



Sustainability: Closing in on a Circular Economy Panel

***New Technologies Open Doors for
Chitosan Applications***







From the Ocean,
For the Ocean.

Tidal Vision is on a mission to create positive and systemic environmental impact by advancing clean chemistry solutions with our chitosan technologies.

After 7 years, Tidal Vision now has ~60 full-time employees and >100,000 sq. ft of production in 3 locations.



**Adding value to seafood
waste and byproducts**

What is Chitosan?

biodegradable • biocompatible • non-toxic

Chitosan is made from chitin, the second **most abundant biopolymer** in the world (after cellulose).

Tidal Vision Chitosan is **upcycled from byproducts** of the seafood industry.

It is the **only biopolymer in the world with a + positive (cationic) charge**.

After independent scientific review in 2020, the EPA added chitosan to the Safer Chemical Ingredient List as a **Green Circle – the highest rating for human and environmental safety**.



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Chitosan's Unique Properties

A versatile biomolecule with unique potential



The **only** biopolymer that naturally has a **positive** electrostatic charge

This makes it useful in 400+ applications on the market today that otherwise require problematic materials or chemicals.

+ Stable & Repeatable

Chitosan is stable and we can modify & characterize precisely

+ Modifiable Building Block

We can modify (MW, DDA, structure) then create novel biomolecules with a chitosan backbone

Novel plant elicitor with a **proven** mode of action

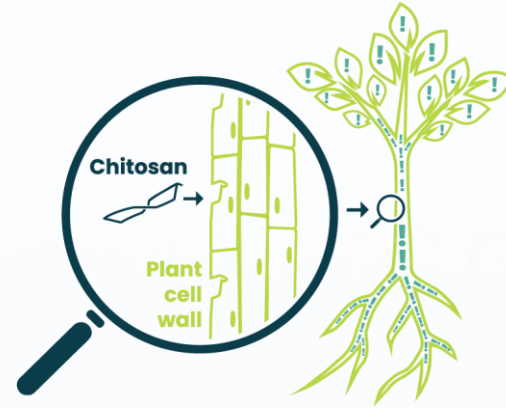
Chitosan triggers a systemic plant response that yields a host of unique benefits in different applications.

+ Safe & Green

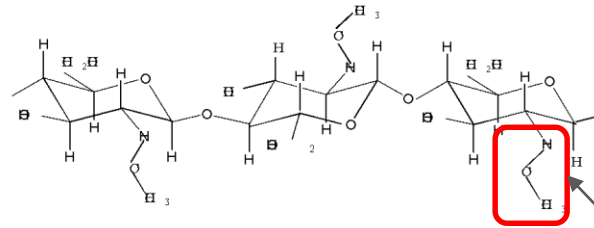
Chitosan is biodegradable, biocompatible, and nontoxic

+ Abundant supply

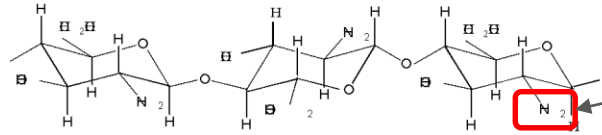
Made from the second most abundant biopolymer on earth!



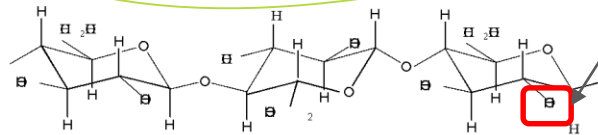
Structural Comparison of Chitosan (to Chitin and Cellulose)



(a) CHITIN



(b) CHITOSAN



(c) CELLULOSE

Molecular structures of Chitin (a), chitosan (b) and cellulose (c)

Note that chitin, chitosan, and cellulose are very similar aside from chitosan's **functional free amine group(s)**.

Due to chitosan's unique structure and being a primary amine with available hydroxyl and amino groups, it is uniquely able to add value **when blended** with metal coagulants (ie. ACH, PAC, Ferric Chloride, etc.), PolyDadmac, and more when **formulated properly**.

At low pH, chitosan's amine group becomes **protonated** (positively charged).

So **chitosan acetate**, chitosan in a homogenous acidic solution, makes it the **cationic polyelectrolyte** and **natural coagulant** we know & love.



