

# FEROFORM



Self / Water Lubricating  
Bearings for Hydro Power



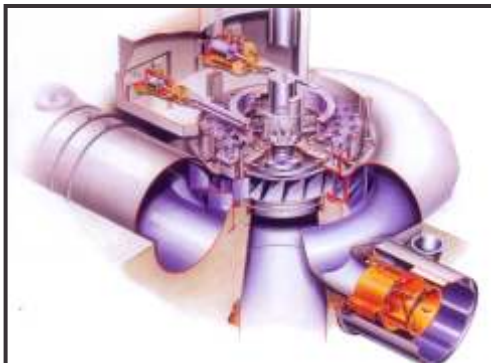
Radial Gates



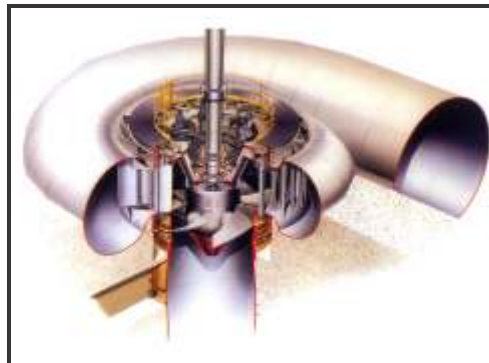
Sluice Gates



Hydro Dam



Francis Turbine



Kaplan Turbine

## APPLICATIONS

FEROFORM T814 is superb high performance composite bearing material Ideal for Hydro Turbines, Radial Gates, Fixed Wheel Gates, Sliding Gates, Butterfly & Spherical Valves, Pumps etc.





## FEROFORM HYDRO INDUSTRY COMPOSITES

The FEROFORM range of materials has been developed by TENMAT to offer the design engineer the chance of replacing metallic, rubber and asbestos based materials with unique, non-asbestos, wearing and bearing composites capable of duplicating, and in some cases exceeding, the performance of asbestos composites.

FEROFORM materials possess strength, durability, dimensional stability and excellent wear characteristics besides exhibiting good resistance to attack by many chemicals.

The resins used have been selected for their good mechanical properties and high thermal and dimensional stability. Both organic and synthetic fibres employed for reinforcement of the resins have been selected from the many types available for their high modulus and stability in water and various chemicals.

The addition of selected friction modifiers such as PTFE (T814) or oil, graphite and molybdenum disulphide enhances the wear properties and life of the materials, enabling them to be operated at higher speeds and loads.

The U.S. Army Corps of Engineers identified a need for a self lubricating bearing material to replace its existing grease lubricating bronze bearings in some 300 large hydro-turbines in the USA when they come up for rehabilitation. However, there was a lack of any detailed historical data regarding performance and life span, so an extensive laboratory test program was set up which simulated worst case conditions, carried out at Powertech Labs in Vancouver, a subsidiary of BC Hydro, TENMAT FEROFORM T814 proved itself capable of operating in both dry and wet conditions of shaft misalignment or deflection under load. Extremely low wear rates indicating long life projection were recorded and the journal showed no sign of wear throughout the test.

## FEROFORM T814:

FEROFORM T814 is a self lubricating bearing incorporating PTFE (Teflon) particles throughout the matrix of the material. A maintenance free 'fit and forget' bearing. The PTFE is located within the material and is therefore present on the entire ID surface.

### FRICITION:

FEROFORM T814 has been independently tested under both wet and dry conditions, yielding a coefficient of friction in the range of 0.04-0.10 depending on the conditions. Plugged bronze type bearings typically have a friction in the range of 0.20-0.30 or higher.

### STICKSLIP:

FEROFORM T814 has static and dynamic friction values that have been shown to be almost identical in independent tests. The 'stick slip' or 'breakaway force' required to rotate the shaft in the bearing is therefore significantly lower. As the bearings are completely self lubricating there is no danger of the high pressure load transformation sector being unlubricated, as can occur in lubricated bearing systems where the injected grease often finds its way to the low pressure side. As the lubricating particles in FEROFORM T814 are incorporated throughout the material matrix and always present on the entire running surface, there is no requirement (as with plugged bearings) to smear the lubrication over the full surface through running the bearing.

