

NUTS & BOLTS

By KEVIN GRAHAM

Aquaculture Plumbing The Arteries and Veins of Your Facility

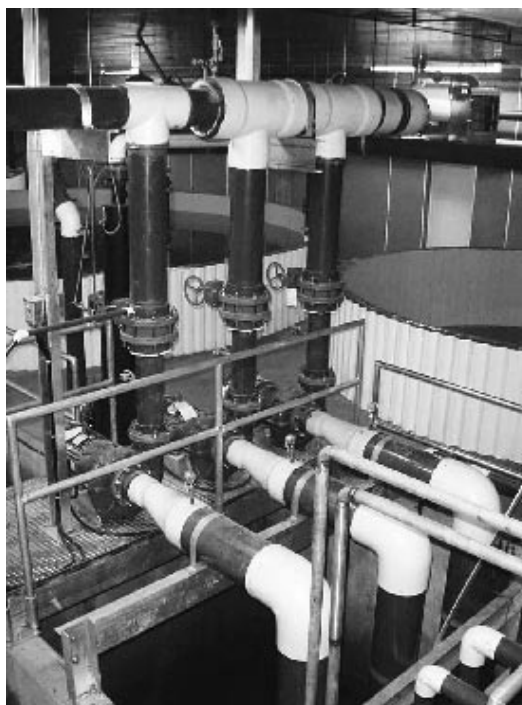
Plumbing networks — pipes connected to the equipment they serve — are the arteries and veins of any hydraulic system. In hatcheries and recirc systems they deliver the lifeblood oxygen, and remove the wastes that are generated. The networks are thus both complex in nature and their designs can be quite specific to individual culture applications. But the basic principles are common to all installations and we will confine this discussion to those unifying features.

As the industry diversifies and includes more species being grown, there is an increasing reliance on continuous-production closed-system designs in both hatcheries and grow-out. Consequently, the demands for efficiency and reliability are driving plumbing designs to meet these continuous service conditions. Practical considerations that are often competing, such as biosecurity, ease of maintenance, and expense, all have to be reconciled around the fundamental realities of the science of hydraulics and the cost of fish production. And whereas redundancy of power supplies and mechanical equipment is commonplace, redundancy within piping networks is not, pointing to the need to have the right system in place. One

has only to experience a burst pipe, seized valve, or other serious plumbing failure to realize that plumbing networks are often taken for granted.

Chief among the many factors to consider when designing, procuring, and installing plumbing networks

is ensuring the hydraulic requirements of appropriate flows and velocities are met throughout the system. Planning runs, sizing pipes and valves, and choosing materials, all play a critical role in the success or failure of any system. The March/April 2002 Nuts and Bolts article — “Pipe Materials and Types for Aquaculture” — is an excellent primer on pipe selection. Valve selection is a similarly broad topic, with valve style, actuation/control, materials, and service rating being important considerations.



An example of pumps and valves connected to a manifold.

Plumbing networks are commonly procured and installed by facility operators. This is especially true for retrofits of process equipment, or adding discrete side-loop processes. Operators are often competent to undertake small projects, because they have an intimate knowledge of the existing system and can address personnel, functional or species-related preferences. With larger projects, it is more often advantageous to bring in expert

design engineers to ensure that the hydraulic flow and velocity demands are met within the parameters of capital and design operating budgets, and a professional plumbing contractor to build the system as designed.

Plumbing System Design

Correct sizing of plumbing is based on meeting the required flow rate. The non-turbulent flow of water is important for maintaining oxygen levels above saturation in the supply lines, ensuring complete transfer of solids in the return lines, and keeping energy costs to a minimum. Efficient waste removal too is highly dependent on maintaining correct velocities. Flow rates that are too high will break suspended particles apart, reducing the effectiveness of solids removal equipment. This is very important in recirculation systems, but can be pivotal in meeting effluent discharge limits. Conversely, low velocities will allow solids to settle in the piping system, where they may perpetually degrade water quality, or form a nucleus for plugs of fungal matting, thus increasing maintenance costs. Where biosecurity is critical, plumbing networks should include provision for disinfection by pigging, chemical shocking, or designed system dismantling.

It is important that all components are sized to be compatible, and meet the designed flow and velocity rates.

- Over-sized plumbing results in unnecessary material expense and costs of labour, downstream maintenance and replacement. For example, the cost of fittings rises much faster than their incremental increase in size, resulting in fully avoidable cost over-runs.
- Under-sized plumbing increases pumping costs and creates imbalances in velocity and flows throughout the system. For a given production rate, the size of culture tanks, equipment, and pumping capacity are selected to provide the designed flow rate. If the plumbing under-performs, all of the other equipment will under-deliver.

A well-designed plumbing system often appears elegant. Repetition of patterns and paralleling of piping (with uniform slopes, constant spacing, and concentric bends) are common features of good design and conscientious execution. As Leonardo daVinci said "Simplicity is the purest form of elegance..." The extra time and care taken will pay off in the long run with:

- More straightforward pipe supports, pipe racks, joint restraint, and thrust blocking,
- Concentration of system components such as clean-outs, valves, low-point drains, high-point air releases, hammer arrestors, P-traps, and traffic-bearing covers,
- More intuitively obvious process flow, possibly reducing the risk or frequency of incorrect valve actuation, and
- Aesthetically pleasing appearance, more conducive to pride of ownership and its attendant benefits.

