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Wastewater Treatment by Flotation

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ABSTRACT. The flotation is succesfully applied as cleaning method of the wastewaters refineries, textile fabrics (tissues), food industry, paper plants, oils plants, etc. In the flotation process with air released, first of all the water is saturated with air compressed at pressures between 0,3 – 3 bar, followed by the relaxed phenomenon of the air-water solution, in a flotation cell with slowly flowing. The supersaturation condition could be applied on the wastewaters treatment. In this case the wastewaters which is in atmospheric equilibrum is introduced in a closed space where the depresion is 0,3 – 0,5 bar. Our paper presents the hypobaric flotation cell and the technological flow of the cleaning the domestic wastewaters.

ПРЕЧИСТВАНЕ НА ОТПАДНИ ВОДИ ЧРЕЗ ФЛОТАЦИЯ
РЕЗЮМЕ: Флотацията успешно се използва като метод за очистване на отпадъчни води от рафинерии, текстилни предприятия, предприятия на хранително-вкусова промишленост, производство на хартия и др. При флотационния процес с въздух, първо водата се насища с въздух под налягане от 0,3 до 3 bar, следва релаксация на разтвора от въздух и вода във флотационна камера с бавен поток. Условия на пренасищане могат да се прилагат към процеса на третиране на отпадъчни води. В този случай отпадъчните води, които са в равновесно състояние с атмосферата се поставят в затворено пространство, където депресията е 0,3 – 0,5 bar. Докладът представя флотационна камера с ниско налягане и технологична схема за очистване на битови отпадъчни води.

Introduction

In practice, the normal (natural) flotation process is different by the flotation with air. In the first case, the material particles lighter than the water (oils, greases) eventually associated with gas bubbles have the tendency to raise to the liquid stationary surface. In the flotation process with air, the material particles heavier than the water are transported to the liquid surface by attaching them with air bubbles.

In this case, the air could be introduced in water likes a very fine bubbles by porous surfacesor by mechanical agitation (flotation with dispersed air); a second modality to obtain the gaseous phase is by the releasing of the solved air in water, as a consvequence of abrupt decreasing of the gas pressure lied in equilibrum with the water, case when the became supersaturated with gaseous phase [1].

The main advantages of the aerating system with air released from pulp are:

- the gas micro bubbles are formed directly on the solid hydrophobic particles surfaces; this aspect excludes the necessity of the collision between the particles and bubbles without negative effect on the selectivity of the process;
- the micro bubbles are in a high number offering a liquid-gas surface greatest than the normal bubbles dimension, in correlation with the specific surface of very fine particles from pulp [2].

We can appreciate that the bubbles from the floater device after a pressurization of the wastewater at 2-5 atm is between 30 – 120 microns.

The ascension velocity follows the Stokes low and the elevating velocity of the complex bubble-particle is between $(0.4 - 2)10^{-3}$ m/s, but this velocity increases with air/suspensions report. [4].

The air releasing takes place in reverse condition those which determines the air solving in liquid phase; if a pressure increasing of the pressure from p_1 to p_2, the air quantity solved in the water will be in accordance with the Henry low:

$$q = k_h\left(p_2 - p_1\right)$$

to a decreasing of the pressure under the p_2 value, will takes place a releasing of an adequate quantity of air.

Rays pointed out that the saturation degree is in correlation with the type (shape)of the pressurization container. So, the static containers conduct to a saturation rate about 50 %, but the using of agitation system increases the air solubility to the 90 % comparatively with the conventional retention time.

The air quantity released theoretically from pulp when the pressure will be reduced from p2 to p1, can be calculated with the relation:

$$q^{'} = q_a\left[fp_2 / p_1 - 1\right]$$

where:q_a –the water saturation with air to the atmospheric pressure, cm^3/dm^3

f –the saturation fraction in the pressurization container [4].

The influence parameters of the process are: the pressure difference, the expansion duration and the solid concentration.

The suspension concentration is in correlation with the air/suspensions report (A/S). When it is used recycling water for pressurization, A/S report is calculated with the formula:

$$A/S = 1.3R(p_2 - p_1)/\ p_1 \cdot Q \cdot c$$

where: R is the volume of recycling water pressurized, dm^3

Q is wastewater flow, dm^3

c is the suspensions concentration from feeding, mg/dm^3

To increase the separation efficiency often is necessary to add flocculation agents in feeding, before their mixing with the recycling water.

The Design and the Functioning of the Hypobaric Flotation Cell

The hypo baric cell flotation cell is an installation with depression, with two novelty elements e.g. a hypo baric static cell and a hydroairator (a special device) which realize the necessary depression above the water mirror and on the other hand, enriching with air of the recycling water.

