Nov. 7, 1967 P. G. GRIMES ET AL 3,351,434

LIQUID-LIQUID TWO-PHASE CONTACTOR

Filed June 8, 1965

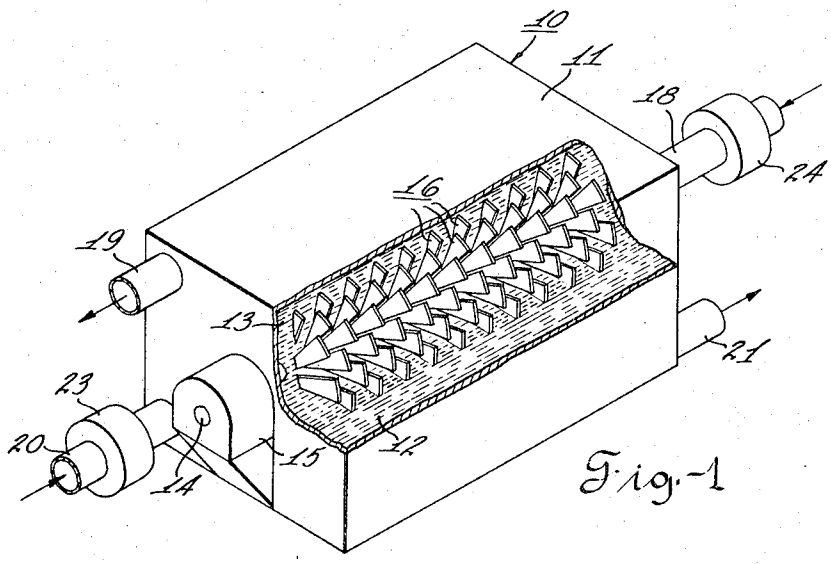


Fig. 1

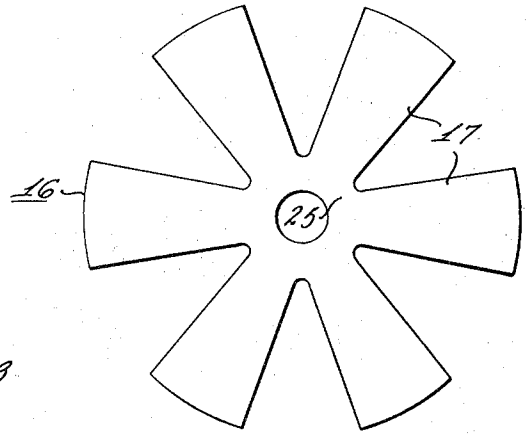


Fig. 2

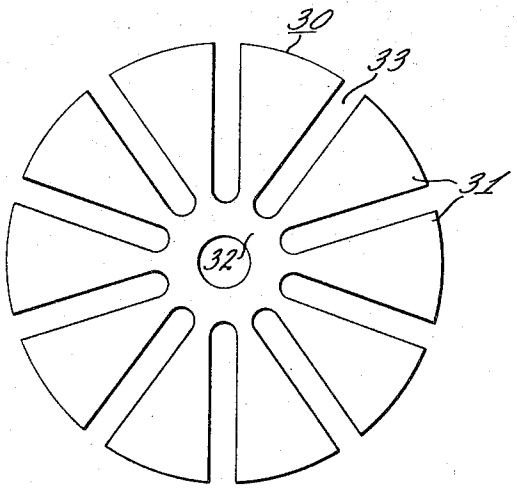


Fig. 3

Inventors
Patrick G. Grimes
Marvin C. Raether
By Robert B. Benson
Attorneys

United States Patent Office 3,351,434
Patented Nov. 7, 1967

3,351,434

LIQUID-LIQUID TWO-PHASE CONTACTOR

Patrick G. Grimes, Milwaukee, and Marvin C. Raether, Middleton, Wis., assignors to Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Filed June 8, 1965, Ser. No. 462,294
3 Claims. (Cl. 23—310)

This invention relates generally to what is known as a two-phase contactor. More specifically, this invention relates to a unique type of two-phase contactor that is particularly designed and useful as a liquid extractor used with two immiscible liquids.

