# Low-Cost Irrigation Sand Filter


## Construction and Operation

## Want to make use of your pond water for irrigation?

**In order to utilize ponds and other surface water sources for micro-irrigation, use of a sand filter is recommended. Commercial models require a substantial, and sometimes cost-prohibitive, investment for small or beginning farmers. A need exists for an effective low-cost alternative.**

Irrigation is becoming more common in the Northeast as climate variability continues to increase risk of water stress in fruit and vegetable production. Ponds can aid in drought resiliency if water is adequately filtered and used to supply highly-efficient micro-irrigation (i.e., 'drip') systems. Producers can construct their own sand filter in order to make use of these on-farm water resources.

**Design Concept**

Drip irrigation systems typically require a water filtration level between 150 to 200 mesh to prevent clogging. Number 20 crushed silica sand is commonly used in media filters, and provides 200 mesh (i.e., 74 microns) filtration. Sand filters force water through a bed of this filter sand, until it becomes partially clogged, and then flow is reversed to backwash out the trapped particles. That process is then repeated, as needed. This design follows that same concept, except it relies on readily available materials to construct the filter vessels and inflow/outflow manifolds.

**Figure 1. Even small ponds can be successfully utilized with efficient irrigation systems**

**Materials**

Most materials needed for construction can be purchased locally at a well-stocked hardware store. A low-pressure limit valve can be ordered through an irrigation equipment supplier,


**Figure 2. Cutting hole in barrel lid (left) and outlet bulkhead fitting assembly (right).**

as can the pressure gauges if not available locally. It is important to use graded filter sand, which is available at pool supply and some hardware stores. A suggested bill of materials is listed in Table 1. Number and type of some fittings can vary depending on construction methods or preference. Most PVC components in this example were 1 1/2", to reduce pressure loss or associated flow reduction, but this also resulted in more expensive fittings.

Holes must be cut in the barrel lids to allow for installation of the inlet and outlets. To enable easier cutting of these holes, a smaller hole can be drilled along the cut-line to allow space to insert the saw blade and start the cut (Figure 2, left) The outlet should extend downward several inches from the lid

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES
University of Vermont Center for Sustainable Agriculture
23 Mansfield Ave., Burlington, Vermont 05401-3323
Director's Office: 802.656.2990 or 1.866.622.2990

**Figure 3. Diffusers constructed by drilling holes in PVC.**

**Figure 4. Limit valve on inlet line.**

inside the barrels, to prevent floating debris from leaving the filter (Figure 2, right).

The inlet directs water through a diffuser (Figure 3), connected to a length of flexible 1" PVC. The flexible PVC allows for the lid to be removed easily. A limit valve (10 psi) should also be placed on the inlet line (Figure 4). This is a safety feature, that prevents the barrels, or other downstream components, from over-pressurizing and becoming damaged. Optional drains with valves were also installed on the side of the barrels, toward the bottom, using a hole saw and 3/4" bulkhead fittings. Pressure gauges (0-15 psi) are needed on the main inlet and outlet lines.

Clean gravel and a cut-to-fit mesh screen are placed over the diffuser to maintain separation from the sand (Figure 5). Filter sand is then placed over the screen (Figure 6). We used 100 lb. of sand in each barrel, but more could be used for longer run-times.

