

**Innovative  
Solutions Tough  
for Wastewater  
Problems**



# **GEM<sup>®</sup> System**

## **Innovative Floatation Technology**



Industrial Wastewater Pretreatment

Steel Industry Petrochemical Food Industry Chemical Mining Municipal Paper Mills And More Challenges

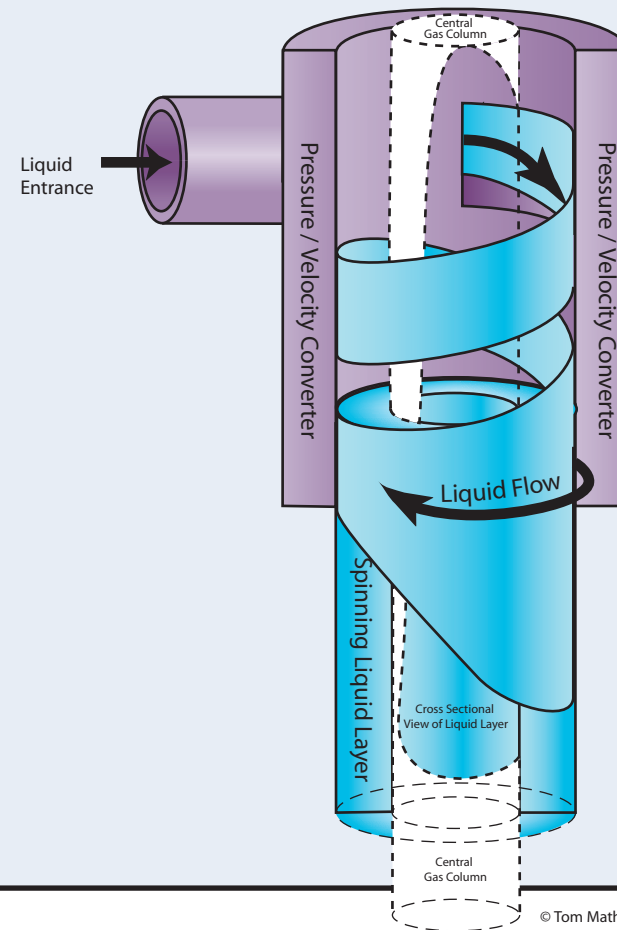


# The Liquid Cyclone Particle Positioner (LCPP) Illustration and Principles

The LCPP provides extremely energetic mixing by sequentially translating liquid "particles" (down to molecular size) throughout a centrifugally rotating liquid layer. In effect, the mass of the individual molecular sized particles act as individual mechanical mixing elements.

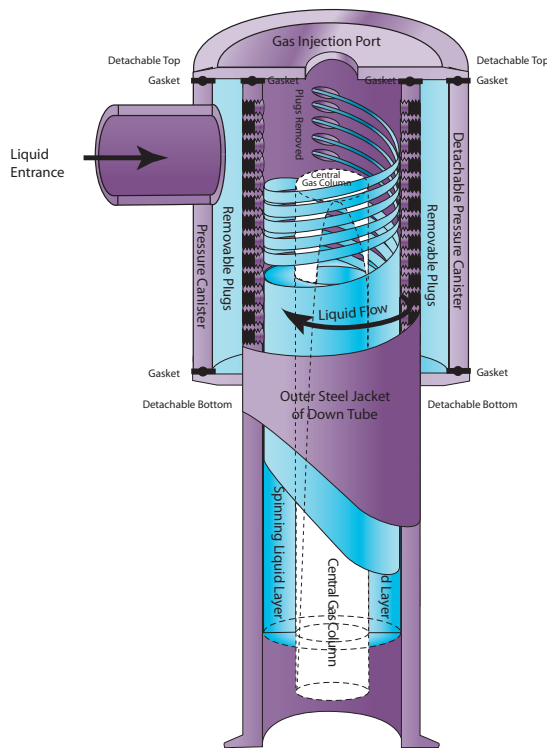
Water, the impurities that it carries, the chemistry that is added to collect those impurities and the gas that is added to float the chemistry all become mechanical mixing elements when exposed to the axial and radial forces inside the LCPP.

Gas is ingested into the water at the molecular level through the highly active liquid gas interface. The gas is rapidly entrained into the water mixture at above atmospheric pressure. Before gas bubbles are ever evolved, there is a homogeneous distribution of water, contaminants, chemistry and dissolved gas.



