Lubrication and Filter Systems for Wind Power Gears
It is particularly important that wind turbine lubricants provide appropriate protection of gearboxes against corrosion, wear, and tear. Most lubrication and hydraulic systems failures are caused by oil contamination. That is why proper oil maintenance, monitoring, and filtration are an essential part of preventive, structured maintenance programs.
Wind power is not only the fastest growing energy production platform in the world, it is also one of the cleanest renewable power sources on Earth. As turbines are getting larger and offshore systems become more common, the possibility to build wind power plants almost anywhere makes their growth inevitable.

Effective and consistent lubrication of components can sometimes be a challenge in wind turbines. Contaminants, like solid particles or moisture can enter the gearbox during manufacturing and assembly, or in the initial run-in process, or during routine maintenance. Contaminants also can be ingested through seals and breathers, or internally generated during regular operations.

Proper oil maintenance, monitoring, and filtration are essential parts of preventive, structured maintenance programs.

Experts recommend equipping wind power systems with:
- Additional filtration systems
- Metal particle monitoring systems
- Solid contamination monitoring systems
- Water-in-oil monitoring systems
- Water removal systems
- High quality desiccant breathers
- Heating systems for cold environments

Wind Energy in Cold Climates

Take advantage of wind power even in the coldest regions of the world. Cold climate and severe outdoor conditions have particularly undesirable effects on wind turbines, primarily affecting plastic and steel components and lubricants.

At low temperatures, the viscosity of lubricants and hydraulic oils increases, causing the oil to stiffen, leaving it unable to sufficiently lubricate the gearbox and bearings.

If the oil is too thick to freely circulate, damage to the gears will occur almost immediately. An increase in internal friction will reduce the power transmission capacity of the gearbox. It is also important to account for servicing and monitoring the system under difficult cold weather conditions. Increased maintenance costs and extended turbine downtime need to be considered.

To significantly improve the dependability and extend the service life of wind turbines under cold, unpredictable winter conditions, Eaton offers a variety of Internormen product solutions.

Lubrication System Diagram

Legend
p1: Pressure filter ON
p2: Pressure filter OFF
p5: Bypass ON
p6: Pressure cooler ON
p7: Pressure cooler OFF
p8: Pressure flow junction
TB: Temperature casing
T1: Temperature filter ON
T6: Temperature cooler ON
T7: Temperature cooler OFF
VM: Flow measuring device
K: Cooler
Q: Oil flow pump
Q1: Oil main flow filter
Q2: Oil parallel flow filter
Q3: Oil flow to the gear
Q5: Deaeration flow
QK: Oil flow cooler
QB: Oil flow bypass
E1: Permanent deaeration
VD1: Valve with filter element 51 psi (3.5 bar)
VD2: Valve to cooler 7.3 psi (0.5 bar)
VD3: Valve to bypass 87 to 174 psi (6 to 12 bar)
**Start Trial Results**

Tests under simulated cold start conditions (down to -22 °F (-30 °C) operating and -40 °F (-40 °C) survival temperatures) and with a special gear oil, yielded the following results:

- Oil flow through the air-oil cooler could be attained after two minutes.
- The adjustable pressure differential valve (VD3) appeared to influence how long it took to see a temperature increase (T7) at the cooler outlet. Based on the oil flow (Qk 20% of the total flow Q), and at pressures from 87 to 174 psi (6 to 12 bar), the times ranged from 10 to 2 minutes.
- All system components worked properly from cold start up to maximum temperature. Whenever measured, oil viscosities were < 4635 SUS (1000 mm²/s), and the oil flow was 100% filtered through the main element (filter fineness 10 µm, fiber glass fleece).

![Temperature Graph](image)

**Filter, Valve, and Cooling System Function from Cold Start to Normal Operating Temperature**

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**Graph Details**

- **Trial Start 1**
  - VD3 174 psi (12 bar)
  - Δ pk min = 55 psi (3.8 bar)
  - OK > 4 gal/min (15 l/min)

- **Trial Start 2**
  - VD3 87 psi (6 bar)
  - Δ pk min = 55 psi (3.8 bar)
  - OK > 4 gal/min (15 l/min)
Performance Tests

Eaton’s Internormen product specialists coordinated with customers and other partners to test the TWF system’s functionality. They simulated cold start conditions (down to -22 °F (-30 °C) operating and -40 °F (-40 °C) survival temperatures) and used special gear oils.

