Oil and Water Separation Technique: An Application of Ultrasonic Vibration Technology

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SITUATION

Currently there are multiple techniques that are used to separate and purify oil water, these two techniques are quite able to reach high product purities making the a viable component of a burgeoning refinery plant however they do have their drawbacks.

- Separation processes are essential technologies for the development of the future [1].
- Oil and water industries are considered as one of the biggest and most important separation industries.
- This project is constrained to oil and water separation industries; in specifics, the Dissolved Air Flotation systems (DAF) [2].

PROBLEMS

The current method of separation of oil and water is accomplishing the required task and is providing economies with an essential industry of great importance to its consumers. Unfortunately, however, there are some problems with the current method, which are reducing the system's efficiency and discouraging the growth of its industry.

Physical

- Efficiency of Air transfer is of 12% at most [3].
- Inability to directly control the speed at which those air bubbles move in the DAF systems.

Economical

- Cost of operation such as energy consumption, transportation of components, maintenance and regular checks add up to a high cost of an essential industry [4] [5].
- Large, and complex system components discourage entrepreneurs from starting an industry of great importance to any economy [4] [5].

SOLUTIONS

We propose to use the following three solutions:

1. Induced Cavitation Bubbles by Ultrasonic Vibrations:

- An oscillator is to provide continuous amplified sinewave signals that are to be converted into soundwaves in the form of vibrations using an Ultrasonic Transducer.
- The Ultrasonic transducer is to replace the air compressor and the recycling pump in the current DAF systems (Fig.1), and is placed on the left side of the tank (Fig.2), hence producing severe ultrasonic vibrations which in turn, generates Cavitation Bubbles in the flow [6].

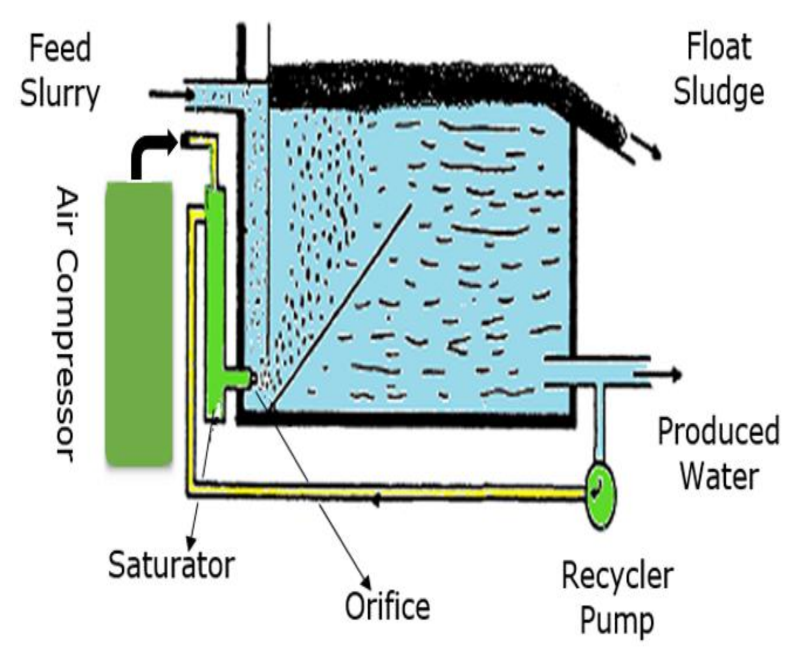

Fig.1: Schematic diagram of a dissolved air flotation plant (DAF) [2]

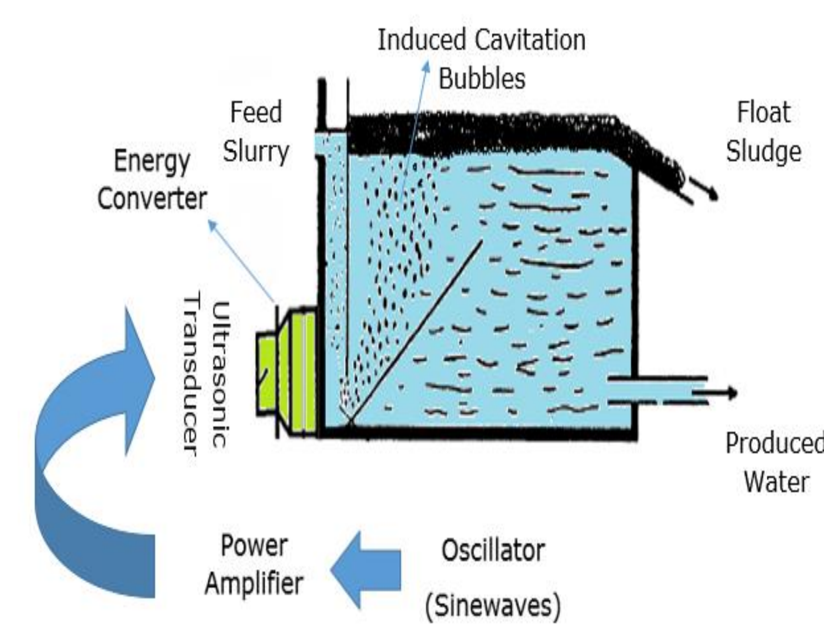

Fig.2: A theoretical schematic diagram of an improved dissolved air flotation plant (DAF)

2. Minimum Sweep Period (MSP):

- By sweeping/changing the transducer's frequency (in Fig.4), larger sized particles has smaller minimum time response than smaller sized particles with respect to this sudden sweep/change [7].
- As a result, they are able to catch up to this sudden change and shift along the nodal planes (Fig.3) until reaching the other part of the wall (reflector side), while smaller sized particles stays in the same nodal plane and move out of the channel (transducer's side).

