

AI 3010 WASTE AND BY PRODUCT UTILIZATION

UNIT II NOTES



Fats, oil, Grease

Fats, oils, and grease, abbreviated as FOG, have become a rising global issue.

It has an impact on the efficiency of wastewater treatment facilities and industrial treatment units. In India, FOG-related concerns cause 47 percent of sanitary sewage overflows and more than 50 percent of sewer obstructions.

There is a need for effective FOG treatment options

Accumulation and solidification of fats, oils, and grease on sewage system walls causes pipe obstruction and clogging. It has a direct influence on the flow of wastewater, resulting in overflow problems. Toxic wastewater may contaminate neighbouring water sources and create environmental contamination, putting public health at risk. As a result, efficient FOG treatment technologies are urgently needed to keep wastewater treatment plants running.

Fats, oils, and grease, or FOG, enter the system through a variety of sources. Households, business enterprises, and factories, on the other hand, are key contributors of FOG. In most cases, FOG is a by-product of the cooking process in the home. Sewer obstructions are also frequently observed as a result of cooking oil and fats being discarded in the kitchen sink.

Commercial enterprises offering food services, such as hotels, restaurants, and cafés, are especially affected by FOG concentration. In terms of industries, food processing and industrial activities have the ability to create a large amount of fats, oils, and grease.

Why is FOG a problem in waste water treatment?

FOG build-up in the system is aided by a fast-expanding metropolitan population, an increase in the number of food outlets, and faulty sewage networks. FOG build-up on the drain surface and in the pipes causes clogging and overflow issues. It can also cause other problems like as odour, bug infestation, and contamination of the land, water, and air. Furthermore, it can erode drain pipes, necessitating costly repairs.

Fats, oils, and grease present a wide range of difficulties in wastewater treatment facilities owing to their delayed breakdown process and high BOD need. Treatment plants in the food processing industry become overburdened, resulting in expensive operational and treatment expenses.

FOG may account for 25-35 percent of the total chemical oxygen demand in raw sewage that feeds into municipal treatment plants. It may also result in:

- Clogging of the system, lowering and restricting capacity.
- Increase in the amount of time necessary for pipe cleaning and maintenance.
- If FOG is not removed adequately from incoming waters, it depletes the surface of oxygen.
- To manage extra FOG, the wastewater facility requires additional energy and capacity.
- It has the potential to impair the performance of microorganisms that feed on sludge, lowering effluent quality.

Other industrial issues are as follows:

- Foaming
- Filament Issues with Nocardia
- High TSS in effluent

Factors affecting oil water separation

Unlike sedimentation, flotation is a solid-liquid or liquid-liquid separation process applied to aggregates that have a lower density than the liquid containing them; these aggregates are *finally* collected as scum (floated sludge) from the surface of the units.

Flotation is termed **natural** when the density differential between the aggregates and the water is naturally sufficient for separation to take place.

Flotation is termed **aided** when it uses outside assistance (gas, air, nitrogen or natural gas and eventually with reagents) to enhance the separation of particles that are naturally floatable (but having an inadequate separation rate).

Flotation is said to be **induced** when the particle's density, originally greater than that of the liquid, is artificially reduced in order to ensure its flotation. This process takes advantage of the capacity of some solid (or liquid) particles for uniting with gas bubbles (usually air or nitrogen) in order to form "particle-gas" pairs that are less dense than the liquid of which they constitute the dispersed phase. Consequently, the phenomenon applied is a triphasic one (gas-liquid-solid) and will depend on the physical-chemical properties of the three phases and especially on the affinity existing between their interfaces (more or less hydrophobic).

Typical terminology refers to average bubbles measuring 2 to 4 mm, fine bubbles a few μm to 1 mm and, finally, microbubbles from 40 to 70 μm .

In the water treatment field, it is customary to use the term of flotation (in the strict sense) exclusively for flotation induced by using microbubbles similar to those found in "white water" delivered by a tap on a water main rich in gas dissolved under high pressure. This process is called **dissolved gas flotation (DAF)**.

However, in minerallurgy and in the oil industry, when air or any other gas is dispersed and produce fine bubbles measuring 0.2 to 2 mm in diameter, this is termed **induced air flotation (IAF)** or induced gas floatation (IGF).

Relationship between design and bubble velocity

A gas microbubble's **rising velocity** through water in laminar operating conditions can be calculated using the Stokes equation (see **different types of sedimentation**) :

$$V = \frac{g}{18 \cdot \mu} \cdot (\rho_L - \rho_g) \cdot d^2$$

where

g = gravity acceleration

d = bubble diameter,

ρ_g = gas density,

ρ_L = liquid density,

μ = dynamic viscosity.