They found that all system components—including the pump, filter, valves, and tube system—worked properly from cold start to the 158°F (70 °C) maximum operating temperature without any negative effect on the overall gear-oil supply.

Twinfil Filter Systems

Features

- Specially designed gear lubrication systems
- Reliably supplies all gear lubrication points as it filters and deaerates the system
- Low noise emission
- Indicates oil operating condition
- Prolongs lubricant service life
- Simple to service
- May be operated in cold weather conditions with an additional, pump-assisted heating system

Available Options

Condition Monitoring Systems

- Metal particle sensors (MPS)
- Water sensors (WSPS)
- Multifunction oil condition sensors (IVS 01)

Water Removal Filter Elements

- Use for particle retention and absorption of free and emulsified water from oil
- Reduce oil aging and deadditivation of fluids
### TWF 1001

**Technical Data**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tr>
<td>Operating pressure:</td>
<td>232 psi (16 bar) maximum</td>
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<tr>
<td>Flow rate:</td>
<td>31.7 gal/min (120 l/min)</td>
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<tr>
<td>Operating temperature:</td>
<td>-22 °F (-30 °C) minimum</td>
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<tr>
<td>Survival temperature:</td>
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<tr>
<td>E-motor - rotary current:</td>
<td>400/690 V, 50 Hz/60 Hz</td>
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<td>E-motor - protection class:</td>
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### TWF 1950

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<tr>
<td>Flow rate:</td>
<td>52.8 gal/min (200 l/min)</td>
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<td>Operating temperature:</td>
<td>-22 °F (-30 °C) minimum</td>
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<td>Survival temperature:</td>
<td>-40 °F (-40 °C) minimum</td>
</tr>
<tr>
<td>E-motor - rotary current:</td>
<td>400/690 V, 50 Hz/60 Hz</td>
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<td>E-motor - protection class:</td>
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### TWF 4000

**Technical Data**

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<td>Flow rate:</td>
<td>66 gal/min (250 l/min)</td>
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<td>Operating temperature:</td>
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<td>Survival temperature:</td>
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<td>E-motor - rotary current:</td>
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<td>E-motor - protection classes:</td>
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### TWF 6000

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<td>Flow rate:</td>
<td>105.7 gal/min (400 l/min)</td>
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<td>Operating temperature:</td>
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<tr>
<td>E-motor - rotary current:</td>
<td>400/690 V, 50 Hz/60 Hz</td>
</tr>
<tr>
<td>E-motor - protection classes:</td>
<td>IP 65</td>
</tr>
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</table>
WGR 60 - Maintenance Unit

- Inexpensive maintenance unit meant for quick, clean change of filter element without oil loss
- Oil is pumped out of the filter housing into an appropriate reservoir and pumped back into the system after the filter has been changed
- Especially suitable for application in wind power plants

<table>
<thead>
<tr>
<th>Technical Data</th>
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<tbody>
<tr>
<td>Dimensions:</td>
<td>20.5 x 14 x 28.7 in (520 x 355 x 730 mm)</td>
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<tr>
<td>Weight:</td>
<td>26.5 lb (12 kg)</td>
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<tr>
<td>Barrel capacity:</td>
<td>16.85 gal (60 l)</td>
</tr>
<tr>
<td>Flow rates:</td>
<td>1.3 to 4 gal/min (5 to 15 l/min)</td>
</tr>
<tr>
<td>Viscosity:</td>
<td>18,540 SUS (4000 mm²/s)</td>
</tr>
<tr>
<td>Suction/pressure hose:</td>
<td>59 in (1.5 m)</td>
</tr>
<tr>
<td>Connection:</td>
<td>G 1/2&quot; threaded</td>
</tr>
<tr>
<td>Power supply:</td>
<td>230 V</td>
</tr>
</tbody>
</table>

