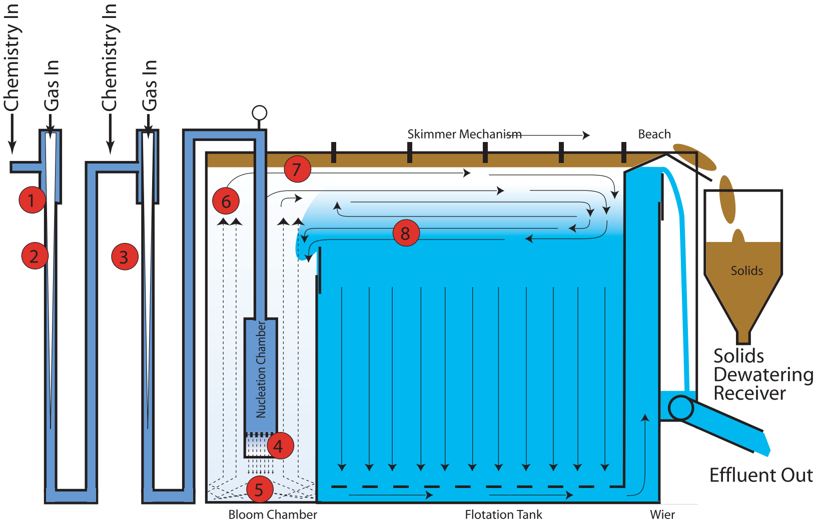
Innovative Solutions for Tough Wastewater Problems

GEM® System

Innovative Floatation Technology

Industrial Wastewter Pretreatment

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



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.

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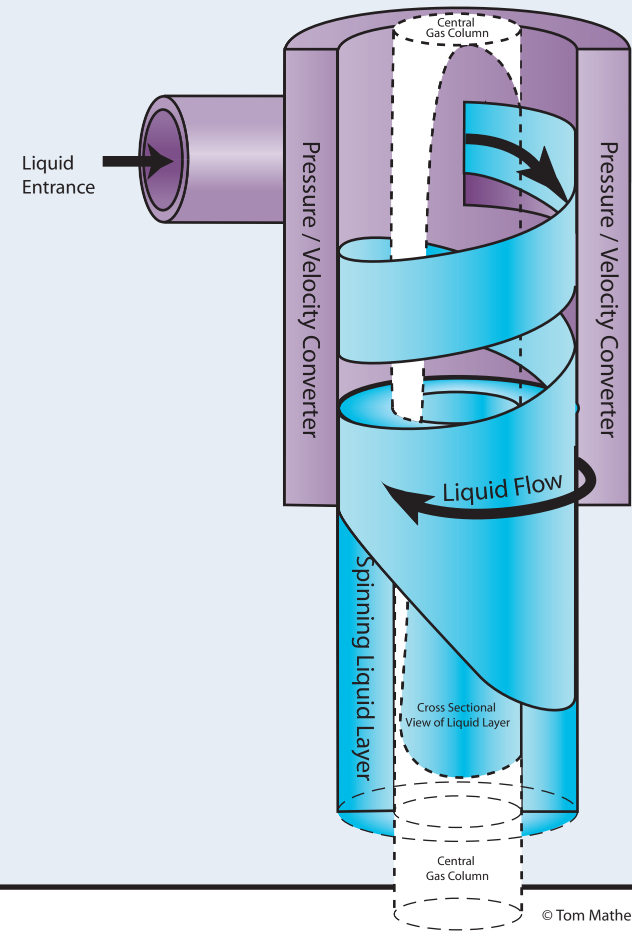
The Liquid Cyclone Particle Positioner (LCPP) Illustration and Principles

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.

