

API® Lesson 11 | Cloudy Water - Flocculation and Coagulation

This lesson plan provides information and an understanding about cloudy water, why it is a concern, how to deal with it to obtain clear water, and a physical experience making and clarifying a synthetic cloud.

The water in a properly set up aquarium or pond normally is clear and for continued pleasure and enjoyment it should remain clear. To understand clear water, we must understand when conditions occur that result in cloudy or murky water and what can be done. This exercise will provide insights and terminology on dealing with cloudy water. At the conclusion of this activity a better understanding of how the importance of clear water plays a role in fish health not just aesthetically, but biologically.

For Instructor/Teacher/Parent

Make sure to read through the entire lesson plan before beginning this with students/family members as materials will need to be purchased and information prep will need to be done.

Learning Objectives

After completing the activities outlined in this lesson plan, students should be able to:

- Understand what can cause cloudy water
- Determine what steps to perform to obtain clearer, cleaner water
- Discuss cloudy water association with fish health
- Why it's important to test your water, how to test, what the results mean, and how to correct them

Length

This activity will take about 2 hours for completion of this exercise.

Materials to complete activity

- 2 each - Balloons
- 1 each - length of fine fish line, 3 foot (90 cm.)
- 2 each - 1-quart (~1.0L) Mason/Ball Jars with lids or Two Clear Pint Glasses with lids
- ½ gallon (~2.0 L) mixing container
- 2 Tbsp. (30ml) Corn Starch
- Stirrer or long handled spoons
- Watch or device to monitor time
- API ACCU-CLEAR™ water clarifier 1¼ oz (37ml) bottle with dropper tip

Key Terms

Review key terms (printable sheet included at the end of the lesson) with students/family members.

- 1) FLOCCULATION/COAGULATION
- 2) ORGANIC
- 3) INORGANIC
- 4) ADSORPTION
- 5) ABSORPTION
- 6) COLLOIDS
- 7) NEGATIVE CHARGE
- 8) POSITIVE CHARGE

Warm Up

Ask a couple of questions to warm up for the lesson:

- 1) Do you currently have an aquarium or pond? If so, why do you want the water to be clear?
- 2) Have you ever seen cloudy water? Describe what you have seen.
- 3) What can cause cloudy water?
- 4) Why do you think it might be important for fish to live in cloudy or clear water?

Before You Start

We often think that clear water is safe water for our fish and aquatic friends or even us and that brown or cloudy water is not as healthy. Well, the only way to tell if any water clear or cloudy is to test the water. Many materials such as ammonia or nitrite are invisible to the naked eye, but we can test for them. We can have high levels of either ammonia or nitrite in water that is clear. pH of water is independent of the whether the water is clear or cloudy. So clear water is just that, it is clear water, neither healthy nor unhealthy, just clear until we test it.

When water is cloudy it can contain both organic and inorganic materials. Organic materials would include algae, protozoa, humic acid, and bacteria to name a few. Even most colors are natural organic matter. While we cannot see the individual particle of color, however, when they are in higher numbers, we will then see the color in the water. Inorganic materials would include silt, gravel dust, mineral oxides, and clay to name a few. All these particles both inorganic and organic have one thing in common, they are small enough, so they do not settle to the bottom or get caught by the filter. When particles are too small to settle or get caught by the filter they are called "colloids". Each colloid by itself is not seen when we look at the aquarium. However, when we have large amounts of colloids in the aquarium the water will appear cloudy or hazy, thus we are seeing the accumulation of the colloids as a group. We can measure the amount of the cloud or haze and that measurement is what is known as Turbidity. The cloudier the aquarium water, normally the higher the turbidity.

Colloids remain in the water because of their small size and negative charge, as a result they do not clump together on their own as they are negatively charged which causes them to repel each other. To clump colloids together we need to neutralize their charge. This is normally done through adding a flocculant or coagulant such as API ACCU-CLEAR water clarifier. A flocculant or coagulant needs to be effective, non-toxic, and insoluble in water. The flocculant needs to be positively charged to attract the negative colloids to make a larger molecule. Much like the poles on a magnet, the negative end of one magnet will repel the negative end of another magnet. If the positive end is open the negative end of the other magnets will connect to it.



Turbid water or water high in turbidity is often associated with dirty aquariums and higher potential disease concerns. Even bacteria in the water often appears as cloudy or grey water. Colloids themselves can often adsorb toxins or have toxins stick to them. Adsorption is when molecules stick to the outside of a colloid. The opposite of adsorption is Absorption. Absorption is when a material normally a fluid is dissolved by or permeates a liquid or solid. To think of how to differentiate between adsorption and absorption use the first letters "ad", in adsorption the materials are held loosely on the surface of the adsorbent, it is added. Absorption is when the material is taken in or soaked up into the colloid. When we eat a pie, we are absorbing it, taking it into our stomach. If we throw a pie at someone it is adsorbed, meaning it sticks to the outside of their body or face.

