Permanent Magnet Motors for Cooling Tower Applications

PAUL HUMBERT
TOWER ENGINEERING, INC
Conventional Drive System Arrangement
PM Motor Fan Drive System
Features & Benefits

- Permanent Magnet Technology
- Improved Reliability
- Adjustable Speed Capability
- Quiet Operation
- Built-in Anti-rotation Capability
- Built-in Motor Heater Capability
- Reduced Maintenance Costs
- Improved Safety
- Soft Start Tower Stress Reduction
- Long Term Warranty
- Lower Energy Consumption
One piece end plates on frame for precise bracket fits.

Stator slots integral to laminated frame. One piece frame / stator results in superior heat dissipation.

Welded thru bolts for rugged construction.

Totally finned surface for optimized heat transfer.
Improved Reliability

Inpro Labyrinth Seal

- Ingress Protection - IP56
  - The first numeral defines the degree of protection against dust.
    5 = Dust protected
    6 = No Ingress of dust per IEC 34-5 this degree of protection is not applicable to rotating equipment such as motors and generators but applicable to electrical enclosures
  - The second numeral defines the degree of protection against water.
    5 = Protected against water jets
    6 = High pressure jets from all directions, (limited ingress permitted)

Water Flinger

CT Paint System
Improved Reliability

- 100% grease fill rate.  
  - Eliminates voids.

- Mobil SHC460 & 220 Synthetic Grease.

- 63 & 62 series ball bearings for smaller HP ratings.

- Ceramic coated OD of ODE to prevent current damage. Ceramic sleeve for 5800 frame motors.

- AC bearings for large HP ratings or to increase L10 life.

- Bearing L10 life min 100,000 hrs.

- Re-lubrication interval based on 17,500 hrs of operation 40°C ambient & 750 FPM Min airflow.  
  - Goal of lubed for life in future.

Grease & Motor Bearings

Ceramic Coated Bearing OD
Improved Reliability

- Vacuum Pressure Impregnated (VPI) Insulation System
  - Insulation System developed for the most demanding applications.
    (i.e. Navy Service, Off Shore Oil Drilling, Submersible Motors)
Quiet Operation

<table>
<thead>
<tr>
<th>Average</th>
<th>High Speed</th>
<th>Low Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Induction NEMA Motor Tower</td>
<td>82.3 dBA</td>
<td>74.4 dBA</td>
</tr>
<tr>
<td>PM Motor</td>
<td>77.7 dBA</td>
<td>69.0 dBA</td>
</tr>
</tbody>
</table>

- Clemson University Test Data
- Data verified by Clean Air Engineering (3rd Party Testing Agency).
Reduced Maintenance Costs

- No Oil Changes or Leaks
- No Gear Reducer Change-outs
- No Drive Shaft Change-outs
- No Flex Disc Change-outs
- No “Tricky” Re-alignment Issues

Substantial Savings on Multi-Cell Cooling Towers
Improved Safety

Conventional Drive Equipment Multi-Component Failure
Increased Efficiency

- Permanent Magnet (PM) motors provide higher efficiencies.
- Limitations of motor control and magnet material performance/cost previously restricted their use.
- Dramatic improvements represent a viable alternative today.

1 - ½ % to 2 - ½% Increased Efficiency
Increased Efficiency

Mechanical Losses

★ Conventional Drive Trains lose energy through couplings, drive shafts and gear reducers.

★ Gear efficiencies are typically stated at 96% (4% transmission loss).

★ Actual transmission losses are greater \textit{up to 15%}. 
# Lower Energy Consumption

<table>
<thead>
<tr>
<th>Clemson University</th>
<th>2-Speed, 326T Induction Motor</th>
<th>PM Motor FL4493</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Load</td>
<td>41.5 Hp</td>
<td>41.5 Hp</td>
</tr>
<tr>
<td>Gearbox and couplings Efficiency</td>
<td>90.2%</td>
<td>N/A</td>
</tr>
<tr>
<td>Motor Horsepower</td>
<td>46.0 Hp</td>
<td>41.5 Hp</td>
</tr>
<tr>
<td>Motor Efficiency</td>
<td>90.0%***</td>
<td>93.1%</td>
</tr>
<tr>
<td>Drive (VFD)</td>
<td>N/A</td>
<td>98.8%</td>
</tr>
<tr>
<td>Input kW</td>
<td>38.1</td>
<td>33.6</td>
</tr>
<tr>
<td>Total Efficiency</td>
<td>81.2%</td>
<td>92.0%</td>
</tr>
</tbody>
</table>

- Clemson University Test Data
- Existing motor is 22 years old; new induction motor is 93.5% efficient.
- Gearbox manufacturer states gearbox efficiency at 96%, but test data indicates mechanical system (gearbox, couplings & driveshaft) is 90.2%.
- Data verified by Clean Air Engineering (3rd Party Testing Agency).

*** Published data.
Lower Energy Consumption

Alcon Laboratories
North Cogen Plant
Ft Worth, TX

Two Cells
› One with existing geared solution
› One with a Direct Drive Solution

100 HP Direct Drive Motor
› Speed 217 rpm

<table>
<thead>
<tr>
<th>Arrangement</th>
<th>Fan Design</th>
<th>Fan Speed (Average)</th>
<th>Present Motor HP</th>
<th>Measured Power Full Load Full Speed</th>
<th>Equivalency Ratio</th>
<th>Full Load Estimated Power Usage</th>
<th>Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Drive</td>
<td>16KW10</td>
<td>217</td>
<td>100</td>
<td>80 KW</td>
<td>1X</td>
<td>80 KW</td>
<td>8.31%</td>
</tr>
<tr>
<td>Geared</td>
<td>16H10</td>
<td>223</td>
<td>125</td>
<td>87.25 KW</td>
<td>1.983X</td>
<td>87.25 KW</td>
<td></td>
</tr>
</tbody>
</table>
Lower Energy Consumption

NOVO Pharmaceutical Denmark

Test of Baldor Permanent Magnet Motor in OCT26 Cooling Tower
performed by Vestas Industrial Cooling & Baldor Electric Germany Gmbh
Measured on 8 April 2011 by independent 3rd party

- Baldor FL4485 Frame
- 37kW, 250 RPM, 400 V operating conditions at full load.
- Hansen Gearbox on old solution referenced to be 97% efficient.
- Energy savings ranged from 8.6% - 18.5% depending on speed.
Merck Pharmaceutical (West Point, PA)
- (2) 75 HP, 127 RPM, 460V, FL4413 Motors
- Installation Oct. & Dec. 2010

Project Update Phase - 1
Merck ran efficiency studies of their existing towers against the installed CTD products
$53K Savings in Energy over three months
Lower Energy Consumption

**Cooling Tower Installation Comparison**

Energy Savings

- **Denmark NL Pharmaceutical application**
  - Cell 5: average = 35.06 kW Traditional solution
  - Cell 4: average = 31.14 kW Baldor Solution
  - Saving 3.92 kW = 11.2%

- **Cargill – Turkey**
  - Analysis - Avg over 2 month period
  - 21kW vs 25kW which will be around a 16%
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Questions?