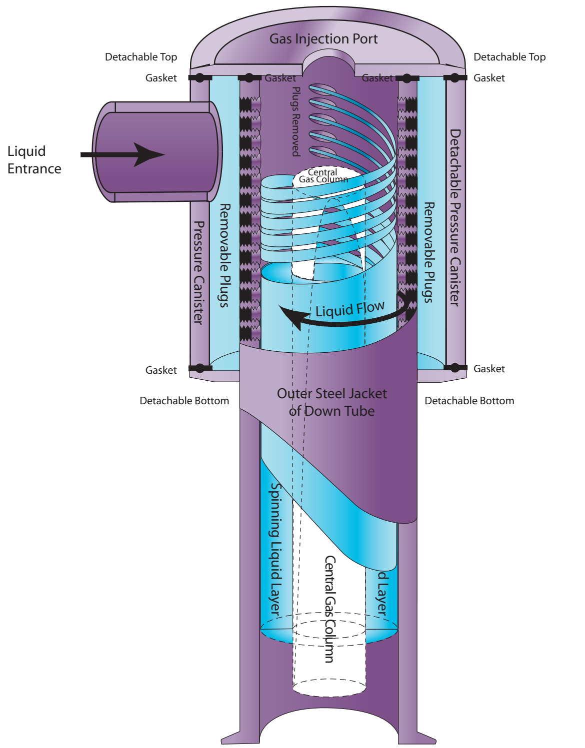
Water, the impurities that it carries, the chemistry that is added to collect those impurities and the gas that is added to float the chemistry all become mechanical mixing elements when exposed to the axial and radial forces inside the LCPP.

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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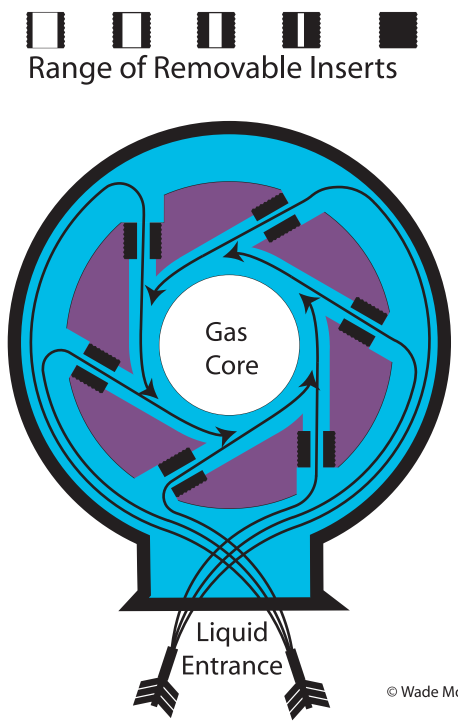
Adjusting the Mixing Energy
Crossectional View



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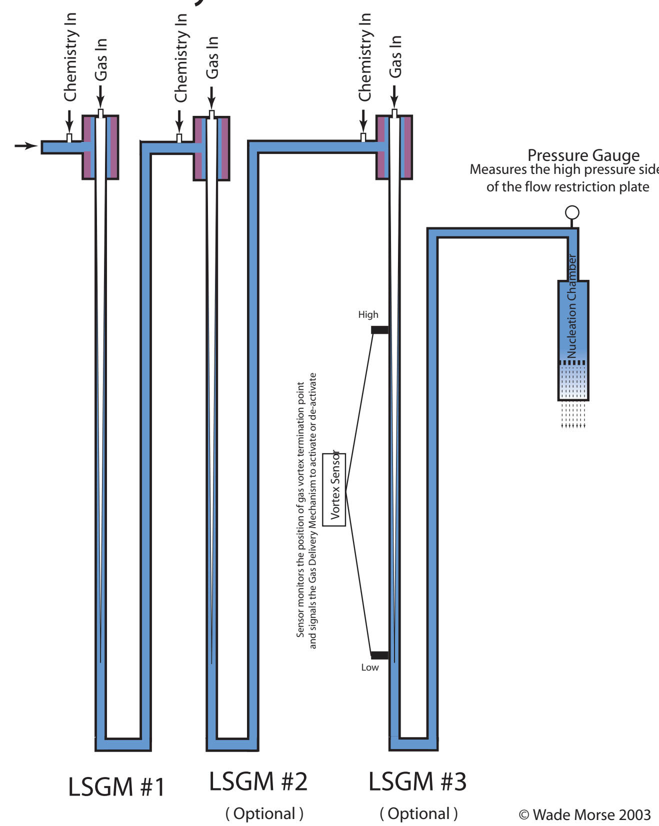
An Array of LSGM Heads



