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Ensuring the Effective Removal of Colloidal and Ultra-Fine Solids via Polymer Chemistry

April 21, 2022

Natural Resource Recycling • Product Classification • Fluid Recovery
Dewatering • Waste Management • Material Handling • Liquid/Solid Separation

Polymer Chemistry

Used to Remove Colloidal and Near Colloidal Suspended Solids from an Aqueous Slurry

Depending on the industry, the use of polymer chemistry to remove colloidal and near colloidal solids, may be considered “dewatering” or “polishing treatment”.

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Visualizing Colloidal Solids

Size Matters

The above visual representation has been magnified 1,000X.

Polymer Separation Applications

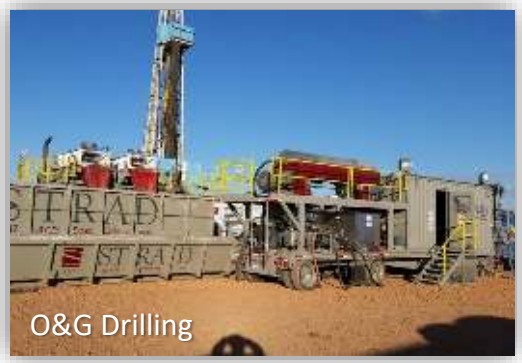
The Number of Applicable Markets and Industries Continues to Grow


Hydro-Vac


Mine Water Recovery


Acid Mine Drainage


Pipeline Drilling


O&G Drilling


Microtunneling

Alternatives Include Real-Estate Demanding Settling Ponds, Power-Demanding Electrocoagulation, or Throughput-Limited Dynamic Spiral Plate Settling.

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Polymer Chemistry Benefits

There are Several Benefits Derived from Effective Polymer Treatment:

Discharge Compliance

Ability to achieve stringent discharge compliance. In many cases, the addition of a dewatering system enables "zero discharge" or "closed loop systems". This also provides for improved site HSE.

Stackable Solids Discharge

When properly managed, dewatered solids are discharged as a stackable solid that can be land applied (a.k.a. land farming) or disposed of via non-Sub-Part B landfills.

Raw Water & Fluid Recovery

Dewatering systems are capable of producing solids-free recyclable water. For water-based drilling application, this means that drilling fluids can be continuously recycled.

Eliminates Open Pits & Evaporation Ponds

As a closed-loop system, dewatering systems allow sites to operate without open pits. This reduces the site location footprint and the environmental impact.

For applications using drilling fluids, polymer-assisted separation improves drilling performance (i.e. pipeline, drilling rig, foundation drilling, water-well drilling and geothermal loop drilling).

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Polymer Basics & Selection

Selecting the Appropriate Polymers Starts With Understanding the Applicable Physics

Defining Colloidal Solids Reactivity

Based on the Molecular Structure of Colloidal Solids:

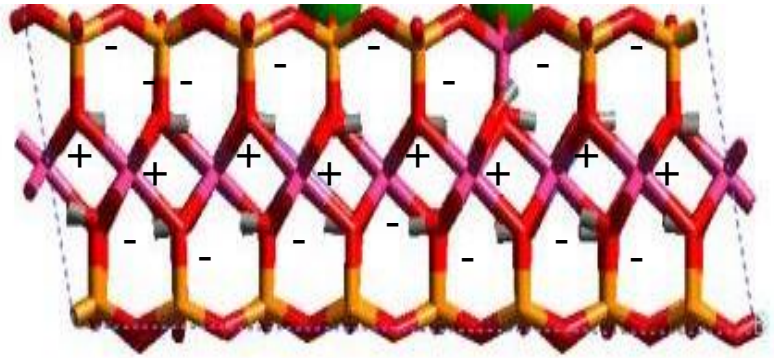
Colloidal Solids Tend to be Built from Three Thin Layers.

A powerful alumina layer, binds two sandwiching silica layers, as a result of its strong positive charge.

Silica (Negatively Charged)

Alumina (Positively Charged)

Silica (Negatively Charged)



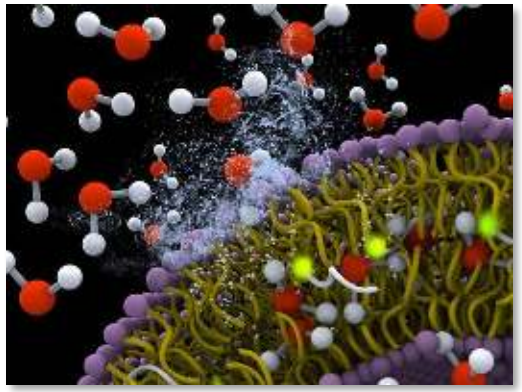
This molecular structure creates a particle that has a strong negative charge on its surface. The strength of this charge defines the level of reactivity.