In the technical references there are some types of vacuum flotation cells whose functioning principle consists of the saturation of pulp with air followed by their introducing in a closed space with lower air pressure. To a decreasing of air pressure a part of solved air releases under micro bubbles form and in their elevating will rally in the froth layer the hydrophobic particles. In order to assure the resistance of bubbles, in the pulp is added frothing agents.

The main disadvantages of these installations are in connection with the products evacuation, because the flotation cells are disposed in vacuum spaces, great energy consumptions and moving parts of installation.

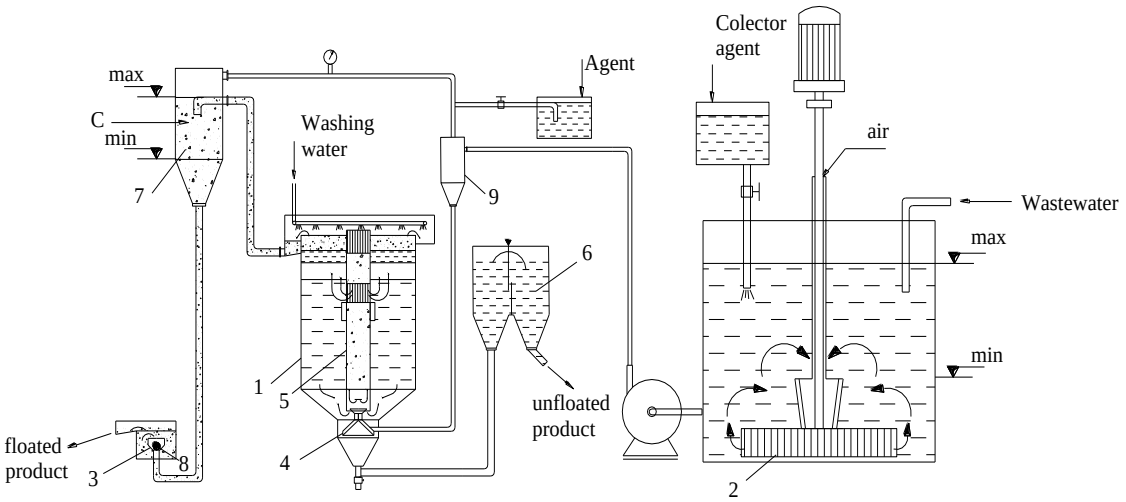
The hypobaric flotation installation presented in figure 1 eliminates these disadvantages, having in component part a flotation cell (1) with hydroairator (9), hermetically closed and with any part in moving. The feeding saturated with air by agitating in the agitator (2), assures the depression necessary to the air releasing and to the froth elevating in the separation basin (7). In this basin, the pulp weight containing the floated product is greater than the ball weight with role of valve of the evacuation hydraulic device (8).

The unfloated product is evacuated to the bottom of cell by the device (6). A part of this product is the recycling water, which feed the hydroairator (9). The emulsion water-air fed tangentially in the accelerating device (4) is interfered with the pulp feeding in floatator device (5), which has oblique slits trough to go out the mineralized bubbles. The floated product is evacuated by the cell overflow in the basin (7). This product that is rich in organic matter can be used in future agricultural activities, like fertilizer agent. The rest of unfloated product can be used in another domains or can be treated in a secondary cleaning phase. [3]

Experiments and Results

The research to the laboratory scale was carried out on domestic wastewaters from Danutoni station and the aim of these researches was to eliminate the organic matter (CCO) and the suspensions from waters. The technological parameters were: the agitation time; the recycling report; the temperature and the separation time.

The simple flotation (without flocculant reagents adding), at recycling reports between 10 – 30 % pointed out the experience of a linear correlation between the process efficiency (the organic matter removal) and the recycling report. To a conditioning time about 3 minutes, the efficiency process of the suspensions removal was in the domain 60 – 80 % and for the organic matter removal, between 45 – 75 %. An increasing of the conditioning time by agitating had a low influence on the flotation efficiency.



HYPOBARIC FLOTATION CELL

1 - flotation cell

2 - Agitator

3 - Flotated product basin

4 - Accelerating device

5 - Flotator device

6 - Unfloated product device

7 - Separation device

8 - Hydraulic device

9 - Hydroairtor

Conclusions

This new hypo baric flotation installation presents some advantages such as:

- A higher efficiency of collision between the solid suspensions and the released bubbles gas;
- The flotation machine has no moving part and the novelty character is absolutely by the fact that whole process (aerating, adhesion, internal circulation, the products evacuation) is a consequence of a synergism between the gravimetric and centrifugal field;
- The obtained results justify the continuation of the research on other wastewaters types.

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