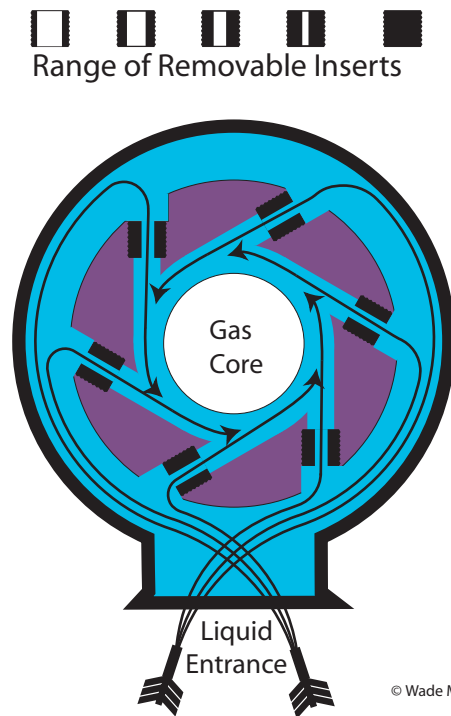
# The Liquid Cyclone Particle Positioner (LCPP) As a Liquid Solid Gas Mixer (LSGM)

Liquid Solid Gas Mixer Head



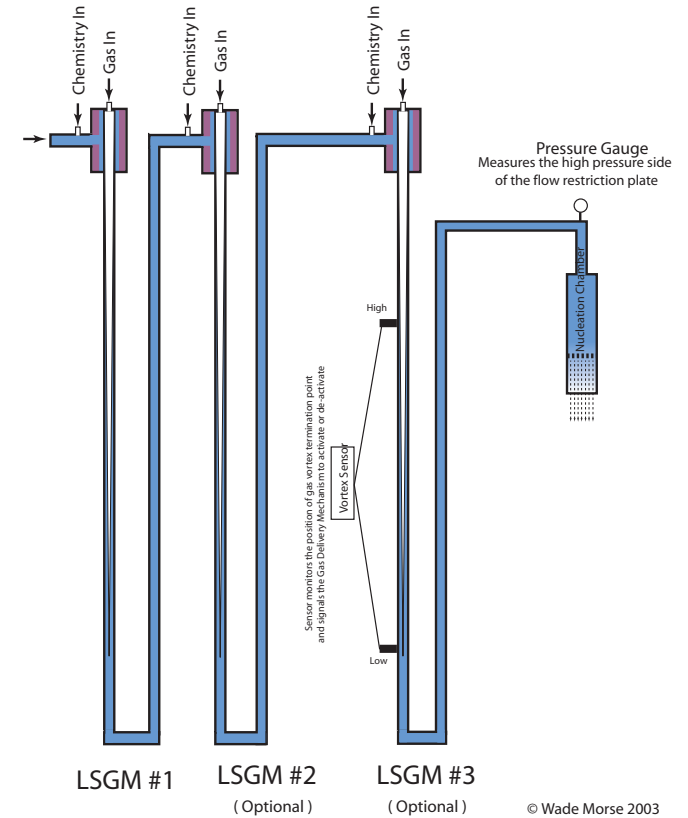
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Adjusting the Mixing Energy  
Crosssectional View