So, when there are large numbers of colloids in the water there is more surface area for toxins to adhere to. The more toxins the more dangerous or toxic the conditions can be. The best way to clean the toxic cloudy, murky water is to flocculate the colloids. Flocculation is the process of having the various colloids come together or stick together to make them larger. As a larger compound they will either be removed by the filter or drop to the bottom of the aquarium and become trapped in the gravel. We can remove the collected colloids either by changing or cleaning the filter material or through water changes when we siphon the aquarium gravel or bottom. To flocculate colloids, we can add a chemical designed to clump the colloids together to form a floc (coagulated colloids into a clump).

Instructions for Learning Activity

1. Understanding Negative and Positive Charge

- a. Obtain two balloons. Inflate the balloons and tie a knot to trap the air.
- b. Now tie the balloons to fine fishing line about 3 feet (90cm.) in length.
- c. Using two balloons tied to fine fishing string hanging from above they will hang next to each other without any attraction or repulsion.
 - i. Record if they hang next to each other or apart.
- d. Rub one balloon against your hair.
 - i. Record how the balloons react to each other.
 1. The negative charge from your hair transfers to the balloon. Now if you have the balloons hang again you will see no reaction, just like before they will lay next to each other.
- e. Next, rub the second balloon against your hair.
 - i. Record how the balloons react each other.
 1. The negative charge from your hair transfers to the second balloon. Now, if you have the balloons hang again you will the two balloons move away from or repel each other.
- f. Next put your hand between the balloons.
 - i. Record how the balloons react to each other.
 1. The balloons are attracted to your hand. A positive charge (your hand) attracts a negative charge (the balloons). This demonstrates the achievement of coagulation and flocculation in action, similar to what happens in water.
- g. The reaction of the balloons represents an example comparable to colloidal suspension in the water. The balloons represent negative particles in the water that always want to repel each other. So, for the particles in the water that cause cloudy water, we need to overcome the negative charges to get everything to clump together so they are no longer small and then can be removed by filtering or settling.

2. Understanding Flocculation and Coagulation

- a. Obtain ½ gallon (~2.0 L) mixing container and fill with water.
- b. Add 2 Tbsp. (30ml) corn starch to the water and stir. The water will become the color of milk.
- c. Now pour the water with corn starch into the two mason jars OR pint glasses. Fill each container with the cloudy water, leaving about 1 inch (3cm.) from the top.
- d. Seal the mason jars with the lids and shake for about 30 seconds.
- e. Place the jars on a flat surface and observe.
 - i. Are each of the jars equal in cloudy appearance? Yes or No
- f. Add 1 drop of API ACCU-CLEAR water clarifier to one jar. Be sure to remember which jar has the ACCU-CLEAR water clarifier and which jar does not have the ACCU-CLEAR water clarifier.
 - i. Over the next 60 minutes observe each jar every 10 minutes. Record what happens to the water in each jar. Does one jar start to clear more than the other?

How to Maintain Clear Water, What Happened?

The Corn Starch is a very small particle about 1 to 10 microns wide, smaller than a grain of sand. In fact, a single molecule of corn starch is about 100 times smaller than a grain of sand. Therefore, you can see a grain of sand but cannot see a single molecule of corn starch. When all the corn starch molecules are suspended in the water you can see the cloudy water, but you cannot see each single particle corn starch.

Almost all colloids have a negative surface. This means that positive charged materials will attract to the surface of the colloid. When adding API ACCU-CLEAR water clarifier, a strong flocculant to the water it adheres to the colloids modifying the outer positive layer of the colloid which then allows the colloids to stick to each other. As more and more colloids stick together the larger particle is known as a floc and heavy enough to either settle to the bottom of the aquarium or large enough to be caught by the filter. So, the colloids were altered so they could coagulate or flocculate into a floc (larger particle) and then precipitate out of the water.

In an aquarium or pond, we have natural flocculants that over time will help to clump the fine particles together allowing them to settle out of the water and fall to the bottom or be captured by the filtration. In newly setup aquatic environments, the naturally occurring flocculants are either not present or not in great enough quantity. By adding a flocculant like API ACCU-CLEAR water clarifier, the fine particles can stick together and settle out more rapidly so you can have cleaner, clearer water. Remember API ACCU-CLEAR water clarifier destabilizes the non-settleable solids floating in the water causing them to stick together to become larger, heavier, and more dense solids. The reason for shaking or even distributing the flocculant into the water is to cause as many collisions as possible of the flocculant with the fine particles. The amount of time for the reactions to occur is affected by many factors such as pH, alkalinity, or temperature, the warmer the water the faster reaction time and the quicker the water will clear.

Now you can explain why aquarium water is cloudy. And what someone should do.

