Orkot TXMM Hydro Bearings

Over 20 years experience in large Hydro

- Guide Vanes and control linkage
- Kaplan Runner Blade bearings
- Turbine Main Shaft Bearings, water lubricated
- Penstock Valve bearings
- Spill Gate bearings

Recent developments

- Small Hydro using running water instead of reservoirs
- Ocean Power; Sea currents, Tidal, Wave Power
Orkot applications in Francis Turbines

Orkot applications in Kaplan Turbines include runner blade bearings
There’s over 30 years experience of Orkot, mainly in large Hydro
Europe and North America have many large hydro plants, built in the ‘30 to ‘80. Orkot is fitted when upgrading existing plants, replacing metal bearings.

Elsewhere in the world new large hydro is being built, i.e. China and South America.

Major turbine manufacturers fit Orkot TXMM bearings; Alstom, Voith, Andritz
Ontario Power Generation
Niagara Falls

- Original turbines built 1922-1930, 10 units

- Operator demands for self-lube bearings to replace bronze

Barings replaced i.e. wicket gate, control ring liners, linkage bearings.

Orkot® TXMM specified on all refurbishments
Three Gorges
Location: Yangtze River, China
Customer: Alstom Power
8 units – Francis, 710 MW each
Head: 85 m

Orkot® TXMM & TLMM
Guide Vane Bearings
Upper Casing and Control Linkage, Three Gorges, China
Eurobras Guri I & II
Owner: Edelca
Location: Venezuela
Customer: Voith, Brazil & Alstom, France
10 units – 400MW each
Head: 162 meters
Orkot TXMM Guide Vane Bearings
Merowe / Hamdab Dam
Owner: Anglo-Egyptian Sudan
Location: Nile River, Sudan
Customer: Alstom Power
3 units – Francis, 300MW each
Head: 175 m
Iberdrola, Spain

Turbine Guide Vane Bearings, ready to be fitted
Servomotors – Trelleborg seals & bearings

Orkot TXMM
Segment for distributor ring

Radial guiding by strips, 2000 mm long, curved to match the radius

Axial bearing from flat laminate

Customer Iberdrola Spain,

[ICO Orkot Info Feb 2010\Case Stories Hydro\Control Ring bearing segments.pdf]
Kaplan Runner Applications

Figure 4: Kaplan Runner/Shaft Assembly
Greaseless Bearings in a Kaplan Turbine

Orkot® Items

1. Main Shaft Bearings
2. Linkage Bearings
3. Upper Guide Vane / Wicket Gate Bearings
4. Intermediate Guide Vane / Wicket Gate Bearings
5. Regulating / Operating Ring Bearings
6. Hub Bearings
7. Blade Bearings
8. Lower Guide Vane / Wicket Gate Bearings
Traditionally Kaplan Runners are filled with hydraulic oil. Usually these have bronze bearings.

- Turbine manufacturers e.g. Andritz, Voith and Alstom offer the plant operators an upgrade of the Kaplan Runner, avoiding the risk of oil contamination of the river water.

For this the metal bearings are replaced by Orkot TXMM.
Example of a Kaplan Runner upgrade, Orkot Hydro bearings replace metal bearings
Pump Storage in Morocco

Hydro Power plant built in year 2002 in Afourer in Morocco (at 220km of Rabat)

Purpose:
Cover peak electricity demand

Solution adopted:
Reversible pump turbines

Power capacity of the plant 460MW

- 2 Pump turbines : 173 MW each, head 595 meters
- 2 Pump turbines : 60 MW each, head 230 meters
Case Story: Pump Storage Morocco

Turbine manufacturer ALSTOM France
Project for 4 Pump turbines AFOURER in Morocco year 2002
Case study Lafourer

Guide Vane bearings;
20 Upper / 20 Middle / 20 Lower bearings per Turbine

Operating Conditions:
Rod material : Stainless steel
Housing material : Cast Steel
Movement : Oscillation 45°
Speed : up to 1.8 mm/s
Radial load : up to 19.8 MPa
Media:  
- Dry but occasionally wet running for Upper bearing
- Middle & Lower bearing operate in water
Temperature : +5°C to +22°C
Service Experience and Field Tests

- More than 20 years service experience
  - Low friction
  - Long lasting
  - Reference List available going back to 1990’s

- Customer field test results
  - First Hydro in UK at Dinorwig Pump Storage Plant
  - US Army Corps of Engineers
  - Hydro Operators Sweden, University of Lulea
  - Norsk Hydro Norway; Norconsult Spill Gate Bearing Test
DINORWIG PUMPED STORAGE – Field Test

Guide Vane Bearing comparative testing; friction and wear 1997 - 1999

Existing grease lubricated bronze
8 modern bearing materials including
  self-lubricating bronze
  self-lubricating composites

Test ran for 2 years, 12,000 hours,
> 10,000 start-stop operations

Result stated by FIRST HYDRO:
Orkot TXMM selected as the preferred product.
**DINORWIG PUMPED STORAGE – Field Test**

**Results 1999**

Comparative tests of various bearing materials,
2 Guide Vane Shafts fitted with Orkot® TXMM (2 x 2 bearings)