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Problem: Chitosan was historically limited to niche water treatment applications



Too Expensive

Chitosan has historically been produced with a process that was expensive (solvents consumed in reaction) and produced hazardous waste. This tradition process also lowers the molecular weight of chitosan.



Limited in Form & Formula

Chitosan has primarily been available in a dry inconvenient form. Dissolving it into a liquid solution can be challenging at scale, especially with higher molecular weights (non-newtonian fluid).



Unreliable

Chitosan can be made in a wide range of specs (DDA, molecular weight, crystallinity, etc.) but historically has been only been available in a narrow range. However, changes in certain specs can increase efficacy 400%+.



You had to do it all

To incorporate chitosan you'd have to rely on overseas manufacturers, figure out how to solubilize it at scale, what specs to use and how to characterize them, and the possibilities were still limited unless you invested in years of R&D.

Build a vertically integrated technology stack to enable new possibilities



Closed-loop manufacturing

When produced in Tidal Vision's closed-loop process, the resulting material is lower cost, has more precise specifications, and can be cloned globally with minimal regulatory complications.



Liquid Form Versatility & Infrastructure

Chitosan must be available in use-specific liquid formulas for efficacy and adoption. Tidal Vision's distributed Hub & Spoke model enables economic delivery in a ready-to-use form for the first time.



Lab + Team

Tidal Vision's world-leading characterization lab & team connects efficacy + repeatability to the same extent as the petroleum industry has for years. Continuous R&D gets products ready for market and builds on previous success.



Water Specific Technologies

- Viscosity modification clears one of chitosan's biggest challenges to adoption.
- Potable Water products are on the market in the USA, and ready for new markets.
- Chitosan Hybrid solutions for technically difficult water clarity challenges.