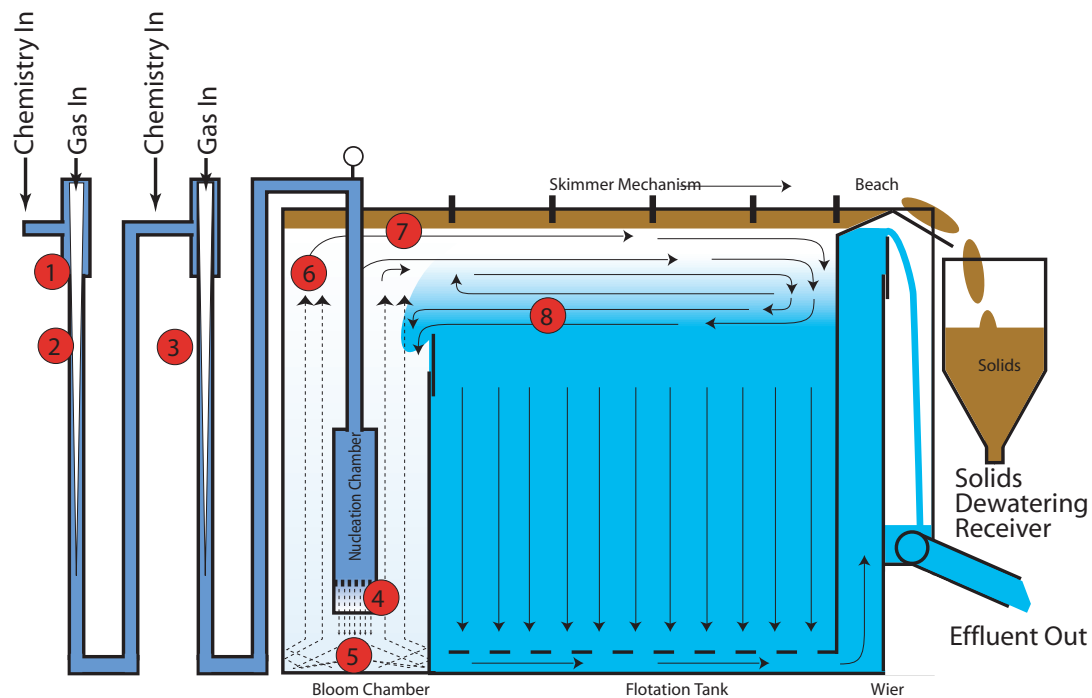
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An Array of LSGM Heads



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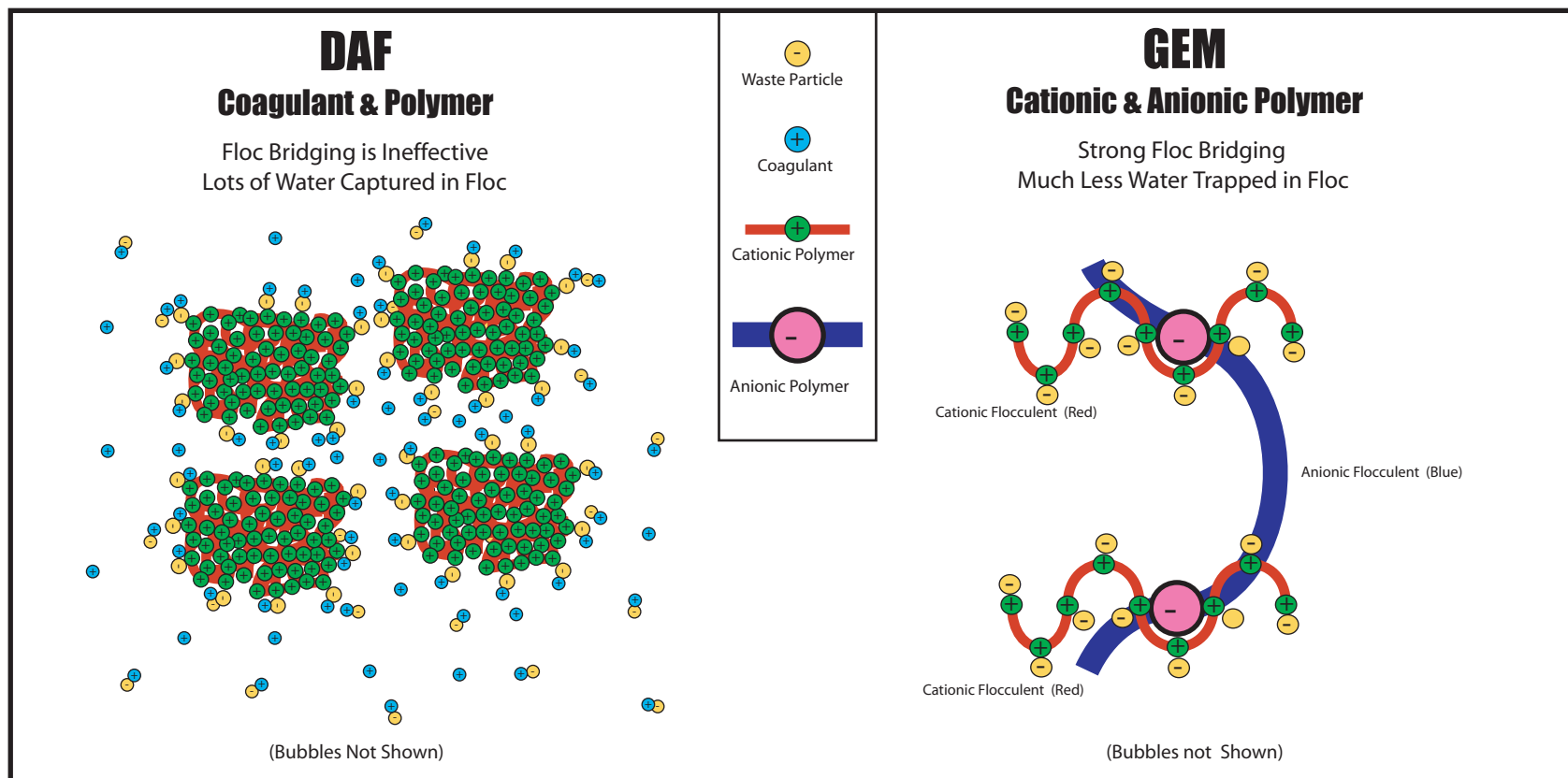
# The Unique GEM Phenomenon- How and where does it all happen?