Stainless shafts of 207 mm diam.
Bearing pressure up to 20 MPa

Wear found after 2 years (1996 to 1998 = 11,816 hours)
Shaft no. 1: 0.043 mm
Shaft no. 2: 0.055 mm

After two years of testing, Orkot® replaced all of the upper and intermediate wicket gate positions with the following average wear:
- Upper guide vanes: 0.07 mm
- Intermediate guide vanes: 0.09 mm
US ARMY CORP OF ENGINEERS (USACE)
Comparative testing of guide vane bearings, 1999

Qualification of self-lubricating bearing materials for Turbine Guide Vane Application

- metallic bearings
- PTFE lining on metal
- composite bearings

Test method:
Assessment of friction and wear and swell in water.
USACE Laboratories (CERL)
US ARMY CORP OF ENGINEERS (USACE)
Comparative testing of guide vane bearings, 1999

Figure E1. Diametrical allowance for swell in water.

TRELLEBORG SEALING SOLUTIONS
Testing in Europe, Hydro Power Plant Operators in Sweden

- Technical University of Lulea, 2004

- Comparative testing of self lubricating bearing materials for turbine guide vane application
  - self lubricating bronze
  - PTFE-lined bronze
  - Composites

![Image of bearing materials]
Test Results Lulea University Sweden, 2004

Orkot TXMM: lowest friction  lowest wear rate
Orkot TXMM in pump turbines, summary

- **Orkot® applications:**
  - Guide Vane bearings
  - Bearing segments for operating ring
  - Linkages bearings

- **Benefits for the customer compared to Bronze material:**
  - Operate in water as well as dry
  - Environmentally friendly, no grease
  - No grease system also brings cost savings
  - Long service life time
  - Easy to install, saves installation costs
- Orkot TXMM
- for newly built turbines
- for replacement e.g. Rubber or Lignum Vitae

**Orkot®**

**Hydro Bearings**

**Main Shaft Bearings, water lubricated**

**Hydro dynamically operated bearings**
Turbine main shaft bearing, split housing, secured by bolts
Split housing in stainless steel (customer supply)
Split Bush with multi-groove design, providing a waterfilm to guide the shaft
Hydro Turbine Main Shaft Stave Bearing, being fitted to replace lignum vitae
American Hydro Corp.
Dells Hydro Plant, Wisconsin USA

Main shaft bearing for Kaplan Turbine water lubricated,

Refurbished 2008
Orkot TXMM has been extensively tested as a replacement of Lignum Vitae
Orkot TXMM in Hydro Power,

- Penstock Valve

- Spill Gates for reservoirs

- Fish Ladders
Penstock Valves

Orkot TXMM Bearings have been fitted up to 1100 mm diameter

Features:
- Typical design loads up to 60 M Pa
- Tight running clearances
- Tolerant to edge loads
- Operated dry or occasionally in water
Penstock and Main Shutter bearings e.g. Ball Valve and Butterfly Valves

- High Precision Bearings fitted in metal inserts
- Reliability on low friction after standstill is of prime importance for plant safety
- Tight running clearance
- Tolerant to edge loads
- Greaseless operation
Lock & Dam Applications

GATE BEARINGS
Wanapum Dam, Spill Gate Bearings
Orkot TXMM in Spill Gate Hinges
Rapid Priest USA
Spillgate Trunnion Bearings, metal bearings originally fitted, replaced by Orkot TXMM
Bronze bushing had seized

Cause of failure = Angle of rotation is too small, lubrication not effective
Research on Spill Gate Trunnion Bearings

Research by Norconsult (Norway) on bearing failures;

**Orkot friction is constant in time**

**Better than metal bearings**
Summary from Norconsult publication
Low friction after standstill

Comparison of measurements

Orkot® TLMM
Hydro Power serves the world and will continue to do so

- Wind energy may potentially cover 5% of the world energy but comes nowhere near to the capabilities of Hydro.

- Hydro currently covers 20% of the world demand with some countries having their electricity demand 100% covered by Hydro.

There’s an emerging market for small hydro

- The industry is seeking alternatives to the use of reservoirs e.g. running rivers and power from the oceans; currents, waves.

- Orkot is already being fitted in prototype generators. The plants are much smaller in size but quantities are likely to become substantial.
Small Hydro turbine, fitted with Orkot guide vane bushes
Concept of a River Turbine
Ocean Power, turbine driven by sea current
Conclusion, Orkot® Bearings offer:

- Bearing design tailored to the individual turbine, based on proven solutions
- Protecting the environment, no grease or oil. Orkot TXMM can also operate dry.
- Extended service life and reliability of the installation.
- Material is safe to handle, easy to install, does not degrade in time
Orkot® Hydro Bearings, benefits

Significant advantages compared to metallic bearings

• Low friction in operation as well as after long periods of standstill

• Even load distribution and tolerance to edge loading

• Preventing shaft wear & damage

Long Service History

• Orkot® experience goes back to 1954.

Meanwhile over 20 years experience in Hydro Turbines
There’s a lot more to tell, but so far any questions?

Thank You!