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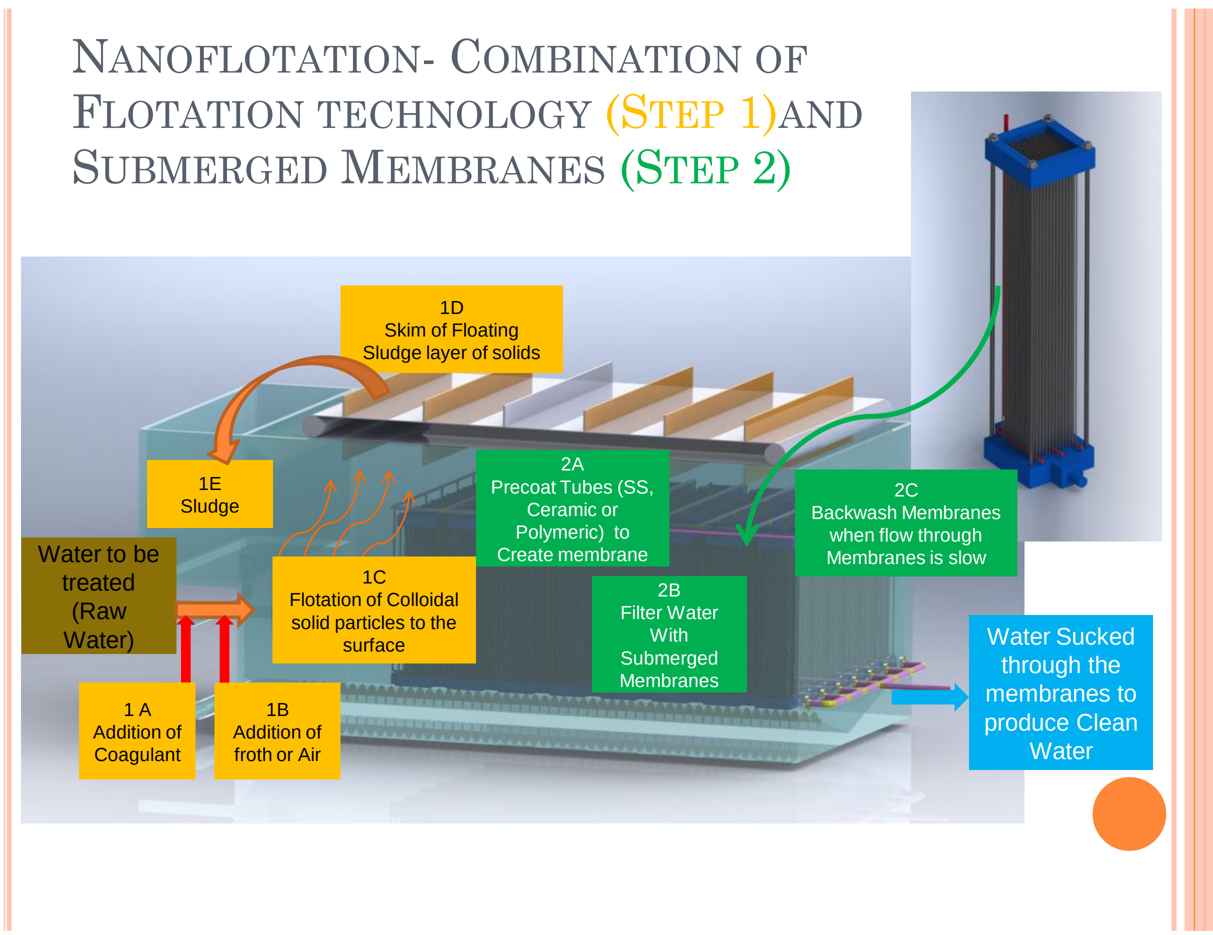
Summary of Nanoflotation Water Treatment Technology

There are Two Steps in Nanoflotation

<u>Step 1:</u> Flotation followed by

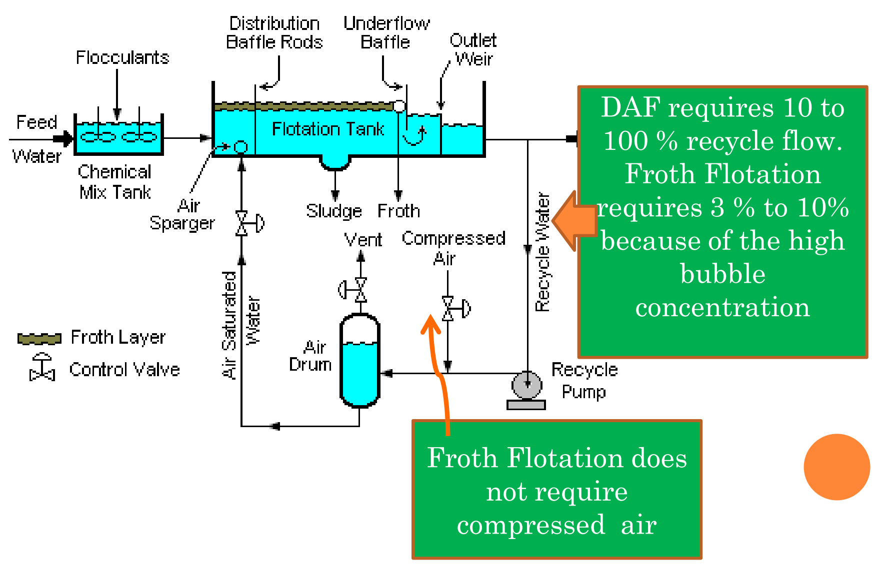
<u>Step 2</u> : **Filtration** using a unique membrane filtration concept where the membrane skin layer is constantly being replaced using a precoat technology. The precoat technology encourages colloidal solids to attach to the membrane skin layer and foul the layer . Once the precoat is exhausted it is then replaced with a new precoat layer.



