Pros and Applications of Nanobubbles - Review

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Abstract

Nanobubbles, generations forms, basic studies and applications constitute a vast research area, included their usage in advanced mineral flotation. There are investigation needs for sustainable generation procedures, stability and understanding the nanobubbles interfacial properties and structures. Results proved that a decrease in pressure makes the super-saturated liquid suffers cavitation and nanobubbles were generated.

Keywords: *Nanobubbles, Pressure, Super saturated, Liquid*

INTRODUCTION

Micro- and nanobubbles (MNBs) are potentially having vast industrial applications such as the purification of wastewater and the promotion of physiological activities of living organisms. To develop such applications, one should understand their properties and behavior, such as their lifetime and their number density in solution. Zeta potential of fine bubbles ranges roughly from -10mV to -70mV under normal terrain, but it differs depending upon the value of pH of the liquid solution. In alkali liquid, fine bubbles show positive charge. It also depends upon how fine bubbles are formed. Charged bubbles show either repulsion or attractive force like Coulomb's force when two bubbles or foreign particles approach to eachother.Zig-zag path of a micro bubble motion according to the alternating electric field occur(Xuetong et al.,2011).

GENERATION OF NANOBUBBLES

There are different types of fine bubble generators commercially sold with different designs, but mechanisms availed are however categorized into shear flow, nucleation, cavitation and

A few examples are shown below

Depressurization Type

- The bubble generation mechanism is based upon homogeneous/heterogeneous nucleation and cavitation through sudden depressurization of the system.
- High bubble number density is attained with the aid of a high pressure pump (Henry's law).
- Small scale device with a high pressure pump is appropriate for laboratory use.
- Large scale device with a high pressure pump should be generally avoided in view of cost performance unless otherwise necessary.

Shear Flow Type

- liquid
- air in
- shear & cavitation field
- micro bubble formation
- Swirl Flow Type (Shear Force)

Water (or water-gas mixture) is running into the vessel in tangential direction to form swirl flow into the vessel. This swirl flow induces negative pressure along the centerline of the vessel, which in turn sucks the air from the top of the vessel (left side picture). Air column is then turn off into fine bubbles by strong shear flows in the outside space of the vessel at the bottom or both ends (right picture).

- Simple structure
- Low cost
- fairy low bubble number density

Micro bubbles have been a "crucial topic" in engineering applications since the mid 1990s. The widespread, low cost, energy efficient production of micro bubbles has been elusive, and generally limited their use to operations that cannot be achieved any other way.Nanobubbles have been a intriguing field as to their longevity and structure, but have mostly been limited to medical applications of ultrasonic imaging and ultrasound-mediated drug delivery, which are very high value uses that may have no other competiting technology. The limitations to more widespread use are clear – ease of production, cost of the equipment, and energy efficiency of their production. The trajectory of miniaturization of energy potentialmicrobubbles towards nanobubbles is assessed (Sadatomi, et al., 2007).

The Pros of nanobubbles

Nanobubbles are described majorly by their diameter – less than one micron and larger than ananometer. The most peculiar feature of a nanobubble is longevity.This longevity has two aspects. The obvious one is the virtual disappearance of buoyant force. Bubbles typically smaller than about 5 microns in diameter do not rise, since the buoyant force is smaller than any current in the liquid, and also swamped by the repulsive forces of such bubbles with each other and other interactive forces. The second, less obvious, element of longevity is physical stability: such bubbles do not dissolve away (Oh et al., 2015). Nano bubbles, once formed, are highly persistent. This is both a blessing and a curse. The benefit that Nano bubbles possess are permanently within the system. Then again, the contents of the Nano bubbleare difficult to extract from the system once they are captured. The physical chemistry of this longevity is an observational mystery that is now attracting considerable attention (Ohgaki, et al., 2010).

