gTET

Hot Wire

The Heat Transformers

ISSUE 3 Q3 2020

News & Updates from Green Thermal Energy Technologies

gTET remains open for business during COVID19

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Turn-key solutions to transform waste into useful energy, delivering economic and climate change benefits

gTET

gTET specialises in innovative solutions at industrial scale for thermal energy management, in particular redeploying waste or renewable streams to reduce opex and carbon footprint.

gTET's revolutionary ORC generators enable thermal energy to be effectively converted into electrical power where this is the most efficient and effective use of the energy.

As we like to say here "*WASTE* is the new *OIL*"

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1. Projects:

1. Projects: Veolia SA, Medical Waste

Veolia Australia contracted gTET in 2019 to design and supply a 200kWe nominal ORC generator to recover wasted thermal energy from its 15 TPD medical waste incinerator in Adelaide South Australia, operating 2 shifts x 5 days per week

Veolia uses very high temperature incineration to process medical waste under very strict controls from the perspective of biohazards, legalities and emissions. Veolia provides an integrated solution for the identification, collection, transportation and disposal of medical waste. Waste undergoes thermal destruction through an automatically controlled waste feed that ensures efficient combustion and complete destruction. The waste is exposed to a chamber temperature of over 1000 degrees Celsius, and the emissions are controlled to exceed current Australian standards.

The emissions processing requires that the exhaust stream is rapidly cooled to less than 250 degrees Celsius before entering the chemical reactors and particulate filters. An exhaust gas to water heat exchanger (EGHX) is used to cool the exhaust stream which, in turn, produces hot water. Until now, the hot water was cooled using air radiators, before being returned to the EGHX, with the thermal energy wasted to atmosphere. Veolia decided to recover this wasted energy using gTET's ORC generator technology.

The new installation takes hot water at a nominal 150°C/11.5lps which is cooled to 120°C in the ORC generator before returning to the EGHX. This generates a nominal 200kWe depending upon the cooling water temperature from the cooling tower.

ORC Generator ready for shipment from gTET

gTET ORC Generator in position at Veolia. Insulated hot water pipes can be seen from the EGHX to ORC.

The air radiators shall continue to be utilised so that the facility can remain operational when the ORC requires scheduled maintenance. The hot water is automatically diverted between the ORC generator and radiators.

Veolia had previously installed 100kWe of PV solar at the factory and the ORC generator installation needed to contemplate that total power generated could not always be consumed on site and, as such, the connection agreement with South Australia Power Networks (SAPN) must consider export. This requirement necessitated additional electrical protection and commissioning requirements from SAPN.

Commissioning of the new installation is anticipated in Q3, 2020 which is expected to provide a financial pay back in less than 10 years together with further demonstrating Veolia's commitment to reducing carbon emissions.

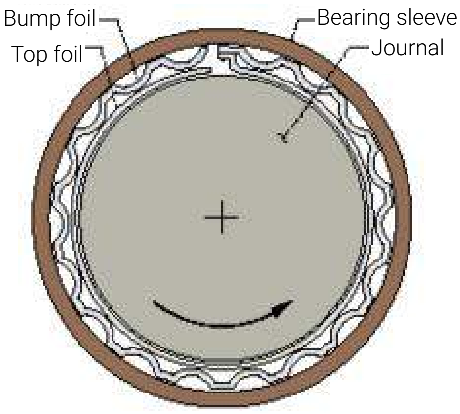
2. Technical Brief:

