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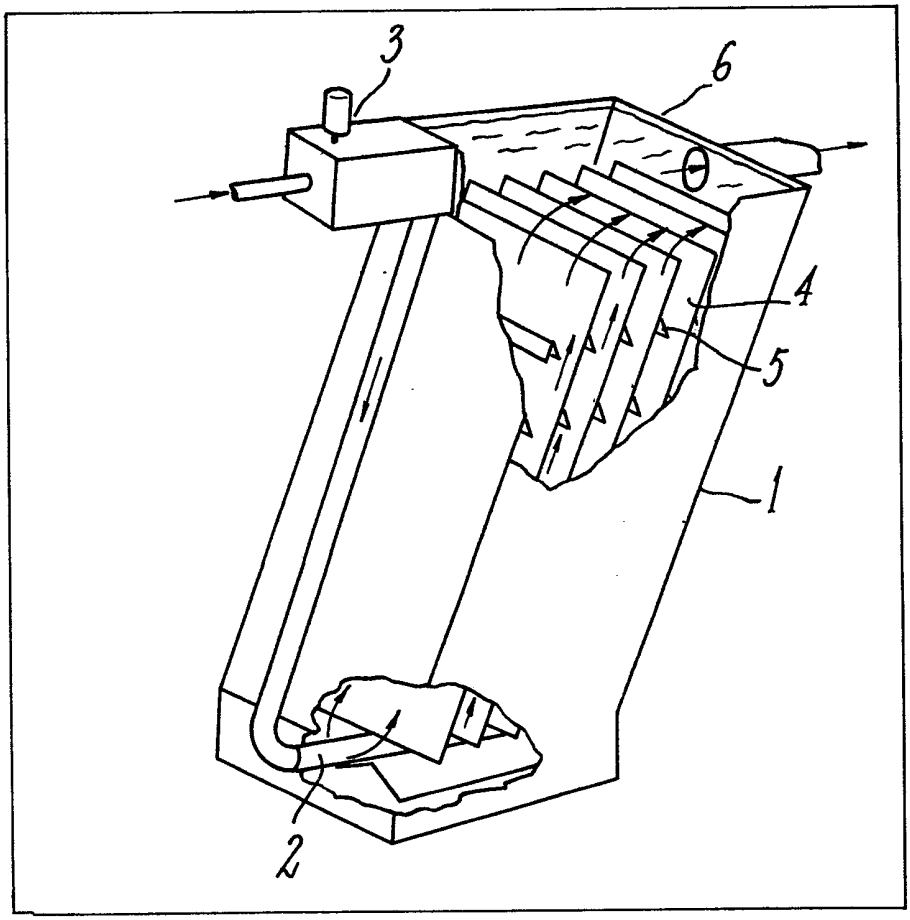
(54) **Mixing fluids**

(57) Apparatus for mixing fluids under a relatively moderate velocity gradient, comprising an enclosure 1 of parallelipipedic configuration having a rectangular configuration, in which the fluids to be mixed flow from bottom to top, and an internal series of parallel plates 4 inclined to the horizontal and supported by triangular-sectioned angle bars 5 having an open base directed towards the lower portion of the enclosure, characterised in that the triangular sectioned angle-bar supports have a vertex angle in the range of 30° to 70° and that the parallel plates supported thereby are inclined to an angle of about 60° to the horizontal.