### ABRASION RESISTANCE:

FEROFORM T814 has been tested independently by the Powertech Labs in Vancouver under wet, dry, edge loaded and abrasive conditions. The material characteristics, friction values and wear rates were identical under each condition (including the addition of abrasive particles). The shaft condition after each of the tests was considered 'polished' even when abrasive particles were added.

### LOAD CARRYING CAPABILITIES:

FEROFORM T814 has a recommended maximum application load of  $-60 \text{ N/mm}^2$  which includes a safety factor of



4). Typical radial gate design incorporates a bearing pressure of 20-30 N/mm. Many radial gate bearings have a diameter to length ratio greater than 1:1.25 due to the angle of the gate arms and the loads. With longer shafts there is an increased risk of edge load effects from shaft deflection due to load or gate movement. With metal bearings the localised high loads due to edge loading may accelerate wear. Due to the resilience and elasticity of FEROFORM T814 the material will conform to accommodate the shaft

### CORROSION RESISTANT:

FEROFORM T814 is a pure composite bearing consisting of synthetic fibres reinforced with a phenolic resin system originally developed at the beginning of the 20th century. In conjunction with a solid stainless steel or plated shaft, the system is corrosion resistant to all but high acid or alkali solutions.

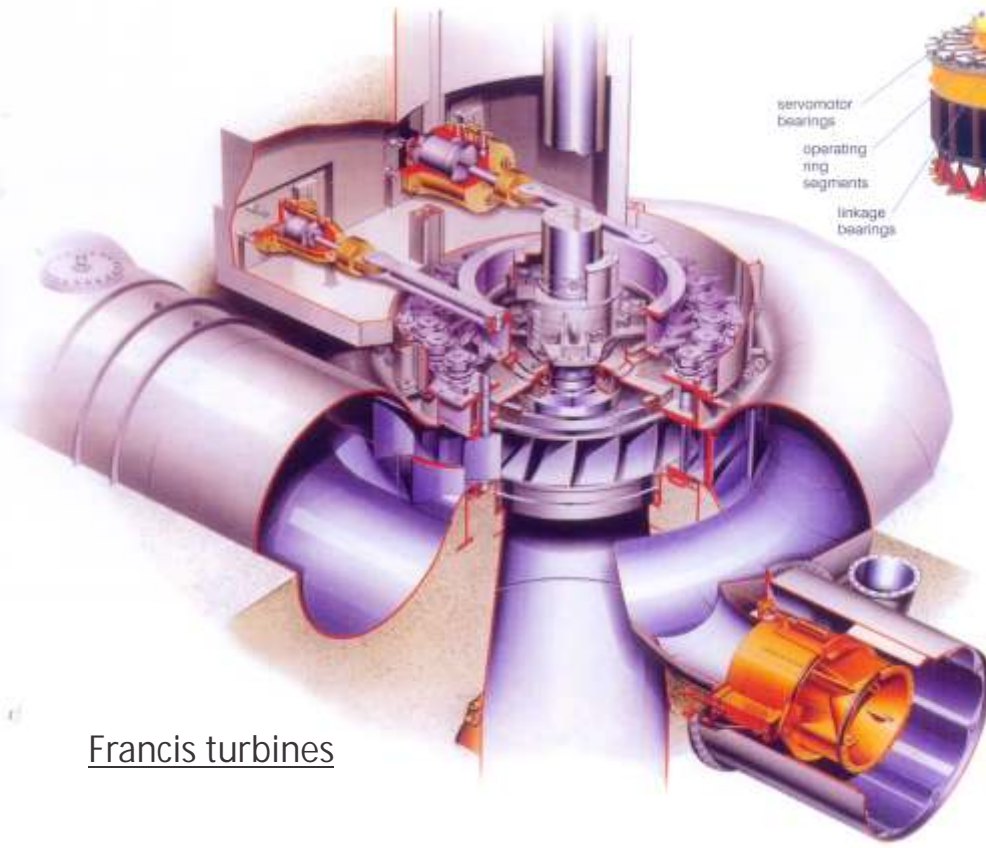
### EASY HANDLING & INSTALLATION:

FEROFORM T814 bearings are typically installed with an interference fit and can be super cooled (with liquid nitrogen or dry ice) prior to installation. FEROFORM has a density of  $-1.3 \text{ g/cm}^3$  is one fifth the weight of bronze. TENMAT can supply both finish machined bearings ready to fit or standard tubes of material oversize on the OD and ID which can be machined locally to the required dimensions.