Defining Colloidal Solids Reactivity

Two Basic Features:

Water Absorption / Hydration

The ability of the solids to absorb water from the slurry due to the attractive forces inherent to the surface of the material. The positive (+) ions in the water swarm around the (-) suspended solids particles. This causes the particle to swell, creating a fluid "envelope" around the particle.



Material Dispersion / Repulsion

The degree (or lack thereof) of a material to cement or agglomerate (i.e. disperse or de-flocculate in the presence of water) is based on the strength of the charge. Since the exterior of the particle tends to be negatively charged, like forces repel.

Reactivity is the combined measure of the desire for the suspended solids to hydrate and/or disperse in an aqueous environment.

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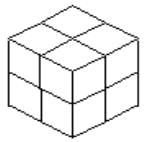
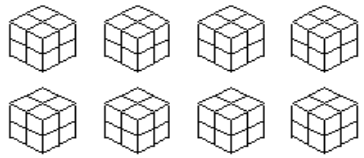
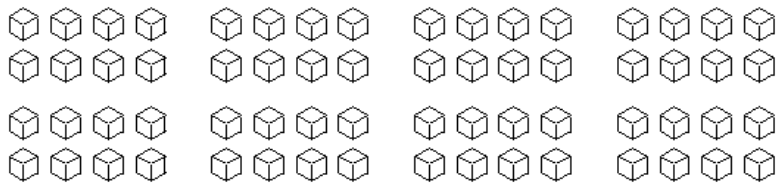
Reactivity is Influenced by Surface Area

As Solids Become Smaller, the Surface Area Grows:

Physical Degradation of Solids	Volume	Surface Area	Surface Area Increase
	1 in^3	6 in^2	N/A
	1 in^3	12 in^2	200%
	1 in^3	36 in^2	600%

Volume remained constant, yet surface area increased by 600%, therefore the liquid volume absorption increases by 600%.

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Polymer Options

There are Two Basic Types of Polymers Available:

Organic Polyacrylamide Polymers (Dry or Liquid)

Advantages

- Higher activation potential.
- NSF drinking water capable.
- No effect on effluent pH.
- No effect on effluent dissolved metals content.
- Normally no pH pre-treatment required.

Disadvantages

- Susceptible to freezing.
- Shorter expiration dates.
- Relatively more expensive.

Inorganic Metal-Based Polymers (Dry)

Advantages

- Not susceptible to freezing.
- Relatively less expensive.
- Indefinite shelf-life.
- Easier to handle.

Disadvantages

- More difficult to activate.
- Likely to effect effluent pH.
- Likely to effect effluent dissolved metals content.
- Commonly requires pH pre-treatment via acid.

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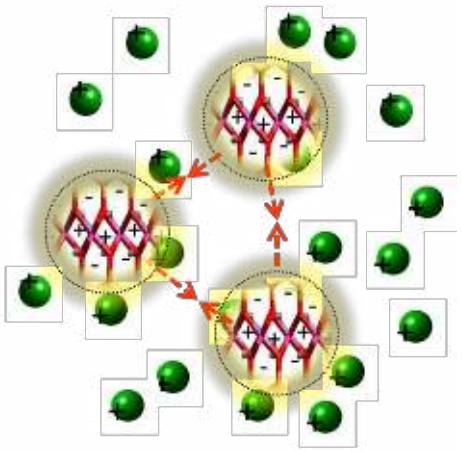
Polymer Types

Two Basic Polymers with Very Different Jobs:

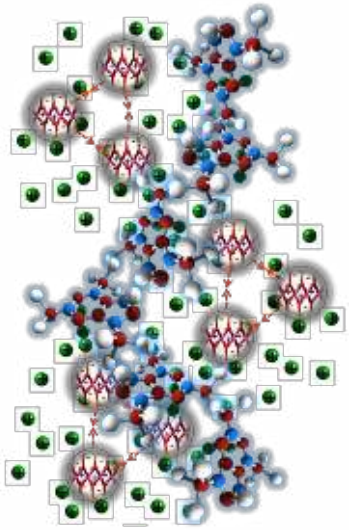
Coagulant

A water-soluble polymer, added to water laden with colloidal and near colloidal solids, neutralizes the particles' negative charge. Once neutralized, the particles can come together to form larger particles called micro-flocs or pin flocs.



