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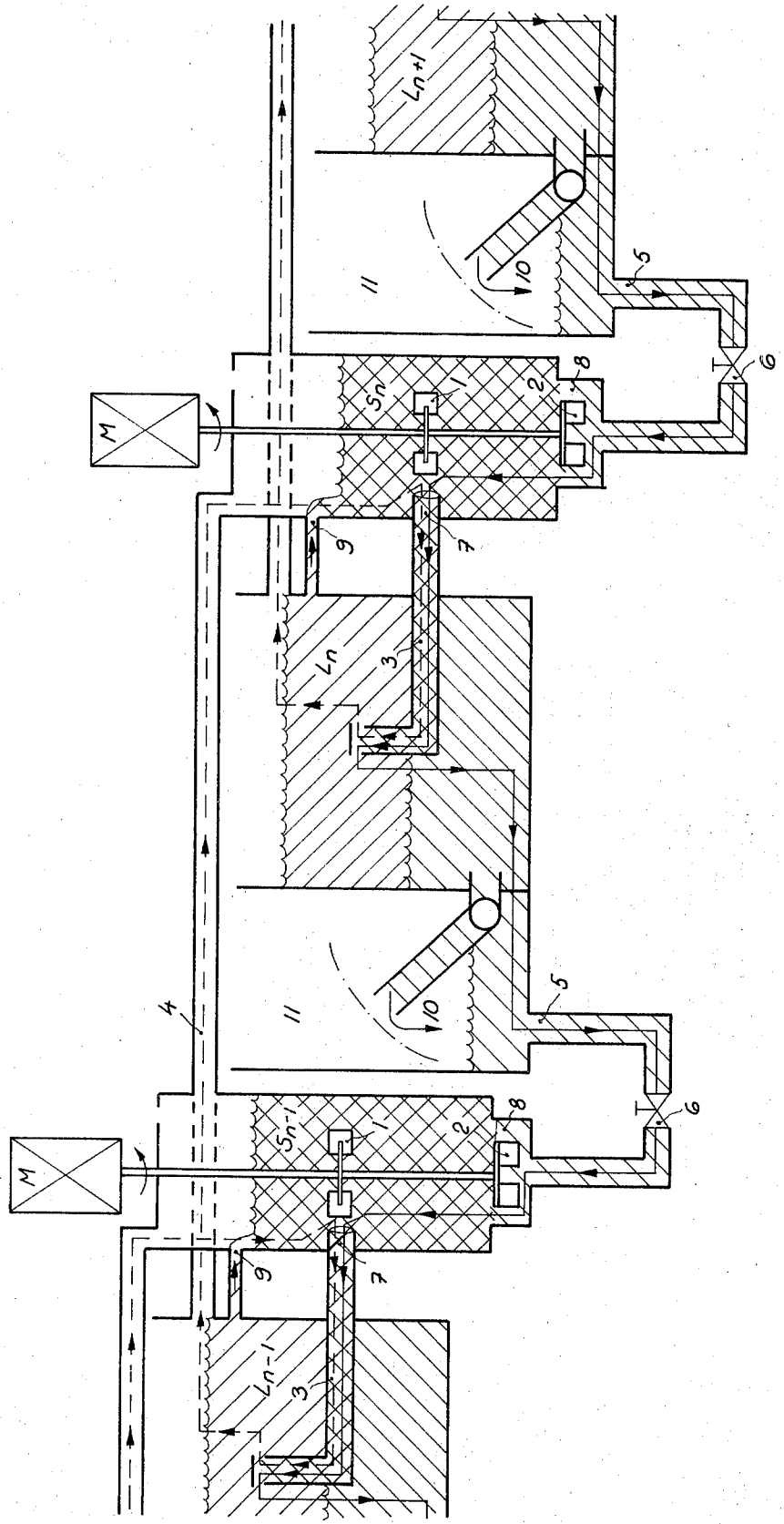

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METHOD FOR STARTING AND STOPPING A MULTISTAGE LIQUID-LIQUID EXTRACTION SYSTEM

