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ULTRASONIC DEGASIFYING DEVICE

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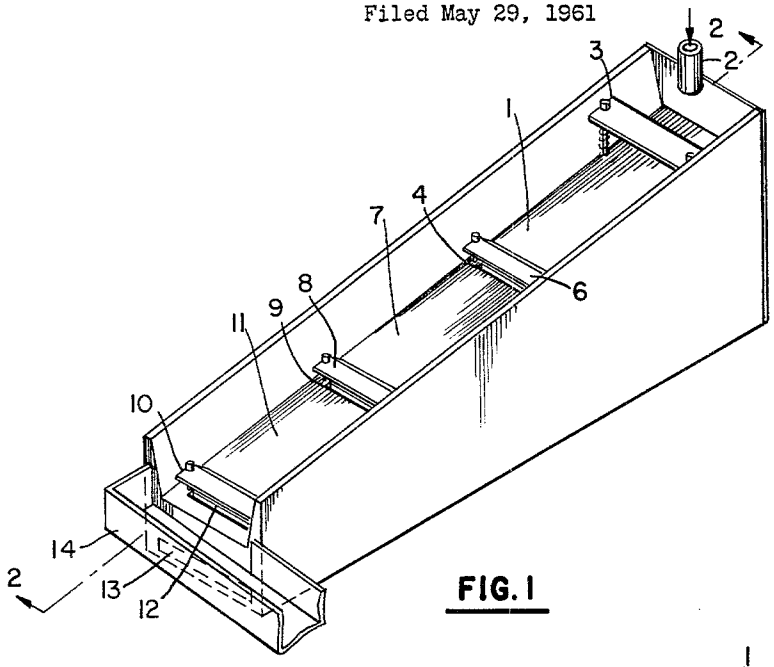


FIG. 1

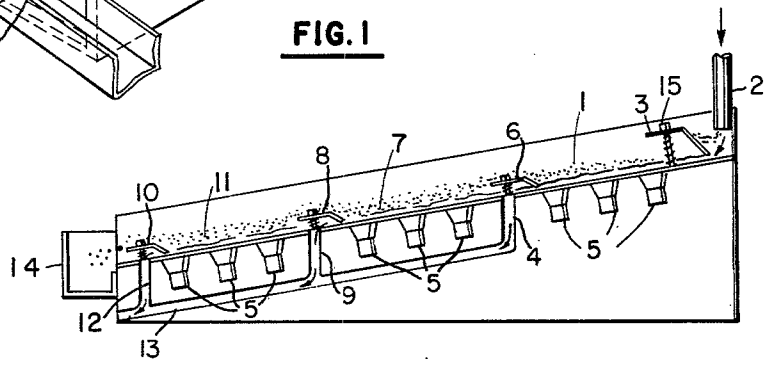


FIG. 2

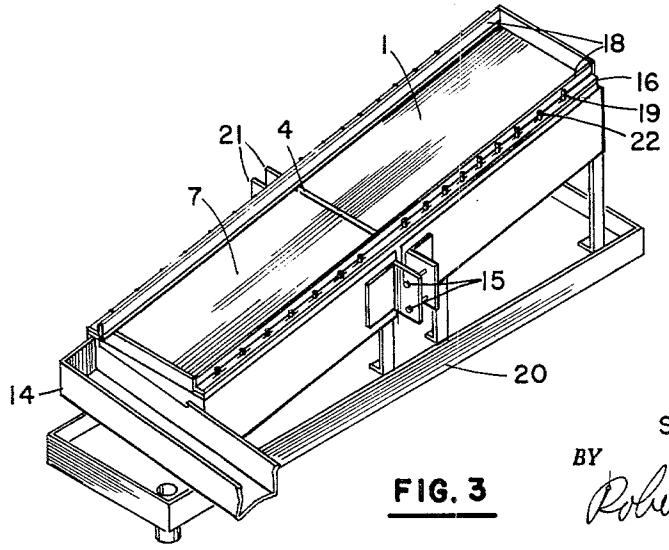


FIG. 3

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ULTRASONIC DEGASIFYING DEVICE

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This invention relates to an improved device for the sonic deaeration of liquids.