Foil Bearings; A Superior Solution for High Speed Turbo-Alternators

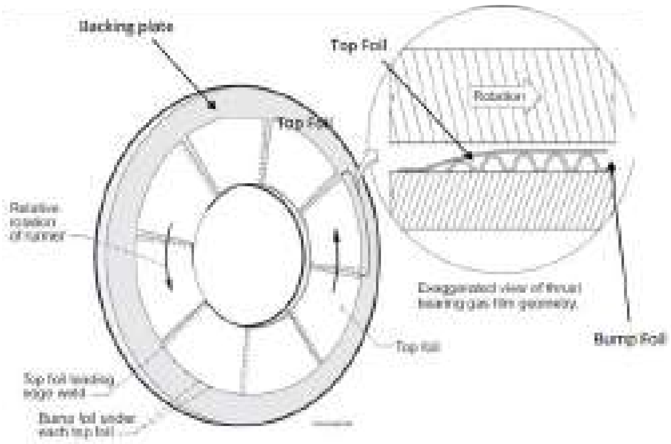
gTET is the only manufacturer globally to deploy foil bearing technology in its ORC Generators which delivers many advantages in its products. There are few companies globally that can produce foil bearing technology originating from the high tech aerospace industry.

Foil bearings, otherwise known as air bearings, are a contactless planar bearing that uses a static thin metallic foil applied with a low friction coating that only contacts the rotating component under low or zero speed. When the moving component reaches a certain speed, "launch speed", a hydrodynamic layer forms between the static foils and moving surface at which point there is zero contact. The hydrodynamic clearances are very small between the moving and fixed surfaces and, as such, both surface finishes must be very fine. Typically very low roughness, hard chromed mirror finish is required for the moving surface and

Teflon finish is used on the static surface.
The fixed top foil contact surface is supported from behind by bump foils that provide the support for the top foil when fully depressed i.e when the moving surface is at speed. Unlike aerostatic or hydrostatic bearings, foil bearings don't require any external pressurization system.



Typical Journal Bearing Design



Typical Thrust Bearing Design

The load that can be supported by the foil bearing relates to the relative speed and area of the opposing bearing surfaces as well as the viscosity of the fluid that the bearings are operating within. To achieve adequate load bearing capacity the speeds need to be relatively high making foil bearings mostly applicable to high speed turbo-machinery. The surface speed is proportional to the rpm and rotor or thrust disc diameter and therefore small diameter shafts must operate at high speed, commonly as high as 100,000rpm. Minimum speeds, for large machines, are typically 15,000rpm. The high speed low load bearing characteristics of foil bearings, compared to roller or planar bearings, makes them best suited to high speed turbo-machinery.

Foil bearings don't require any lubricant, in fact, any lubricant may impact the hydrodynamic properties and may cause the foils to grab with consequential failure of the bearing. The oil-less characteristics of foil bearings makes them ideal for applications where oil within the working fluid of the machine becomes an issue. For example,

1. compressed air or blowers used in ventilation or medical equipment must be oil free to prevent human inhalation

2. refrigeration, heat pumps or ORC generator performance is deteriorated when oil is present in the working fluid.

Since foil bearings are designed specifically for the fluid in which they operate then any changes in the fluid or its characteristics will alter the bearings performance often with catastrophic consequences. For example when using the foil bearings designed for use in a refrigerant in vapour phase, the bearings will quickly fail if the refrigerant condenses during operation within the bearing.

Heat in the bearings is created from the hydrodynamic fluid frictional losses and so they must be cooled primarily by managing cross flow of the hydrodynamic fluid. System design requires that a pressure difference is maintained across the bearing to maintain cross flow cooling. The system design must also consider heat transfer to and from the bearing as part of the cooling design.

Foil bearings are uni-directional and typically have little tolerance to operation in the incorrect direction. The foils are secured on the leading edge but free to move on the trailing edge resulting in the free edge 'grabbing' on the moving surface if operated in the wrong direction.