CSM 01 - Contamination Sensor Monitor

Applications
In-line particle counting in the oils used in wind turbine gearboxes quickly can become a challenge:
- High viscosity oils and variations in outdoor temperatures can significantly affect measurement systems
- Foamed oils make particle counting in wind power plants additionally difficult

Features
- Use as a stationary or mobile condition monitoring system
- Operates off-line, independent of the system being measured
- Analyzes the amount and size of solid contamination in hydraulic and lubrication fluids
- Easily upgraded with additional sensor modules to measure other important fluid parameters
- Measures foamed oils accurately
- Effective for early detection of changes in fluid cleanliness and oil composition as well as contamination increases
- Useful for quality control, maintenance, and during initial operations

Additional Options:
Electric, electronic, or visual pressure differential indicators to monitor filter operating conditions. They may be connected to the filter without any tubes.
Twinfil Filter Systems with Additional Pump-assisted Heating System

Features
- Specially designed gear lubrication system
- Additional heating plates
- Reliably supplies all gear lubrication points as it filters and deaerates the system
- Low noise emission
- Indicates oil operating condition
- Prolongs lubricant service life
- Simple to service

<table>
<thead>
<tr>
<th>Technical Data</th>
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<tbody>
<tr>
<td>Operating pressure: 217.5 psi (15 bar) maximum</td>
</tr>
<tr>
<td>Operating temperature: -22 °F (-30 °C) minimum</td>
</tr>
<tr>
<td>Survival temperature: -40 °F (-40 °C) minimum</td>
</tr>
<tr>
<td>Pump heating: 4 x 100 W, 230 V</td>
</tr>
<tr>
<td>E-motor: Customer-specific</td>
</tr>
</tbody>
</table>

HSH – Oil Pre-heater for Suction Hoses

Features
- Suction hose heater placed inside the Eaton Internormen DN 60 suction hose
- Additional 59” (1.5 m) heater connection line and inlet
- Excellent cold start performance of the gear pump

Benefits
- High power (350 W/m) ensures exceptionally quick heat-up time: from -22 to 40 °F (-30 to +5 °C) in 20 minutes
- Overheat control prevents oil combustion
- Outer sheath, made of stainless steel wave tube, is leak-proof and compatible with different media
- Temperature control at the surface of the stainless steel wave tube (up to a maximum of 140 °F (60 °C))
- Hose to heater is sealed without compression glands
- Various hose lengths available (standard: 59” (1.5 m))

<table>
<thead>
<tr>
<th>Technical Data</th>
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<tbody>
<tr>
<td>Tube length: 59” (1.5 m) (other lengths available on request)</td>
</tr>
<tr>
<td>Connections: 2 x SAE 2” (other connections available on request)</td>
</tr>
<tr>
<td>Nominal diameter: DN 60</td>
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<tr>
<td>Power supply: 230 V~ (other supply voltages available on request)</td>
</tr>
<tr>
<td>Power: 350 W/m</td>
</tr>
<tr>
<td>Operating temperature: -22 °F (-30 °C) minimum</td>
</tr>
<tr>
<td>Survival temperature: -40 °F (-40 °C) minimum</td>
</tr>
</tbody>
</table>
HS – Heating Systems

**Features**

- Provides quick additional gear oil heating when extremely low temperature conditions push oil viscosity up to 741,600 SUS (160,000 cSt (mm²/s))
- Two types available - HS 10 and HS 16 - each operates at 116 or 174 psi (8 or 12 bars) maximum pressure
- Fitted for survival temperatures from -40 to 176 °F (-40 to 80 °C)
- Systems are maintenance-free and equipped with a monitoring device to prevent oil overheating