System design services can be obtained from third party consultants, and may be wrapped into sales contracts for specified equipment or



Tank field piping under assembly and before backfilling.

package systems. For larger, more complex retrofits, or complete system installations, make sure that the designer fully understands the unique aspects of the project, and has experience in aquaculture.

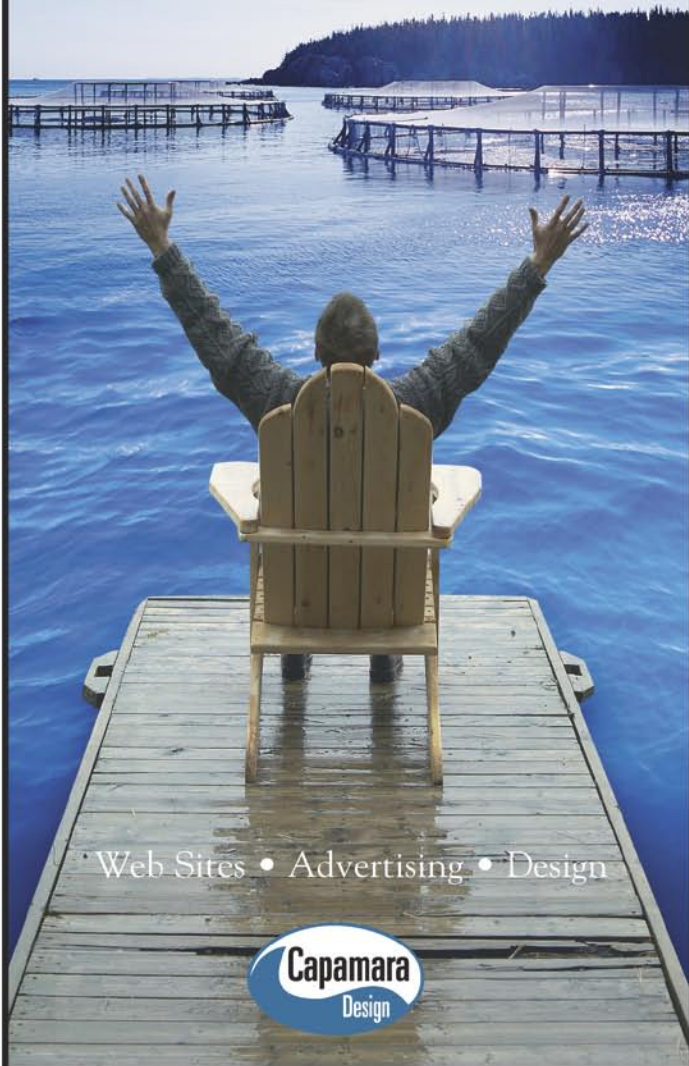
Materials Take-offs

Once the design is finalized, decisions about procurement must be made. Having components on site when they are needed is important for time-sensitive projects, logistically challenging locations, or installations where contractors have 'stand-by' provisions for delays beyond their control. There are several different approaches to out-sourcing materials.

- If the installer is to provide the materials, it's best if they develop the materials list. Installers usually command a discount with plumbing suppliers, so this is often the most cost-effective approach. You should always ensure that they provide sufficient unions or flanged connections to allow equipment to be disconnected if required.
- Plumbing retailers will produce a materials take-off on speculation that they'll make the sale. They can often work from a basic sketch, a process flow diagram, or cut sheets of the equipment to be interconnected and a short explanation of the project. This can

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be a worthwhile service, as good suppliers have an intimate knowledge of standard design practices, and the availability, dependability, and relative costs of different fittings. It's unlikely that they would warrant this free service to the extent of absorbing the cost of flying in any pieces they might have missed.

- Equipment sales companies can often provide a take-off as a courtesy. As a rule though, the farther the plumbing gets from equipment they normally deal in, or their field of expertise, the more likely their take-off might include inappropriate or unwanted items.
- Design firms offer a materials take-off as part of their fee for design service. Depending on their experience, they may have a better understanding of relevant issues than plumbing retailers; but again, it's unlikely they would warrant their work beyond the fee charged for their service.

Plumbing Installation

The cost of installing plumbing usually pales in comparison with the total project costs, let alone the costs of any failures and subsequent repairs. The larger the diameter of the plumbing, the more challenging it is to address the different installation concerns. Pipefitting is a licensed trade, so here are a few very basic pointers:

- Shipping and handling. Make sure materials are received in good condition and that there is adequate storage space. Installation will go more smoothly if all materials are clean and dry, and the pipe is not scuffed or deformed.
- Climate control. For glued piping, temperature control can be an important issue. High temperatures cause the glue to set quickly, so more force is required and less time is available to assemble joints. Conversely, if the temperature is too cold, the solvent may not soften the plastic sufficiently.
- Joint preparation. For any type of connection, cleanliness and the reduction of internal stresses is important. For glued joints, beveling the pipe-end prevents the glue from smearing off of the socket, and a slight rotation once inserted helps fill in any glue-starved channels. For high-pressure systems, the full insertion depth is critical, so pipe-ends need to be square. Pipes that exceed a chop saw's capacity should be cut slightly long, the correct length marked all around the pipe, and the excess ground down to the mark.

There are many aspects to consider when a plumbing network is designed and installed. How much can be accomplished 'in-house' will largely depend on the availability, skill, and experience of the staff. Any 'experts' brought in must be familiar with the specific requirements of the aquaculture industry. The system has to support living creatures, and errors could be fatal.

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