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ABSTRACT OF THE DISCLOSURE

An extraction apparatus of the type described in our U.S. patent application Ser. No. 178,729 is stopped by closing the connection between the mixing space and its auxiliary space and mixing is discontinued, so that the dispersion cannot flow back into the auxiliary space; after the heavy and the lightweight phases have separated from each other in the mixing zone, the heavy phase in the lower part of the mixing zone is allowed to flow by its own weight into the auxiliary space by opening the connection between the mixing space and its auxiliary space, the level in which is kept considerably lower than the liquid level in the mixing zone during the operation, then the connection between the auxiliary space and the mixing zone is reclosed; and the extraction is started by first starting the mixing in the mixing zone while the connection between the mixing zone and the auxiliary space is carefully opened, and finally the feeding of heavy phase from the settling zone into the auxiliary space is started after the surface level of the heavy phase in the auxiliary space has lowered sufficiently.

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to a method and device for stopping and starting an extraction apparatus and specifically to a method for stopping and starting an extraction apparatus of the type introduced in the U.S.A., patent application Ser. No. 178,729.

Description of the Prior Art

U.S. patent application Ser. No. 178,729 describes an extraction apparatus for extraction according to the counter-current principle. This apparatus contains several stages and each stage includes a settling tank, a mixing chamber, and an auxiliary space. The lower part of the settling tank is connected to the auxiliary space with a regulatable overflow pipe along which heavy phase is fed as an overflow into the auxiliary space and from there further into the mixing chamber provided with a mechanical mixer for mixing into a dispersion the light-weight phase emerging from the settling tank of the preceding stage and the heavy phase pumped from the auxiliary space; the dispersion is fed into the settling tank of the same stage through a head pressure pipe. The mixer and the pump of the mixing chamber have been advantageously mounted on the same vertical shaft. When pumping and mixing must for some reason be interrupted, the heavy and the lightweight phases separate again from each other in the mixing chamber. The heavy phase settles at the bottom of the mixing chamber and the lightweight phase on top of it. If mixing is now continued from this situation, a so-called false dispersion is formed in which drops can be created from a phase which is not meant to be the drop phase. The settling properties of such a false dispersion are usually considerably poorer than those of a true dispersion which is formed in the mixing chamber when the apparatus is in operation and in a steady state.

The object of the present invention is to provide a method for stopping and starting an extraction apparatus which contains several preferably vertically stepped extraction stages in series, each consisting of a mixing zone, a settling zone, and an auxiliary space into which heavy phase is fed from the lower part of the settling zone and from which it is further fed into the mixing zone. Lightweight phase, again, is conducted into the mixing zone from the settling zone of the preceding stage in order to mix it with the heavy phase and to pump the formed dispersion into the settling zone of the same stage. The object is also to provide an extraction apparatus for counter-current extraction, an apparatus which can be stopped and restarted without danger of forming any false dispersion after the restarting. The stopping and starting of the apparatus can also be achieved with considerably greater freedom than in the multiphase mixer-settler apparatuses, to which the starting device here described has not been applied.

SUMMARY OF THE INVENTION

According to the invention the extraction apparatus is stopped by (a) closing the connection between the mixing space and its auxiliary space and mixing is discontinued, so that the dispersion cannot flow back into the auxiliary space; after the heavy and the lightweight phases have separated from each other in the mixing zone, the heavy phase in the lower part of the mixing zone is allowed to flow by its own weight into the auxiliary space by opening the connection between the mixing space and its auxiliary space, the level in which is kept considerably lower than the liquid level in the mixing zone during the operation, then the connection between the auxiliary space and the mixing zone is reclosed; and (b) the extraction is started by first starting the mixing in the mixing zone while the connection between the mixing zone and the auxiliary space is carefully opened, and finally the feeding of heavy phase from the settling zone into the auxiliary space is started after the surface level of the heavy phase in the auxiliary space has lowered sufficiently.

