# SHUNT BIOFILTRATION: A CONCEPT AND DESIGN FOR INCREASING CAPACITY

KEYWORDS: biofilter, shunt, airlift, pumps, recirculating, systems, aquaculture
*Aquaculture 2004*; Honolulu, HI; March 4, 2004. Book of Abstracts.

William A. Wurts, Ph.D., Aquaculture Specialist
*www.ca.uky.edu/wkrec/Wurtspage.htm*

It is commonly understood that nitrifying bacteria break down nitrogenous wastes, ammonia and nitrite, in recirculating systems. These bacteria coat the surfaces of the biofiltration media. As the effluent water exits the culture tank and flows into the biofilter chamber, ammonia and nitrite are brought into contact with the biofiltration media. The bacteria absorb these wastes, and oxygen is combined with the nitrogen, presumably through enzyme-protein activity. Ammonia and nitrite are then converted to nitrate, which is not toxic to most aquatic animals. Because the bacteria must absorb these compounds from the effluent water, nitrification is dependent on waste concentration and contact time (exposure) of water with the biofiltration media. In a traditional recirculating system, water leaves the culture tank and passes through the biofilter once before returning to the culture tank. Therefore, exposure to nitrifying bacteria and the rate of nitrification is governed by biofilter volume and the flow rate of water entering the biolfilter. For example, if the effluent flow rate from the culture tank is 20 gal/min and biofilter volume is 600 gal, residence time in the biofilter and exposure to nitrifying bacteria would be 30 min.

A shunt circumvents flow within a system. Venous blood, low in oxygen, is pumped by the right ventricle of the heart into the lungs where the blood is re-oxygenated for arterial circulation. The blood then flows from the lungs back to the left ventricle, which distributes oxygen-rich blood to the body through arteries. A septal defect in the heart is a hole in the wall between the right and left ventricles. With the presence of a septal defect, some of the oxygen-poor venous blood is pumped through the hole in the central wall of the heart and is mixed with the re-oxygenated arterial blood in the left ventricle. As such, some of the venous blood is redistributed to the body with the arterial blood, bypassing the lungs, and a shunt is formed.

Creating a shunt, that bypasses the culture chamber and independently circulates water back through or within the biofilter, prolongs wastewater contact time with the biofilter media (i.e. nitrifying bacteria). In the example presented above biofilter volume was 600 gal and effluent flow rate was 20 gal/min. If wastewater within the biofilter was recirculated at 600 gal/min (independent from effluent inflow, 20 gal/min), contact time with nitrifying bacteria would expand 30-fold, an increase of virtual residence time from 30 min to 900 min. Extending wastewater exposure to the nitrifying bacteria increases the amounts of ammonia and nitrite that can be de-toxified. The net effect is expansion of biofiltration capacity without increasing system volume or the amount of biofiltration media. A biofilter with a high output wastewater shunt (recirculator) can be readily constructed using airlift pumps, an internal shunt grid and/or external shunts. Either circular or rectangular tanks could be used as biofilters.

For biofilter designs, see slide show at *http://www.ca.uky.edu/wkrec/ShuntBiofilter.htm* (and *http://www.ca.uky.edu/wkrec/AirliftPumps.pdf* ).