Flotation Tank System

- 1. Gas Entrainment-**  
Dissolve the gas into 100% of the stream. Creating bubble/particle attachments when gas is at its smallest - in a dissolved state.
- 2. Linearization of Polymer-**  
Uncoil the polymer chain to expose ALL of the charge sites to particles.
- 3. Complete mixing-**  
Insures that ALL particles are attached to the exposed charge sites.
- 4. Nucleation-**  
Dissolved gas evolves into a bubble that is already in contact with the particle and the charge site.
- 5. Coalescence-**  
The pre-attached bubble then swells when additional dissolved gas molecules contribute to it.
- 6. Floc to Floc Attachments form-**  
Small floccules knit together, expanding gases drive out excess water.
- 7. Top Delivery-**  
Mass flow carries flocs to top of tank, where they deposit and continue to de-water.
- 8. Recirculation Tank-**  
Semi-buoyant floc is pulled back into the entry stream. Potential carryover forms additional attachments to fresh incoming unused bubbles and floats to surface.

# 1. The GEM uses better chemistry –making cleaner water and drier solids



\* Data from Laundry Performance Sheet

DAF	TSS Before = 1700	TSS After = 125
	COD Before = 8430	COD After = 1670

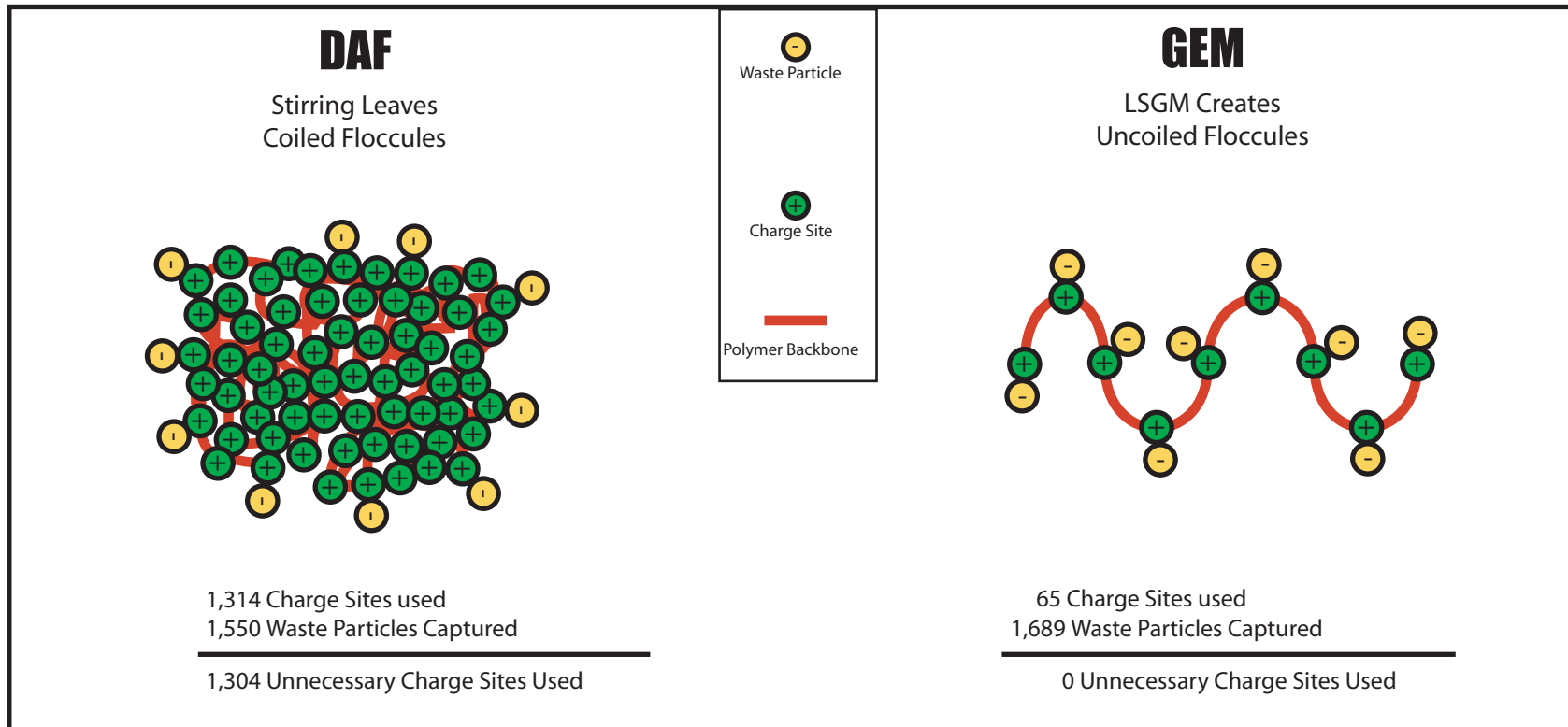
% Solids before pressing = 0.5% - 2%

GEM

TSS Before = 1700	TSS After = 16.7
COD Before = 8740	COD After = 660

% Solids before pressing = 20% - 30%

## 2. The GEM opens up the chemistry so that it will work more efficiently



\* Data from Laundry Performance Sheet

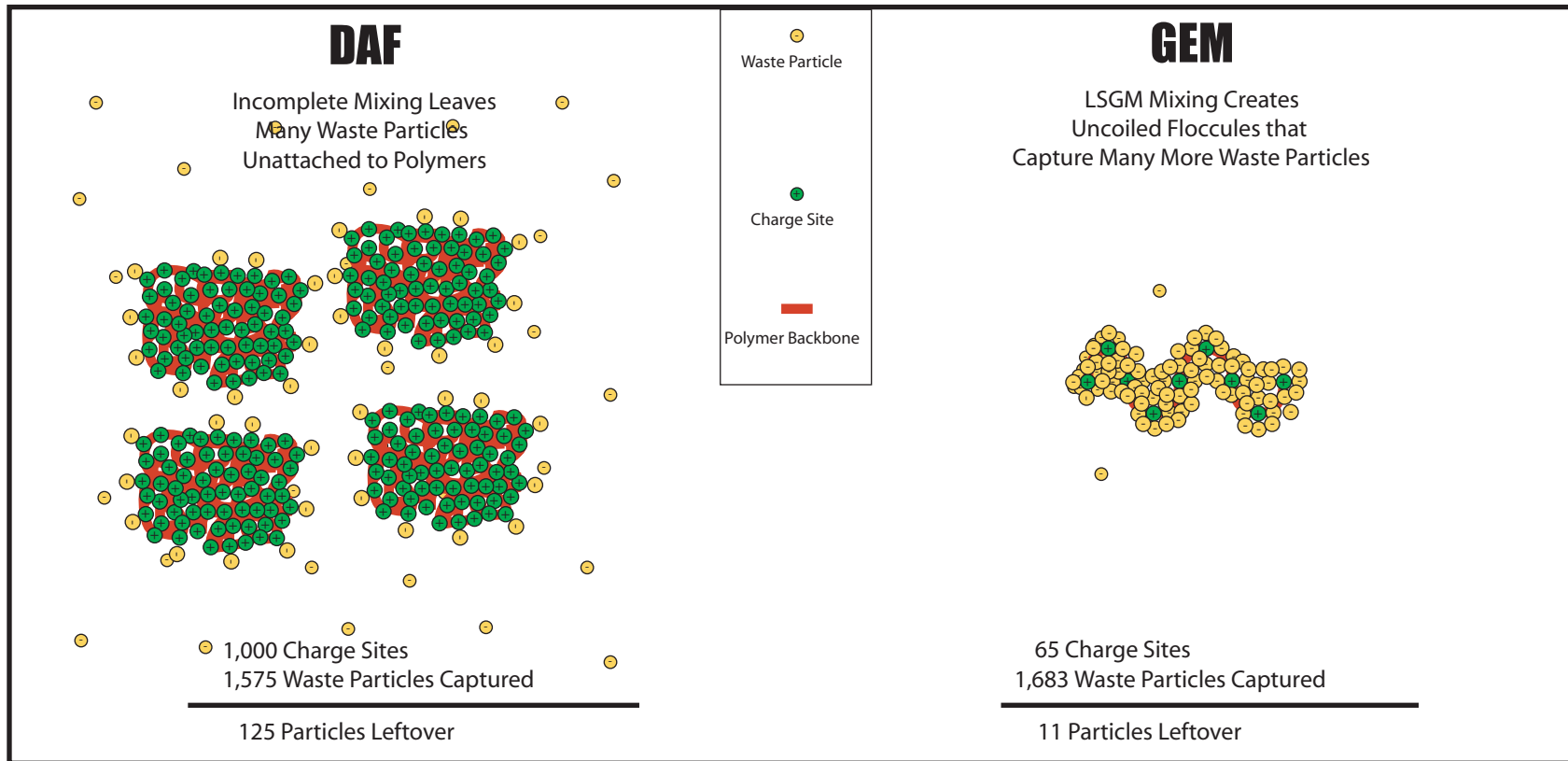
DAF	PPM Coag used = 1177
	PPM Cat used = 137
	PPM Ani used = 0
	Total PPM = 1314

