ROUSSELET ROBATEL
703 West Housatonic Street – Ste L15
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manufacturing centrifuges and centrifugal extraction equipment

ROUSSELET ROBATEL MODEL LX MULTISTAGE CENTRIFUGAL EXTRACTOR OPERATING PRINCIPLE

Rousselet Robatel multistage LX centrifugal extractors are stage-wise contactors. Up to 7 stages can be installed in a single rotating assembly for extremely high extraction efficiency in a very compact machine.

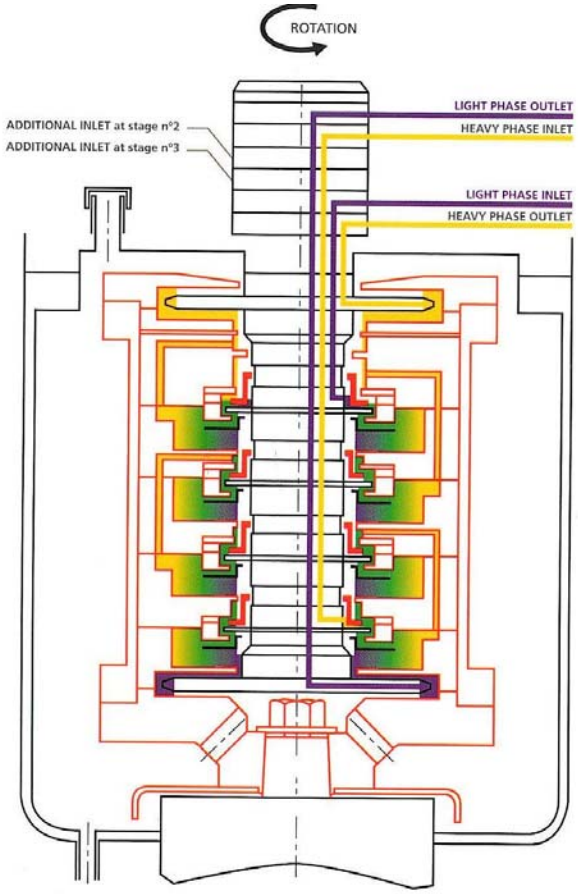

Figure 1: Flow diagram of a pilot scale four stage multistage centrifugal extractor

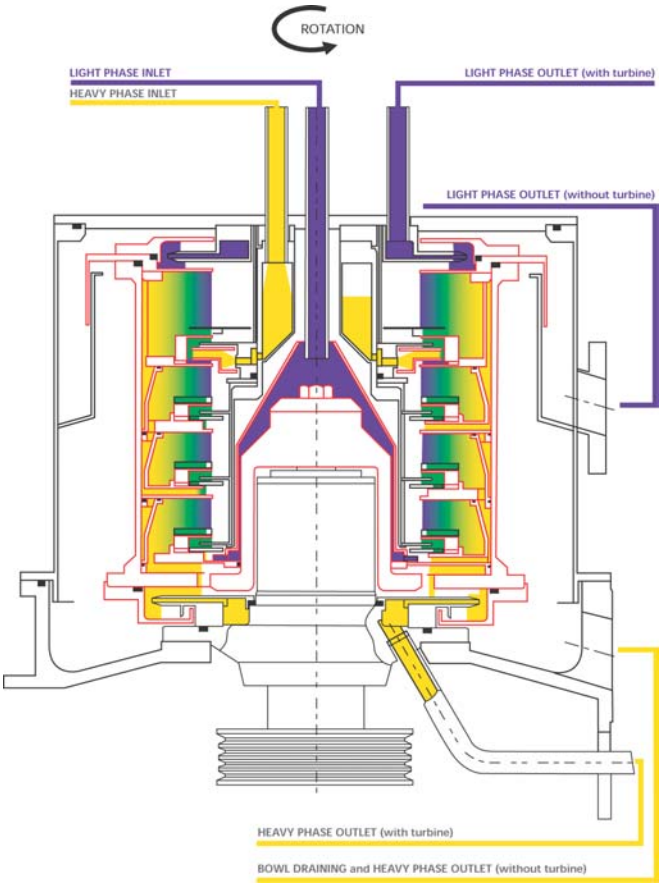

Figure 2: Flow diagram of an industrial scale four stage multistage centrifugal extractor.

A feed solution, containing one or more solutes (shown in yellow), and an immiscible solvent (shown in purple) with a different density than that of the feed solution are fed to opposite ends of the multistage extractor. Each stage consists of a mixing chamber and a decantation chamber with interstage countercurrent liquid flow analogous to a pump-mix mixer-settler.

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DESCRIPTION OF A MECHANICAL STAGE

Each stage of the LX extractor includes:

- **a mixing chamber** where the two liquids are mixed by means of a stationary agitation disc mounted on the central drum. The high relative speed between the stationary agitation disc and the rotating walls of the mixing chamber create an extremely fine dispersion. The agitation disc and the mixing chamber's inlet and outlet channels form a pump which draws the two phases from the adjacent stages and also transfers the dispersion to the settling chamber.

