Surfactants and Recycling Cleaners

Presented to:

13th Annual Indiana Pollution Prevention Conference

September 22, 2010

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Summit Water Treatment

Definitions

- Surfactants – Short-hand for surface active agents
- Surface Tension – cohesiveness of a liquid at the point of phase definition between a gas and a liquid (interface). Measured in dynes / cm
- Micelle-Dynamic aggregation of surfactant molecules. Micelles act in conjunction to reduce surface tension
- Anionic Surfactants - are negatively charged.
- Non-ionic Surfactants - have no charge
- Foam-The expression at the surface of the presence of both reduced surface tension and air
- CMC – Critical Micelle concentration

Names for Surfactants

- Soaps*
- Detergents*
- Wetting Agents
- Emulsifiers
- Demulsifiers
- Defoamers
- Corrosion Inhibitors
- Solubilizers

How Surfactants Cause Problems in Waste Water Treatment

- Surfactants reduce the surface tension of water. Lowers the CMC value.
- Distilled water has a surface tension of 72 dynes / cm.
- Water which has a surfactant load ranges from 32 to 40 dynes / cm.
- Surfactants also generate foam which inhibits settling.
- Foams can suspend particles which carry heavy metals, phosphates, and oily complexes which can results in discharge violations.
- Surfactants also contain dispersants which suspends colloids in solution.
- In addition, surfactants interfere with the balance of charges which are important in settling heavy metals.

Main Classes of Surfactants

- Anionics (negatively charged) – they interfere with the flocculants. Most common class
- Non-ionic (no ionic charge) – they primarily interfere with settling of colloids. Rapidly increasing in use.
- Cationics (positively charged) – they interfere with primary coagulants. Rarely encountered in industrial applications.

Anionic Surfactants

- Linear Alkylbenzene Sulfonates (LAS)
- Phosphate Esters
- Tend to be higher foaming
- Not easily bio-degradable
- Typically used in emulsification applications
- Measured by MBAS test procedure

Methyl Blue Active Substances

- Commonly referred to as a MBAS test
- Standard Method 5540 C.
- Comprised of three successive extractions from acid aqueous medium containing excess methyl blue cations into chloroform.
- This is followed by a aqueous backwash and a measurement of the blue color in the chloroform by a spectrophotometer at a wavelength of 652 nm
- Range of accuracy is 0.025 to 2.0 mg/l

Non-ionic Surfactants

- Are rapidly overtaking the role of anionic in industrial applications
- Tend to be lower foaming
- May require elaborate foam “packages” to enhance their effectiveness
- Are bio-degradable
- Main characteristic is the presence of a “cloud point”
- Main classes are Alcohol Ethoxylates and Alkylphenol Ethoxylates
- Measures by the CTAS test

Cobalt Thiocyanate Active Substances

- Commonly referred to as the CTAS
- Standard Method 5540 D
- Involves an ion exchange to remove the ionic interferences. The residual is treated with cobalt thiocyanate, followed by a single extraction into methyl chloride and read by a spectrophotometer at a wavelength of 620 nm.
- Detection range is from 0.1 to 30.0 mg/l.

The Mechanism of Surfactants

Two properties:

1.) Adsorption at the interface
 -concentrate at the surface
 -displace other fluids

2.) Dynamic Aggregation
 - as concentration increases,
 surfactants form aggregates
 at the surface called micelles
 - suspend soils and act as interferences
 to settling

3.) Dispersion, suspension, and solubilizing are the opposite of coagulation and flocculation

How Foam is Produced

Two requirements for foam to develop:

1.) Must lower the surface tension
Micelles "eat" away at the surface tension

2.) Must have an input of air into the liquid
Air bubbles rise to the surface and form a double layered body called a "lamella"

Types of Foam

- Polyhedron Foam. Large foam. Can look though it. Tends to be geometrical. Can be iridescent Easily breaks. Also called “open cell foam”
- Ball Foam. Smaller foam. Not easily broken down. Can actually make shapes with. Cannot see through it. Tends to be rounded in shape. Also called “closed cell foam”
- Both types can occur at the same time. However the polyhedron is always suspended over the ball foam.

Methods of Testing Foam

Done in Two Steps:

1.) Produce the foam

Several accepted methods using agitation, beating, shower, or air

2.) Measure the Foam Height

Either visually or by transparency

How to Treat Foam and Surfactant Problems

- Defoamers interfere with micelle formation. Silicone based Defoamers are recommended for wastewater application. However, defoamers will add to the FOG load.
- Inorganics. Sulfite-based compounds such as Sodium Metabisufite, Magnesium Bisulfite and sodium thiosulfite are effective in reducing surfactant affects. However the addition of sulfites lowers pH and may re-solubilize heavy metals.
- Oxidation. Some surfactants, particularly the anionics are susceptible to oxidation. Oxidizers such as peroxide, permanganate, and sodium hypochlorite can be used. Ozone has also shown some promise if you can get the gas into solution. However, oxidizers may also destroy the polymers used in flocculation.
- Biologicals. The use of “bugs” and enzymes has proven acceptable in municipal applications. They are very successful in “chewing up” surfactants without affecting other processes. However they are very temperature dependent and may require a considerable time allotment to do the job.
- Activated Carbon: Will take out surfactants without additional use of chemicals. Can be a very effective effluent polisher to the POTW. It is limited in flow susceptible to plugging up.

Surfactants and Chelators

- Can be a very difficult and insidious factor in preventing successful wastewater treatment.
- Know what you are dealing with and best to combat their effects will allow you to accomplish your goals in meeting discharge compliance limits

Foaming

- Caused by surfactants in soaps
- The surfactants are protected by “foam packages” which cushion the effect of pH which may affect performance of the surfactants
- Foam and soaps inhibit settling which may lead to violations in discharge limits
- Both foam and soaps suspend particles which is what they are designed to do
- High levels of soaps also increase phosphate loads
- Soaps also impart ionic charges which may upset the neutralization process necessary for complete precipitation and clarity of the supernatant

Foaming (continued)

- Currently being controlled by additional manual treatment with Sodium Metabisulfite in the West Tank
- Soaps are controlled primarily by pH adjustments and/or the use of reducing agents such as sulfite based compounds
- In the future, Magnesium Bisulfite will be used more to control foaming.
- The concept of increasing hardness in water also deserves some consideration

Recycling Cleaners

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