GEM	PPM Coag used = 0
	PPM Cat used = 10
	PPM Ani used = 0
	Total PPM = 10

## 3a - Unique mixing environment

- 1) Mixing energy can be changed without affecting flow.
- 2) Mixing energy can be customized for optimal performance with each chemical.
- 3) As new products become available the mixing energy can be adjusted on site.
- 4) High energy mixing is extremely effective with newer high viscosity products.
- 5) High energy mixing replaces large contact chambers with one vertical

# 3. The GEM utilizes a unique mixing environment to capture more contaminants



\* Data from Laundry Performance Sheet

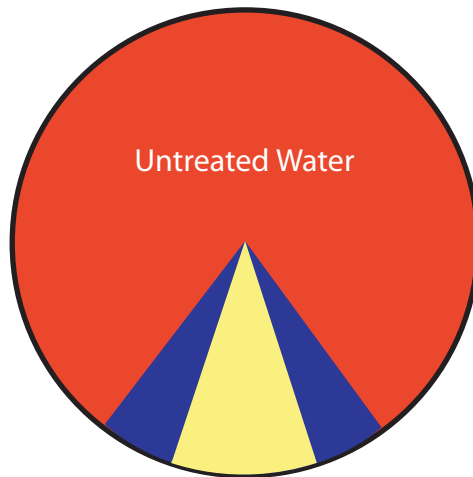
DAF TSS Before = 1700 Tss After = 125  
 COD Before = 8430 COD After = 1670