Removal of air or other dissolved gases in liquids presents a problem which is frequently encountered in industry. It has been found that dissolved gases can be liberated by subjecting the liquid to intense sonic vibration either in the audible or ultrasonic range and preferably in the latter. However, the use of sonics has encountered some practical difficulties of which two are especially significant. The first problem arises that the efficiency of degasification will vary greatly with the dimensions of the liquid layer exposed to the sonic vibrations. Thus, for example, a very deep layer is difficult to degasify completely especially if viscous and where a reliable and reproducible degree of degasification is an important factor, the liquid dimensions become quite significant. The difficulties of a deep or thick layer, which have been appreciated for the first time and solved by the present invention, are not inconsistent with the general laws of sound transmission according to which whenever there is an interface between a denser liquid and a less dense one such as a gas the great difference in acoustic impedance results in a reflection of a substantial portion of the sonic energy. Another factor in some instances and even more important factor results from the fact that in many liquids or liquid emulsions coalescence of bubbles of gas may produce foaming and this production of froth, which is sometimes uncontrolled, presents a serious limitation on the utility of sonic degasification with many liquid media. Other practical drawbacks have been encountered, namely efficiency of degasification, that is amount of liquid which can be treated per unit time, per unit of sonic energy, and the undesirability of using batch processes in many cases.

According to the present invention the difficulties which have hitherto stood in the way of wide scale efficient sonic degasification are completely removed. Essentially in the present invention the liquid to be treated runs down an inclined container in the form of a chute and means are provided, preferably adjustable weirs, which dimension accurately the thickness of the liquid layer flowing down the container. It is thus possible to flow the liquid medium rapidly in a layer of definitely and accurately controlled thickness and produce a high output continuously as the thickness of the layer can be adjusted and maintained at the optimum for the sonic power employed and frequency thereof. In other words the output per unit of treatment area and per unit of sonic energy is markedly increased and is maintained at an optimum figure continuously and reliably.

The increased efficiency which is obtained with the controlled layer operation and in an inclined container, which for brevity will be referred to throughout the specification as a chute without however connoting any particular proportion of width to thickness of layer, is always obtained when the present invention is used. In addition when frothing is a problem the weirs of the present invention, which are the preferred liquid layer thickness controlling means, also prevent interference by reason of froth or foam. This froth may either be held back or caused to overflow the top of the weir and removed in a launder or by other suitable means for further treatment such as froth settling and repeated sonic degasification or for other purposes. When the frothing is very severe, which may occur with some emulsions, such as latices, it

is desirable to break up the chute by a series of intermediate weirs with the intermediate discharge of degasified liquid. The froth overflowing the weir can then be directed onto the next portion of the chute and subjected to further treatment. This separation into a plurality of zones with a plurality of weirs or slots makes this invention applicable to the solution of degasification problems with extreme frothing which might not be satisfactorily handled with a single chute which would have only two weirs, one at the top to determine layer thickness and one at the bottom to separate froth.

As in many industrial processes the best compromise will be chosen between additional equipment or equipment complexity and the problem of handling different materials. Thus for a liquid which is to be degasified but presents little or no froth problem the chute can effectively be used in the form of a single zone which lends itself to very cheap and simple production and presents an economy in first cost. However, when the excessive frothing renders such a simple modification of the present invention insufficient the chute can be broken up into as many zones as are required by the problem.

Reference has been made above to solution of the frothing or foaming problem as overcoming a disadvantage or drawback which has hitherto interfered with sonic degasification of many liquids or liquid systems. This is not necessarily the case. There are certain operations such as froth flotation in which the production of a foam or froth and its separation from the rest of the liquid is desired. The present invention can be used in such instances where the liquid medium contains sufficient dissolved gases so that an adequate froth can be produced. Of course in such cases small amounts of frothers and the usual froth flotation collectors for different minerals are utilized. For many froth flotation operations frothing by sonic degasification is more expensive than by simple means such as mechanical flotation machines or air machines. For such flotations the present invention does not present any attractive economic picture. However, in froth flotation where a very fine separation is required and particularly where slimes present a serious problem or where the ore had to be ground to an extremely small size to liberate the desired values, as in the case in some cement rock beneficiations, very small froth bubbles produce improved results and in such cases the present invention presents advantages Also the violent sonic vibrations tend to keep extremely fine particles or slimes from agglomerating and this is sometimes of such serious consequence that ordinary froth flotation has only been useful when the ore has been subjected to extensive and sometimes expensive pretreatment such as elaborate desliming. The agitation also causes flotation chemicals to disperse uniformly even though they may have low solubility. With ores where the above problems are serious the present invention is useful as the additional cost of producing the foam by sonic vibrations is more than offset by the improved result obtained. Therefore, the present invention should not be considered as limited to operations where the foam or froth is an unavoidable and undesired phenomenon and includes also such operations where the production of a froth is actually desired.

