Waste water treatment by flotation

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Úprava odpadovej vody flotáciou

The flotation is succesfully applied as a cleaning method of waste water refineries, textile fabrics (tissues), food industry, paper plants, oils plants, etc. In the flotation process with the released air, 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 could be applied in the waste water treatment. In this case the waste water, which is in the atmospheric equilibrum, is introduced in a closed space where the depression is 0,3 – 0,5 bar. Our paper presents the hypobaric flotation cell and the technological flow of cleaning of domestic waste waters.

***Key words**: flotation,,* Waste water treatment

Introduction

In practice, the natural flotation process differs from 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 stationary liquid 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 the latter case, the air could be introduced in water in very fine bubbles by a porous surfacesor (by the mechanical agitation flotation with dispersed air). A second modality to obtain the gaseous phase is by releasing of the solved air dissolved in water, as a consequence of abrupt decreasing of the gas pressure in the water being supersaturated with the gaseous phase [1].

The main advantages of the aerating system with air released from the 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 the negative effect on the selectivity of the process;
- the micro bubbles are in a high number offering a liquid-gas surface greater than that of the normal bubbles, in correlation with the specific surface of very fine particles from the pulp [2].

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

The ascension velocity, following the Stokes low, of a bubble-particle complex is between $(0,4 - 2)10^{-3}$ m/s, but increases with the air/suspension ratio. [4].

The air releasing takes place in a reverse direction which determines the air dissolving in the liquid phase; if a pressure increases from p_1 to p_2, the air quantity dissolved in the water q will be in accordance with the Henry law:

$$q = k_h(p_2 - p_1)$$

A decreasing of the pressure under the p_2 value will cause 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 p_2 to p_1, can be calculated with the relation:

$$q' = q_a[fp_2 / p_1 - 1]$$

where:q_a is the water saturation with air at the atmospheric pressure, cm^3/dm^3,and f is 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.

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The suspension concentration is in correlation with the air/suspensions ratio (A/S). When the recycling water is used for the pressurization, the A/S ratio 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,and c is the suspension concentration of the feed, mg/dm^3

To increase the separation efficiency often is necessary to add flocculation agents to the feed.

The design and functioning of the hypobaric flotation cell

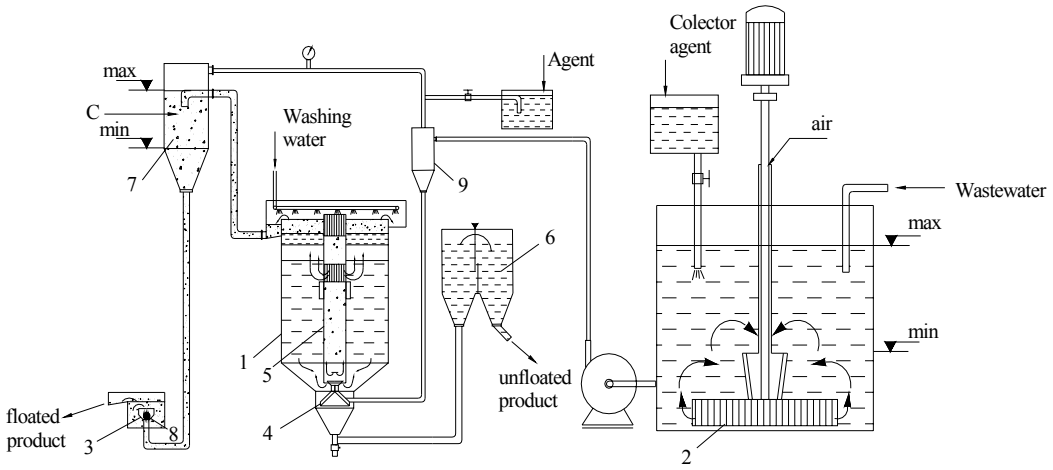
The hypo baric cell flotation cell is an installation with a depression two novelty elements, i.e. a hypo baric static cell and a hydroaerator (special device) which realize the necessary depression above the water level and on the other hand, enriching the recycling water with air.

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 a lower air pressure. After decreasing the air pressure, a part of dissolved air is released in the form micro bubbles, elevating the hydrophobic particles in the froth layer. In order to assure the resistance of bubbles, frothing agents are added to the pulp.

The main disadvantages of these installations are connected with the evacuation, (because the flotation cells are disposed in vacuum), a great energy consumption and moving parts of the installation.

The hypobaric flotation installation presented in fig. 1. eliminates these disadvantages, having connected the flotation cell 1 with hydroaerator 9, hermetically closed and with any moving part. The feeding saturated with air by agitating in the agitator 2, assures the depression necessary for the air releasing and 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 the valve of the evacuation hydraulic device 8.

The unfloated product is evacuated to the bottom of the cell by the device 6. A part of this product is the recycling water, which feeds the hydroaerator 9. The emulsion water-air fed tangentially in the accelerating device 4 is interfered with the pulp feeding in the flotation 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, as a fertilizer agent. The rest of the unfloated product can be used in another domains or can be treated in a secondary cleaning phase. [3]



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 - Hydroaerator

Experiments and results

The research at the laboratory scale was carried out on domestic wastewaters from the Danutoni station with the aim to eliminate the organic matter (CCO) and the suspensions from them. The technological parameters were: the agitation time recycling ratio temperature and the separation time.

The simple flotation (without adding flocculants), at recycling reports between 10 – 30 % experienced a linear correlation between the process efficiency (the organic matter removal) and the recycling report. To the conditioning time about 3 minutes, the efficiency process of the suspensions removal was between 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.

Conclusion

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

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

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