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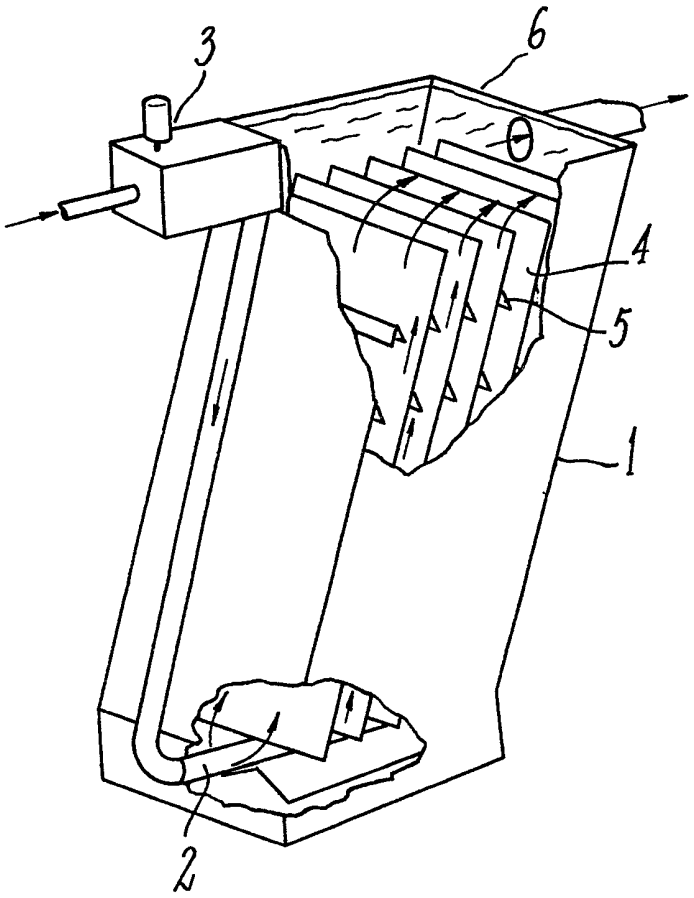
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SPECIFICATION

Improvements in or relating to apparatus for mixing fluids under moderate velocity gradient

The present invention relates to an apparatus for accomplishing any low-speed mixing operation involving at least two fluids.

This apparatus is applicable notably to catalysis, coalescence and precipitation operations, notably to the flocculation of water preliminary to its subsequent treatment by decantation, flotation and filtration.

In the treatment of consumption water or industrial water intended for various manufacturing processes, the raw water generally before the decantation or flotation, undergoes firstly a coagulation treatment and then a flocculation with the addition of reagents for the purpose of forming with the particles in suspension and the colloidal substances an easily separable flock with a view to promote the subsequent decantation or flotation process. A proper coagulation requires a fast mixing of the raw water with the reagents and modifies the very state of the colloidal particles. The subsequent flocculation of these colloidal particles with the solid particles in suspension is carried out by mixing at low speed the coagulated water and the flocculation reagents.

The coagulation is accomplished in a fast operating mixer and the flocculation is performed either in the lower portion of the decanter proper or in a separate apparatus called flocculator which is a mixing chamber into which the raw water previously mixed with the coagulation - flocculation reagents, issuing from the fast reactor and of which the mixing with the flocculation reagents is continued at low speed, is introduced. In order to increase the probability of mutual contact between the coagulated particles and the flock being formed, it is essential to stir the coagulated water both slowly and homogeneously.

Known flocculators used in the prior art comprise stirring means such as blades or propellers. Blade flocculators consist essentially of tanks provided with horizontal or vertical blades rotating at a slow rate yet sufficient to prevent the accumulation of sediments on the tank bottom. A plurality of blades may be secured to a common horizontal shaft rotatably driven by a motor. The linear speed of each blade is proportional to the distance from this blade to the axis of rotation and may thus vary for a same velocity of rotation. This rotational velocity is kept within certain moderate limits in order to avoid breaking the previously formed flock and permit a gradual increment in the flock size; however, it is difficult to set this velocity at the proper value.

The resulting flocculation is a diffused flocculation in which the concentration of the suspended matters is that of the raw water incorporating the coagulation - flocculation reagents.

Propeller-type flocculators are more elaborate apparatus comprising essentially tanks provided with one or a plurality of propellers producing a whirling motion in the water and reagent mass in order properly to stir same. The energy dissipated in the tank is the same at any distance from the axis of rotation of the propeller, but the whirling motion thus created makes it extremely difficult to exert a proper control of the contact between the coagulated particles and the flock. The contact times are relatively long and it is hardly possible to produce a flock re-circulation.

