Electric agitators or air blowers are commonly used to enhance carbon dioxide removal and aerate live fish transport tanks. While these devices are practical and readily available, they can have some disadvantages: high initial investment, possible equipment or power failure and, may cause water temperature to rise more rapidly during transport. Recently, the use of pure oxygen gas for fish transport has become more commonplace. There are several advantages to the use of this method: equipment can be leased, there is little chance of equipment failure, it may reduce water temperature slightly, water turbulence is limited and loading rates can be increased by 25 percent.

Pure oxygen flow rates used for live transport generally range from 3-6 L/min of oxygen gas for each 378.5 L of fish transport water. Actual flow rates will vary from load to load and must be adjusted accordingly. Oxygen is introduced into the water as very fine bubbles through porous materials, such as air stones or diffuser hose. Certain types of irrigation hose work well for oxygen diffusion. Dissolved oxygen (DO) concentrations are dependent on bubble size; smaller bubbles produce higher levels. Because water agitation is minimal with pure oxygen injection, carbon dioxide tends to accumulate; reducing oxygen availability to fish during long trips if water is not exchanged. If accumulation is slow and oxygen levels are adequate, channel catfish will tolerate 20-30 mg/L of carbon dioxide.

A 160 L liquid oxygen container will supply approximately 127,000 L of oxygen gas. That would supply oxygen to:
- 3,785 L of transport water for 70.5 hours at 3 L/min-379 L.
- 3,785 L of transport water for 35.3 hours at 6 L/min-379 L.

Compressed oxygen gas is available in steel cylinders which are commonly used for welding. These cylinders are available in a number of sizes containing from 3,455-13,820 L of compressed gas. Cylinders containing 3,455 and 6,910 L are relatively easy to handle. Compressed gas cylinders are generally used for short trips on small scale transport trucks and trailers:
- a 6,910 L cylinder would supply oxygen to 3,785 L of transport water for 3.8 hours at 3 L/min-379 L.
- a 6,910 L cylinder would supply oxygen to 3,785 L of transport water for 1.9 hours at 6 L/min-379 L.

It is important to maintain DO within a specific range relative to the water temperature of transport water (Table 1).
Table 1. For the following temperatures, dissolved oxygen in freshwater transport tanks should be maintained within these ranges.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Dissolved Oxygen (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.6</td>
<td>6.4–9.9</td>
</tr>
<tr>
<td>18.3</td>
<td>6.2–9.5</td>
</tr>
<tr>
<td>21.1</td>
<td>5.8–8.9</td>
</tr>
<tr>
<td>23.9</td>
<td>5.4–8.4</td>
</tr>
<tr>
<td>26.7</td>
<td>5.2–8.0</td>
</tr>
</tbody>
</table>

Oxygen concentrations can be adjusted up or down by increasing or decreasing gas flow rates with a regulator valve/gauge assembly and a flow meter. Oxygen levels below the minimum recommendation may stress or suffocate fish. Levels above the maximum concentration could cause gas bubble disease or tissue damage. Standard catfish loading rate recommendations are made for transport water at 18.3°C. Loading rates must be reduced approximately 25 percent for every 5.6°C increase above 18.3°C. Using pure oxygen gas and by carefully monitoring DO, standard loading recommendations may be increased by 25 percent.

- 0.45 kg of ice will lower the temperature of 38 L of transport water approximately 1.1°C. Ice must be made with unchlorinated water to protect fish.

At a water temperature of 18.3°C, 1.8 kg of 0.45 -0.9 kg catfish can be transported for every 3.79 L of hauling water using standard electric aeration methods. However, 1.8 kg of fish will occupy the same space as 1.9 L of water. For any loaded transport volume (fish + water), 1/3 of the space is occupied by fish and 2/3 is water. Therefore, loading rates are calculated on 2/3 of loaded tank volume. For a 3,785 L loaded volume, 2,524 L of water (2/3 X 3,785) are available to be loaded with 1,199 kg of catfish (2,524 L X 1.8 kg/3.79).

Using pure oxygen gas, 2.3 kg of 0.45 -0.9 kg catfish may be transported for every 3.79 L of hauling water at 18.3°C. However, that slightly changes the volumetric relations discussed above: approximately 4/10 (0.38) of loaded volume (fish + water) is fish and 6/10 (0.62) is water. Using the previous example -- a 3,785 L loaded volume -- 2,271 L of water (6/10 X 3,785 L) are available to be loaded with 1,378 kg of catfish (2,271 L X 2.30 kg/3.79 L).

It is important to remember that liquid oxygen can not be stored. Even though the tank is insulated, the liquid oxygen will eventually warm up and become gas. The tank is designed to vent gas as the liquid oxygen warms. Therefore, most of the oxygen will eventually leak out. However, oxygen in compressed gas cylinders can be stored indefinitely.

For related information click on the topics below:
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As: Using salt to reduce handling stress in channel catfish. World Aquaculture, 26(3): 80-81.
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