The two-phase contactor generally utilizes a plurality of elements which are dipped into a liquid, exposed to gas and then returned to the liquid. This type of device can also be used with two immiscible liquids in which case the elements pass through one liquid into the other and then return to the first liquid. One purpose of passing the disks alternately through the different liquids is to extract from one liquid a particular component and transfer it in the second liquid. An example of this type of an application would be the transfer of an acid from hexane to water or the transfer of penicillin from a fermentation media to an organic liquid, after which the organic liquid is evaporated leaving the penicillin concentrate.

The primary difficulty encountered in utilizing a two-phase contactor in handling two immiscible liquids has been the problem of getting a sufficient volume of the liquids to flow through the contactor because of the interference of the disk. Some attempts were made to overcome this problem by forming holes in the disk but it was found that these holes tended to film over and form a wall and thereby prevent further flow of liquid through the openings.

The two-phase contactor of this invention overcomes the problems described above by providing a disk having a unique configuration which effectively transfers a component of one solution into the second solution while still permitting the liquids to flow thorugh the contactor.

Therefore, it is the object of this invention to provide a new and improved two-phase contactor.

Another object of this invention is to provide a new and improved two-phase contactor as an extractor in connection with two immiscible liquids.

Other objects and advantages will be apparent from the following description when read in connection with the accompanying drawings, in which:

FIG. 1 is an isometric view of a two-phase contactor of this invention;

FIG. 2 is a front view of the preferred disk for use in the two-phase contactor of this invention; and

FIG. 3 is a front view of an alternate disk for use in the two-phase contactor of this invention.

Referring more specifically to the drawings by characters of reference, the two-phase contactor **10** of this invention is illustrated as a liquid-liquid extractor having a tank **11** with a first solution **12** flowing in the lower portion of the tank and a second solution **13** flowing in the upper portion of the tank. A horizontally disposed shaft **14** is rotatably mounted in a pair of spaced apart bearings **15** and a plurality of disks **16** are mounted on the shaft **14** intermediate the bearings **15** for rotation in a substantially vertical plane. The disks are located so that about one-half of each disk is in contact with each of the two solutions in the tank. A suitable source of power such as an electric motor is provided for rotating the shaft. Preferably the shaft is rotated at a relatively slow speed to avoid creating an excess amount of turbulence in the contactor tank.

The tank **11** is provided with appropriate inlets and outlets to control the flow of the various solution through

the tank. Specifically, as shown, there is an inlet **18** in the upper portion of the tank at one end thereof and an outlet **19** at the other end of the tank in the upper portion. In the lower portion of the tank there is an inlet **20** at one end and an outlet **21** at the other. It is preferred that the solution in the lower portion of the tank flows countercurrent to the solution in the upper portion of the tank. Therefore, appropriate pumping means such as pumps **23**, **24** are provided to direct the flow of the solutions in the desired directions.

The preferred disk **16** as illustrated in FIG. 2 is basically a flat circular member with a plurality of pie shaped sections removed. Hence, the disk has a plurality of rather wide, arcuately spaced spokelike members **17** extending radially outward from a hub **25**. The purpose of having the disk in this configuration is to provide a sufficient space between the spokelike members **17** to allow liquid to flow longitudinally through the tank as the disks are being rotated. It is important that the width of the space between the spokelike members is sufficient to prevent filming over by the liquids or solutions being treated.

An alternate disk **30** is illustrated in FIG. 3. In this disk a plurality of arcuately spaced members **31** extend radially outward from a hub **32** and form therebetween radial slots **33**. The disks **30** have the advantage of having a more uniform width throughout their length and thereby allow for a greater amount of liquid to flow at the radially inner portion of the disk members as compared to disk **16** while also providing more surface area on the disk for use as a transfer agent. The disks **16** tend to break up any filming over of the solutions more quickly than the disks **30** and, hence, are preferred for use with more viscous solutions.