Moreover, the known apparatus, whether of the blade or propeller type, comprising one or more members movable in a water medium, tend to become the seat of considerable corrosion, entailing relatively frequent breakdowns. On the other hand, their power consumption is far from negligible.

With the present invention it is possible to obtain a flocculation, the separation between the resulting flock and the water medium being accomplished during a later stage and in another apparatus, by decantation or flotation. Thus, the inconveniences characterising known flocculators are safely avoided. In fact, with the apparatus of this invention the contact time between water and reagents is particularly short, and consequently the over-all dimensions of the apparatus are minimized. Besides, any risk of corrosion is safely precluded ant the power consumption is reduced to zero.

The apparatus according to this invention is free of the inconveniences characterizing known flocculators and performs a particularly efficient flocculation.

In addition, since the water and reagent contact time is extremely short in the apparatus of this invention, the general dimensions of the apparatus can be reduced considerably.

The apparatus according to this invention is characterized essentially in that it comprises a parallelipipedic enclosure of rectangular cross-sectional configuration, in which the fluids are caused to flow upwardly; this enclosure comprises an internal series of parallel plates advantageously inclined to an angle of about 60° to the horizontal and supported by means capable of imparting a whirling motion to the mixture to be obtained.

According to a specific form of embodiment of this invention, these last-mentioned means comprise triangular-sectioned supports such as angle-bars having a vertex angle advantageously within the range of 30° to 70°, with an open base directed towards the bottom of the enclosure.

These supports or angle-bars consisting of a corrosion resistant material selected from known and suitable metal alloys or plastics are secured to one another and to the walls of the enclosure by welding, sealing or bolting; in a preferred arrangement according to this invention and in the case of relatively thin plates (<2 mm), the plates are secured to the angle bars by means of a snap-fitting device such as a pawl or tongue, or dome-fastener, or snap insert device.

Reference will now be made to the single Figure of the accompanying drawing illustrating diagrammatically by way of example, in perspective view with parts broken away, a typical form of embodiment of the apparatus of this invention.

The coagulated water to which the flocculation reagents have been added is introduced into the

mixing enclosure 1. In this example, the enclosure 1 consists of a parallelipipedic chamber having a square cross-section, and the water and reagent mixture is introduced into the power portion of this chamber by means of a quick-action mixer 3 through a conduit 2.

The coagulated water and flocculation reagents mixing operation takes place as the water circulates upwards through the series of parallel inclined plates 4. These plates 4 are secured to supports consisting according to the present invention, of angle bars 5 having their vertex angles within the range of 30° to 70° and open bases directed towards the lower portion of the enclosure. With the arrangement according to this invention, namely the provision of supporting angle-bars disposed as shown in the Figure, a whirling motion is imparted to the mixture circulating in the enclosure, thus promoting considerably the mixing action exerted thereon. Another advantage resulting from this arrangement is that the plates 4 can be inclined to a relatively pronounced angle to the horizontal, for example and preferably of the order of 60°, so that the flocculation produced in the apparatus is particularly efficient and affords a substantial reduction in the contact time between the water and the reagents, thus minimizing the over-all dimensions of the apparatus.

EXAMPLE 1

A same water having 29 FTU (Formazin Turbidity Units, which is the international turbidity unit), pH = 7,6, containing 3,7 mg/liter of organic substances measured by its oxidability to $KMnO_4$ is treated in an acid medium, and at a temperature of 14,5°C, in a propeller-type mixing enclosure and in a mixing enclosure according to this invention. The rated water output was 56 cubic meters per hour.