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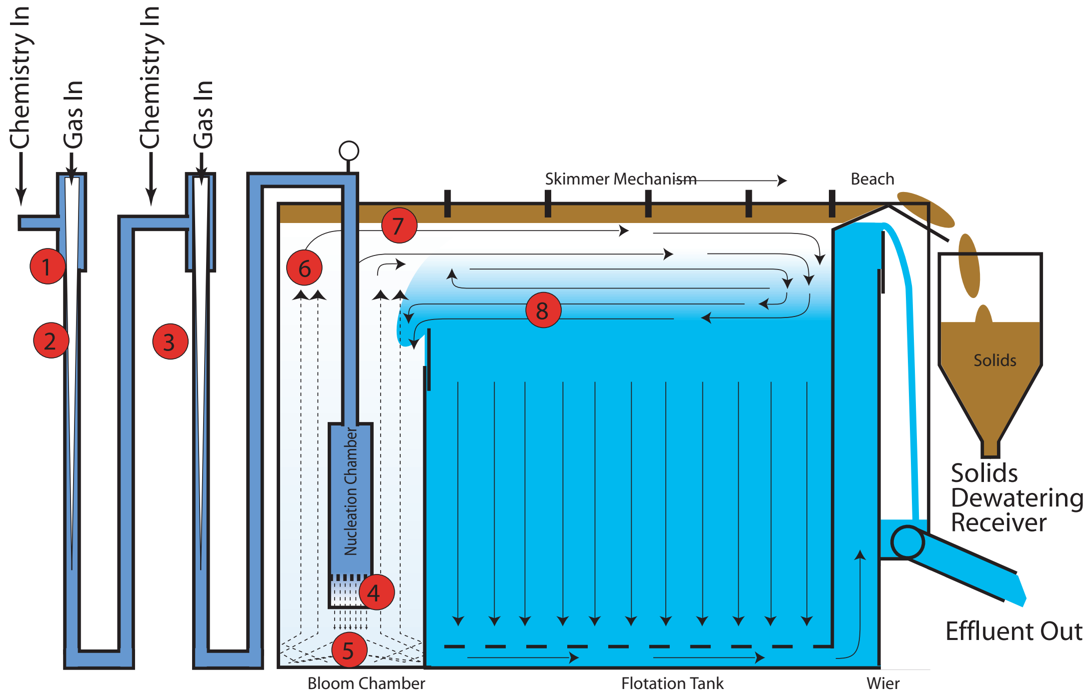
The Unique GEM Phenomenon-
How and where does it all happen?



Flotation Tank System

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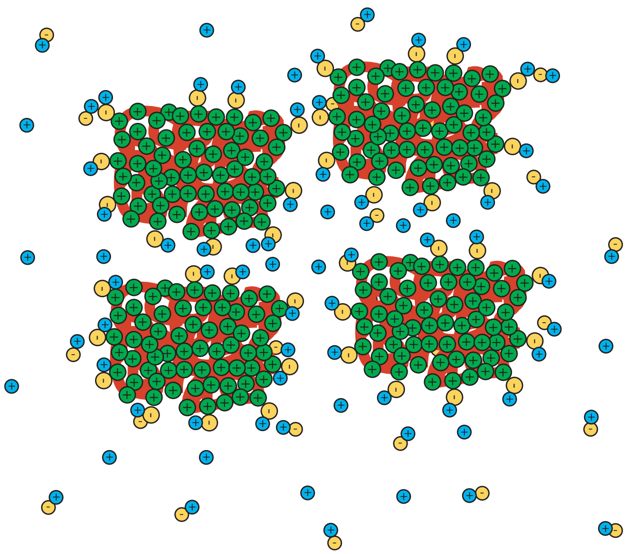
CWT