- **a settling chamber** in which the liquids are separated by the centrifugal force generated by the rotating bowl. The heavier liquid (shown in black on Figure 3) occupies the outer portion of the bowl. The light liquid (shown in gray on Figure 3) occupies the inner portion of the bowl.

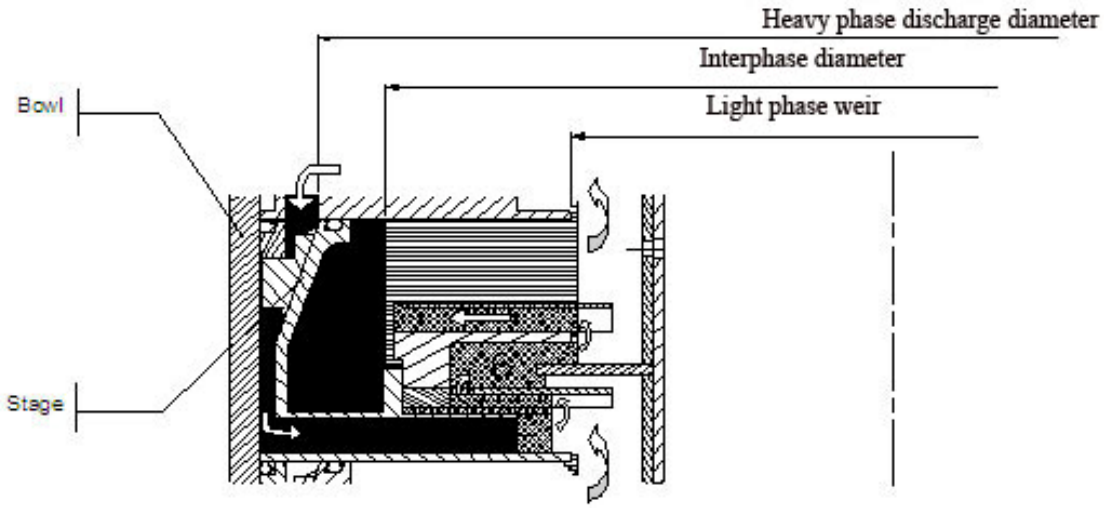

Figure 3: Cutaway diagram of a single extraction stage in a multistage extractor

The position of the liquid / liquid interphase is regulated using a fixed diameter light phase weir and interchangeable heavy phase weirs of different diameters to accommodate a wide range of density ratios.

Due to the large interfacial area created by the intense mixing, and thanks to the efficient centrifugal phase separation, the extraction efficiency is very high. Each mechanical stage nearly corresponds to a theoretical stage.

The liquids are discharged from the LX extractors by gravity or by centripetal turbines.

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MULTISTAGE EXTRACTOR MULTIPLE INLET CONFIGURATIONS

Rousselet Robatel pilot scale multistage centrifugal extractors are equipped with intermediate inlets. They may therefore be operated as a 1, 2, 3, or 4-stage extractor [as examples] to rapidly assess the improvement in extraction efficiency as a function of the number of stages.

The multiple inlets accommodate a wide variety of flow configurations and extraction processes since a third liquid that is miscible with one of the two liquid phases in the extractor may be fed to stage #2 or stage #3. This is useful to change pH or ionic strength along the extraction profile or to scrub (wash) the extract prior to its discharge from the extractor (refer to Figure 4 below).

The intermediate inlets can also be used for a fractional extraction whereby the feed solution is introduced in Stages #2 or #3, with the two solvents being introduced at Stages #1 and #4.

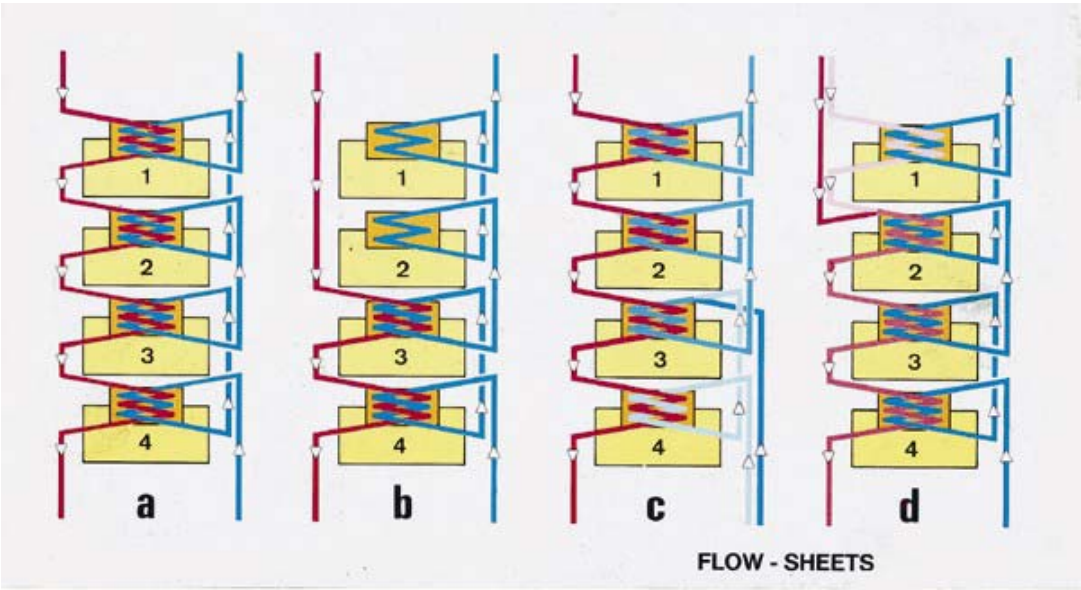

Figure 4: Flow configurations of a pilot scale four stage multistage centrifugal extractor

