# *Air-Lift and Flow Rate*

**Grade Level**:
5-12

**Subject Area**:
Aquaculture, Biology, Mathematics, Engineering, Computer Science

**Time**:
*Preparation time*: 10 minutes
*Activity*: 40 minutes (one class)
*Clean-Up time*: 10 minutes

**Student Performance Standards (Sunshine State Standards)**:
*02.02* Demonstrate proper safety precautions and use of personal protective equipment. (SC.912.L.14.6, SC.912.L.16.10; SC.912.L.17.12, 14, 15, 16; MA.012.A.2.1, 2).
*03.01* Employ scientific measurement skills (SC.912.E.7.8; SC.912.L.14.4; SC912.S.3.1, 9; MA. 912. A. 1.5; MA.912.S.4.2; MA.912.S.5.1, 3; MA.912.S.5.2, 3, 4, 5).
*03.06* Interpret, analyze, and report data (SC.912.L.16.1; SC.912.N.1.1, 2, 3, 4, 6, 7; SC.912.N.2.2, 5; SC.912.N.3.1; SC.912.N.4.1; MA.912.S.3.1, 2; MA.912.S.4.2; MA.912.S.5.1, 2, 3, 4, 5).
07.01 Select and demonstrate the use of agriscience tools, equipment, and instruments (SC.912.L.14.4; SC.912.P.12.2; SC.912.P.12.3 SC.912.P.12.4; SC.912.P.12.9; MA.912.A.1.4, 5, 8; MA.912.A.2.1; MA.912.G.3.1; MA.912.G.8.6; MA.912.S.3.2).
*12.01* Recognize and observe safety practices necessary in carrying out aquaculture activities (LA.910.1.6.1, 2, 3, 4, 5).
*12.03* Safely operate aquaculture machinery and equipment (LA.910.1.6.1, 2, 3, 4, 5).
*13.02* Explain how changes in water affect aquatic life (LA.910.1.6.1, 2, 3, 4, 5; SC.912.L.17.2, 3, 7, 10).
21.01 Identify and use basic computer programs (LA.7.6.1, LA.1112.6.4.1, SC.4.N.3.1).

**Objectives**: Students will be able to:

1. Create an air-lift pump using simple materials.
2. Compare and contrast air-lift designs.
3. Calculate the flow rates of water through their air-lift systems.

**Abstract**:
Understanding how a re-circulating system works can be difficult, especially when there is no visual example. In this lesson, students will create a mini RAS system in a bucket (or aquaria) to demonstrate how water flow-rate can be manipulated in an air-lift system. A simple air pump and PVC pipes are used to circulate water throughout the bucket. By changing the size of the PVC pipe and the position in the water column, the water flow rate will change. Students will be asked to

manipulate these variables, calculate the corresponding flow rates, and graph and interpret their results.

**Interest Approach**:
Ask the students to think about an aquarium as a simple RAS system. Do they think that aquarium will survive with just air? How will the water move? Have them think about any other kind of operation that uses air to propel/move things or create energy.

**Student Materials**:

1. Aquarium aerator and tubing
2. Aquarium or bucket with a water depth of at least 12"
3. PVC pipe-½", ¾", and 1" diameter cut to at least 1' lengths
4. PVC elbows - ½", ¾", and 1"
5. Stopwatch
6. Graduated cylinder
7. Small (1 liter) plastic container
8. Airstone (small enough to fit into a ½" PVC pipe)
9. Calculator

**Teacher Materials**:

| *Material* | *Store* | *Estimated Cost* |
|---|---|---|
| Aquarium air pump | Aquatic Ecosystems, Walmart, Petco, Petsmart | $9 and↑ |
| Airline tubing | Aquatic Ecosystems, Walmart, Petco, Petsmart | $1.20 per ft |
| Aquarium or bucket at least 12" deep | Local hardware store, Walmart | $3 and ↑ |
| PVC pipe: ½", ¾", and 1" diameter | Local hardware store | $3 and ↑ |
| PVC elbows - ½", ¾", and 1" | Local hardware store | $0.50 and↑ |
| Stopwatch | Target, Walmart | $10 and↑ |
| Graduated cylinder (500 ml) | Carolina Biological | $8 and ↑ |
| Small plastic container (1 liter) | Carolina Biological, Plastics.com | $10 and↑ |
| Airstone (small enough to fit into a ½" PVC pipe) | Aquatic Ecosystems, Walmart, Petco, Petsmart | $1 and ↑ |
| Grid paper or access to | NA | NA |

Excel or other graphing
program

**Student Instructions:**

1. Fill aquarium, bucket, or tank to a depth of at least 12 inches.
2. Cut PVC pipe and attach appropriate elbow.
3. Graduate each pipe at 1" intervals.
4. Run the airline from the aerator through the elbow and out the bottom of the ½" pipe.
5. Attach airstone and pull back tubing so that the airstone is level with the bottom of the pipe.
6. Place the pipe in the water at varying degrees of submergence (e.g. at water level, 10% submerged, 20 % submerged, etc.
7. Turn on aerator – water will begin flowing through the pipe.
8. Using a stopwatch, determine the time to fill the plastic collecting container being held under the outflow of the pipe — calculate the flow rate (milliliter/minute).
9. Repeat three times (replication).
10. Follow the same procedure with the airstone removed (steps 6 – 9).
11. Follow the same procedure for the ¾" and 1" pipes.
12. Calculate the flow results in 350 ml of water captured from the pipe outflow with each sized pipe used.
13. Solve the proportion for X — 20 seconds/350 ml = 60 seconds/x ml.
14. Flow rate (X) = 1050 ml/minute.
15. Graph your results.

**Teacher Instructions:**

*Preparations*:

1. Assign *RAS Components* handout as a reading assignment for homework.
2. Divide supplies into the appropriate number of groups.
3. Collect the water needed (or have students help).

*Activity*:

1. Guide students through the step by step guide and make sure all groups are working at the same pace.
2. Direct students to record data in their lab notebooks and/or on the classroom board.
3. Once each group have their three flow results (for each of the different sized pipes) walk the class through one flow rate calculation, then have the groups complete the rest of the problems.
4. Ask the students to graph their group's results either on grid paper or using Excel.

5. Facilitate students' interpretations of their results and allow time for them to write a summary report for their homework.

*Post work/Clean-up*:
1. Dump water and clean all materials in freshwater (with student's help).
2. Supplies can be stored for future labs.
3. Wipe down all laboratory tables.

**Anticipated Results:**
1. Students will create a simple air-lift pump to demonstrate how flow-rates are influenced by pipe diameter or degree of submergence.
2. Students will differentiate appropriate pipe sizes and explain the importance in air-lift designs.
3. Students will be able calculate the flow rates of water through their air-lift systems and in varying situations.

**Support Materials:**
1. *Types of Systems* presentation
2. *Site Selection and Appropriate Systems* presentation
3. *Recirculating Systems* presentation
4. *Recirculating Aquaculture Systems Components* handout

**Explanation of Concepts:**
Formulas and calculations
Engineering and design

**Support Materials**

***Recirculating Aquaculture Systems Components***

Handout