DESCRIPTION OF THE DRAWING

The enclosed figure shows a schematical cross-sectional side view of a part of the extraction apparatus comprising the improvement of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In this apparatus, each step or stage consists of three separate or partitioned chambers, namely, mixing chamber S, settling chamber L, and auxiliary space **11**. The different stages have been indicated with subindices $n-1$, n, $n+1$, etc. The lower part of settling chamber L has been connected to auxiliary space **11** with overflow pipe **10**, which has been fitted into auxiliary space **11** and which can be regulated in the vertical direction so that the overflow stops completely when the end of the pipe is at its highest position. The regulating margin required by the pipe downwards from this highest position is determined by the spacing of the stages and the desired level of the interface between the heavy and the lightweight phases in the settler. The lower part of auxiliary space **11** has been connected to the lower part of mixing chamber S with overflow pipe **5** provided with valve **6**. Mixing chamber S also contains a vertical shaft rotated by motor M. At the lower part of the shaft there is heavy phase pump turbine **2** in pump box **8** and in the middle of the shaft, mixer **1** which moves the dispersion along head pressure pipe **7** in front of the mixer and dispersion pipe **3** into settling chamber L. Number **9** refers to the lightweight phase return pipe fitted between settling chamber L and mixing chamber S, and **4** indicates lightweight phase overflow pipe from settling chamber L into the upper part of mixing chamber S of the following phase.

In the drawing the lightweight phase has been indicated with ruling slanted to the left and the heavy phase with ruling slanted to the right. Lightweight phase flows from settling chamber L_{n-1} along overflow pipe **4** into mixing chamber S_n of the following phase and from there further under the influence of mixer **1** through head pressure pipe **7** and dispersion pipe **3** into settling chamber L_n, where the lightweight phase separates again into a separate phase, etc. The heavy phase flows counter-currently in relation to the lightweight phase. The heavy phase separated at the bottom of settling chamber L_{n+1} is fed into auxiliary space **11** through overflow pipe **10**, which has been connected to the lower part of settling chamber L_{n+1}, turns on the vertical plane, and is thus regulatable in the vertical direction. From auxiliary space **11**, heavy phase is pumped into mixing space S so that the surface level in auxiliary space **11** is considerably lower than in mixing chamber S_n into which heavy phase flows through pipe **5**. The pumping effect is created with pump turbine **2** fitted in the pump box at the bottom of mixing chamber S_n, and mixing of the heavy phase with the lightweight phase is achieved with mixer **1**, whereafter the dispersion is fed into settling chamber L_n, where the heavy phase again separates into its own phase, etc.

In this apparatus, each stage has been provided with auxiliary space **11**, the volume of which and the height at which it is placed must be such that it can receive all heavy phase settling in the settler after the stopping when valve **6** is opened. In each auxiliary space **11**, which the heavy phase of the preceding phase enters along overflow pipe **10**, it is possible to regulate the height of this overflow pipe. From auxiliary space **11** the heavy phase is fed into the lower part of mixing space S separate from the lightweight phase, which enters mixing space S from above or in the middle. Because of its greater density the heavy phase flows into mixing space S even without any pumping, but in this modification pump turbine **2** is used at the bottom of the mixing space; under normal operating conditions the pump turbine keeps the level in auxiliary space **11** considerably lower than the level in mixing space S. From mixing space S the dispersion can be fed directly into settling space L along pipe **7**, **3**. It is also possible to create the flow without auxiliary devices, owing to a rise in the center of gravity in mixing space S. However, when it is desired that the level of settling space L of the same stage is higher than the respective level of mixing tank S, head pressure pipe **7** or the like is used near the mixing turbine. Keeping the level in settler L higher than the level in mixing tank S makes it possible to return lightweight phase back into mixing tank S of the same phase and to change the phase proportions in mixing chamber S independently of the entering flows of the entire extraction apparatus. The advantage thus gained is that the desired dispersion can be kept in mixing chamber S, usually with the heavy phase in drops and dominant and stable. Head pressure pipe **7** or a corresponding device makes also possible an inner circulation of the heavy phase; the circulation may be needed to create more advantageous settling properties.

