Locking in to Cooling Tower Fill Assembly

By Jim Wallis and Richard Aull

Film fill increases heat rejection and reduces air resistance but also adds to the cost of cooling tower construction. Mechanically assembled film fill offers the same benefits with less labor costs while providing environmental benefits.

The performance of industrial cooling towers has improved significantly over the last 25 years due to the development of highly efficient plastic film fills. Older cooling tower designs use splash fills that break up the hot return circulating water into small droplets, allowing them to be cooled through evaporation and convection driven by ambient air flowing at 600 ft/min (3 m/sec). Newer cooling towers use film fills that increase the circulation water surface area exposed to the airflow and significantly increase heat rejection and reduce air resistance. The change from splash fills to film fills increased cooling tower efficiency by two times or greater.

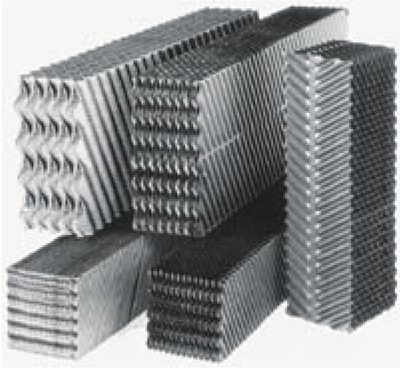

Figure 1. Newer cooling towers use film fills that increase the circulation water surface area exposed to the airflow, thereby increasing heat rejection and reducing air resistance.

Cooling tower film fills first were made of corrugated asbestos sheets or other materials. As engineers saw the benefit of increasing the density (number of sheets per lineal space) of the film fill packs -- from a sheet spacing of 3.94" (100 mm) to 0.75" (19 mm) or less -- other construction materials were considered. Increasing sheet density and having an engineered sheet design improve the cooling potential. The increase in sheet density was allowed by using plastics. Today, the most commonly used film fill sheet material is rigid PVC (Cooling Technology Institute Std. 136). It is durable, provides a long service life, is excellent for wetting (conditioned to allow surfaces to be covered completely by water), is self-extinguishing and can be formed into many shapes (figure 1).

During the 1960s and 1970s when asbestos-board film fill was used, the fill assembly cost was as great as the fill sheet cost. This was due to the bulky nature of the fill sheets, the required fasteners and spacers, and the installation time required.

The use of plastic film fill changed the manufacturing process of standard cooling towers (figure 2). Of course, there really is no such thing as a standard cooling tower because tower design depends on a number factors, including approach temperature (wet bulb cold water temperature), ambient air conditions, heat rejection required, flow rates and plant space available.

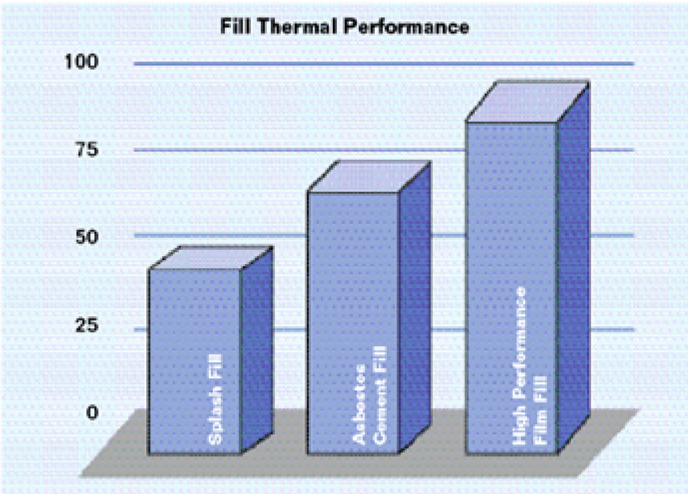

Figure 2. Plastic film fill improves the thermal performance of cooling towers.

For discussion, suppose a power plant, refinery or industrial plant will require cooling towers that will use 106,000 ft^3 (3,000 m^3) or more of cooling tower film fill. This volume of cooling tower fill represents 8,833 fill packs with a dimension of 2 x 1 x 6' (610 x 305 x 1,830 mm). If the fill packs are to be assembled at the cooling tower site, it requires 142,000 fill sheets, 2 x 6' at the specified sheet thickness. Because the assembled fill will take up to 10 times the shipping space compared to shipping unassembled fill, assembly at the job site, near the cooling tower, has significant economic advantages.

There are many ways to assemble rigid PVC film sheet into fill packs, including the use of either solvent glue or other bonding cements, heat welding and various methods of mechanical assembly. The most common method of assembly is solvent cement, also referred to as gluing. This method is quick and at a relatively low cost as a percentage of the total fill cost. Table 1 compares the cost of installing cooling tower fill. The typical fill assembly cost is 25 percent of the fill material cost. This assembly cost for the most common method of assembly -- using solvent glue -- includes both labor and glue.