It is an advantage of the present invention that it does not require any special type of sonic driver but the driver must be able to operate over wide domain. Thus the driving units may be piezoelectric transducers, for example those using ceramics with metal loading blocks to permit a more extended surface of contact with the chute, or any other suitable type of sonic transducer may be employed whether of the piezoelectric, magnetostrictive or other types. The only requirement is the obvious one that the nature of the transducer employed must be

suitable for the frequency desired and for the loading applied by the chute and its liquid layer. Good sonic practice should, of course, be followed so that an efficient transfer of input power into sonic vibrations is obtained. Otherwise, however, the present invention is not concerned at all with particular designs of sonic transducers and in the more specific description below in connection with the drawing these transducers will be shown in purely diagrammatic form.

Reference has been made above to a wide range of frequencies either in the audible or ultrasonic range. This is not to say that all frequencies are equally effective. The proper frequency should be chosen in connection with the characteristics of the liquid medium to be degasified. For most operations the ultrasonic frequencies, for example, from 20 to 50 kc., which does not annoy human beings, are preferred but the invention is not limited thereto and the best frequency will be chosen in each case in conjunction with the characteristics of the liquid medium such as its viscosity, acoustic impedance and the like. For some operations frequencies well into the audible range are useful.

The device of the present invention has been described in connection with problems where frothing is severe, or where it is essential to avoid the presence of froth in the degasified liquid even to a very small degree. With many liquids the requirements are not quite so stringent and in a number of cases a simpler construction serves the purpose adequately. Simplification may take place along two lines. The first is to use only a single zone which has been referred to above, and the second line which provides multiple zones involves simplification of thickness controlling means. Thus, for example, when a chute is divided into a number of zones by intermediate slots, through which discharge of clear degasified liquid can take place, it is not necessary that there be a weir or other means for separating froth from liquid at the beginning and end of each zone. It is sufficient that the slots be so dimensioned, by adjustable means if necessary, so that only a predetermined portion of the degasified liquid flows through the slot. In such cases it is possible to have a weir or other thickness adjusting means only at the beginning of the first zone and the end of the last zone. In fact, in an extreme case where the characteristics of the liquid are very favorable there may be only a weir or similar means at the top of the chute, any froth and degasified liquids being separated at the bottom end by a slot, the froth running over the lip formed by the end of the chute. In such a case there will sometimes be some waste of degasified liquid flowing over with the froth, and in certain cases a slight contamination as some of the froth may go down the slot at the end of the last zone. Where, however, the conditions of operations are such that this can be tolerated a cheaper device may be used.

Weirs have been referred to as the preferred means for maintaining an initial film thickness. For most purposes they constitute the preferred embodiment, but the invention is not limited thereto and other means such as precise inlet conduit control may be used. The essence of the invention is that the film or layer of liquid starting down the chute does not exceed a predetermined thickness. In multiple zone chutes, of course, the thickness will decrease down the chute as a portion of the degasified liquid escapes through the slots. This, however, is not objectionable because normally the problem is presented by a liquid layer which is too thick. Thinner layers can ordinarily be tolerated as the liquid goes down the chute and is degasified.

With heavily frothing liquids where it is not desired to utilize the froth itself defrothing or defoaming means may be employed such as a blast of sound vibrations in air striking the surface of the flowing liquid.

The invention will be described in detail in conjunction with the degasification of a stable latex which does not agglomerate under sonic vibrations but which does produce froth. The invention will also be described in conjunction with the drawings in which:

FIG. 1 is an isometric view of the chute with multiple zones providing for retreatment of froth;

FIG. 2 is a longitudinal section along the lines 2—2 of FIG. 1, and

FIG. 3 is an isometric view of a simplified apparatus without weirs.