### SHAFT MATERIAL:

For Bronze bearings the shaft hardness must be at least 100 HB higher than the hardness rating of the bronze. For FEROFORM T814, TENMAT recommend a minimum shaft hardness of 200 HB and a  $0.8 \mu\text{m R}$ , or better.

# Hydro Application



Francis turbines



## Francis turbines

- Servo-motor bearings
- Operating ring sliding segments
- Linkage bearings
- Wicket gate / guide vane bearings

## Gates

- Intake gate sliding segments
- Intake gate roller bearings
- Spillway gate bearings
- Lock gate bearings
- Trash rake bearings
- Fish screen bearings

## Valves

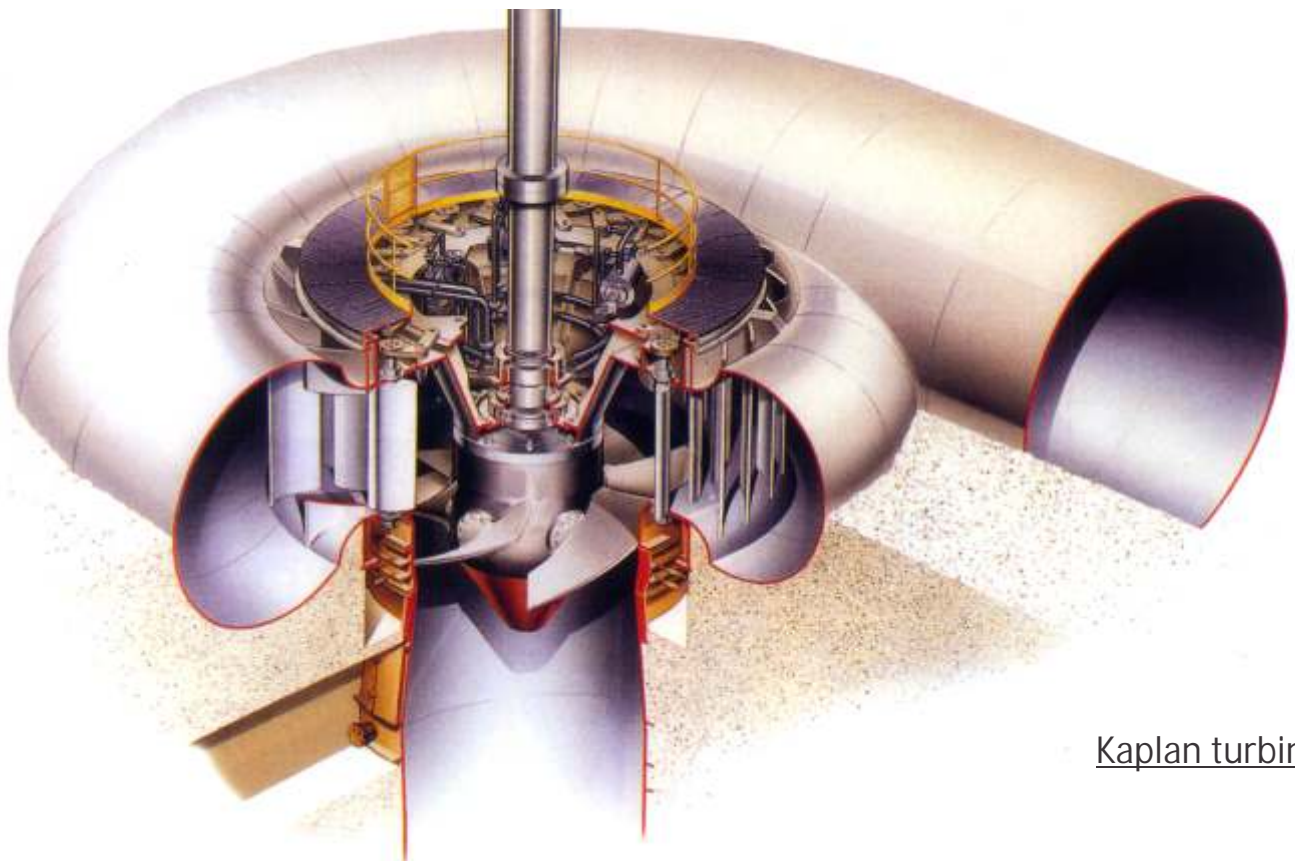
- Ball and butterfly valves trunion bearings