Flow Diagram A: Illustrates normal operation as a 4-stage countercurrent extractor.

Flow Diagram B: Illustrates operation as a 2-stage countercurrent extractor by introducing the light phase into Stage #3. Note that if the light phase were introduced into Stage #2, three countercurrent extraction stages would be obtained.

Flow Diagram C: Illustrates contact between two miscible heavy phases and one light phase; for example three extraction stages plus one scrubbing stage (or other combinations).

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Flow Diagram D: Illustrates contact between one heavy phase and two miscible light phases; for example three extraction stages plus one stage of heavy phase washing with a diluent (or other combinations).

PILOT SCALE TESTING

For any centrifugal extractor, the maximum throughputs and extraction efficiencies can only be determined by testing the technology on a laboratory and pilot scale. The performance parameters of a multistage centrifugal extractor will vary depending on the solvents used, viscosity, temperature, density ratio, surface tension, and phase flow rate ratio.

Specifically, for a centrifugal extractor, G-force and the mixing energy are important factors to consider during testing. As shown in the table below, increased rotational speed provides a higher driving force for separation. However, as rotational speed increases, this will also increase the mixing energy imparted to the liquid / liquid system.

Therefore, the maximum rotational speed may not yield the best results. The vigorous mixing at the higher speed may create a dispersion that is more difficult to separate. Typically, there is a "bandwidth" of rotational speeds that balances the right amount of mixing with adequate G-force for effective separation. By testing at several different rotational speeds on a pilot scale, this bandwidth can be quickly evaluated.

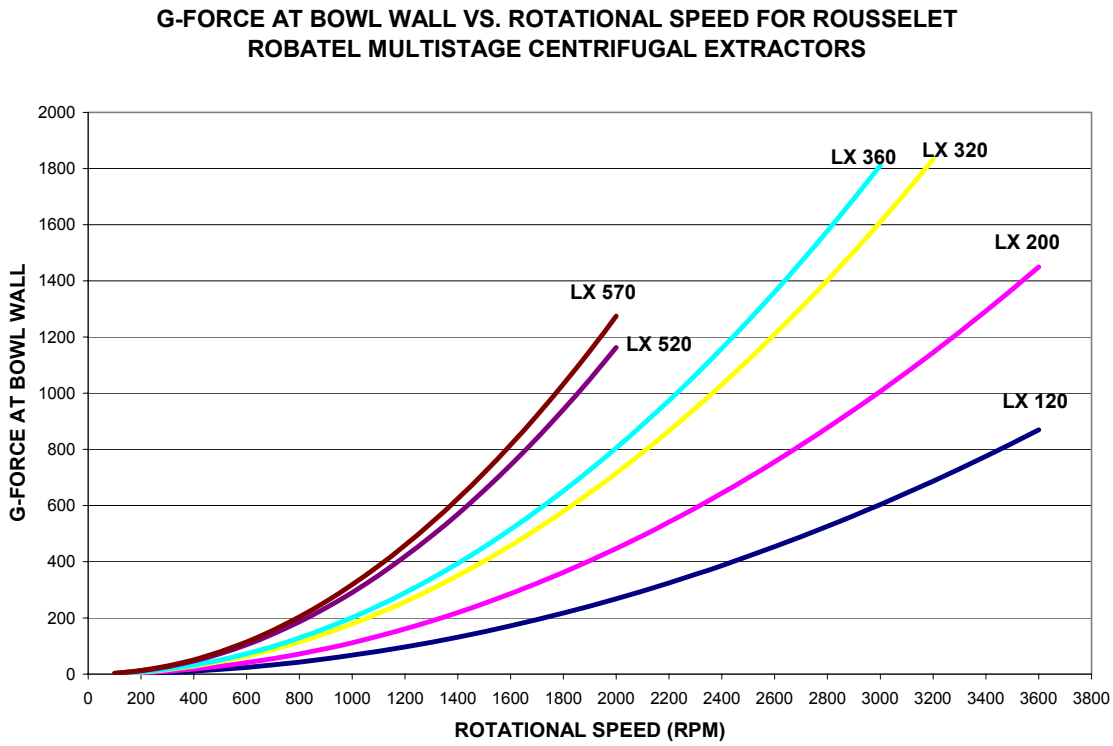

Figure 5: Rotational speed vs. G-force for Rousselet Robatel multistage centrifugal extractors