### HS 10

<table>
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<tr>
<td><strong>Operating pressure:</strong></td>
<td>116 or 174 psi (8 or 12 bar) (maximum)</td>
</tr>
<tr>
<td><strong>Operating fluid:</strong></td>
<td>Poly-alpha-olefin or mineral oil-based gear oils</td>
</tr>
<tr>
<td><strong>Starting viscosity:</strong></td>
<td>741,600 SUS (160,000 mm²/s) (maximum)</td>
</tr>
<tr>
<td><strong>Operating temperature:</strong></td>
<td>-22 °F (-30 °C) minimum, 86 °F (30 °C) (maximum)</td>
</tr>
<tr>
<td><strong>Survival temperature:</strong></td>
<td>-40 °F (-40 °C) minimum, 176 °F (80 °C) (maximum)</td>
</tr>
<tr>
<td><strong>Operating voltage:</strong></td>
<td>400/460 V AC (other voltages upon request)</td>
</tr>
<tr>
<td><strong>Frequency:</strong></td>
<td>50/60 Hz</td>
</tr>
<tr>
<td><strong>Hydraulic thermal output:</strong></td>
<td>1000 W (maximum)</td>
</tr>
</tbody>
</table>
| **Electric thermal output:** | H1: 2 x 100 W, 230 V AC  
H2: 2 x 160 W, 230 V AC  
H3: 3 x 2500 W, 400 V AC |
| **Geared pump:** | 80 cm³/rev, 13.74 gal/min (52 l/min) at 750 rpm, 16.38 gal/min (62 l/min) at 500 rpm |
| **Electric motor:** | 3.0 kW |

### HS 16

<table>
<thead>
<tr>
<th>Technical Data</th>
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<tbody>
<tr>
<td><strong>Operating pressure:</strong></td>
<td>116 or 174 psi (8 or 12 bar) (maximum)</td>
</tr>
<tr>
<td><strong>Operating fluid:</strong></td>
<td>Poly-alpha-olefin or mineral oil-based gear oils</td>
</tr>
<tr>
<td><strong>Starting viscosity:</strong></td>
<td>741,600 SUS (160,000 mm²/s) (maximum)</td>
</tr>
<tr>
<td><strong>Operating temperature:</strong></td>
<td>-22 °F (-30 °C) minimum, 86 °F (30 °C) (maximum)</td>
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<tr>
<td><strong>Survival temperature:</strong></td>
<td>-40 °F (-40 °C) minimum, 176 °F (80 °C) (maximum)</td>
</tr>
<tr>
<td><strong>Operating voltage:</strong></td>
<td>400/460 V AC (other voltages upon request)</td>
</tr>
<tr>
<td><strong>Frequency:</strong></td>
<td>50/60 Hz</td>
</tr>
<tr>
<td><strong>Hydraulic thermal output:</strong></td>
<td>1500 W (maximum)</td>
</tr>
</tbody>
</table>
| **Electric thermal output:** | H1: 2 x 100 W, 400 V AC  
H2: 2 x 250 W, 400 V AC  
H3: 6 x 2500 W, 400 V AC |
| **Geared pump:** | 80 cm³/rev, 13.74 gal/min (52 l/min) at 750 rpm, 16.38 gal/min (62 l/min) at 500 rpm |
| **Electric motor:** | 3.0 kW |
Wind Power Coolers

High performance oil coolers

High or increased oil temperatures lead to oil deterioration, which again leads to decreased efficiency, wear and tear and reduced service life of equipment and components.

In order to prevent high operating and maintenance costs and prolong the life expectancy of a system, oil has to be cooled and thus enabled to perform trouble-free lubricating, sealing, corrosion protection or cooling.

Designed and dimensioned to suit your needs and requirements

INTERNORMEN offers a wide range of high-quality standard and custom designed oil coolers, with excellent cooling capacities and designed to withstand hardest operating conditions.

Efficient cooling begins with optimal dimensioning and extensive product testing: considering various factors (like e.g. the application area, environment or cooling medium) we are able to offer exactly the right cooler size or type to suit your specific requirements.