As the bubble diameter increases, its increasing rising velocity augments the flow turbulence around the bubble and Stokes law ceases to apply; therefore figure 31 makes successive use of

the Stokes, Allen and Newton (see **different types of sedimentation**) equations to calculate the rising velocity of bubbles measuring between 20 and 20 000 μm .

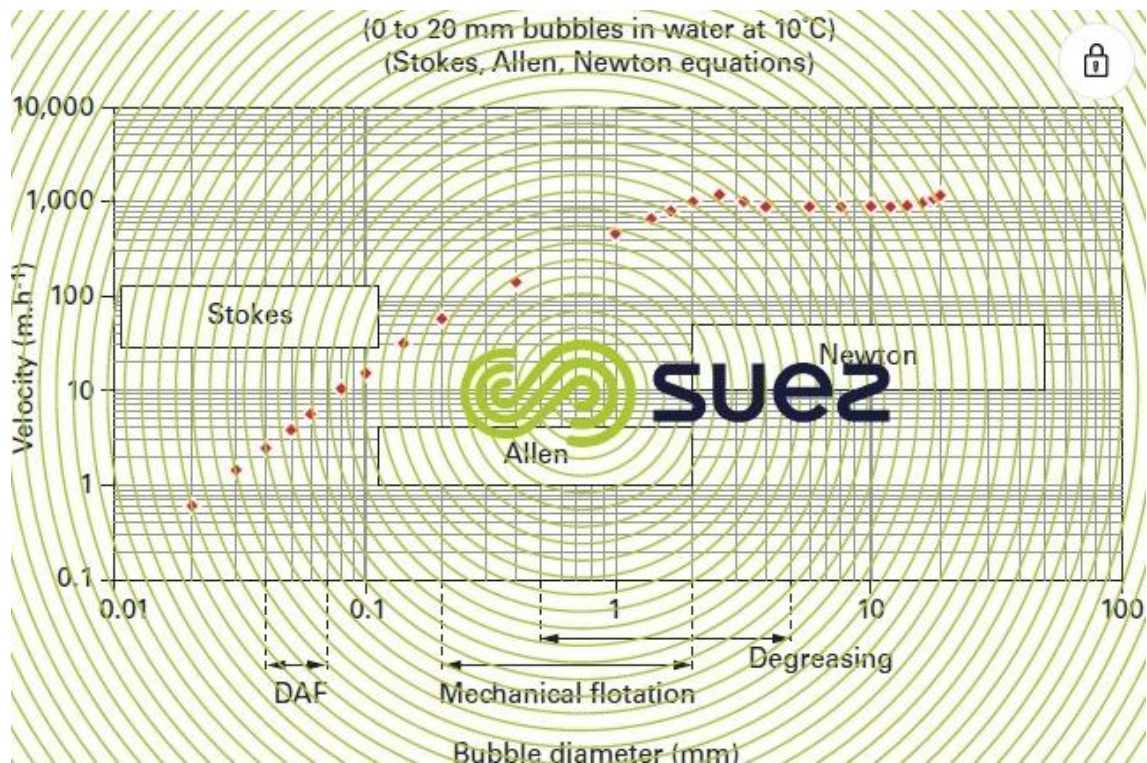


Figure: Air bubble rising velocity in water

INFERENCE

- 50 μm bubbles have a rising velocity of approximately $6 \text{ m} \cdot \text{h}^{-1}$ to 30°C or $4 \text{ m} \cdot \text{h}^{-1}$ to 10°C ;
- whereas the rising velocity of bubbles that have diameters of approximately 1 mm is approximately 100 times higher.

Rising velocity

The Stokes equation continues to apply when:

- ρ_d is the particle-bubble "composite" and when ρ_g is replaced by ρ_a = particle-bubble "composite" density which directly depends on the gas volume/composite volume ratio;
- allowance is also made for the "gas bubble-particle" shape or sphericity.

bubble size considerations

The use of microbubbles is required for floc separation; in effect, there is 8,000 times more gas in a 1.2 mm bubble than in a 60 μm microbubble; therefore:

- if we want a good **distribution** of bubbles over the entire section of the unit, using bubbles of a few millimetres in diameter would result in a gas flow rate that is much higher than the one applied with microbubbles, and this large quantity of gas would create extremely disruptive turbulent currents.
- the increased bubble concentration increases the **probability of collision** between solid particles and bubbles. Furthermore, the low microbubble rising velocity compared with the fluid mass, means that microbubbles will **adhere** well to the fragile particles that make up the floc;
- finally, bonding will be easier if the microbubble diameter is lower than that of the suspended floc.

Larger bubbles (fine or even medium bubbles will do) can be used to **separate out voluminous particles that are lighter than water, hydrophobic** and that float naturally and where we only seek to enhance their floatation and to maintain the «cake» on the surface. This applies to fats separation.