In operation, the two immiscible liquids or solutions are pumped through the two-phase contactor tank in their different strata. As the shaft **14** rotates, the disks **16** are wetted by the solution containing the component to be transferred. As the wetted disk moves through the second solution the component is transferred to the second solution in which it is more soluble than the first solution. The second solution is then removed from the tank through the outlet and the component separated therefrom.

To effectively carry out the transfer of a component from one solution into the second solution, the material of the disk has to be carefully chosen so that it is only wettable by the solution containing the component to be transferred. Furthermore, the second solution is not only insoluble in the first solution, but is also of substantially different density so that it is easily separated from the first solution. Also, the component has to be more soluble in the second solution than the first solution so that the component will transfer from the first solution to the second as the disks rotate through the second solution. The disks are rotated at relatively slow speeds to avoid creating excessive turbulence which creates stable emulsions which in turn prevent complete separation of the solutions after transfer of the component.

Experimental work has shown that materials such as polymerized fluorcarbon and polymerized acrylic have unique characteristics which make them wettable by one solution and not by another. It has been further found that the roughing of the surface of these materials affects the amount of liquid that they will pick up in either phase. As an example, in a contactor used as an extractor between an aqueous solution and an organic solution such as hexane, a polymerized acrylic disk will be wetted by the aqueous solution and transfer a component of this solution to the organic solution. Hence, for each particular application the material of the disk has to be chosen

after consideration of the materials being treated, the direction of transfer, and the component to be transferred.

Another use of the two-phase contactor in connection with two immiscible liquids is a heat transfer device. This is accomplished by the disks as they rotate through a solution to pick up the hotter liquid and pass it through the cooler liquid whereby the cooler liquid picks up heat from the hotter liquid. The hotter liquid remains separate from the cooler liquid because of the differences in densities and solubility between solutions. Of course, the process could be reversed so that the cooler liquid is more wettable than the hotter liquid and thereby will be picked up by the disk and passed through the hotter liquid so as to cool that liquid.

Although but two embodiments of this invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications can be made herein without departing from the spirit of the invention or from the scope of the appended claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An apparatus for contacting first and second immiscible liquids comprising: an elongated tank having its longitudinal axis generally horizontal, a shaft extending longitudinally of and rotatably mounted in said tank, means for rotating said shaft, a plurality of disks wettable by said first liquid and not wettable by said second liquid mounted on and axially spaced along said shaft and positioned within said tank, means for introducing said first and second liquids near opposite ends of said tank, means for conducting said first and second liquids in countercurrent relation through and for withdrawing them near opposite ends of said tank, said disks having arcuately spaced radially extending members in planes perpendicular to the axis of said shaft protruding to the outer periphery of the disks and forming generally V-shaped slots therebetween, the width of said slots being

sufficiently large to prevent said liquids from filming over between adjacent radially extending members.

2. The apparatus of claim **1** in which the slots in said disks have substantially uniform width in an arcuate direction along substantially their entire radial dimension.

3. A liquid-liquid contacting process comprising the steps of flowing through an elongated vessel a first liquid having a component to be extracted, flowing through said vessel in contact with and countercurrent to said first liquid, a second liquid immiscible with and of different density from said first liquid and in which said component is more soluble than in said first liquid, and rotating within said vessel, about an axis generally parallel to the interface between said liquids, disks which are wettable by said first liquid and are not wettable by said second liquid and having arcuately spaced, radially extending portions in planes perpendicular to said axis and radial slots therebetween of sufficient width to prevent said liquids from filming over between adjacent radially extending portions, said disks being rotated at a sufficiently slow speed to prevent formation of a stable emulsion of said first and second liquids.

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REUBEN FRIEDMAN, *Primary Examiner.*

J. DECESARE, *Assistant Examiner.*