GEM TSS Before = 1700 TSS After = 11  
 COD Before = 8740 COD After = 660

## 4. The GEM dissolves gas into all of the water to create more bubbles to float the particles

### DAF

Typically Dissolves Air into  
Only 10% to 20% of the Water

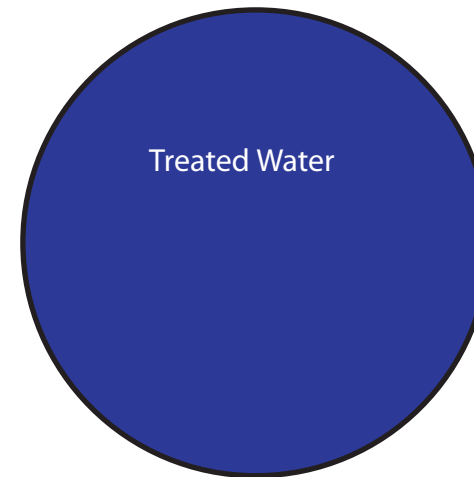


**10 to 20%**

1 to 2 Million Bubbles Generated

### GEM

LSGM Dissolves Air into  
100% of the Water



**100%**

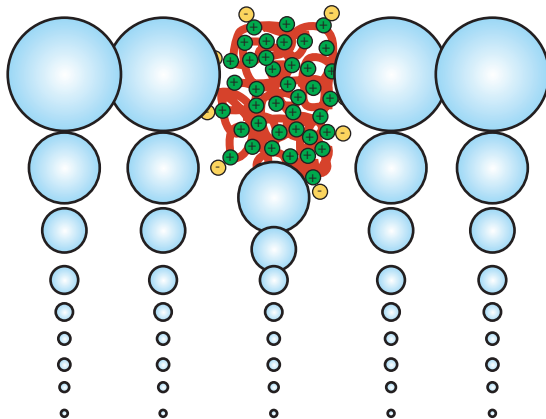
10 Million Bubbles Generated

# 5. The dissolved gas contacts the particles before it becomes a bubble to capture smaller particles

## DAF

### Collision Method

Pre-Formed Bubbles are Released Under Pre-Formed Floc

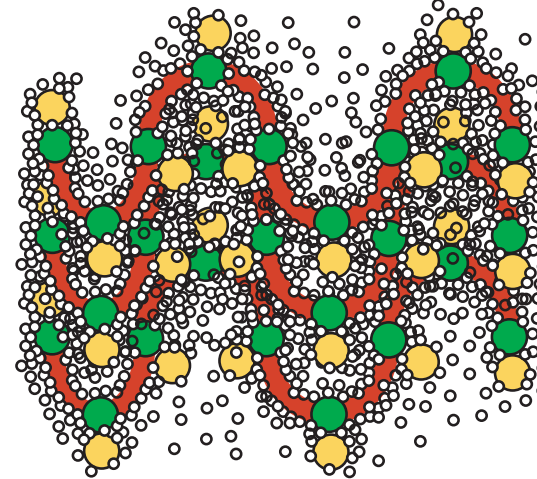


Collision of Proper Size Bubble is Unlikely  
Many Bubbles are Already too Large to Stick

## GEM

### Floc Seeding Technique

Dissolved Gas is Attached as Floc Forms  
Nucleation Inside and Around Forming Floc



When Pressure Drops  
Bubble Can Grow Extremely Large  
Because it is Already Attached

\* Data from Laundry Performance Sheet

DAF	TSS Before = 1,700	TSS After = 125
	COD Before = 8,430	COD After = 1,670

GEM	TSS Before = 1,700	TSS After = 16.7
	COD Before = 8,740	COD After = 660

## 5a - Different Bubble Attachment Method

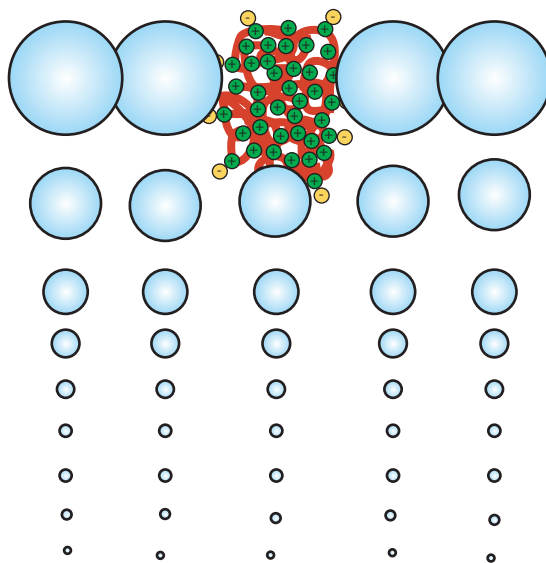
- 1) Gas is dissolved into 100% of stream first.
- 2) Gas is homogenously mixed into waste water before floc structure is formed.
- 3) As floc forms bubble contact is insured- inside of floc structure- under pressure.
- 4) Bubbles will attach to smaller particles- attachment made when bubble is smallest.