Attenuated total reflectance infrared spectroscopy recorded that the surfaces of the nanobubbles contain hard hydrogen bonds that may reduce the diffusivity of gases through the interfacial film. In comparison with micro bubbles and fine bubbles, Nano bubbles have very small carrying capacity. Where the fine bubble quite often leaves the system having transferred only a small fraction of its "cargo", the micro bubble, due to its small carrying capacity and maximum transfer rates (surface area per unit volume increases with diameter), frequently becomes capacity-limited . In some cases nanobubbles expensively produced with high energy density techniques have high transfer efficiencies and performance. Nevertheless, quite a lot of the biomedical uses of Nano bubbles stem from their ability to deliver materials in a controlled fashion. The migration of Nano bubbles can be directed by ultrasonic fields, and their interfaces can be loaded with surfactant materials that are typically held by high interfacial affinity (Lee et al.,2004).

INFLUENCE OF NANOBUBBLES IN MEDICAL FIELD

- Nanobubbles are much useful for ultrasound imaging, providing the compressible surface for reflection of the irradiated waves.

- Imaging of tumors by a mixture of nano particles and nanobubbles, stabilized by block co-polymers, has proven a successful technique for medical diagnostics ((Ikeura et al., 2013). .
- For biomolecular separations, very small bubbles, termed aphrons, have observed to be particularly useful extraction properties. An emerging technique for the recovery of microbial secondary metabolites, such as antibiotics in pre-dispersed solvent extraction (PDSE) processes.
- Nano and micro bubbles at the micron scale form colloidal gas aphrons are availed for gas phase extraction, such as for lactoferrin and lactoperoxidasefromsweet whey Protein separations are typically by interfacial affinity, rather than phase transfer.
- Most current applications for nanobubbles are high value added activities – such as Drug delivery – for which the cost of synthesis is a secondary issue (Kirezieva et al., 2015).

If energy efficient, low cost nanobubbles were available, commodity applications many be found that depend on the existence of the "permanent" heterogeneity in the liquid at the uniformly dispersed typically in nanobubble sites. For instance, steam forms from nucleate boiling at flaws in the heat transfer surface in power stations, which are localized on the boundaries.

Shrimp Breeding By Nano-Bubbles Water Treatment Technology

The major concerns have been the destruction of mangroves and other wetlands for the construction of shrimp farms, salinization of the soil, biological pollution of native shrimp stocks, depletion of wild fish populations through large inputs of fish meal and fish oil in commercial shrimp feed(Joshi, et al.,2013), eutrophication; and the release of chemicals in the environment.

Shrimp farming in Malaysia in particular, has been expanded sporadically following huge demand in the international market. This fast progress is however accompanied by lack of adequate planning and regulation at the national policy level. This unplanned and haphazard shrimp farming is gathering considerable debate due to its negative environmental and socio-economic consequences.

In current scenario, one of the important discoveries in interfacial physics is nanobubbles, which are micro/nano-scope gaseous domains that form at the interface between solid and liquid. Nano-bubbles (NB) present characteristics that make them special in relation to the ordinary bubbles (macro-bubbles) because of their minimized diameter size. Some of the merits of the NB are their high specific area (surface area per volume) and the high stagnation in the liquid phase, which increase the gas dissolution. It has been reported that when nano-bubbles collapse, free-radical generation occurs, due to the high density of ions in gas–liquid interface just before the collapse (Ikeura et al., 2011a).

There are applications of NB in different fields, which include the water treatment by flotation, taking advantage of the high specific area of NB; the sterilization availing ozone gas, which has its dissolution increased with NB generation; contrast agent for ultra sonography and the possible use in food industry for foam products, carbonated drinks and as a nutritional supplement carrier, in which bubble stability is desired ((Ikeura et al., 2011b). Furthermore, the use of Nano-bubbles in water was assessed to be effective for the acceleration of metabolism in shellfishes and vegetables, as well as in aerobic cultivation of yeast, accelerating the growth and increasing the yield.

CONCLUSION

Nano bubbles serves various effects to lives, it has positive effect to large lives, and negative damages to small living things. That is because of their different durance against radicals, majorly against active oxygen. The effects vary from life to life, are typically influenced by the radius distribution and the amount of the bubbles, and inevitably affected by environmental factors including liquid temperature, liquid contents, flow rate, flow pattern, and so forth. This paper garners information about nanobubbles.

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