A chute is shown in FIG. 1 divided into three zones 1, 7 and 11. Latex enters the top of the chute at 2 and is adjusted for thickness by the weir 3 and its positioning screws. The weir is adjusted so that a layer of predetermined thickness is produced in the first zone. All along the bottom of the chute are sonic transducers 5 which are shown diagrammatically as of a modern piezoelectric type and which operate at a frequency of about 22 kc. to avoid annoyance to human beings.

At the end of zone 1 there is another weir 6 and a slot 4 in the bottom of the chute. The clear layer of degasified latex flows across the slot and a predetermined portion flows down, depending on the dimensions of the slot. The foam is kept from flowing down the slot by the weir 6 and the thinner layer of liquid, still carrying its foam, flows on through zone 7 which is terminated by another weir 8 with a slot 9. Finally the third zone is terminated by a weir 10 with a slot 12 permitting froth to overflow into a launder 14. All of the slots communicate with a common collecting conduit 13.

In the second and third zones the overflowing froth is further degasified and additional amounts of degasified liquid, including a degasified liquid which flows past the slots separating the zones, is removed through successive slots 8 and 12 at the end of zones 7 and 11. As has been pointed out above the layers become thiner in succeeding zones and the degasification which separates the froth into further degasified liquid and gas does not suffer from excessive losses of sonic energy by reason of the change of acoustic impedance at the bubble interfaces which severely limits operations in thick layers.

FIG. 3 illustrates a simplified form of apparatus the same elements bearing the same numerals. The apparatus is composed of two chambers which form the zones 1 and 7. No weirs are provided, the thickness of the layer at the top being controlled by inlet conditions. The chambers are provided with flanges 21 which carry bolts 15 permitting an accurate dimensioning of the slot between each pair of chambers. Instead of having rigid side walls, a layer 16 of soft material, such as rubber, extends along the sides. It is provided with slot openings 19 through which protrude studs 22. The slot openings 19 in the rubber wall should not be confused with the slots 4 in FIGS. 3 and 4, 8 and 12 in FIGS. 1 and 2 they perform a different function permitting adjustment of the slot 4 by moving the two portions of the chute to form the slots which separate the portions of the chute and which perform the entirely different function of removing degasified liquid. The purpose of the slots 19 is to permit adjustment of the slot 4 in FIG. 3 so that only degasified liquid will be removed without any significant contamination of froth. Substantially all of the froth and a small amount of the degasified liquid pass on to the second zone 7. On these studs is bolted a pair of walls 18. Adjustment of the screws 15 is only through a very short distance, ordinarily a fraction of an inch, and therefore there is sufficient room in the slots 19 so that the soft material 16 does not have to buckle excessively over the slots.

Degasified liquid flowing down through the slots between the containers is collected in the pan 20 and flows out at the bottom end. Any froth formed which overflows from the last zone is caught by a launder 14 of the same type as in FIGS. 1 and 2. The final slot for degasified liquid is formed between the last chamber and the launder in a manner similar to FIGS. 1 and 2.

The simplified construction shown in FIG. 3 is suitable primarily for liquids which do not foam to any serious degree, and this makes possible the elimination of froth controlling weirs. Two zones are shown in FIG. 3 but the number can be increased if desired by bolting on further chambers.

I claim:

1. An apparatus for degasification comprising in combination,

(a) an inclined chute having a bottom and side walls and means for applying high frequency sonic waves to the bottom of the chute,

(b) means for introducing a gasified liquid to be degasified onto the upper top of the chute,

(c) a first film forming weir means spaced above, across and within the chute at the upper end for directing liquid down the chute in a thin film,

(d) a plurality of discharge outlet slots extending along the length of the chute with each of said individual slots being transverse across the bottom of the chute, the last of said slots being located at the lower end of the chute,

(e) weir means spaced above, across and within the length of the chute preceding each slot defining a plurality of first narrow passage means across the length of the chute, said weir means extending over and beyond each of the slots to form a plurality of second passage means above the weir means, said plurality of first passage means removing degasified liquid flowing therethrough and down through the slots and the plurality of second passage means for removing foam flowing over the weir means into a zone on the chute defined between each slot and a next succeeding slot,

(f) means for collecting and removing degasified liquid flowing down through each of the slots, and

(g) means subsequent to the last slot adjacent the bottom of the chute to receive and remove foam overflowing the last of the second passage means.

2. An apparatus according to claim 1 in which the weir means are adjustable to define first passage means of varying dimensions between said weir means and the chute.

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