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

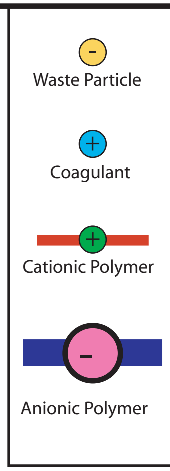
DAF

Coagulant & Polymer

Floc Bridging is Ineffective
Lots of Water Captured in Floc



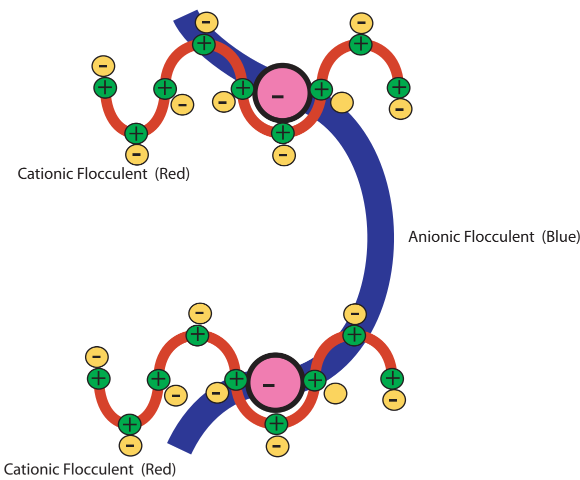
(Bubbles Not Shown)



GEM

Cationic & Anionic Polymer

Strong Floc Bridging
Much Less Water Trapped in Floc



(Bubbles not Shown)

* Data from Laundry Performance Sheet

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

% Solids before pressing = 0.5% - 2%

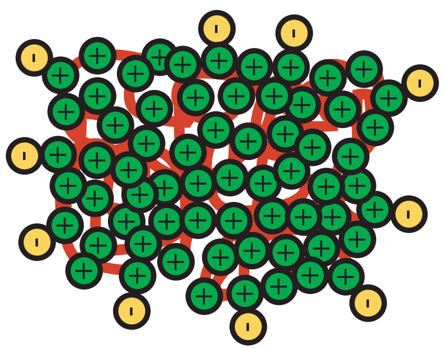
GEM	TSS Before = 1700	TSS After = 16.7
	COD Before = 8740	COD After = 660

% Solids before pressing = 20% - 30%

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

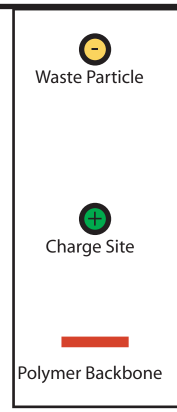
DAF

Stirring Leaves
Coiled Floccules



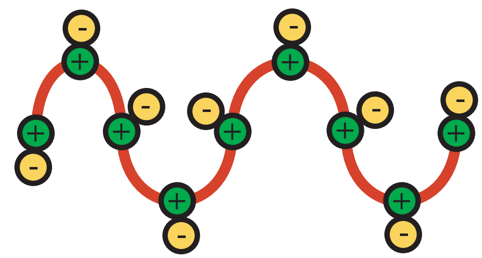
1,314 Charge Sites used
1,550 Waste Particles Captured

1,304 Unnecessary Charge Sites Used



GEM

LSGM Creates
Uncoiled Floccules



65 Charge Sites used
1,689 Waste Particles Captured

0 Unnecessary Charge Sites Used

* 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.

