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SPS Separation Processes Service

DESIGN OF SIMPLE GRAVITY SETTLERS FOR THE COALESCENCE OF LIQUID-LIQUID DISPERSIONS

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BACKGROUND AND SCOPE

The separation of two immiscible liquids from an unstable dispersion is an essential step in liquid-liquid contacting applications; and the simplest means to achieving this separation (the gravity settler) is found in mixer-settler extractors and disengagement sections of column contactors.

The design aim for a gravity settler is to prevent flooding or carryover of the light phase with the heavy phase, or vice versa. This in turn requires a knowledge of the velocity of coalescence (i.e. throughput per unit area) as a function of the thickness of the layer of mixed phases (the dispersion band) which forms at the interface. This functional relationship is difficult to predict from physical property data alone, and is profoundly affected by impurities; hence an alternative approach is needed if settler space is not to be wasted. The method used in this report involves making measurements of the transient rate of collapse of a dispersion of the process fluids in a laboratory batch mixer-settler, and using the results to predict the band thickness versus throughput relationship for a continuous settler.

The methods are based on theoretical and experimental work at ETH Zürich and Harwell.

The design report describes this predictive method and goes on to discuss details of settler design and construction.

SUMMARY OF CONTENTS

The introductory chapter briefly reviews the types of settler layout which have found large-scale application, and goes on to describe the state of the art in the theoretical description of coalescence and the factors which influence coalescence rates.

Design Guide

The design guide summarises the steps to be taken in designing a simple gravity settler, laid out as flow charts. The essential design equations are also listed.

Prediction of Continuous Flow Dispersion Band Height

This chapter describes the way in which the continuous flow dispersion band thickness versus throughput relationship is predicted. An appropriate batch disengagement test is described, from which coalescence parameters can be derived which can be used to predict continuous settler performance. Different methods of calculation are suited to different shapes of batch curve. Sample calculations are given in an appendix.

Dimensions of the Disengaging Zone

The final choice of dispersion band thickness and the principal settler dimensions is described.

Internals of the Gravity Settler

This chapter completes the detailed design of the simplest settler with a discussion of feed, flow calming and outlet arrangements.

Design Strategem for Other Geometries

Here the approach described in earlier chapters is extended to a number of variant geometries:

- The 'Combined Mixer Settler'
- The multi-tray settler, including the possibility of retrofit to a simple settler
- Centrifugal separators
- The disengaging zone of a column contactor.

Operational Considerations and Materials of Construction

The remaining two chapters review such matters as start-up and shut-down, instrumentation, control of interfacial crud, safety, and appropriate materials of construction.