Advantages of Eaton’s Internormen Coolers:

• Compact design
• High cooling performance
• Low noise level (essential for indoor installations)
• Various sizes
• Various types (e.g. plate coolers)
• Customer-specific solutions
• Different accessories (e.g. adapters)

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### CI 61

<table>
<thead>
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<tr>
<td>Operating pressure:</td>
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<tr>
<td>Weight:</td>
<td>108 lbs (49 kg)</td>
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<td>Noise level:</td>
<td>82 dB, +/- 3 dB</td>
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<tr>
<td>Working temperature:</td>
<td>-22 to 131 °F (-30 to +55 °C)</td>
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<tr>
<td>Survival temperature:</td>
<td>-40 °F (-40 °C)</td>
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<tr>
<td>Motor:</td>
<td>1.1 kW</td>
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<tr>
<td></td>
<td>400 - 690 V, 50 Hz</td>
</tr>
<tr>
<td></td>
<td>1450 rpm, 4-pin</td>
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### CI 71

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<td>Operating pressure:</td>
<td>290 psi (20 bar)</td>
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<tr>
<td>Weight:</td>
<td>201 lbs (91 kg)</td>
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<tr>
<td>Noise level:</td>
<td>80 dB, +/- 3 dB</td>
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<tr>
<td>Working temperature:</td>
<td>-22 to 131 °F (-30 to +55 °C)</td>
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<tr>
<td>Survival temperature:</td>
<td>-40 °F (-40 °C)</td>
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<tr>
<td>Cooling capacity:</td>
<td>45 KW</td>
</tr>
<tr>
<td>Motor:</td>
<td>1.1 kW</td>
</tr>
<tr>
<td></td>
<td>690 V, 50 H</td>
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<tr>
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<td>905 rpm, 6-pin</td>
</tr>
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</table>
All of the listed cooler types have been flushed acc. to ISO 4406 contamination class 16/14/11, with a low viscosity fluid as a flushing medium.

**CI 81**

**Technical Data**

- **Operating pressure:** 290 psi (20 bar)
- **Weight:** 245 lbs (111 kg)
- **Noise level:** 62 dB, +/- 3 dB
- **Working temperature:** -22 to 131 °F (-30 to +55 °C)
- **Survival temperature:** -40 °F (-40 °C)
- **Cooling capacity:** 51 KW
- **Motor:** 1.1 kW
  - 690 V, 50 Hz
  - 905 rpm, 6-pin

**CI 91**

**Technical Data**

- **Operating pressure:** 290 psi (20 bar)
- **Weight:** 302 lbs (137 kg)
- **Noise level:** 83 dB, +/- 3 dB
- **Working temperature:** -22 to 131 °F (-30 to +55 °C)
- **Survival temperature:** -40°F (-40°C)
- **Motor:** 2.2 kW
  - 3 x 690 V, 50 Hz
  - 905 rpm, 6-pin

**CI 101**

**Technical Data**

- **Maximum operating pressure:** 290 psi (20 bar)
- **Test pressure:** 435 psi (30 bar)
- **Weight:** 346 lbs (157 kg)
- **Noise level:** 83 dB, +/- 3 dB
- **Cooling capacity:** 60 KW
- **Motor:** 2.2 KW
  - 3 x 690 V, 50 Hz
  - 6-pin
Filter Systems
- Twinfil
  - Lubrication and Filter Systems for Gears
    - TWF 1001
    - TWF 1950
    - TWF 4000
    - TWF 6000
- Filter Units
  - Stationary
    - US 10
    - US 22 with MPS 01.2
- Lubrication Systems
  - For Main Bearings of Wind Turbine Gears
- Supplementary Products
  - WGR 60
    - maintenance unit for filter change
  - Filter Elements

Contamination Monitoring Systems
- Sensors
  - Metal Particles
    - MPS 01.2
    - MPS 03.1
  - Water Contamination
    - WSPS 01 - 05
  - Oil Condition
    - IVS 01
- In-line Measuring Systems
  - Particle Counter
    - CSM 01
    - MPM 01 - Set
  - Water Contamination
    - WSTM 01 - Set
  - Oil Condition
    - IVS 01
- On-line/Off-line Measuring Systems
  - Multi-analysis Systems
    - DCM 01
  - Water Contamination
    - WSH 01

Heating and Cooling Systems
- Heating Systems
  - HS 10
  - HS 16
  - HSH - Heated Suction Hose
- Cooling Systems
  - CI 70
  - CI 81
  - CI 91
  - CI 101
  - Plate Cooler
    - WO - CI 95

For more information, please e-mail us at filtrationinfo@eaton.com

Visit us online at eaton.com/filtration for a complete list of Eaton’s filtration products

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