Polymer Composites as Construction Materials

Application Summary Sheet 20

Title: Cooling Towers

Target Audience: Design Engineers, Suppliers, Composite Manufacturers

Keywords: Corrosion resistance, Water cooling, High temperature applications, durability, HVAC, Filtration, Process Industry, Modular construction, Polymer composites

Overview of application / summary:

This application concerns industrial cooling towers with uses ranging from water cooling for small power generators to large air conditioning systems or chlorine processing plants. The cooling towers are exposed to severe internal operating conditions such as high temperature, wet, corrosive and abrasive environments and sustained loading.

FRP composites have been employed in cooling towers as secondary components (including pipes and fan stacks) for over 30 years, the primary structure traditionally being constructed from wood, concrete or steel. However, FRP composites are now prevailing as the most suitable *primary* structural material in view of their superior performance in hostile environments and other beneficial properties.

Consequently, the cooling tower industry has seen a rapid uptake of FRP towers in recent years. The design flexibility of composites has allowed new types of cooling tower to be developed which are more efficient and cost effective than previous designs and materials. The modular, cellular construction systems provide structures of high integrity that can be rapidly installed. The desirable environmental properties of FRP materials also help the structures meet the increasingly stringent legislation imposed on them.

Impact of application

Engineering:

- Inherent corrosion, moisture and temperature resistance of FRP composite materials significantly increases the durability and service life of the structure.
- Composite parts offer more flexibility of shape than steel or timber. Components can therefore be manufactured with features that enable rapid connection and modular construction, minimising the material content whilst providing the required buckling strength.

- The modular design methods associated with FRP structures are quicker and easier. A standard range of field erected towers can be formulated efficiently from the initial design.
- Suitable limit-state design methods account for the variability of all the material parameters - allowing production of safe but efficient designs.
- FRP structures exhibit superior dynamic response to high wind loads in comparison to conventional structural materials.
- Maximising the glass volume not only enhances the material strength and stiffness properties, but reduces creep and hygrothermal effects due to the lower resin content.

Financial:

- Although comparable to conventional tower structure materials in initial cost, FRP composites offer significant through life cost savings. They have longer service lives, lower replacement frequency and require little maintenance.
- Less raw material use in the overall structure brings associated cost savings.
- Gains are made form the rapid installation, which is much less labour intensive due to the lightweight components.
- Transportation costs are also reduced as less, lighter weight material is required.
- The lower replacement frequency also reduces the significant process downtime costs associated with structure replacement.

Environmental:

- FRP is preferable to wood in instances where environmental issues are a factor since it contains no preservatives that could leach into the water being cooled.
- Composite materials can aid compliance to legislation regarding discharge to rivers. Greater cooling capacity means that the water released can closely approximate the temperature of the river as stipulated in regulations.
- It has also been proved that composite tower structures offer reduced noise emission due to their preferable dynamic behaviour.

Social

- The construction process is evidently safer. The lightweight components ensure simple and smooth operation.
- It is anticipated that this will become a very significant market for FRP structures and rapid growth is expected in the coming years. This is based on the high uptake in the U.S. and successful recent examples in the UK.

Robustness of research

The primary structures have developed from the initial use of secondary FRP composite parts in towers; consequently there is very little underlying research into specific cooling tower structure design. However, structure design is based on well developed practices used in other areas of the construction industry. A recent example is a monocoque design by Maunsell, based on the Advanced Composite Construction System (ACCS), which has been successfully exploited in bridges and other primary structures.

These applications are mainly manufacturer driven, pushing the major financial and engineering benefits of FRP composites to existing and potential structure owners.

Future developments

It is expected that as the advantages of the ACCS design become more widely known, further applications will follow in what could become a very significant market for composites.

Where to get further information

Companies

CASE Cooling towers:
www.compositeaqua.com/coolingtowers.htm

Optima Cooling Towers:
www.hamon.com

Bedford Reinforced Plastics Inc.:
www.bedfordplastics.com

Articles

"A Composite Monocoque Cooling Tower Design"
Duckett, W & Cadei, J. (Maunsell Ltd)
NGCC Annual Conference, BRE, Watford. October 30-31 2001.