Expand Water Treatment Application Technologies



Storm water



Potable water



Wastewater



Reclamation & Mining
Runoff + Wastewater



Oil refinery wastewater |
DAF + tight oil emulsion



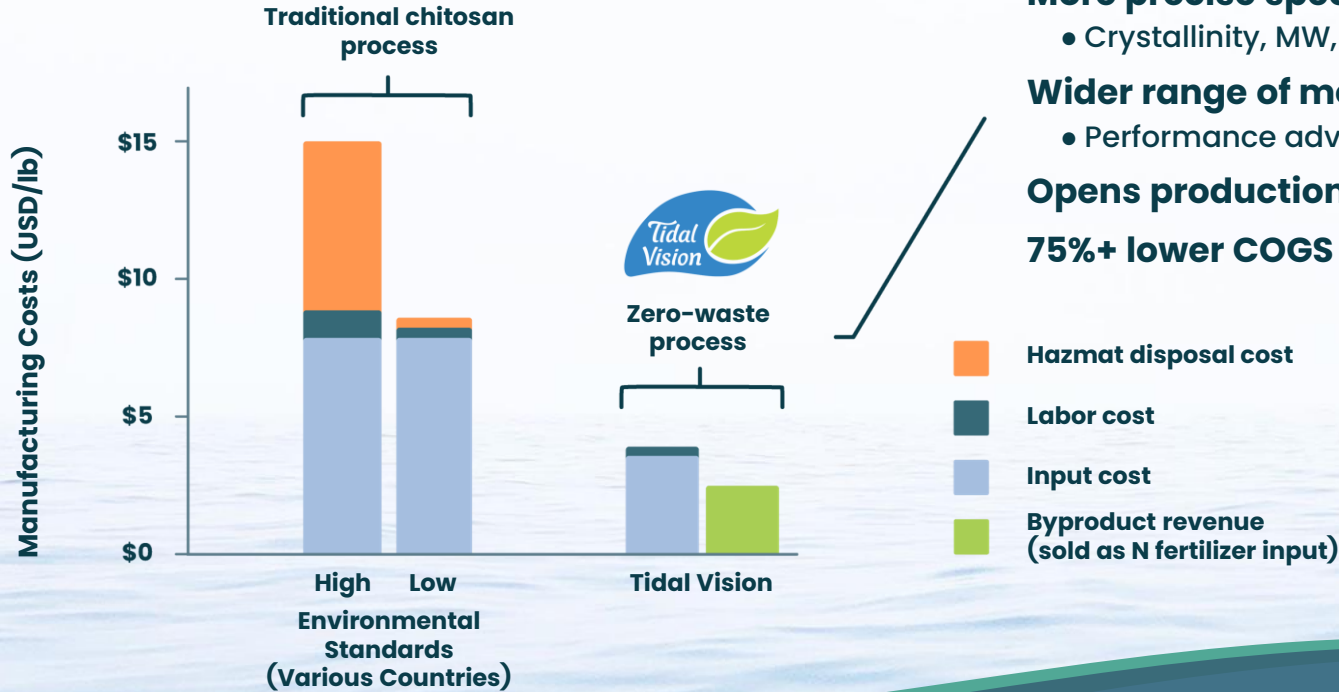
Resource Recovery |
Food production



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Upstream Process Innovation

We make chitosan lower cost and we make it **greener**



More precise specs

- Crystallinity, MW, PDI, DDA

Wider range of molecular weights

- Performance advantages

Opens production globally

75%+ lower COGS



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Our Impact

The power of the circular economy

Advanced upcycling

We take an abundant & problematic byproduct from sustainable fisheries

Crustacean shells are slow to naturally biodegrade due to their high calcium carbonate levels, so they either create ecological issues if concentrated on the ocean floor, or they are sent to landfills or incinerators.



Zero-waste production process

Full utilization of the raw material

The byproduct from our chitosan extraction process is a 6-7% nitrogen fertilizer input

Doesn't produce any hazardous waste

Unlike our overseas flake competitors, our process produces no biohazardous waste

Displacing toxic synthetic chemicals

In Textiles: Toxic antimicrobials & fire retardants

In Agriculture: Chemical pesticides, fungicides and insecticides that harm pollinators. Further, chitosan increases the bioavailability or plant uptake of many other crop inputs

In Water Treatment: Non-biodegradable flocculants and coagulants

+ Life cycle costs of synthetic chemical production

+ Human handler health & safety

+ Value-add, non-toxic, biodegradable biosolids/residuals



Preventing chemical runoff

Further, our Tidal Clear™ products are currently used to remove pollutants from our waterways on a commercial scale

Chitosan is 100% biodegradable, biocompatible, and nontoxic

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The Hybrid Model

Chitosan blends outperform metal-based components alone:

- Greater than 5X turbidity reduction with Tidal Clear Hybrid vs. ACH
- 63% improvement in filterability
- 47% lower TDS
- ACH concentration reduced by 68% by supplementing with chitosan

Full Report: [link](#)

Settling & Gravity Filtration	Tidal Clear 1% chitosan acetate (Non-hazmat)	50% ACH high basicity solution	Tidal Clear Hybrid (TCH) (Non-hazmat)	Competing Product: BHR-P50
NTU - Turbidity	10.08	2.06	< 0.5	< 0.5
Mins to filter 95% of supernate	30	26	16	30
TDS Total Dissolved Solids (mg/L)	262	390	265	265



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Molecular Weight of Coagulants, Floc-builders, and Flocculants

Metal salts – FeCl ₃ , Alum (Al ₂ (SO ₄) ₃)	162–342 Daltons	}	Coagulants (inorganic and organic)
Polymerized metal salts – PAC, ACH	150–5 k Da		
Synthetics – Polyamines	150–5 k Da		
Tidal Vision Ultra Low MW chitosan	500–25 k Da	}	Floc-builders Act as coagulants and flocculants
Plant based – tannin, lignin, starch	500–25 k Da		
Chitosan biopolymer (tunable with TV)	25 k–1,500 k Da	}	Flocculants
Polyacrylamides (+ some pdadmacs)	1 M to 30 M Daltons		

Performance improvements & indirect cost savings from chitosan hybrids

Chitosan hybrids directly lower cost compared to metal coagulants.