The considerable advantage gained by keeping the level in auxiliary space **11** continuously much lower than the level in mixing tank S is connected with the starting and stopping of the apparatus. When mixer S is stopped, valve **6** in pipe **5** between mixing tank S and auxiliary space **11** is closed simultaneously and, if necessary, the overflow pipe in auxiliary space **11** is raised so that there is no further flow into auxiliary space **11** from the preceding settler, and after a while the dispersion has separated into two phases in the mixing tank, at which time valve **6** can be opened into auxiliary space **11** and the heavy phase can be drained entirely from mixing space S.

When the extraction apparatus is restarted, valve **6** is first kept closed and then opened slowly, which eliminates the formation of a false dispersion.

Th following advantages are gained with an extraction apparatus according to the above structure:

The stages are hydraulically independent of each other.

The capacity of the apparatus is independent of the densities of the liquids and the variations of the densities.

Even when extracting so-called difficult solutions, it is possible to easily interrupt the extraction and restart it without the phase inversion characteristic of most other apparatus structures.

No separate control devices, except for the control pipe for the interface in the mixing space, is needed.

Outside pumps and pumps driven by other than the mixer motor are not needed.

Because the efficiency of the pump turbine at the bottom of the mixing tank and thereby its lifting height and the volume flow caused by it can be regulated by raising or lowering the pump turbine, exactly the same apparatus can, especially when there is a slight gradation from one phase to another, be used for the extraction of all those solutions which do not form stable emulsions and which can in general be settled with normal gravity without interfering with the basic dimensioning of the apparatus.

What is claimed is:

1. A process for the countercurrent extraction between a heavier liquid and a lighter liquid comprising a plurality of horizontally displaced extraction stages, each stage comprising a mixing zone, a settling zone and an auxiliary zone, said auxiliary zone being disposed between each settling zone and the mixing zone of the preceding extraction stage, and in which the lighter liquid is conveyed from the settling zone to the mixing zone of each subsequent extraction stage, which process requires occasional stopping and restarting, which comprises the steps of:

(a) introducing the heavier liquid from the lower part of the settling zone of one extraction stage into the auxiliary zone of the same stage and introducing said heavier liquid from said auxiliary zone into the mixing zone of the preceding stage,

(b) introducing the lighter liquid from the upper part of the settling zone of each extraction stage into the mixing zone of the following extraction stage in order to mix with the heavier liquid to form a dispersion,

(c) pumping the formed dispersion from said mixing zone into the settling zone of the same extraction stage,

(d) keeping the liquid level in each auxiliary zone lower than the liquid level in the mixing zone of the next preceding stage during the extraction process,

(e) closing the connection between the mixing zone and the auxiliary zone and discontinuing mixing so that the heavier and the lighter liquids separate from each other in the mixing zone and the extraction process is stopped,

(f) opening said connection between the mixing zone and the auxiliary zone so that the heavier liquid which has separated in the mixing zone can flow by its own weight into said auxiliary zone, until only the lighter liquid remains in the mixing zone,

(g) reclosing the connection between the mixing zone and the auxiliary zone,

(h) restarting the mixing in the mixing zone and reopening the connection between the mixing zone and the auxiliary zone

(i) when the level of the heavier liquid in the auxiliary zone has returned to a level substantially lower than in the mixing zone, introducing said heavier liquid from the settling zone into the auxiliary zone and carrying out normal operations as in steps (a) through (d),

(j) said auxiliary zone being of such volumn that it is capable of receiving all the heavy liquid which has

settled in the mixing zone of the next preceding stage after step (e) and

(k) said auxiliary zone being so located with respect to the mixing zone that said heavier liquid in said step (f) flows to the auxiliary zone due to the difference in hydrostatic pressure.

2. The method of Claim **1**, characterized in that part of the lightweight phase of the settling zone is returned to the mixing zone at a point which is above the outlet for the dispersion.

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