

AGRISCIENCE EXERCISE

ANIMAL SCIENCE & BIOTECHNOLOGY

Key Concept: Aquaculture Science

Sub-Concept: Production of Aquatic Animals

Agricultural Context: Calculations of water volume and flow rate are used throughout the agricultural industry.

Exercise: **Calculating Turnover Rate of Water in Aquaculture System**

Applied Principle(s): Physical sciences, Mathematics

Goals:

1. Calculate water volume.
2. Calculate water flow rate.
3. Calculate water turnover rate.

Preparation Time:

Materials:

- Pencil and paper
- Calculator
- Tape measure
- Bucket
- Watch with second hand (or stopwatch)

References: Parker, R. (1995). Aquaculture Science. Albany, NY: Delmar Publishers.



Teacher Preparation:

► *Information regarding calculations required for this activity may be found on the Teacher Background Sheet attached to this activity.*

► Procedures for conducting this activity may be altered to encourage student use of the problem-solving process. You may wish to present the activity as a problem for them to solve, rather than providing them with the procedures outlined below.

► The use of this activity may be enhanced by having students determine water turnover rate before and after flushing the system, so that the two numbers can be compared, and reasons for differences discussed as a group.

Procedures for Conducting the Activity:

1. Calculate the total volume of water contained in the entire system, including the fish tank, filter tank, and any attached hydroponics containers (gallons). [For the purposes of this exercise, do not include water contained in pipes and hoses.] Record answer on data sheet provided.
2. For *each* outlet returning water into the fish tank:
 - a. Place a bucket under the outlet, collecting water for a period of 30 seconds.
 - b. Weigh the amount of water collected during the 30-second period, and multiply by two (2) to arrive at the flow rate (pounds per minute). [Note: Don't forget to subtract the weight of the bucket from the total water weight each time.]
 - c. Record the flow rates on the data sheet .
3. Add the flow rate calculations from each outlet together to arrive at the total pounds of water flowing into the tank per minute. Record answer on data sheet.
4. Divide the answer from step 3 by 8.34 to determine the gallons per minute flowing into the tank. Record answer on data sheet.
5. Based on the total volume of water in the system, calculate the time required for complete turnover of all water. Divide the total gallons contained in the system (from step 1) by the gallons per minute flowing into the tank (from step 4). Record answer on data sheet.
6. Discuss with the class other applications of the skills practiced in this activity. Examples could include calculating the flow rate of a farm well, determining water volume of a pond, etc.

AGRISCIENCE EXERCISE

Calculating Turnover Rate of Water in Aquaculture System

STUDENT DATA SHEET

A. Total Volume of Water in System

System Part	Measurements*	Cubic Feet (ft ³)**	Total Gallons (ft ³ x 7.48)
Main Tank			
Filter Tank			

TOTAL FOR ALL
PARTS = _____

*for rectangular/square container: length, width, height of water in feet

for circular container: diameter of container, height of water in feet

**square/rectangle = l' x w' x h' of water

circle = $\pi \times r'^2 \times h'$ of water

B. Total Gallons Per Minute (GPM) Flowing into Main Tank

Weight of bucket (B) = _____ lbs.

Outlet Number	Total Wt./30 Sec. (A)	Actual Water Wt. (A-B) = (C)	Lb/Minute ((C)x 2)
1			
2			
3			
4			
5			

TOTAL LB/MINUTE = _____

GPM = Total Lb/Min / 8.34 = _____ / 8.34 = _____

C. Time Required for Total Turnover of All Water in System

$$\text{Total Turnover Time} = \frac{\text{total gallons in system}}{\text{gpm flowing into tank}}$$

$$= \underline{\hspace{4cm}}$$

$$= \underline{\hspace{4cm}}$$

TEACHER BACKGROUND INFORMATION

Calculating Turnover Rate of Water in Aquaculture System

A. To determine the volume of water contained in a square or rectangular tank:

- | <u>Steps</u> | <u>Example</u> |
|--|---|
| 1. Calculate cubic feet of water in the tank by multiplying (in feet) the length times the width times the height of the water. $[l' \times w' \times h' = \text{ft}^3]$ | Water in tank measures 4' wide, 6' long, and 3.5' high.
$4' \times 6' \times 3.5' = \underline{84 \text{ ft}^3}$ |
| 2. There are 7.48 gallons in one cubic foot of water. Multiply the figure from step 1 by 7.48 to determine the total gallons of water in the container. | $84 \text{ ft}^3 \times 7.48 = \underline{628.3 \text{ gal.}}$ |

B. To determine the volume of water contained in a circular tank:

- | <u>Steps</u> | <u>Example</u> |
|---|--|
| 1. Calculate the cubic feet of water in the tank by multiplying pi (3.14) times the radius of the tank (in feet) squared times the height of the water (in feet).
[Note: radius = $\frac{1}{2}$ diameter]
$[\pi \times r'^2 \times h' = \text{ft}^3]$ | Tank diameter measures 6'.
Water height measures 2.5'.
$\text{radius} = 6' / 2 = \underline{3'}$
$r'^2 = 3' \times 3' = \underline{9'}$
$\pi \times r'^2 \times h' = 3.14 \times 9' \times 2.5'$
$= \underline{70.65 \text{ ft}^3}$ |
| 2. There are 0.748 gallons in one cubic foot of water. Multiply the figure from step 1 by 0.748 to determine the total gallons of water in the container. | $70.65 \text{ ft}^3 \times 7.48 = \underline{528.5 \text{ gal.}}$ |

C. To determine gallons of water flowing into a tank per minute (gpm):

<u>Steps</u>	<u>Example</u>
1. Water must be collected from each outlet returning water into the fish tank.	There are 3 return-water outlets bringing water into the tank, so 3 measurements will be taken.
2. Weigh the bucket which will be used to collect the water. This amount will have to be subtracted from the water weight for each measurement.	Bucket weighs <u>1.75</u> lb.
3. Collect water from one outlet for a period of 30 seconds, and weigh the bucket. Subtract the bucket weight from the result to obtain water weight in pounds.	Total weight = <u>14</u> lb. Water wt = 14 - 1.75 = <u>12.25</u> lb.
4. Multiply actual water weight collected in 30 seconds by two (2) to arrive at pounds per minute.	12.25 x 2 = <u>24.50</u> lb/min
5. Repeat steps 3 and 4 for each return-water outlet flowing into the tank.	Outlet #2 = <u>18.70</u> lb/min Outlet #3 = <u>21.00</u> lb/min
6. Add the pounds per minute from all outlets to obtain the total pounds of water flowing into the tank per minute.	12.25 + 18.70 + 21.00 = <u>51.95</u> lb/min
7. One gallon of water weighs 8.34 pounds. Divide the answer from step 6 by 8.34 to determine the total gallons per minute flowing into the tank.	51.95 / 8.34 = <u>6.23</u> gpm

D. To determine the time required for complete turnover of all water:

1. Divide the total gallons contained in the system by the gallons per minute (gpm) flowing into the tank .	Tank holds <u>125</u> gallons of water. GPM = <u>6.15</u> 125 / 6.15 = <u>20.32</u> minutes for complete turnover
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