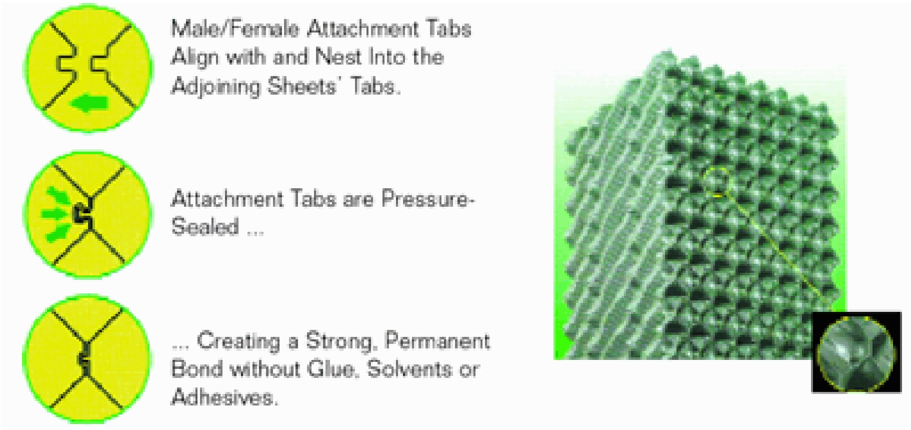

Figure 3. The mechanical assembly system is designed with male/female attachment tabs that fit snugly into each other. To make the attachment permanent, the tabs are pressure sealed.

Besides the quality and operational considerations of fill assembly, the installation of the fill in the tower should be given adequate consideration. When gluing on-site, it is important that the fill packs are staged in an area to allow for complete curing of the bonded area, which typically takes 48 hr. If the glued packs are handled prior to curing, the installed pack will have a significantly reduced load-carrying capability. Poorly installed fill can affect tower efficiency by 10 percent or more.

Environmental Issues. U.S. and state environmental regulations require approval for any manufacturing or assembly site using organic solvents. This can add time and cost for site assembly. Avoiding registration at site assembly exposes your company and your client to fines imposed by federal and state environmental offices, which would be at a minimum $25,000 and usually greater.

Health and Safety Issues. In the United States, OSHA 29 CFR 1910.1200 covers the employee health issues related to the use of potentially toxic materials and provides guides to limit employee exposure. In the United Kingdom, the health and safety rules provide limits of VOC exposure and require frequent sampling to ensure that employees are not exposed to excessive amounts. If tests indicate, the manufacturing or field-assembly site must be ventilated to protect employees from high levels of exposure.

Solvent adhesives are flammable and increase the risk of fire. At a facility in Korea, a significant fire started at the gluing location, caused by welding near to the gluing area. This fire engulfed the assembly area and expanded to envelop the cooling tower. Because of concerns about fire at refineries or other industrial sites, some owners will specify no gluing at the site.

Mechanical Assembly of Fill Film

Table 1. Cost to Install 106,000 ft³ (3,000 m³) of Cooling Tower Fill					
Method of Fill Installation	**Media Cost**	**Freight**	**Cost of Assembly**	**Install Fill Media in Tower**	**Total**
Assembled Packs Shipped from Manufacturing Site 1,000 miles To Site	$267,000	$54,000	$0	$9,600	$330,000
Unassembled Sheets Glued at Site	$201,000	$6,000	$57,000	$9,600	$273,600 (18% Savings)
Unassembled Sheets Heat-Welded At Site	$201,000	$6,000	$69,000*	$9,600 (14% Savings)	$285,600
Mechanical Assembly At Site in Tower Bay	$201,000	$6,000	$18,000	$0	$225,000 (32% Savings)

*Includes additional time for heat welding and cost of rental equipment. Quality concern of heat welding PVC also must be considered.

This table compares the cost of installing cooling tower fill. Typical fill assembly cost is 25 percent of the fill material cost. The assembly cost for the most common method of assembly includes labor and glue.

In a typical 2 x 1 x 6' fill pack, there are more than 4,000 bonding points. In a glued pack, the assembler would glue each of these bonding points to make a durable fill pack. In a mechanical assembly fill pack, the bonding points are male/female attachment tabs that fit snugly into each other. To make the attachment permanent, the tabs are pressure sealed (figure 3).

To assemble a pack, the first step is to assemble two fill sheets into a pair by pressure sealing the attachment points. Each pair is, in effect, a small fill pack with high beam strength proportional to its depth. Then these pairs are attached to other pairs using the same pressure-seal tabs. The number of pairs attached determines the pack width. The final pack is designed to be as durable as a glue pack and has a weight-carrying capability 10 times greater than the average fill load (fill and water weight).

Several cooling tower manufacturers have successfully used the mechanically assembled fill in cooling towers in Japan, Thailand, Mexico, Europe, South America and the United States. It is reported that the field-assembled system is as fast as gluing; in addition, it eliminates the need for and shipping of glue materials. This is a positive aspect because some countries restrict the shipment of solvents due to the drug control laws.

The mechanical system eliminates glue cleanup and the risk of fires. The fill also satisfies the demands of end users who specify a fill with no hazardous materials or materials that cause objectionable odors. In the Laem Chabang Power Plant in Thailand, which is situated close to an office complex, the owner was concerned about glue fumes irritating the neighbors. In this case, the mechanical assembly system was used with great success.

The system can be used on various sheet thicknesses so that thicker material can be selected for higher loads or more severe operation conditions such as seawater applications, food processing or aggressive process contamination. Or, if circulation water temperatures are high, high temperature plastics can be used. Some high temperature plastics such as polypropylene cannot be bonded using conventional gluing methods. Considering economics, engineering, environmental and health and safety issues, the mechanical assembly system might be a good choice.

Jim Wallis is international director of Brentwood Industries Inc., Reading, Pa., and Brentwood Asia Ltd., Bangkok, Thailand. Richard Aull is engineering manager of Brentwood Industries Inc., Reading, Pa.