# 6. Attached gas swells after it contacts the particle- to harness bubbles of greater size

## DAF

### Collision Method

Pre-Formed Bubbles are Released Under Pre-Formed Floc

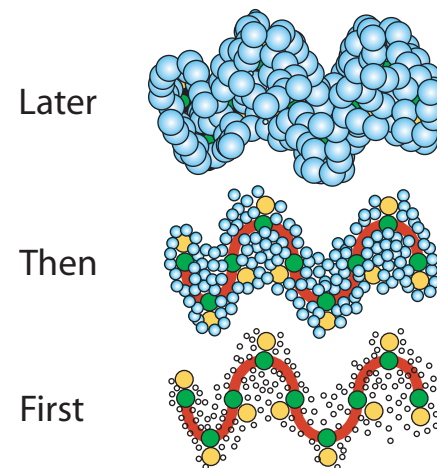


Collision of Proper Size Bubble is Unlikely  
Many Bubbles are Already too Large to Stick

## GEM

### Floc Seeding Technique

Evolution of Dissolved Gas  
First- Nucleation Inside and Around Forming Floc  
Then- Dissolved Gas Converts to Micro-Bubbles  
Later- Coalescence Expands Attached Bubbles



Bubble Can Grow Extremely Large  
Because it is Already Attached

## 6a - Different Bubble Attachment Method

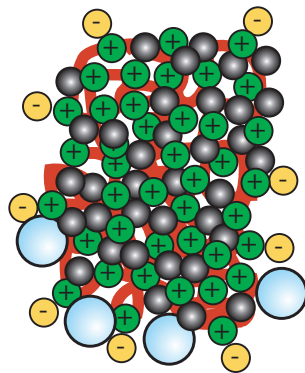
- 1) Dissolved gas is part of floc structure.
- 2) Pressure is dropped, nucleation occurs, coalescence expands trapped bubbles.
- 3) As bubbles grow inside and around the floc structure, flocs knit together.
- 4) Larger bubbles rise faster than smaller bubbles and carry flocs to surface very quickly.
- 5) Floc structure is different than DAF. Bubbles are mechanically trapped in floc.
- 6) Bubbles will not detach from floc over time.

# 7. The expanding bubbles drive water out of the solids to create drier sludge that is easily dewatered

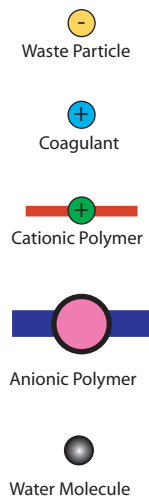
## DAF

### Collision Method

Bubbles are Attached Externally  
No Effect on Water Trapped in Floc



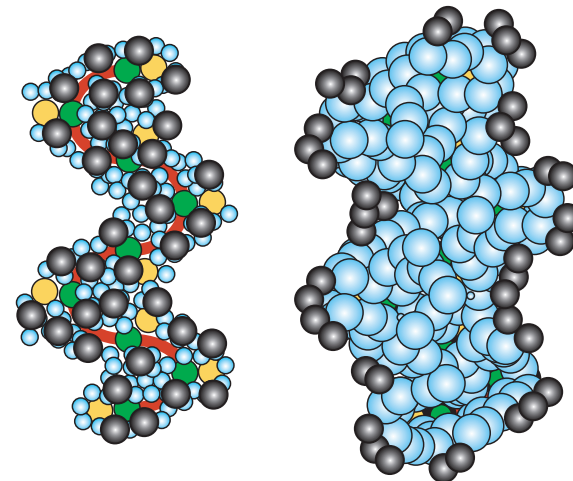
No Effect on Water Trapped Inside Floc  
Bubbles that Stick Can't Affect Water Content



## GEM

### Floc Dewatering Technique

Dissolved Gas Converts to Micro-Bubbles  
Coalescence Expands Attached Bubbles  
Bubbles Squeeze out Trapped Water



Bubbles Grow Extremely Large  
As Bubbles Swell, They Squeeze Out Water

\* Data from Laundry Performance Sheet

DAF    % Solids before squeezing    = .05 % - 2%  
      % Solids after 100psi squeeze = 60%

GEM    % Solids before squeezing    = 30%  
      % Solids after 30psi squeeze = 66%

## 9a - Smaller Components, Less Expense

- 1) GEM uses smaller Flotation tank.
- 2) GEM uses in-line hydrocyclones not cascading tanks for mixing.
- 3) Direct Injection of polymers requires no mixdown system.
- 4) Less chemistry (ppm) needed + higher concentration = much smaller chem pumps.
- 5) Drier solids need less space for holding tanks.
- 6) High end polymers allow decanting of solids-75% of solids volume is shed as free water.