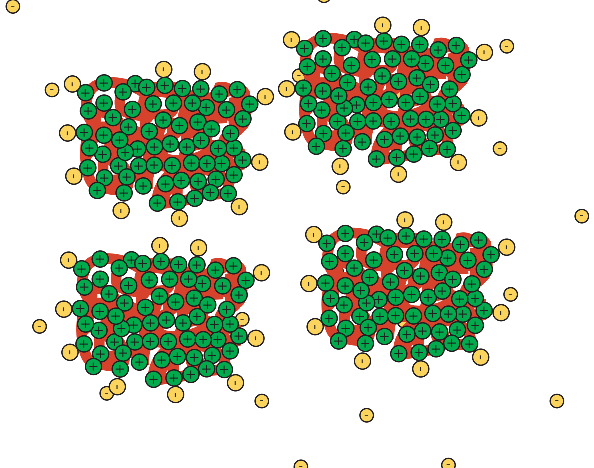
5) High energy mixing replaces large contact chambers with one vertical

CWT

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

DAF

Incomplete Mixing Leaves Many Waste Particles Unattached to Polymers



1,000 Charge Sites
1,575 Waste Particles Captured

125 Particles Leftover

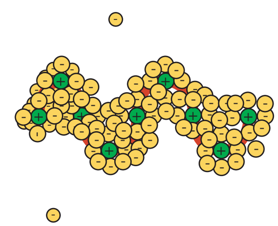
Waste Particle

Charge Site

Polymer Backbone

GEM

LSGM Mixing Creates Uncoiled Flocculesthat Capture Many More Waste Particles



65 Charge Sites
1,683 Waste Particles Captured

11 Particles Leftover

* Data from Laundry Performance Sheet

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

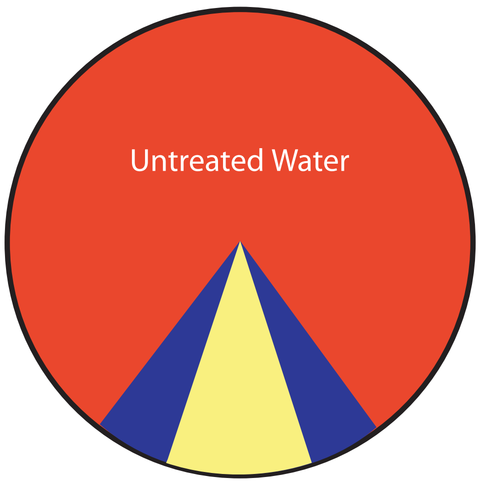
GEM TSS Before = 1700 TSS After = 11
COD Before = 8740 COD After = 660

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

CWT

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%

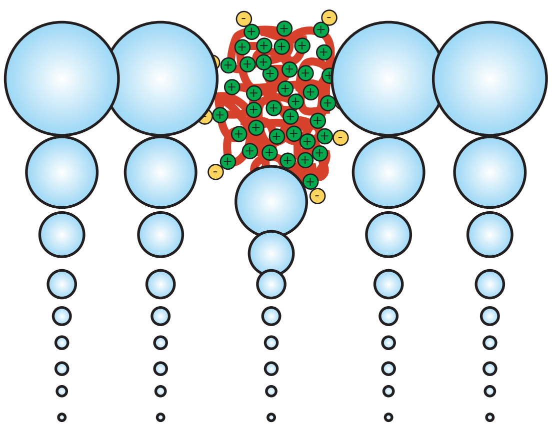
10 Million Bubbles Generated

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

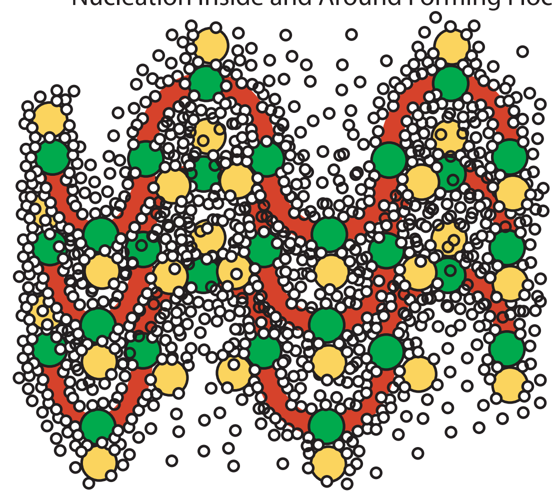


Collision of Proper Size Bubble is Unlikely
Many Bubbles are Already too Large to Stick

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.