**Table 1. Bill of materials**

| Item | Number Needed |
|---|---|
| Metal drum w/ removable lid and gasket and ring clamp | 2 |
| Filter sand, #20 | 200 lb. |
| Clean gravel | 100 lb. |
| Metal mesh screen | 10 $ft^2$ |
| Pressure gauge, 0-15 psi | 2 |
| Limit valve, 10 psi | 1 |
| Sch. 40 PVC, 1 1/2" | |
| Pipe | 10'+ |
| Elbow | 8 |
| Tee | 7 |
| Union | 6 |
| Valve | 6 |
| Bulkhead fitting | 4 |
| Slip x male thread adapter | 6 |
| Sch. 40 PVC, 3/4" | |
| Nipple, 2" | 2 |
| Valve | 2 |
| Bulkhead fitting | 2 |
| PVC reducer, 1 1/2" x 1/2" | 2 |
| Galvanized reducer, 1/2" to 1/4" | 2 |
| Galvanized nipple, 1 1/2" x 6" | 1 |
| Galvanized nipple, 3/4" x 2" | 2 |
| PVC reducer, 1 1/2" x 3/4" | 2 |
| PVC reducer, 1 1/2" x 1" | 2 |
| PVC slip x male thread, 1" | 2 |
| Flexible PVC, 1" | 6'+ |
| Sch. 40 PVC, 1" | |
| Pipe | 6' |
| Tee | 4 |
| Elbow | 4 |
| Cap | 6 |

This design uses two barrels to increase the volume of filter sand available and to enable pre-filtration of the water used for backwashing. To reduce cost, a one-barrel system is also possible, but would forego filtration of backwash water or require a disc filter to be used for pre-filtration of backwash water. The barrels are elevated and leveled on blocks for stability and to help prevent corrosion of the metal.

**Operation**

During normal filter operation, the main inlet and outlet valves are opened, as well as the inlet valve leading to each barrel. Both backwash valves are kept closed (Figure 7). Irrigation is performed as needed and the inlet and outlet pressure gauges are monitored periodically.

**Figure 5. Clean gravel and screen over diffuser.**

**Figure 6. Filter sand placed in barrel.**

During normal filter operation, the pressure difference from the inlet to the outlet will be < 2 psi. As the sand clogs with particles, the pressure difference will slowly increase. When the difference reaches 5 psi, the system can be backwashed to flush out debris and rejuvenate the sand bed.

In order to backwash, one of the backwash valves is opened, while the main outlet valve and the barrel inlet valve on the opposite barrel are closed. Wastewater will be discharged from one of the backwash lines. Backwash should continue until the pressure difference is returned to approximately 2 psi. This process is repeated for the other barrel.

**Cost**

In total, the materials and supplies to construct this system cost approximately $550. The cost could decrease substantially if free or low-cost barrels can be sourced locally. The total cost is considerably less than commercial two-unit media filters, which range from $1,000 to more than $4,000.

**Considerations and Summary**

While experience and testing of this prototype are limited, the participating producer expressed satisfaction with the design due to elimination of time spent cleaning a pre-existing disc filter. It was estimated that time savings over the course of one growing season could total 20 hours. The filter was plumbed in and valves placed to allow for reversion back to the existing filter if necessary, reducing risk to the cooperating farmer. Other performance data related to filtration performance is forthcoming.

This filter was installed in a system utilizing a solar pump, where flow was consistently 9 GPM during operation. No testing has been performed in a higher flow system, more typical of commercial fruit and vegetable operations. Furthermore, less than a season of irrigation was performed using the filter; design modifications may be required. The design presented here serves as a starting point for those needing affordable filtration of pond and other surface water. Further experience and improvement may result in a more refined and robust design.

**For more information:**

http://www.uvm.edu/~susagctr/?Page=resources/index.php#farmclimadaptation

Roberts, B.W., and C.W. O Hern. 1993. Inexpensive sand filters for drip irrigation systems. *HortTechnology* 3(1):85-89.

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**Figure 7. Front view of sand filter system with various components identified.** Note: Sampling valve and pressure relief valves were for evaluation only, they are not required if appropriate limit valve is installed.


**Figure 8. Rear view of sand filter system with various components identified.** Note: Sampling valve and pressure relief valves were for evaluation only, they are not required if appropriate limit valve is installed.

**Contact:**

**Joshua Faulkner**

**Farming and Climate Change Program Coordinator**

**UVM Center for Sustainable Agriculture**

**802-656-3495**

**Joshua.faulkner@uvm.edu**