Many aquarists get quite upset when they set up their aquarium or fill their pond and the water is not perfectly clear. Hobbyists also get quite concerned when they have an aquarium, whether new or old, and suddenly, they cannot see their fish anymore. The conditions occur more frequently in a newly set-up aquarium or pond than most people realize. In new aquariums and ponds, the addition of gravel, rocks, plants, decorations, and other materials, when setting up their aquatic environment to satisfy their desires can cause particles/debris in the water. Most people do not properly wash the gravel and rocks and dust releases slowly from these materials once the water is added and gradually builds up, becoming worse and worse. Many fish owners overfeed their fish leading to excess fish waste or fine particles of food leftover that float in the water leading to

cloudy water. Filters are designed to remove debris from the water, but the fine dust is so small the filter cannot trap it. The material will often gradually naturally settle overtime and fall to the bottom, only to be easily stirred up from fish or water movement. When a new aquatic environment is setup it is a sterile environment with very few beneficial bacteria present. During this initial startup period any fish waste, uneaten fish food or excess organics is not consumed by the bacteria and accumulate in the aquarium. This process leads to cloudy water often referred to as "New Tank Syndrome". Additionally, maintenance in established aquatic environments, such as water changes, filter cleaning, and trimming and re-potting plants can stir up dirt and debris. In all these instances, a flocculant or coagulant such as API ACCU-CLEAR water clarifier will quickly restore the aquatic environment to a perfectly clear condition.

API ACCU-CLEAR water clarifier is a unique colorless, inorganic polymer that rapidly eliminates all forms of cloudy water caused by dirt, silt, dust, and other small floating debris. A flocculant or coagulant works by causing tiny, suspended particles in the water to clump together. These clumps quickly fall to the bottom of the aquariums and ponds or are removed by the filter.

Questions

- Pass out the Questions worksheet (printable sheet included at the end of the lesson) to each student/family member.
- Review the answers to the questions during the discussion section of the lesson.

Discussion

- After finishing the items above including the questions and key terms, engage students/family members in a brief discussion about the lesson:
 - Why does water become cloudy?
 - Will water clear naturally?
 - Why do most people care if their water is cloudy?

Quiz

- Once you've finished the discussion, pass out the Quiz worksheet (printable sheet included at the end of the lesson) to each student/family member.
- Have them complete the quiz and then review the answers/have an open discussion about the answers with them. Answers are below.
 1. What is the difference between adsorption or absorption?
 - Adsorption is when molecules stick to the outside of a colloid. Absorption is when the material is taken in or soaked up into the colloid
 2. Why does water in an aquatic environment become cloudy?
 - Cloudy water most often occurs as a result from the build-up of materials that float in the water such as uneaten fish food, fish waste, gravel or rock dust, dead plants, etc. Additionally, during maintenance of aquarium or pond causes cloudy water. Maintenance often stirs up dirt and debris that is very fine and stays suspended in the water.
 3. What happen to cloudy water particles once they are flocculated or coagulated?
 - The particles clump together and are either removed by a filter or settle to the bottom.
 4. Which of the following are organic materials?
 - A. protozoa,
 - B. humic acid
 - C. bacteria
 - D. algae

- E. All of the above
 - The answer is E. All of the above
- 5. Which of the following are in-organic materials?
 - A. silt
 - B. gravel dust
 - C. mineral oxides
 - D. clay
 - E. All of the above
 - The answer is E. All of the above
- 6. Why did the balloons repel each other and move away from each other?
 - The balloons were each charged with negative charges. And like charges do not stick together.

APPENDIX

See items below to be passed out to the family members or students for the lesson.

KEY TERMS

FLOCCULATION/COAGULATION

A process by which colloidal particles come out of suspension in the water to form a large particle (floc) and often settle out of suspension normally due to the addition of a clarifying agent.

ORGANIC

Materials derived from living matter such as plants, animals or bacteria

INORGANIC

Materials derived from non-living matter such as rocks, gravel

ADSORPTION

Adhesion of molecules or materials to a surface

ABSORPTION

When a molecules or material is taken in or sucked into another material

COLLOIDS

A mixture in which one substance of microscopically dispersed insoluble particles are suspended throughout another substance

NEGATIVE CHARGE

An object with an electrical property that has an excess of electrons at the subatomic scale. is negatively charged

POSITIVE CHARGE

An object with an electrical property that the number of protons exceeds the number of electrons.

LEARNING ACTIVITY SUPPORT



MATERIALS FOR CLOUDY WATER



INITIAL SETUP OF CLOUDY WATER



SETUP WITH API ACCU-CLEAR REACTING



JARS WITH & WITHOUT API ACCU-CLEAR USAGE

DISCUSSION QUESTIONS

1. Why does water become cloudy?
2. Will water clear naturally?
3. Why do most people care if their water is cloudy?

QUIZ

1. What is the difference between adsorption or absorption?
2. Why does water in an aquatic environment become cloudy?
3. What happen to cloudy water particles once they are flocculated or coagulated?
4. Which of the following are organic materials?
 - A. Protozoa
 - B. Humic acid
 - C. Bacteria
 - D. Algae
 - E. All of the above
5. Which of the following are in-organic materials?
 - A. Silt
 - B. Gravel dust
 - C. Mineral oxides
 - D. Clay
 - E. All of the above
6. Why did the balloons repel each other and move away from each other?

CONTACT US & ADDITIONAL RESOURCES

For more information regarding this lesson plan, API® brand, or any general fishkeeping questions and/or comments, feel free to contact us below:

- Website: www.apifishcare.com
- Telephone Number: 1-800-847-0659