Onshore wind turbine installation & Grouting
Meeting the Industry

New product introduction - MasterFlow 9400

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MasterFlow 9400

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MasterFlow 9400

Market demands

» New generation of wind turbines more powerful with ever growing hub heights

» Ever higher loads acting on the foundations, requiring superior designs

» More rapid assembly of the towers, aiming for the lowest levelized cost of energy (LCoE)

» Superior workability in a wide temperature range
  ▪ Long working time in warm conditions
  ▪ Rapid hardening even at cold temperatures

» Certified materials, complying with the regulations of the different countries

» Durable foundations
  ▪ Maintenance free installations
  ▪ Excellent fatigue resistance
Cost optimized foundation installation

- Reducing time for grouting works: reduce mixing operations, big bags instead of 25 kg bags, pumping instead of pouring
- Optimum use of weather windows: applications in cold and warm conditions
- Durable foundations: superior design using superior grouts

Improved risk management

- Faster assembly of tower reducing the risk for early age defects
- Easier material installation: minimizing failures on site
- Improved quality of works and better Quality Assurance: on site Quality Control, intense Factory Production Control (FPC), confirmation of material quality from different production sites
- Certified product: independently tested and validated/certified by expert or recognized body
- Installation by specialist grouting contractors e.g. BASF LC’s
MasterFlow 9400

New material especially developed for compatibility with the newest generation of onshore wind turbines.
MasterFlow 9400

Independent testing – Quality assessment

» Excellent workability at wide temperature range
  ▪ Potlife ≥ 180 minutes at elevated temperatures
  ▪ Potlife ≥ 240 minutes at 20°C or below

» Low porosity
  ▪ Air content < 4 %
  ▪ Wet density of approx. 2400 kg/m³

» High early and final compressive strength
  ▪ ≥ 50 MPa after 24 h at 20°C
  ▪ ≥ C100/115 (which is the highest strength class in EN206)
  ▪ Characteristic strength: 117 MPa (cylinders)
MasterFlow 9400

Independent testing – Quality assessment

» High early strength

![Graph showing early compressive strength development](image)

» High final strength
  - $f_{ck}$ vs. $f_{cm}$ for cylinders

![Table showing test results](image)

<table>
<thead>
<tr>
<th>Test</th>
<th>Test method</th>
<th>2°C</th>
<th>10°C</th>
<th>15°C</th>
<th>20°C</th>
<th>30°C</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$f_{ck}$</td>
<td>86.1</td>
<td>94.4</td>
<td>105.0</td>
<td>109.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$f_{cm}$</td>
<td>94.8</td>
<td>94.8</td>
<td>94.8</td>
<td>94.8</td>
<td>94.8</td>
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</tbody>
</table>
MasterFlow 9400

Independent testing – Quality assessment

» Excellent fatigue resistance

acc. Model Code 1990

acc. Model Code 2010
MasterFlow 9400

Application method and Prototype application

» Mechanical mixing and placing
  ▪ Mixing with forced action pan mixers
  ▪ Pumping with worm or piston pumps

» MasterFlow 9400 available in
  ▪ 25 kg bags
  ▪ 500 kg big bags

» Large volume applications
  ▪ Preferably using Putzmeister P715 or similar
  ▪ Using 300 to 500 liter mixers and big bags

» Reduced number of mixes
  ▪ Reduced QC frequency while ensuring constant quality
  ▪ Lower material loss

» Watch points e.g.
  ▪ Concrete surface preparation
  ▪ Free standing water
  ▪ Protection of pre-stressing bolts
  ▪ Adequate curing
First application using MasterFlow 9400

- Gamesa prototype: Bremerhaven, March 2017
- Turbine type: Adwen, 8 MW
- Installation by BASF LC - Azul
- 4 tons of MasterFlow 9400
- Intensive quality control on site
- Compressive strength under jobsite conditions
  (150 x 300 mm cylinders)
  - After 39 h: 63.4 MPa
  - After 45 h: 66.7 MPa
  - After 64 h: 78.8 MPa
  - After 28 d: 115.8 MPa
First application using MasterFlow 9400

- Impressions - © Azul
MasterFlow 9400
Application method and Prototype application

First application using MasterFlow 9400
- Impressions - © Azul
MasterFlow 9400

Application method and Prototype application

First application using MasterFlow 9400
- Impressions - © Azul
## MasterFlow 9400

### Features – Advantages - Benefits

<table>
<thead>
<tr>
<th>Features</th>
<th>Advantages</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grouting larger volumes in shorter period</td>
<td>- Faster grouting works</td>
<td>- Reduction of overall installation cost</td>
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<tr>
<td></td>
<td>- Shorter weather windows</td>
<td>- Optimized assembly time</td>
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<tr>
<td>Rapid strength development</td>
<td>- Installation in short weather windows</td>
<td>- Cost and time saving</td>
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<td></td>
<td>- Installation in cold conditions</td>
<td>- Durable and secure foundation</td>
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<td></td>
<td>- Reduced risk of early age damage</td>
<td></td>
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<tr>
<td>Material available in 500 kg big bags</td>
<td>- Fewer individual mixes, minimizing failures on site</td>
<td>- Improved quality assurance</td>
</tr>
<tr>
<td></td>
<td>- More focused quality control</td>
<td>- Lower cost for grouting works</td>
</tr>
<tr>
<td>Applicable from +2 to +35°C</td>
<td>- Long working time in warm conditions</td>
<td>- Optimized assembly time</td>
</tr>
<tr>
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<td>- High early strength even in cold weather</td>
<td>- Little to no weather downtime</td>
</tr>
<tr>
<td>High final strength</td>
<td>- Resists higher loads from ever growing turbines</td>
<td>- Optimized / Lower cost of energy</td>
</tr>
<tr>
<td></td>
<td>- Can be considered for smaller flange designs</td>
<td>- Further design optimization possible</td>
</tr>
<tr>
<td>High fatigue resistance</td>
<td>- Resistant to dynamic loads</td>
<td>- Excellent durability</td>
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<td></td>
<td></td>
<td>- Maintenance free installation</td>
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<tr>
<td>Independently validated by external</td>
<td>- Certified quality</td>
<td>- Improved risk management</td>
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<tr>
<td>laboratories</td>
<td>- Full material and process control</td>
<td>- Secure wind turbine installation</td>
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</table>
MasterFlow 9400

A prefect match of the market demands

**Product benefits at a glance:**

- **High fatigue resistance**
  Absorbing dynamic loads

- **Universal**
  Designed for use with majority of turbine types

- **Excellent durability**
  Guaranteed longterm electricity production

- **High early strength**
  Allows earlier pre-stressing of the anchor bolts

- **Secure installation**
  Application by BASF Licensed Contractors

- **Proven high quality**
  Evaluated by Gamesa and external laboratories