Flocculant

A water-soluble polymer added to coagulated slurry that brings together the coagulated particles to form longer and larger particle chains. As the flocculant chains become larger, they become heavier and stronger.



There are situations that may be encountered in which a coagulant may not be necessary. In addition, there are suppliers that can provide a combination polymer that provides both a coagulant and a flocculant.

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Deployment of Polymers

Polymer Management Systems Do Influence Polymer Effectiveness

Pre-Treatment is Key

Most Polymer-Assisted Treatment System Fail Due to Inadequate Pretreatment

Oversize Scalping

The effectiveness of polymers drops dramatically as the size of the solids in the slurry increase. Polymer are designed for colloidal and near colloidal solids. By allowing fine and intermediate solids into the treatment system, the effectiveness of the chemistry is reduced. This ultimately increases the required polymer dosage.

pH Management

Management of the pH is a more important concern when using inorganic polymers. However, extremely acidic or caustic pH's can also negatively affect organic polymers. As such, pH adjustment may be required to achieve the desired results.

Slurry Dilution

If the concentration of colloidal and near colloidal solids are too high, there may not be sufficient time for the polymers to interact with all of the suspended solids. This can also lead to loading problems for the separation system deployed. For example, a decanter centrifuge should not be fed a slurry with more than 1% solids when using polymers.

Prior to starting any polymer-assisted dewatering project a clear understanding of the percent solids and particle size distribution of the slurry is required.

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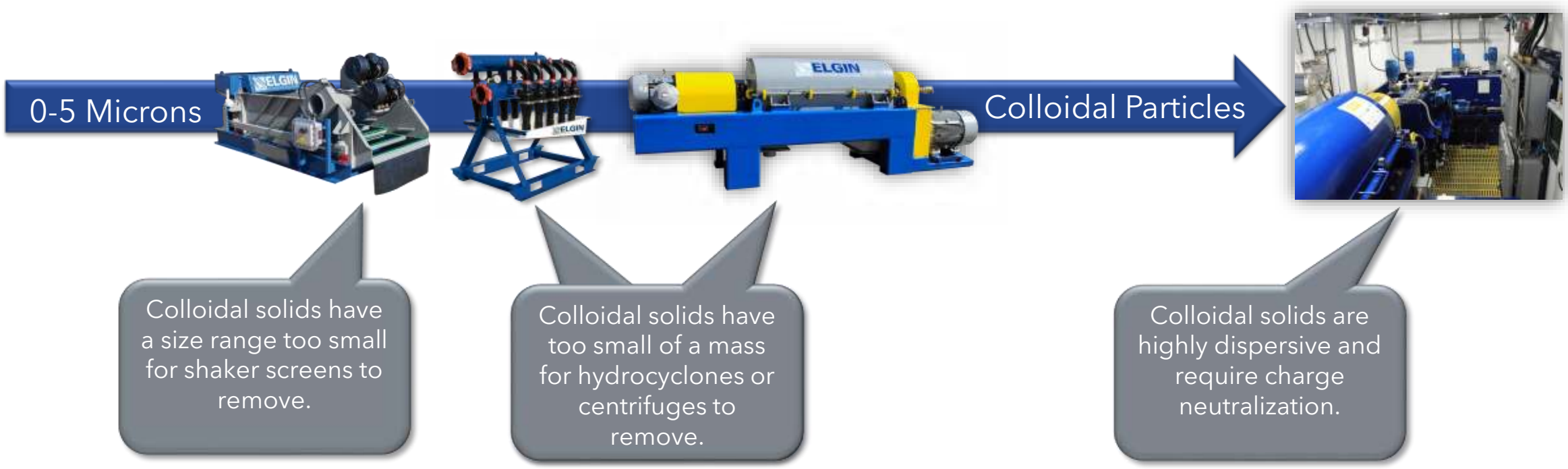
Pre-Treatment is Key

Polymer-Assisted Treatment Systems are a **Complement** Not an Independent Solution



Polymer consumption geometrically grows with the percentage of solids and the particle size distribution of those solids.