The mixing enclosure according to this invention has a square cross-section, each side measuring 1,65 m, and a height of 2,5 m, and comprises an internal series of 9 parallel plates set at an angle of 60° to the horizontal and each supported by four angle bars spaced 0,60 m from each other and disposed horizontally; these bars have a vertex angle of 60° and an open base directed towards the bottom of the enclosure. The velocity of the upward flow of the mixture is 20 m/h. The following reagents are utilized;

55 g/m³ of Al sulphate, and

1 g/m³ of an alginate sold under the Trade Name "Aqualgine S.A.".

After a 6-minute contact period, the flocculated water was decanted.

After a 5-minute decantation, a 58% reduction of the organic substances was obtained.

After 10 minutes of decantation, the organic substance reduction was 64,9%.

In a propeller-type enclosure, for a same rated output of 56 m³/h, the same water and the same amounts of reagents, after a contact time of 30 mn, the flocculated water was decanted and the following results have been recorded:

After 5 minutes: a 32 percent reduction of the organic substances.

After 10 minutes: a 40,5 percent reduction of the organic substances.

The power consumption of the propeller enclosure was 375 watts.

The results obtained are summarized in the following Table:

		Propeller Flocculator	Plate Flocculator
Contact time		30 mm	6 mn
Power requirement		375 Watts	0
Raw water plus Reagents	FTU turbidity	29	29
	pH	7,6	7,6
	Organic substances (H^+ medium)	3,7	3,7
Decanted water	after 5 minutes: FTU turbidity	4	1,3
	after 5 minutes: Organic substances (H^+ medium)	2,5	1,55
	after 5 minutes: Reduction %	32	58
	after 10 minutes: FTU turbidity	2	0,8
	after 10 minutes: Organic substances (H^+ medium)	2,2	1,30
	after 10 minutes: Reduction %	40,5	64,9

EXAMPLE 2

As in Example 1, a raw water having a pH = 7,16, a 31 FTU turbidity and containing 6, 7 mg/liter of organic substances measured by its oxidability to $KMnO_4$ was treated in an acid medium in a propeller-type enclosure and in a mixing enclosure according to the invention, respectively. The rated water output was 7 m³/hour. The mixing enclosures were disposed ahead of a flocculator.

The mixing enclosure according to this invention had a square cross-section having 60-centimeter sides and a height of 2 m, and comprised six 35 mm

angle bars supporting three inclined plates.

In the propeller enclosure, the following substances were added to the raw water:

90 g/m³ of Al sulphate;

1 g/m³ of "Aqualgine S.A.", and

10 g/m³ of Na OH.

In the enclosure according to this invention, the following substances were added to the raw water:

60 g/m³ of Al sulphate;

0,9 g/m³ of "Aqualgine S.A.", and

8 g/m³ of NaOH.

After 8 minutes of contact in the mixing enclosure according to this invention and 45 minutes of contact in the propeller enclosure and flottation of the flocculated water effluent, the reduction in the organic substance contents was 64,2% in the propeller enclosure and 67,2% in the enclosure according to this invention. The turbidity changed from 31 to 1,5 FTU and from 31 to 0,8 FTU, respectively, and the oxidability changed from 6,7 to 2,6 mg/litre and from 6,7 to 2 mg/litre, respectively

The propeller enclosure was equipped with a propeller dissipating 0,5 kW.

CLAIMS

1. Apparatus for mixing fluids under a relatively moderate velocity gradient, comprising an enclosure of parallelipipedic configuration having a rectangular configuration, in which the fluids to be mixed flow from bottom to top, and an internal series of parallel plates inclined to the horizontal and supported by triangular-sectioned angle bars having an open base directed towards the lower portion of the enclosure, characterised in that the triangular sectioned angle-bar supports have a vertex angle in the range of 30° to 70° and that the parallel plates supported thereby are inclined to an angle of about 60° to the horizontal.

2. Apparatus according to claim 1, characterised in that the plates and their supports are secured to one another by means of snap-action fittings or inserts.

3. Apparatus substantially as described hereinabove with reference to the accompanying drawing.

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