Step 1: Froth Flotation or Dissolved Air Flotation (DAF)

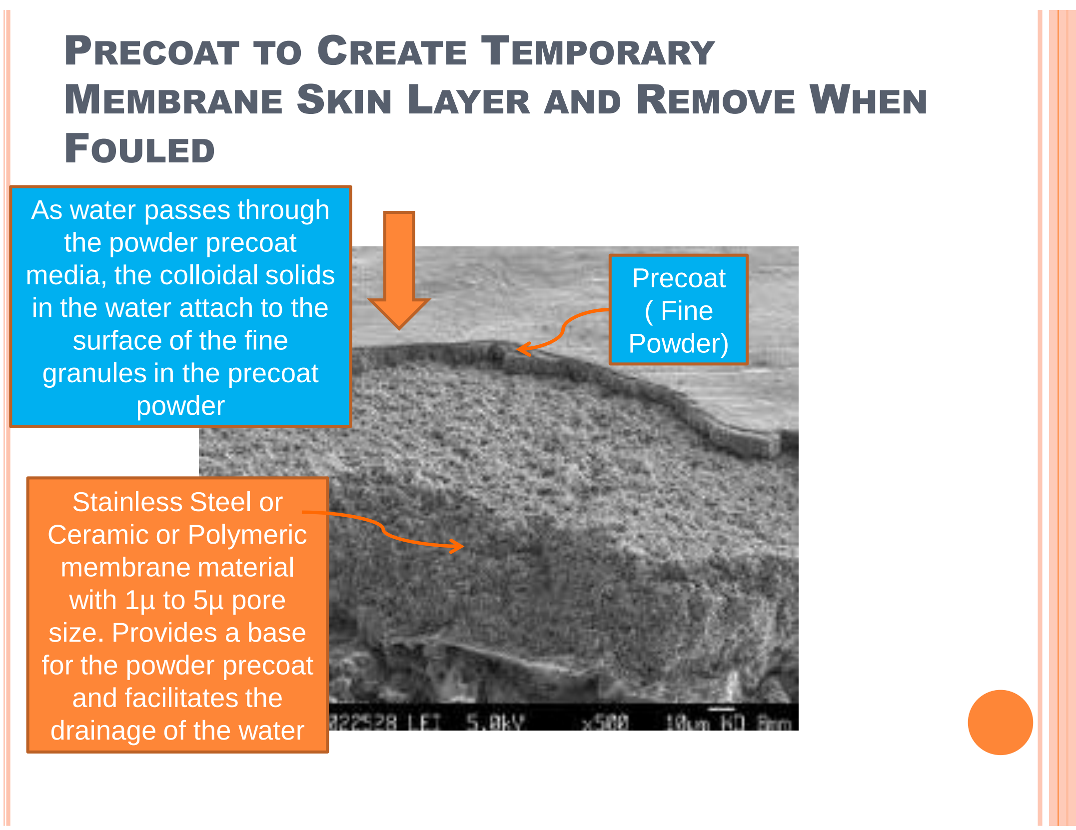
1. The ionic charge (positive+ or negative-) on the froth bubble as a result of the surfactant , can be used with the ionic charge in the coagulants to create neutral environment for particles. Making particles non polar is important for hydrophobicity and the attachment of solid particles to other solid particles causing flocculants. The flocculated particles will then attach to bubbles and rise to the surface in the water tank.
2. With froth technology 3 to 10 % by volume of bubbles can be added to the waste water. With DAF, the maximum bubble concentration is 0.7 to 0.9 %. Froth technology will likely provide a better separation of the solids in the waste water than DAF technology
3. The Froth technology significantly reduces the amount of water that needs to be recycled. As a result, the energy used in Froth systems is much less than in DAF systems. For Drinking water treatment , DAF systems require 10 to 15% of the treated water to be recycled where Froth technology only requires 3 to 5%. For Industrial waste water treatment , DAF systems require 50 to 100% recycle and Froth technology requires only 10%.
4. For Industrial Water treatment ,the hydraulic loading rate for the design of the flotation tankage is twice as high for DAF flotation systems compared to Froth Flotation systems. As a result tankage is much larger in DAF systems than Froth technology systems
5. The operating cost of Froth Flotation Systems is significantly higher than DAF systems because of the chemistry cost for the surfactant in Froth systems.

