

PURE OXYGEN AND LIVE FISH TRANSPORT

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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 with 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%.

Pure oxygen flow rates used for live transport generally range from 3-6 liters/minute of oxygen gas for each 100 gallons 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 levels 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 liter (42 gallon or 5.6 cubic foot) liquid oxygen container will supply approximately 127,000 liters of oxygen gas. That would supply:

* at 3 liters/min-100 gal -- 1,000 gallons of transport water for 70.5 hours.

* at 6 liters/min-100 gal -- 1,000 gallons of transport water for 35.3 hours.

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 liters (122-487 cubic feet) of compressed gas. Cylinders containing 3,455

and 6,910 liters are relatively easy to handle. Compressed gas cylinders are generally used for short trips on small scale transport trucks and trailers:

* at 3 liters/min-100 gal -- a 6,910 liter cylinder would supply oxygen to 1,000 gallons of transport water for 3.8 hours.

* at 6 liters/min-100 gal -- a 6,910 liter cylinder would supply oxygen to 1,000 gallons of transport water for 1.9 hours.

Temp (F)	Dissolved Oxygen (mg/L)
60°	6.4-9.9
65°	6.2-9.5
70°	5.8-8.9
75°	5.4-8.4
80°	5.2-8.0

Oxygen concentrations can be adjusted up or down by increasing or decreasing gas flow rates with a regulator valve/gauge and a flow meter. Oxygen levels below the minimum recommendation may stress or suffocate fish. Levels above the maximum recommendation could cause gas bubble disease or tissue damage. Standard catfish loading rate recommendations are made for transport water at 65° F. Loading rates must be reduced approximately 25% for every 10° increase above 65° F. Using pure oxygen gas and by carefully monitoring DO, standard loading recommendations may be increased by 25%.

* 1 lb of ice will lower the temperature of 10 gallons of transport water approximately 2° F. Ice must be made with unchlorinated water to protect fish.

At a water temperature of 65° F, 4 lbs of 1-2 lb catfish can be transported for each gallon of hauling water using standard electric aeration

methods. However, 4 lbs of fish will occupy the same space as 1/2 gallon 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 1,000 gallon loaded volume, 667 gallons of water ($2/3 \times 1,000$) are available to be loaded with 2,670 lbs of catfish ($667 \text{ gal} \times 4 \text{ lbs}$).

Using pure oxygen gas, 5 lbs of 1-2 lb catfish may be transported for every gallon of hauling water at 65° F. However, that slightly changes the volume 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 1,000 gallon loaded volume -- 600 gallons of water ($6/10 \times 1000 \text{ gal}$) are available to be loaded with 3,000 lbs of catfish ($600 \text{ gal} \times 5 \text{ lbs}$).

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

* A volume of 1.0 cubic foot is approximately 28 liters, or 1.0 liter approximates 0.035 cubic foot. A flow rate of 1 cubic foot/min (cfm) is the same as 28 liters/min ($1.0 \text{ liter/min} = 0.035 \text{ cfm}$).