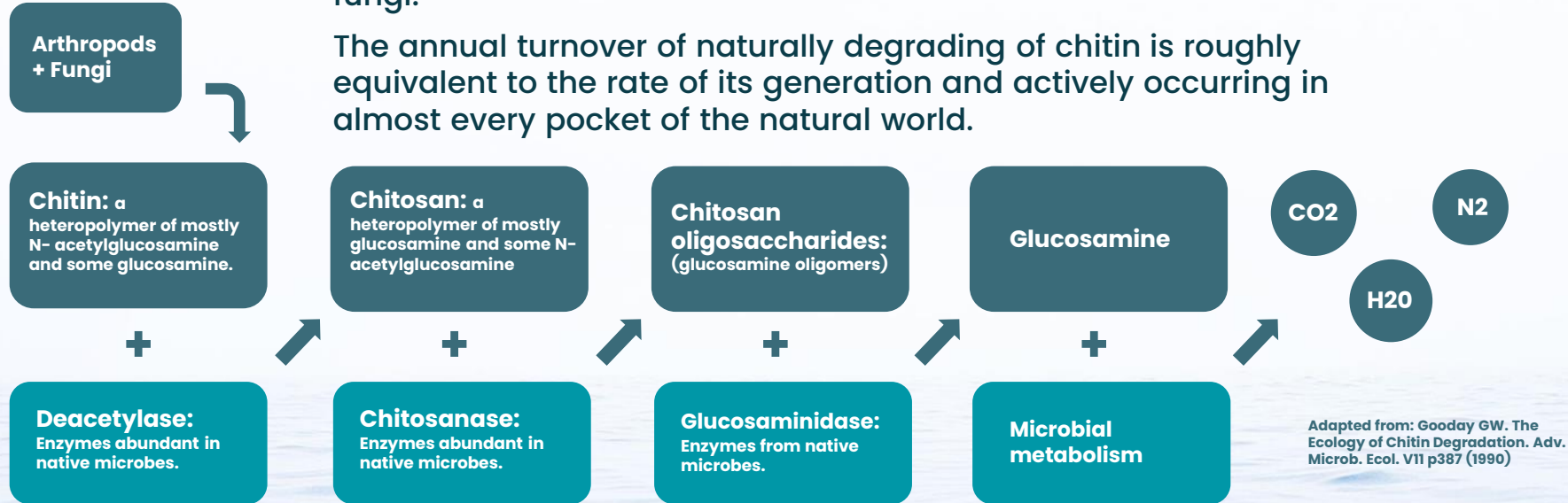
This is due to Tidal Vision's higher molecular weight performance advantages, which only require 0.5% to 1% chitosan concentrations to reduce metal concentrations by 60–85%. This brings performance advantages and indirect cost savings:

- 40–80% Lower TDS going into filtration system
- Lower Sludge Volume = lower disposal costs
- Drier solids
- Higher throughput from less filter blinding, less backwashing of filters
- 5–10% better filterability and cleaning cycle times on clean media initially
- 20–40% faster settling velocity than metal coagulants alone
- No caustic handling (safety and lower cost) due to elimination of pH adjustments
- Non-hazardous makes freight and logistics simpler, safer, and lower cost

Biodegradation Process of Chitosan

Chitin is the essential structural material in arthropods (jointed-leg invertebrates such as crustaceans, insects and arachnids) and fungi.

The annual turnover of naturally degrading of chitin is roughly equivalent to the rate of its generation and actively occurring in almost every pocket of the natural world.



Our **technology stack** empowers our **commercial divisions**



Tidal Clear[®]
BIOPOLYMER WATER SOLUTIONS

**Economical &
sustainable water
treatment**



Tidal-Tex[®]
BIOMATERIAL SCIENCE

**Safe & nontoxic
performance
material solutions**



Tidal Grow[®]
AgriScience

**Revolutionary crop
protection and
nutrient use efficiency**



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Tidal Clear®
BIOPOLYMER WATER SOLUTIONS

Already used to remove toxins from 2+ billion liters of contaminated water per month!

Tidal Clear provides biodegradability & higher performance at a lower cost as a turnkey coagulant and flocculant line for one of the most chemical consuming parts of industrial water treatment.

Due to chitosan's unique structure & properties, it increases performance and adds value when used alone *or* synergistically with mainstream synthetic polymers.

Market Drivers: The coagulants that are most widely used today have aquatic toxicity at low dosages, are non-biodegradable, and are under increasing regulatory scrutiny.

 Metal based coag

Natural & Biodegradable	✓	✗
Non-hazmat	✓	✗
High Strength Flocc	✓	✗
Enables Sludge Upcycling	✓	✗
Lower Application Rates*	✓	✗

*Tidal Clear displaces 10-30X the amount of synthetic polymers per amount of chitosan

A few of our customers



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by



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 **Tidal Clear**™
CHITOSAN WATER SOLUTIONS



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