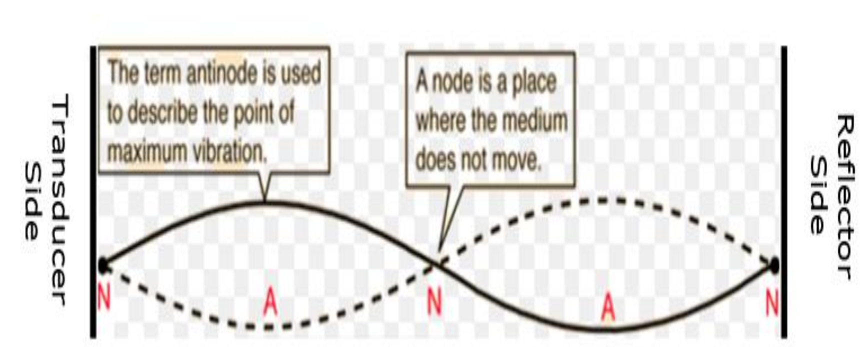

Fig.3: A schematic representation of a Standing Wave Field [8]

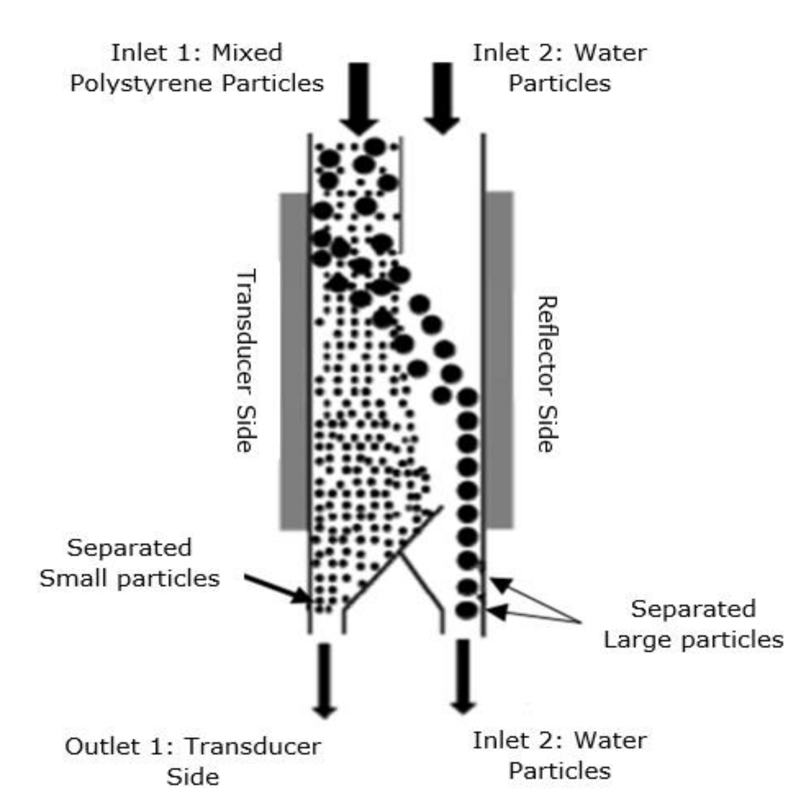

Fig.4: Separation procedure and the separator schematics [6]

3. An Integrated System:

- Combining the past (what is already out there) with the present (solution one and two) in series to produce the future; hence, reducing size and cost, while increasing the number of induced air bubbles along with other features. Thus, producing a combined efficiency that is equal/ or greater than the efficiency of any individual solution.

EVALUATION

Cavitation Bubbles by Ultrasonic Vibrations

- Limited up to a certain flow rate speed.
- Limited size and number of cavitation bubbles [5].
- Controls all sizes of byproducts

Minimum Sweep Period (MSP)

- Gives direct control over the process (technical improvement).
- Increase in the speed of the separation process (as a whole) [6].
- Doesn't control small byproducts

An Integrated System

- Smaller size
- Lower cost
- Equivalent/Greater efficiency
- Greater number of induced bubbles

REFERENCES

[1] Separation technologies for the industries of the future. Washington, D.C.: National Academy Press, 1998.

[2] J.A. Kitchener, The froth flotation process: past, present and future in brief, In: K.J. Ives (Ed.), The Scientific Basis of Flotation, NATO ASI Series no 75, 1984, pp. 19-20 (Chapter 1).

Further References are available upon request