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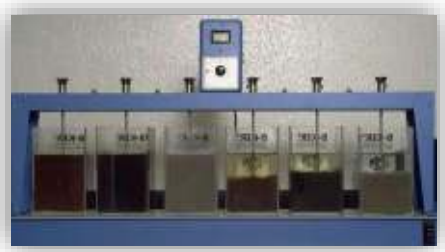
Planning is Key

Even With Proper Pre-Treatment, the Introduction of Polymers Must be Planned

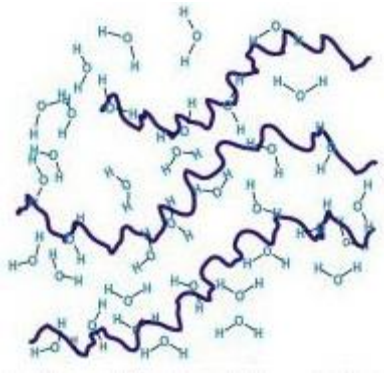
Dosage & Dilution Bench Testing

The polymer dosage is slurry specific. It should not be assumed that one application is the same as the next. Bench-testing will define the best polymer combination, possible additional pre-treatment required, the required dilution, and the dosage necessary to achieve the desired reaction.



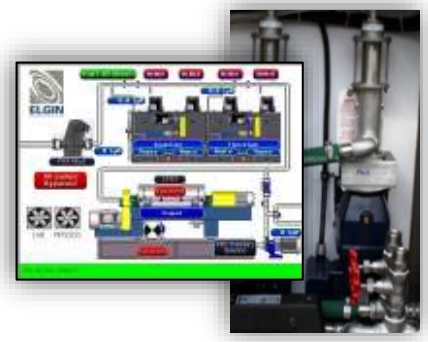
Polymer Preparation & Hydration

Polymers are provided in neat or concentrated forms. As such, they must be properly diluted and allowed to hydrate. This process of hydration allows the polymers to "relax" and maximizes their efficacy.



Precision Control & Measurement

Under-dosing and over-dosing will reduce the effectiveness of your treatment plan. Under-dosing will provide a fraction of the effectiveness needed, where over-dosing can lead to major system challenges down-stream of the polymer treatment system.



Controlled Mixing & Residence Time

Proper mixing and shear of polymers is necessary to ensure complete chemical reactions; Contact is required. Further, polymers require residence time to achieve the desired treatment results. Too much residence time can shear the polymer bonds and insufficient residence time will result in an inadequate reaction.

System automation and capacity must not be overlooked. Though "poor boy" systems can provide an affordable option, they will drive up the cost of labor and increase the risk of improper dosage.

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Treatment System Options

There are Countless Configurations Available to Meet Every Possible Application

Depending on the site conditions, the overall volume of product to be treated, and the characteristics of the slurry, Elgin's Engineering Team can provide a bespoke system fitting your needs.

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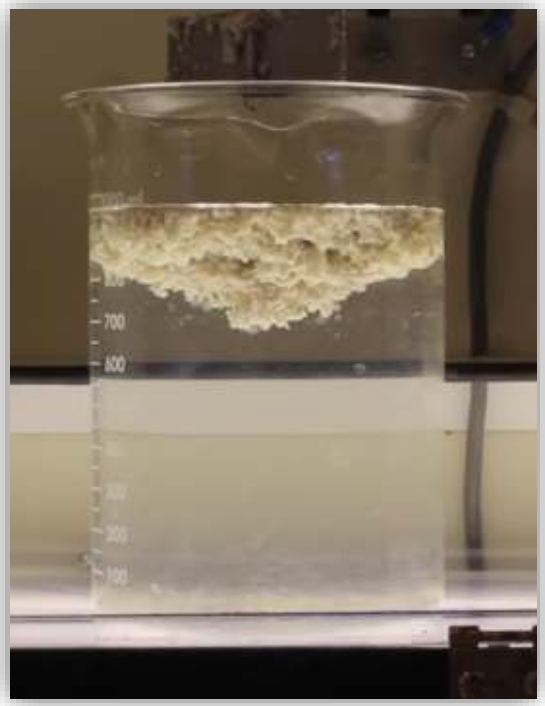
Indications of Success

