Hybrid Treatment Systems for the treatment of horticultural production water

What are Hybrid Treatment Systems?

The Hybrid Treatment Systems (HTS) described in this factsheet are comprised of combinations of woodchip denitrification bioreactors and selected mineral media cells using vertical flow constructed wetland design and specific flow characteristics that function to remove plant pathogens and/or nutrients and/or excess agrichemicals. The site-specific combination of media, design and flow characteristics dictates the HTS capability to remove particular contaminants to meet the operation's production and environmental requirements.

Denitrification woodchip bioreactors and constructed wetlands have been described in two earlier factsheets. Briefly, a denitrification bioreactor consists of a cell filled with a carbon source (woodchips) that is operated under constantly saturated (anaerobic) conditions in which nitrate-N is converted to N_2 gas in a process called denitrification. Research into the use of these systems has determined that the system is also very effective at removing fungal plant populations from irrigation water, making it an effective disinfection method if operated properly. To date, denitrification bioreactors have not commonly been used in the greenhouse and container nursery operations.

Constructed wetlands, on the other hand, are more commonly used to clean greenhouse and nursery irrigation water. Vertical flow wetlands have proved to be quite effective, and consist of 2-4 cells containing mineral media that provides primarily physical but also some chemical removal of contaminants, and supports plant and microbial growth that plays a role in removing nutrients from water being treated. To some extent, agrichemicals are also degraded though there is little specific information on this for the horticulture industry.

There are a number of mineral media that have been evaluated for the removal of phosphorus from solution, from materials such as limestone gravel and filter sand which have limited capacity to remove phosphorus to those which have high phosphorus binding capacity such as wollastonite and, in particular, slag from the steel making industry. Depending on the requirements of the operation, media can be selected that will remove phosphorus from the water or not. In recirculating systems that are not connected to surface water by way of holding ponds, phosphorus removal is not required. Where holding ponds can have direct connections to surface water, or where the operation may wish to remove nutrients to prevent excess algal growth etc, materials that have strong P-binding capacities are preferred. Mineral media also function in the system to filter, reduce biological oxygen demand (BOD) and increase the oxygen level of water.

Hybrid treatment systems can be built to suit the site-specific needs of various production systems by combining the nitrogen and pathogen removal capacity of the denitrification bioreactor, the phosphorus removal capacity of mineral media as required, and the functional design of vertical flow wetlands. These systems should not be planted but can be used as outdoor production surfaces once they have been established.

How is a HTS constructed?

Hybrid treatment systems are outdoor treatment systems that need to be designed carefully to achieve the treatment goals of the operation. The first questions that need to be answered are:

1. *What are the treatment goals?*
   - i. Water clarity (solids and/or tannin removal?)
   - ii. Pathogen removal?
   - iii. Nutrient removal, e.g. nitrogen or phosphorus?
   - iv. Other, e.g. aluminum or agrichemical?

2. *What is the daily water volume that needs to be*

treated calculated or measured over the production cycle? This requires detailed monitoring or calculations of the water leached from the production area and any other areas that produce water requiring treatment. Note: the system size – and therefore capital cost and treatment performance - depends on getting good numbers at this stage.

3. *Where will it be located?* Is there space? How will the water move to and from the HTS?
4. *What other infrastructure is required?* For example: collection point or tank/pond for the untreated water, holding tank/pond for the treated water, piping to deliver the water to and from the HTS, electrical requirements, etc.
5. *Is there permitting required?* Yes, if the water discharges to the environment.

Stages in construction:

Figure 1: Cells with impermeable liners and collection piping

Figure 2: Filled cell with distribution piping

Figure 3: finished HTS, covered in landscape cloth and returned to useable production area

Removal rates of particular constituents depend primarily on:

- Type of media: woodchips for N removal, mineral media for filtration, P removal, and BOD removal,
- Water and oxygen levels in the media: the denitrification cell must be saturated and anaerobic at all times,
- Hydraulic retention time: longer retention times or recirculation within the HTS increase treatment extent, and
- Temperature: HTS perform best in the summer above 10°C (biological activity increases), particularly for the denitrification cell.

Who can use HTS?

- Growers with sufficient landbase depending of volumes to be treated;
- Growers who want to remove multiple contaminants (e.g. pathogens, undesirable nutrients, pesticides, solids and BOD);
- Growers who may want to retain some nutrients in closed-loop systems, or
- Growers who need to meet environmental discharge standards.

Consult a firm familiar with proper design and construction of these engineered systems.

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