MASS TRANSFER INTENSIFICATION IMPLEMENTING THE USE OF STATIC MIXERS IN Co/Ni SOLVENT EXTRACTION

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ABSTRACT

Residence time plays a crucial role in any solvent extraction process. The mass transfer rate is significantly increased by reducing the oil droplet size of an oil-in-water dispersion. Therefore, residence time reduction through increased mass transfer rates is vital for optimising these processes. Recently, there has been a renewed interest in using static mixers to reduce the droplet size of these dispersions. Several studies have documented the efficacy of static mixers in reducing droplet size in these dispersions. However, characteristic equations of these static mixers have yet to be sufficiently developed. These equations describe the inherent efficiency of different static mixers in various separation systems.

This study seeks to develop characteristic equations for different static mixer configurations in a Co/Ni separation system. The parameters incorporated in these equations include the Sauter mean diameter of the oil droplets (d_{32}), the diameter of the pipe (D), the Weber number (We), Reynold's number (Re), and the number of static mixer elements used in the system (ne). The study considers the development of correlations with pre-determined fitting parameters (α,β,γ,δ) descriptive of each unique static mixer design. The characteristic equations take the following form:

$$\frac{d_{32}}{D} = \alpha We^{\beta} Re\gamma n_e^{\delta}$$

This study provides an approach to developing these characteristic equations using droplet size reduction in a Co/Ni solvent extraction system. The droplet size reduction was determined using existing settling velocity correlations. These characteristic equations were developed in various flow regimes for small-scale and large-scale applications. After creating these equations, a computational fluid dynamics (CFD) model was constructed in Star-CCM+ to verify the validity of these equations under different conditions.

The research conducted provides empirical confirmation that static mixers are not only able to decrease residence time in solvent extraction processes but also that static mixers exhibit different behaviour in different systems. The research results represent a further step towards optimising solvent extraction processes using static mixers.

Keywords: Solvent extraction, Static mixers, CFD, Co/Ni separation, Residence time