NCR101 Committee on Controlled Environment Technology and Use
2002 Annual Meeting
National Phytotron at Duke University and North Carolina State University Phytotron

Station Report

Greenhouse Engineering
Division of Alex Turkewitsch, P.Eng. Ltd.

Company Profile

Greenhouse Engineering is a Canadian company specializing in engineering services for commercial, institutional, and research greenhouse facilities. Greenhouse Engineering offers services ranging from planning, feasibility studies, greenhouse and growth facility specialist consulting, and design/build systems.

Our international client list includes architects, greenhouse operators, manufacturers, institutions, governments, research organizations, universities, and bio-technology companies. We design a wide variety of greenhouse facilities, ranging from plant production ranges, garden centers, shade houses and lath houses, compartmentalized research greenhouses, conservatories and custom structures. Growth chamber facility design, including facility layout, service requirements, automated irrigation systems and containment considerations is also offered.

Our professional design services include structure and cladding, mechanical, electrical and control systems, lighting, shading, cooling, fogging, irrigation, and mechanization. Greenhouse Engineering is also called upon to perform inspections, project management, and engineering evaluations.

The Year in Review

This has been the year for University plant growth facilities at Greenhouse Engineering. We have been involved in greenhouse or combined greenhouse and growth chamber projects for the University of Toronto, York University, the University of California at Davis, the University of Pennsylvania, the University of Texas at Austin and are just getting started at the University of Guelph. The majority of these projects call for air conditioning in some if not all of the compartments. This appears to be a trend, driven by demands for greater control over summer temperatures and the resulting improvements in repeatability. We are hearing from researchers that they are planning for level 2P containment, even if they don't require it at present and want to have the equipment in place to be able to operate the greenhouses in recirculation mode, with only makeup air to be filtered. This is a further push for air conditioning.

Automated irrigation is also gaining popularity with research greenhouse users. Long considered impractical due to the traditional mix of plant specimens in different containers all located on one bench, automated irrigation is included in the planning of most new facilities, at least over a portion of the bench area. Automated irrigation is also finding its way into growth rooms. Certainly it is ideal for work which involves replication and if properly planned and implemented, can reduce the tedium of hand watering, improve the uniformity of water and nutrient application and reduce weekend duties. Commercial nursery irrigation systems are poorly suited to small greenhouse compartments. Researchers are asking for RO water as a source and greater accuracy of nutrient application than was obtainable with the siphon injectors without resorting to mixing the nutrient solutions by hand. Sub irrigation systems are often chosen for their simplicity, independence from bench to bench and the fact that all irrigation overage is collected.

New (and Reinvented) Solutions

At the University of Toronto, we designed a new rooftop research greenhouse facility for the Department of Botany. Now under construction and slated for occupancy by the fall of 2002, this facility consists of 15 new compartments and upgrades to 5 existing compartments. Six of the new compartments are air conditioned. Four edge supported and fully gasketted glazing is used throughout. The doors are 4' wide, of anodized aluminum and have bulb seals on the upper three sides and drop seals without thresholds at the floor.

The air conditioning system was engineered and custom fabricated from scratch, using chilled water air handler units, located under the perimeter benches. The air flow is similar to that found in growth rooms (about 7.6 m^3 per minute of

air per m^2 of floor area), due to the fact that the temperature drop across the chilled water coil is limited to 5C to minimize the reduction in wet bulb temperature. The air flow in each compartment is toroidal, with return air to the air handler units flowing down the walls, the chilled air exiting the units horizontally under the benches and rising through the benches. This circulation pattern is assisted by a centrally located overhead vertical air flow fan. This tube axial fan draws air up into its inlet and expels it horizontally in a circular pattern. Fog nozzles are mounted in a ring just above the fan outlet. The system at present uses ridge ventilators for free cooling when outside conditions permit and for makeup air. Three way mixing valves and circulation pumps permit full range modulation of the chilled water supply temperature and thus of the cooling capacity with constant air flow being maintained. The concept is adaptable to DX coils and mechanical makeup air systems (filtered if required). Since the air handler units are located within the compartment and the circulation pattern is assisted by the vertical air flow fan, no ducting to or from the compartment or within the compartment itself is used. A vertical deflector of greenhouse glazing material is used as a barrier adjacent to the unit inlet (against the compartment sidewall), to avoid short circuit air flow from the cooler outlet to the inlet.

For a simple automated irrigation system, we chose ebb and flow sub irrigated benches. Each bench has its own sump tank and sump pump, located between the bench legs on the concrete floor below the bench. The sump pump is activated by the environmental control computer and floods the bench through a water inlet valve located in a small sump at on end of the bench. This valve serves both as inlet and outlet. When the sump pump stops, the water drains back through the same hose, and through the pump back into the tank. Makeup water is by a simple mechanical float valve. The makeup water comes from one of three sources: RO water, tempered city water or water fed from the fertilizer injector. The fertilizer injector is itself connected to one of those two plain water sources. Each compartment has its own fertilizer injector station, consisting of a water pressure driven piston injector. All irrigation connections are made by quick connect hose bibs to allow easy configuration of individual benches.

New Alliances

Over the past year, Greenhouse Engineering has formed alliances with two consulting firms in complementary and related fields of practice. One of these is Montgomery Smith Inc., of Burlington, KY, headed by Jim Smith. Jim works extensively for conservatories, arboreta, botanical gardens, providing full scope design services, building evaluations, planning and advice for restorations. Our companies have collaborated on three projects over the past year. We have also conducted three design projects in the past year with CEA Technologies International, of Aylmer, Ontario, with agronomist Ron Evans. Ron is experienced with feasibility studies, economic analyses of greenhouse crop production systems, specialized growing systems and greenhouse technology.

The Near Future

Institutional plant growth facilities typically have gestation periods of 3 to 5 years, from fund raising, through design, tendering, construction and commissioning. That considered, it is remarkable how quickly new trends are established and spread throughout the community. I look to increasing demands for biological containment, air conditioning and automation extending beyond environmental controls to irrigation and even crop management and materials handling. Supplemental lighting levels will also continue to rise, especially in the new air conditioned greenhouse compartments.

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