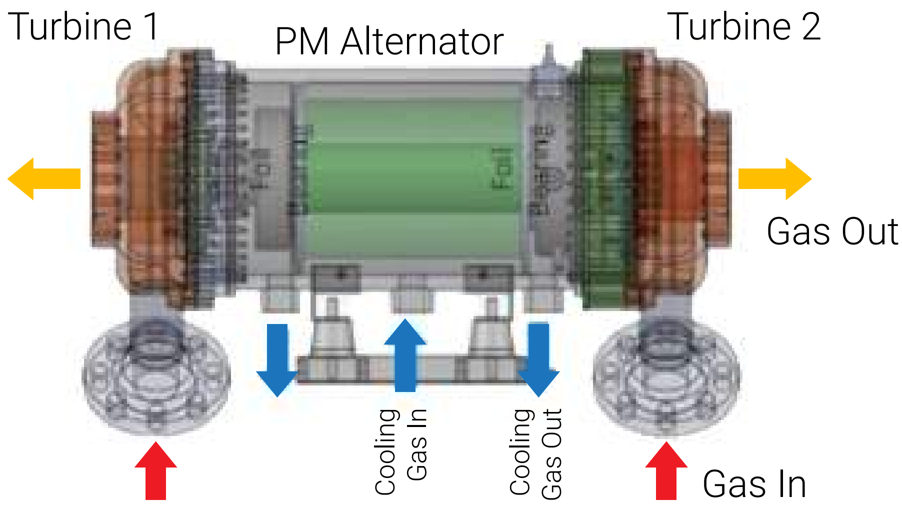
The foils are typically stainless steel and Teflon coated on the contact surface. The deflection and dimensional accuracy and hydrodynamic fluid properties are the most critical characteristics for foil bearings and these characteristics remain substantially consistent over a wide temperature range. This makes foil bearing excellent for use in applications that may experience a wide temperature range unlike magnetic bearings that contain temperature sensitive electrical components or lubricated bearings that require lubricant specifically for the selected operating temperatures.

Once the foil bearing has 'launched' the small losses are only associated with the hydrodynamic layer windage, therefore efficiency is very high. gTET's 200kW PM turbo-alternator achieves 98% efficiency from mechanical input of the turbine through to electrical output of the alternator where the majority of loss is associated with the stator and rotor in the alternator. Bearing losses will exhibit as heat and noise. Consequently foil bearings also create very low noise.

Foil bearings exhibit good reliability due to the few parts associated with the construction. By comparison, magnetic bearings require electric coils, position sensors, magnetic electronic drives, hermetically sealed cabling and bump stops while lubricated bearing require separate lubrication systems with associated pumps, piping, valving, filtering etc. The fewer the parts, the less likely failures can occur. Similarly, the lack of ancillary equipment associated with foil bearings reduces cost, complexity, assembly time, weight and system packaging requirements.

Foil bearings only wear during the stop/start cycle when the bearing surfaces make contact. This makes them ideal for applications that have continuous operation or few start/stop cycles such as power generation. This results in the only maintenance requirement being to replace the bearings upon reaching a predetermined number of start/stop cycles. gTET typically specifies that its turbo-alternators are over-hauled and bearings replaced after 2000 start/stop cycles.

The hydrodynamic layer formed is very thin, of the order 40 micron, however it is self-centralising in that the force inversely increases with the thickness of the hydrodynamic layer thereby centralizing the rotating shaft or thrust disc. This also means the bearings are quite tolerant to axial misalignment. Design clearances and manufacturing tolerances are very small, relative to other bearing technologies, in order to achieve the very accurate loading between the fixed foil and moving shaft required to form the hydrodynamic layer. gTET's novel turbo-alternators deploy twin radial turbines that apply equal but opposite thrust to the shaft thereby minimizing the thrust loads. The permanent magnet rotor is fixed to the same shaft as the turbine impellors with foil journal bearings located behind each impellor and a single foil thrust bearing used to centralize the shaft. It operates at 45,000rpm producing 750Hz, 200kWe, electrical output. The mating IGBT inverter continually adjusts the electrical loading on the alternator to maintain a constant speed at the turbo-alternator under varying heat load conditions. This results in an ORC generator system that easily copes with varying heat loads that are typically associated with waste or renewable heat sources and turns down to very low loads without needing to trip.



Typical thrust and journal bearings similar to those in gTET's turbo-alternators

gTET provides Waste to Energy (W2E) solutions with zero capital investment