FROTH FLOTATION- ENERGY EFFICIENT WITH LOWER RECYCLE FLOW AND NO COMPRESSED AIR REQUIREMENTS.



<u>Step 2:</u> **Filtration using a Membrane Precoat**

1. The Precoat technology allows for the membrane skin layer to be customized or changed to match the best characteristics of the forces that will cause the colloidal solids in the water to attach to the membrane skin Layer (precoat). As the water passes through the precoat layer, the colloidal solids in the water attach to the fine powder in the precoat . The three key forces that make colloidal solids attach to powder in the precoat are Van der Waal forces, Hydrophobicity and Electrostatic forces.
2. Loading / flux rate is much higher for the precoat technology . Based on the pilot testing, the flux rate is 10 times higher than typical membranes. This higher flux rate makes it economically viable to use more durable yet more costly membrane materials such as Stainless Steel. As a result the membrane base (tube) can last much longer with the only change being the membrane skin layer (precoat) .
3. Need for chemistry ,such as acids and bases, to remove fouling from the membrane skin layer, is reduced significantly but there is a need to add a precoat material in the amount of 20 to 50 mg/l of water being treated.
4. The precoat technology for membranes will eliminate the typical membrane requirement of limiting the flux (flow rate), known as the threshold flux, and the pressure levels. In existing membranes, threshold flux rate and pressure are limited to reduce rapid fouling of the membranes. The precoat technology concept encourages the precoat to have fouling (attachment of colloidal particles). Therefore precoat membranes can be operated at higher flux rates and pressure. Increases in flux rate and pressure could lead to significantly greater efficiencies.



Application of Nanflotation Technology

1. Lake waters for the removal of algae, solids(TSS), colloidal solids, fertilizers , organics (Total Organic Carbon-TOC) and metals
2. River Water for the removal of solids ,colloidal solids, metals, fertilizer, and organics (TOC)
3. Pharmaceutical waste waters and the removal of vegetative solids, colloidal solids, organics (TOC), Chemical Oxygen Demand (COD),
4. Pulp and Paper waste water and the removal of solids (TSS), colloidal solids, organics (TOC) and production of high quality water for reuse
5. Pig Farms waste water and the removal of solids (TSS), colloidal solids, organics, ammonia, phosphates, metals and production of high quality water for animal drinking water.
6. Mines tailing pond wastewater at coal mines or metal mines for the removal of colloidal solids for water discharge to rivers and lakes or water reuse in the mine of for a water source to produce drinking water for the community near the mine or serving the mine.
7. Breweries' waste water and the removal of solids, organics (TOC) and COD for discharge into rivers and lakes
8. Tanneries' waste water and the removal of solids, organics (TOC) and COD. (Note Colour is a problem in tanneries and Nanoflotation could possibly remove colour but would have to be tested for this application)
9. Chemical Factories waste water and the removal of colloidal solids, organics (TOC and COD) and metals for discharge to rivers or lakes or reuse in the factory
10. Fertilizer factories waste water and the removal of colloidal solids, organics (TOC and COD) and metals for discharge to rivers or lakes or reuse in the factory
11. Effluent from sewage treatment plants to provide source water for drinking water facilities. In this application the standard effluent from a sewage treatment plant that had primary settling or activated sludge treatment could then be treated with nanoflotation followed by some method of disinfection (chlorine and /or UV) which would then produce drinking water. This would be an excellent application in drought stricken areas or limited fresh water areas.
12. Pure water systems which are used in the pharmaceutical industry, the power generation industry or any industry that produces steam through the use of a boiler, and the computer wafer and chip industry. In this application reverse osmosis (RO) is typically used to produce the pure water. In every RO system there is a requirement to pre-treat the water. Typically the pre-treatment has been a sand or multimedia (garnet, sand, anthracite) filter. The requirement was that the water after pre-treatment had to have a Silt Density Index (SDI) less than 5. SDI relates to the clarity of the water. The purpose of the pre-treatment was to remove the colloidal solids so RO membranes will last longer. This standard has changed over the last 10 years where the requirement now is to have the treated water with an SDI less than 3. To accomplish this SDI level Ultra filtration (UF) membranes are used instead of the multimedia filters. The lower cost, low energy option to UF is Nanoflotation. Nanoflotation followed by RO can produce pure water. Test results on the Nanoflotation showed SDI's less than 1
13. Drinking water systems where the source water is from a lake or river and possibly brackish waters (total dissolved solids are in the 2000 to 3000 mg/l range). Nanoflotation will provide high quality water that would require disinfection as a final treatment method. Depending on the TDS level, RO may also be required on the effluent from the Nanoflotation system.

Treatment of waste waters for discharges into Rivers of Lakes. The significant benefit of nanoflotation is that it also raises the dissolved oxygen (DO) level significantly. As a result, with nanoflotation's ability to remove colloidal solids and reduce organics, it has the added benefit of increasing the DO levels in the discharge going into an oxygen depleted river or lake.