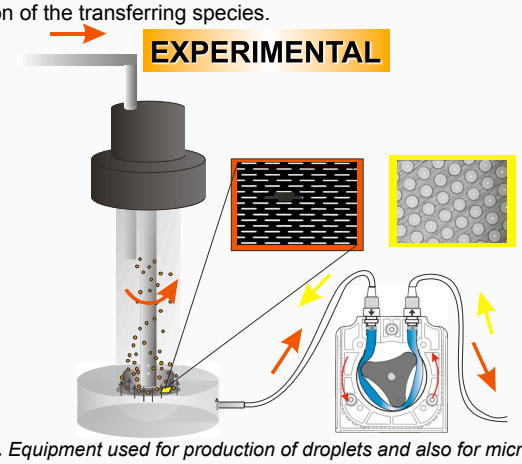
RESEARCH OVERVIEW

- The purpose behind this work is to produce polystyrene-divinylbenzene **resin particles** smaller than are conventionally available (down to 20 μm) suitable for removal of metal cations such as cesium (Cs^+), strontium (Sr^{2+}), copper (Cu^{2+})… from waste waters.
- For resin production **membrane emulsification (ME)** in a simple stirred cell is being used.
- In **preliminary tests** sunflower oil and 2% Tween 20 aqueous solution were used to commission the system (ME). With increase of shear stress on the membrane surface the droplets decreased in size.
- After production such particles are being used in a stirred **microfiltration** with slotted pore surface microfilters system (**MF**) (not column) and such use permits the passage of colloidal particles. **Transport properties** are **easily obtained** from such tests.
- In **preliminary tests** conventional ion exchanger (**IX**) Dowex 50WX8 was used for removal of copper ions.
- Rates of copper sorption on to ion exchange resin were found to be dependent on mass transport limitations due to aqueous film diffusion and internal particle diffusion of the transferring species.

EXPERIMENTAL

DROPLET PRODUCTION
yellow arrows,
circular 10 μm pores membrane

Dispersed phase (oil) was injected through the membrane pores into the aqueous continuous phase (2% Tween 20 solution).



MICROFILTRATION with IX
red arrows,
slotted membrane

Adsorption of copper ions on commercial ion exchange resin Dowex 50WX8 (strong acid cation resin containing 8% divinylbenzene d_{50}=240 μm) 100-200 (sieved) was monitored in stirred system with slotted membrane.

Fig 1. *Equipment used for production of droplets and also for microfiltration*

MODELLING - COMBINED IX AND MICROFILTRATION

Mass balance of the cation in stirred system:

$$V\frac{dC}{dt} = F(C_o - C) - \frac{3}{R}mD_{ef}\frac{\partial q}{\partial r}\bigg|_{r=R}$$

Boundary conditions

At the start fresh liquid:

$$q(t=0, 0\le r\le R)=0$$
$$C(t=0)=0$$

Centre of the resin and full radius of the resin

$$\frac{\partial q(t\ge 0)}{\partial r}\bigg|_{r=0} = 0 \qquad \frac{\partial q(t\ge 0)}{\partial r}\bigg|_{r=R} = \frac{k}{D_{ef}\rho_s}(C-C^*)$$

The system of equations (PDE and ODE) must be solved simultaneously so PDESOL (Numerica, Dallas, USA) was used.

RESULTS AND DISCUSSION

MEMBRANE EMULSIFICATION

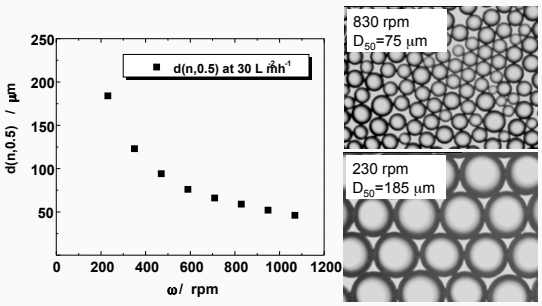


Fig. 2 *Influence of rotation speed on median droplet size*

COMBINED IX AND MICROFILTRATION

FEW REGIONS

A - all the mass transfer resistance is in the **aqueous film**

B - suitable concentration gradient is achieved, resin has good internal diffusivity copper is easily **transferred internally**

C - Internal transfer of copper will continue until resin resistance to mass transfer increases when **copper concentration** in the resin becomes **high**

D - **saturation** of the resin

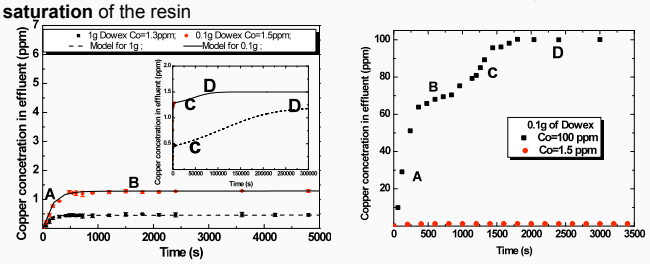


Fig. 3 *Influence of different mass of ion exchanger or inlet conc. (Co) on effluent*

CONCLUSION

Membrane emulsification is suitable for production of uniform small ion exchange resin particles.
Ion exchange onto small resin particles in stirred microfiltration system provides:
•Very fast kinetics, good loading,
•IX Particles retained on microfilter,
•Colloidal material pass microfilter,
•Cyclic process: treat, regenerate…
•Excellent technique for determining mass transport properties.

FUTURE WORK

- **Further work on commercial IX in order to deduce mass transfer coefficients necessary for modelling**
- **Production of smaller IX particles and testing in MF system**
- **Comparing results obtained with IX in MF and conventional column-type operation, which is best?**

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