## Pelton turbines

- Injector bearings
- Deflector bearings

## Kaplan turbines

- Servo-motor bearings
- Linkage bearings
- Trunion bearings
- Blade bearings

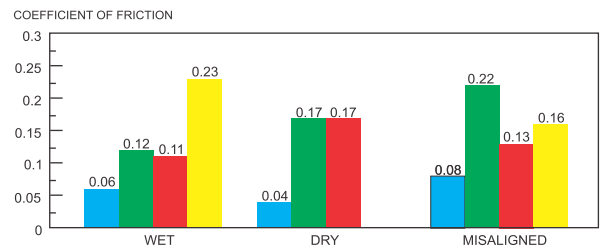


Kaplan turbines

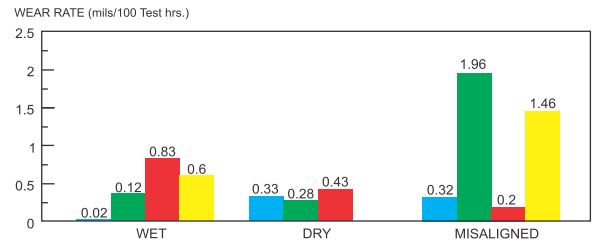
# Property Data

PROPERTIES	UNIT	T814
COMPRESSIVE STRENGTH	MPa	310
	PSI	44950
NORMAL WORKING STRENGTH	MPa	75
	PSI	10875
COMPRESSIVE YIELD	%	2.5
TENSILE STRENGTH	MPa	80
	PSI	11600
SHEAR STRENGTH	MPa	85
	PSI	12323
IMPACT STRENGTH	KJ/m	55
DENSITY	g/cm <sup>3</sup>	1.32
BRINELL HARDNESS	HB	25
WATER SWELL	20°C	0.2
	80°C	1
FRICTION	μ	0.04
		-0.08
THERMAL EXPANSION	x10 <sup>-6</sup> /°C normal	70
	parallel	30
NORMAL MAXIMUM	°C	100
TEMPERATURE	°F	212
INTERMITTENT MAXIMUM	°C	120
TEMPERATURE	°F	250

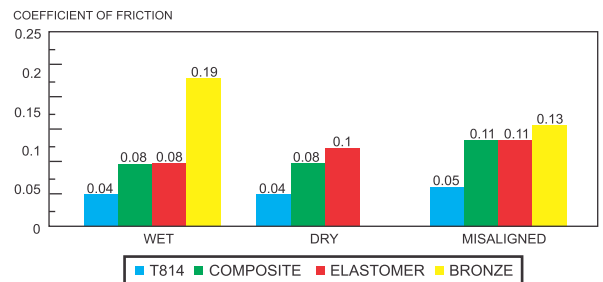
## FEROFORM T814 PERFORMANCE - STATIC FRICTION



## FEROFORM T814 PERFORMANCE - WEAR



## FEROFORM T814 PERFORMANCE - DYNAMIC FRICTION



Test results taken from Powertech Labs INC. A subsidiary of B.C. Hydro, Canada

## FEROFORM PR18

### LOW COST PUMP BEARING SOLUTION LOW COST..... HIGH PERFORMANCE.... LONG LIFE

PR Grade Bearings : Cured Polyester Resin Matrix Reinforced with Woven Synthetic Fibre Cloth FEROFORM PR Grades Hydro Bearings

FEROFORM PR 18 is a high performance bearing material with excellent dry running capabilities at high load. Low friction properties & low wear rates are characteristics of this product.

Tenmat the leading composite bearing manufacturer introduce FEROFORM PR18 grade of self / water Lubricated Hydro bearing.



PROPERTY	PR18	PR18
Density	g/cm <sup>3</sup>	1.3
Ultimate Compressive Strength	Mpa	300
Normal Working Pressure	Mpa	75
Compressive Yield @68.9MPa	%	2.5
Brinell Hardness (nominal)		25
% Swell in Water	@ 20°C	0.15
Average Coefficient of Friction	Dry	0.08
	Wet	0.12
Coefficient of Thermal Expansion	10-7°C normal	110
	parallel	40
Maximum Continuous Operating Temperature	°C	100



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