AGITATION OPTIONS FOR CLEANING & DEGREASING

Choosing an agitation system for an industrial cleaning or degreasing application

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The main reason for choosing this subject is because there seems to be some misconception about the use of ultrasound in cleaning and degreasing plants. The statement that ultrasonics can replace solvent degreasing systems is, technically, incorrect. To date, the only viable option is a properly designed Aqueous Degreasing Plant tailored to the customers needs. Ultrasonic action in the degreasing tank may, or may not, be indicated for the application being studied. In the case of many degreasing applications, the use of ultrasound is not even necessary. In other words, the use of ultrasound could be an engineering overkill and expensive in respect to the work that has to be carried out on the products. The overkill factor is amplified as the size of a plant increases. For instance, a very large properly designed ultrasonic degreasing plant could cost R 1.2 M to buy whereas the same plant using eductors costs about R 250,000. (This is based on a quotation that was presented both ways in 2006). Eductors were chosen and the two plants supplied have been working very satisfactorily for longer than 25 months. The products leaving the degreasing plants are cleaner than required by the European end-user's specification.

Ultrasonic action in the degreasing tank may, or may not, be indicated

The type of agitation system chosen in a degreasing plant depends on the number of articles being cleaned per hour, the material the product is made of, the complexity of the product being cleaned, the contaminant to be removed, the residence time required and the degree of difficulty envisaged. The size of the baskets, tank (or degreasing plant) is also determined by these parameters. The type of chemical, chemical additive or solvent used in a plant is dependent on the type of contaminant, oils or greases that are to be removed. An important consideration is the means to be used to bring the chemical continuously and efficiently into intimate contact with the contaminant to be removed. The means that is used may, or may not, be solved by an ultrasonic solution. A guide to the right type of agitation to use for a degreasing plant is discussed in the paragraphs ahead.

1 Ultrasonic Agitation

Ultrasound (Ultrasonic agitation) is generally superior to any other type of agitation if applied correctly at the right energy density (Intensity). However, some types of ultrasonic generators and transducers used for cleaning purposes are, although often used, actually not entirely suitable for ultrasonic cleaning. This is explained as follows: -

Discrete or single frequency transducers - are used for most other ultrasonic applications but suffer from three distinct disadvantages in cleaning applications.

Single frequency, single wavelength systems produce standing waves in the tank liquid which produce high amplitudes of sound in some places and none in others. Assuming that the transducers are bottom mounted a wave travels up from the transducers until it reaches the interface of the water and air and is reflected downwards. As it passes downwards it interacts with the up coming wave, reinforcing it at some places and cancelling it in others resulting in high amplitudes at the antinodes of the resultant wave and no amplitude at the nodal points. A standing wave can be demonstrated very effectively in air if a high energy ultrasonic transducer is directed down to a flat plate 250 mm below it. The wave pattern itself cannot be seen but polystyrene foam pellets will seemly levitate at three or four levels. The pellets move away from the higher amplitude areas within the wave pattern and settle in the areas of no amplitude. Demonstrating the presence of standing waves in a liquid requires a tank having glass sides.

The high amplitudes at the antinodes are not the only reason for structural damage to delicate articles. Because of the nature of single frequencies, resonance within the articles can also destroy a delicate product. For instance, electronic components, microchips and small bearings may be severely damaged.

Another disadvantage of using discrete frequencies is that the wavelength of sound in water varies between 47 and 72 mm for frequencies of 32 and 20 kilohertz respectively and will throw a shadow or be reflected when an article being cleaned is larger than the wavelength. It will not enter into any hole or orifice which is smaller than the wavelength. This is the principal of Radar and echo location equipment. Of course, unless special techniques are employed,

the standing waves will result in stratified cleaning - i.e. cleaning in some places and not in others. The effects of discrete frequencies are particularly noticeable in high intensity ultrasonic systems.

Simultaneous Multi-frequency - In this case primary ultrasonic frequencies of between 20 or 25 kHz. generated simultaneously and continuously with a random range of frequencies to over 100 kilohertz and all the disadvantages of single frequency is eliminated. i.e. For all practical purposes there are no standing waves and no high amplitudes generated. Resonance in delicate items, such as microchips, cannot occur. Brinelling[1] of small bearings is a well known consequence of cleaning using discrete frequency ultrasonic baths.

When to consider the use of ultrasound in a cleaning or degreasing bath.

When dealing with this subject it is necessary to realize that, although the design of ultrasonic generators and transducers are an exact science, their application to a cleaning system is more an art than a science and expertise in this art is born out of many years of experience.

The following is a short list of applications in metal finishing where the use of ultrasound would be indicated.

- The required degree of cleanliness and speed of cleaning cannot be achieved by conventional methods.
- The need arises to clean assemblies or sub-assemblies without having to dismantle them.
- The article is so intricate that conventional methods fail to achieve results.
- Whenever the articles to be cleaned have orifices and blind holes.

Hydrosonics

The effect of Hydrosonics is the same as that for ultrasonics but the ultrasound is produced by liquid whistles operating in the ultrasonic range of frequencies used for cleaning. Ultrasonics uses electro-mechanical transformers called transducers to produce the ultrasound whereas Hydrosonics makes use of liquid whistles to produce the ultrasound. Hydrosonics is more cost effective in larger tanks and can be used to clean or degrease products moving at higher

[1] ***Brinelling*** - *Permanent deformation of the bearing surfaces where the rollers (or balls) contact the races.*

velocities. An example is in the production of link chains travelling at a velocity of say 10 metres per second. The residence time in the tank is too short for conventional ultrasonic's to be effective.

Swept and Pulsed Frequency Ultrasonic Systems

These types of ultrasonic systems are technically inefficient. The details of why swept frequency systems are inherently inefficient are not dealt with here for the reason that the subject is technical and beyond the scope of this paper. These systems have been devised in a vain attempt to simulate and compete with Simultaneous Multi-frequency systems.

2 Pumped Agitation

Pumped agitation has been used for cleaning or degreasing simple products. This method of agitation has rarely been used since the advent of the Eductor system.

3 High Volume Eductor

The use of eductors in cleaning and degreasing plants is, next to ultrasound, the next best choice the plant design engineer has to achieve intimate contact between the chemical in a tank and the contaminant on the products being cleaned.

Eductor driven degreasing plants can be used in almost all applications except a few where very delicate articles are being cleaned. Example: During the manufacture of microchips and other similar products. Eductor driven cleaning or degreasing plants can sometimes be half the price of an ultrasonic plant.

4 Mechanical Agitation

Mechanical agitation describes the action when a basket full of product is moved up and down several times a minute. This mechanical movement is achieved by the use of a manipulator or other mechanism. The action is very efficient and can be used for almost any application on a parallel with eductor driven plants.

5 Sparging with Air

Sparging with air is a very effective system but should not be used on heated tanks. The air passing through the liquid medium in the tank acts as a cooling load and opposes whatever heating system is being used to raise the temperature of the tank liquid. The consequences of this results in wasted energy and hunting of the heating system controllers.

6 Tumbling Agitation

This is also a very effective agitation system. The design engineer must consider the possibility of damaging the articles being cleaned or degreased. Damage, however, is very rare if the drum rotational speed is low. The articles being cleaned fall comparatively slowly through a medium having the viscosity of water.

The author of this article, Irvin Tarr has been involved in all facets of the design of process and solvent degreasing plants, aqueous degreasing plants, ultrasonic generators and transducers since 1979 to the present date. During the early part of this period, using ground breaking “State of the art” technology he introduced the first ultrasonic solvent and aqueous oil cooler cleaners to the industry and later adapted this technology to general aqueous degreasing applications.