The University of Oklahoma

SCHOOL OF CIVIL ENGINEERING AND ENVIRONMENTAL SCIENCE

ENVIRONMENTAL IMPACT EVALUATION AND LIFE-CYCLE COST ANALYSIS OF TRADITIONAL AND INNOVATIVE COOLING TOWER TECHNOLOGY

EXECUTIVE SUMMARY

The traditional cooling tower is gradually being replaced with innovations in design: factory assembly, low-profile towers, fiberglass-reinforced plastic (FRP), polyvinyl chloride (PVC) cellular fill, and low-pressure nozzles. One manufacturer, Tower Tech, Inc., of Oklahoma, has been a leader in new design features: a patent for a modular tower, development of a unique rotary spray nozzle which can deliver a spray of water in virtually any shape at low head loss with very little vertical displacement, placement of multiple direct-drive fans below the cooling tower matrix, and use of an enclosed and elevated cold water basin. The purpose of this study was to compare conventional and innovative cooling tower technology with respect to the following areas:

1. Environmental impact,
2. Safety aspects (both installation and maintenance),
3. Energy saving,
4. Operations and maintenance, and
5. Miscellaneous aspects, including ultimate decommissioning and disposal.

The table presented below summarizes the potential benefits found for the innovative technology in the areas of environment, worker health and safety, energy use, and operations and maintenance. It is our opinion that the innovative design will reduce the environmental impacts which are often associated with traditional, induced-draft cooling towers. Forced-draft design reduces the distance of plume travel, limiting off-site deposition. Factory assembly will eliminate the on-site impacts (noise, dust) associated with heavy construction equipment, and the low profile greatly reduces the visual impact and decreases pump costs. The total elimination of wood and metal reduces the requirements for chemical activities.

The innovative technology offered by Tower Tech, Inc., offers many advantages in the area of worker health and safety. Factory assembly allows management better supervision over workers, the placement of mechanical parts at ground level allows most maintenance tasks to be performed without the risk of falling from heights, and the enclosed design eliminates both the need for confined space entry and sludge removal. The patented nozzle design reduces the chances of clogging, thus reducing the need to access the nozzle above ground level, and the multiple fan/motor design results in light, easier-to-handle mechanical parts.

One significant finding of the study was the savings in fan energy costs possible using this unique multiple-fan design. For cities with 99% wet bulb temperatures above 77° F (e.g., Miami, Houston), savings in annual fan motor costs of up to 54% were seen. For cities with 99% wet-bulb temperatures below 77° F (e.g., Buffalo, Denver), savings in annual fan motor costs of up to 46% were seen. These savings were calculated as the actual power used by the fan motors, not the brake horsepower required to drive the fans.

A comparison of lifetime costs (purchase/transportation and fan/pump energy costs) for Tower Tech, Inc., towers and non-corrosive towers of three other manufacturers was also conducted. The study considered towers constructed of fiber-reinforced plastic, with PVC fill, and containing no metal parts (Tower Tech, Inc.). Towers sized for the air conditioning market (400-2400 tons), as well as those which would suit the industrial market (6000-30000 GPM) were studied. Tower lifetimes of 5-, 10-, 20-, and 30-years were considered for each size of tower. For the comparisons which were made, the Tower Tech, Inc., towers had the lowest lifetime costs. However, comparisons were based on theoretical performance, which may vary from actual performance. Also, other comparison, not examined, could have identified lower lifetime costs.

In summary, the cooling tower industry is changing rapidly as many design innovations are introduced. The results of this research have led the authors to conclude that innovations such as those pioneered by Tower Tech, Inc., offer potential benefits in the areas of environmental impact, worker safety and health, energy use, and operations/maintenance.

Potential benefits of innovative cooling tower technology:

Innovative Feature	Environment	Worker Health and Safety	Energy	Operations/ Maintenance
Factory assembly	Confines impacts to manufacturing site	Better supervision of workers	More efficient manufacture	
Modular design			Allows units to phase in and out	Malfunction of one unit does not shut down operation
Low profile	Less visual impact	Less risk of falling from elevation	Lower pump head	Easier access to components
FRP/PVC fill construction	No chemicals to treat wood rot or metal corrosion; no release of zinc	Fewer chemicals to handle		Reduced replacement of parts
Low pressure nozzle, square distribution		Reduced maintenance, less need to access nozzle	Reduced pressure means less energy to operate nozzle	Higher efficiency, less clogging of nozzle
No open basin	No access to algae, birds, etc.	No sludge cleanout required		Less maintenance
Enclosed design	Less sunlight on internal parts (less algae)	No need for confined space entry		
No louvers			Less resistance to airflow	Fewer parts to maintain
Multiple fans, motors		Lighter, easier for worker to handle	Reduction in energy use in high wet bulb cities	Malfunction of one unit does not shut down operation
Forced draft	Shorter travel distance of plume, less offsite deposition			Fan handles cool, dry, clean air
Fans at grade level		Safer access, doesn't require climbing		

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