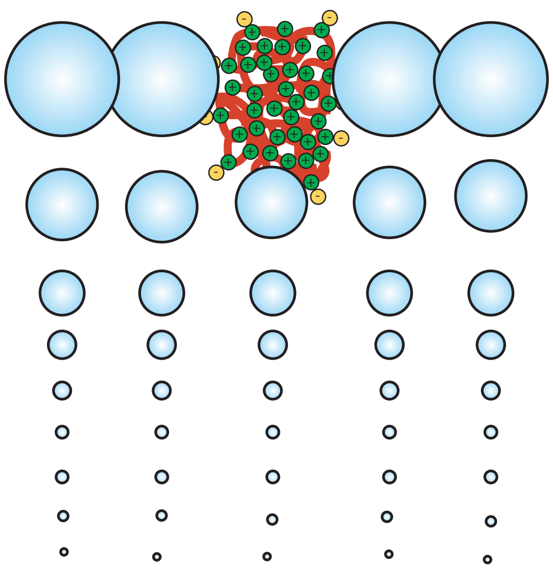
CWT

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

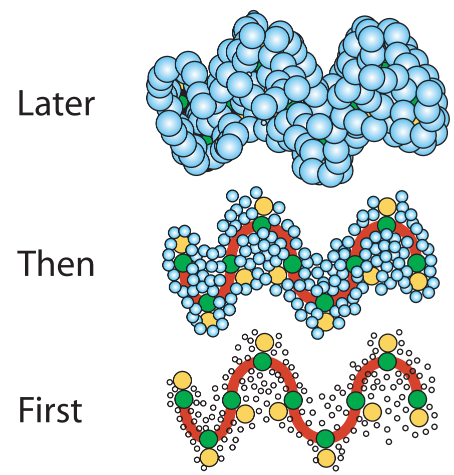


Collision of Proper Size Bubble is Unlikely
Many Bubbles are Already too Large to Stick

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.

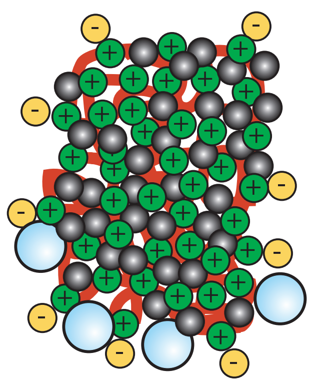
CWT

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

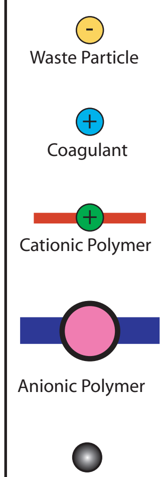
DAF

Collision Method

Bubbles are Attached Externally
No Effect on Water Trapped in Floc



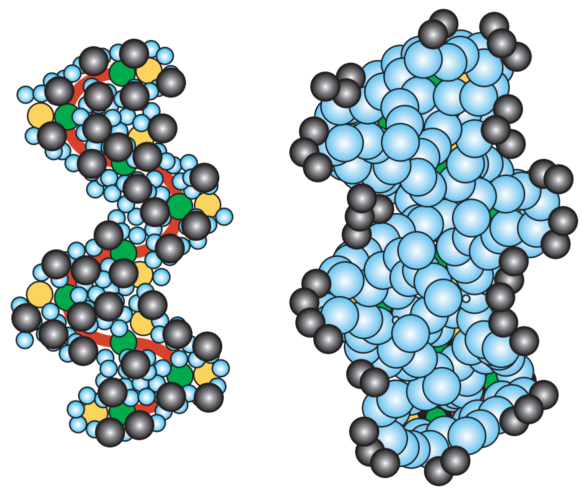
No Effect on Water Trapped Inside Floc
Bubbles that Stick Can't Affect Water Content



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.