Identifying a Successful Polymer-Assisted Process

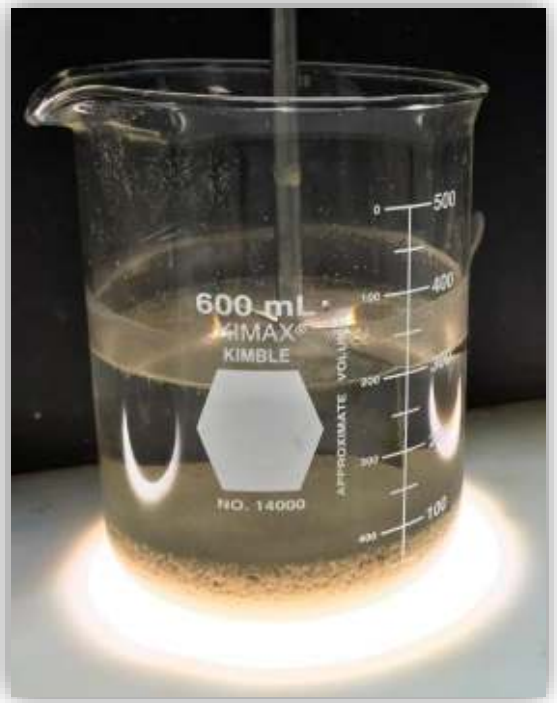
Visual Indicators for Success

Proper Bench-Testing is the Key to Achieving Results



Floating Floc will Likely Produce Poor Results

A “Chunky” Sinking Floc Tends to Provide the Best Indication of a Shear-Stable Floc



Small and Highly Granular Floc Will Likely Produce Poor Results

If the floc floats, or appears highly granular and small, then a different polymer chemistry should be considered. The goal is to create a “shear-stable” floc.

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Polymer-Assisted Solids Separation Economics

Driven By Interconnected Financial and Environmental Objectives

Water and/or Drilling Fluid Reclamation

Polymer-assisted dewatering systems recover fluids extracted from solid/liquid slurries. When unrecovered, this lost fluid or water can cost thousands per day.

Waste Solids Volume Reduction

By reclaiming fluid from waste spoils or cuttings, the overall volume (or weight) of the waste solids is lowered, therefore lowering transport and disposal costs by the same percentage of fluid recovery, generating savings.

Waste Solids Declassification

Depending on the application, or even on the region in which the activity is occurring, the reduction of the fluid content can lower the disposal hazard classification of the waste dewatered solids.

Though many polymer-assisted solids separation systems are deployed to achieve regulatory compliance, the best systems will recover valuable water and generate a financial return or help avoid disposal costs.

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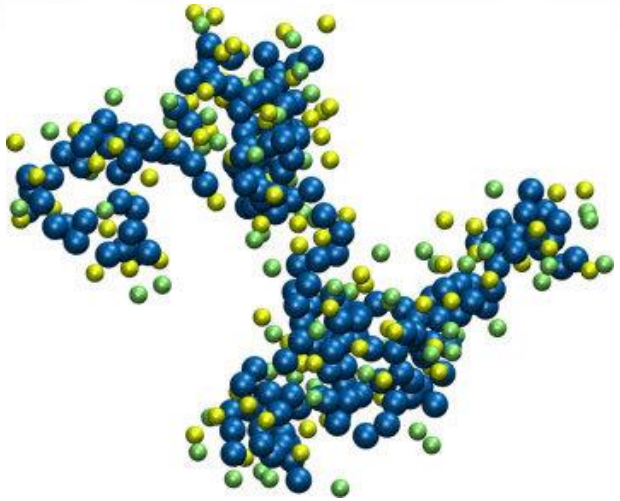
Parting Thoughts

The Link Between Employee Education, Equipment Efficacy and Environmental Equity



As with all technology, its effectiveness is inherently limited by the quality of the personnel we entrust to deploy and operate It. The more we do to educate, certify and retrain our most valuable assets, the more our organizations, and the world we live in, will benefit.

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Ensuring the Effective Removal of Colloidal and Ultra-Fine Solids via Polymer Chemistry

https://www.youtube.com/watch?v=Y0E6ioTLg2E.
https://www.youtube.com/watch?v=qb5hGTak0d8.
https://www.youtube.com/watch?v=SlejXEQ0Dv4.
https://www.youtube.com/watch?v=lNTvuEs8Tcc.
https://www.youtube.com/watch?v=-ccdAp0_J5U.

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