GE 1.5 Extra Life Gearbox Achieves 4x Life

Premature failure modes prevented by Moventas upgrades and verified in DigitalClone® Software

Challenge

Premature failures in the GE 1.5 gearboxes are driving unexpected downtime and increased costs. The industry is seeking solutions to reduce future failures.

Solution

To solve these failure modes, Moventas developed upgrades for the GE 1.5 gearboxes. The Extra Life gearbox was designed for any type of gearbox being replaced to reduce future failures. Sentient Science validated the technology advances and life extension claims for the owner operator community and quantified the improvements in performance, durability and reliability.

Results

The computational testing showed an overall gearbox life improvement by a factor of 4x. The life extension achieved was due to improvements made to the case carburized ring gear, integrated planet gear bearings, high speed stage bearings, tooth surface roughness, and material specification upgrades in both bearings and gears. The key factors in the analysis accounted for in DigitalClone computational modeling are the material quality, surface roughness, and stresses based on full gearbox model subjected to real turbine operating conditions, which aren't accounted explicitly in industry standards.

> "We partnered with Sentient to use DigitalClone modeling to quantify key technology improvements made and to prove the Extra Life gearbox is the lowest lifetime cost gearbox on the market for the GE 1.5 platform. The Extra Life gearbox has a 5-year warranty and extends life by a factor of 4x."
>
> - Simon Schmidt, SVP Business Development and Product Management
>
> moventas | GEARED FOR NEW ENERGY

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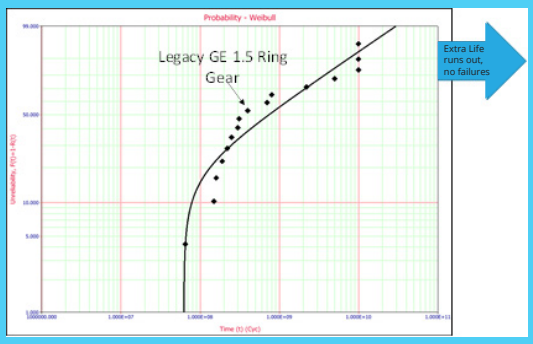
Case Study Details

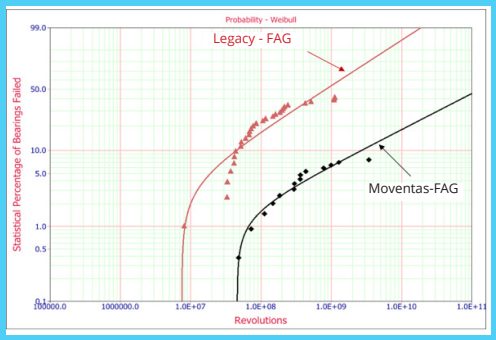
Results:

Enhancement 1 - Case Carburized Ring Gear:



A case carburized ring gear is used in the Extra Life GE 1.5 gearbox instead of other technologies (such as induction hardened) used for gear hardening. 1000+ contact and bending simulations were conducted in DigitalClone software considering case carburized microstructure, geometry, operating conditions, lubricant properties, surface finish, and residual stresses to demonstrate improved durability. The results demonstrated an improved L10 life from 7 years to 20 years mainly due to better material quality with no detrimental defects/inclusions, and surface finish.

Enhancement 2 - Integrated Planet Gear Bearings:

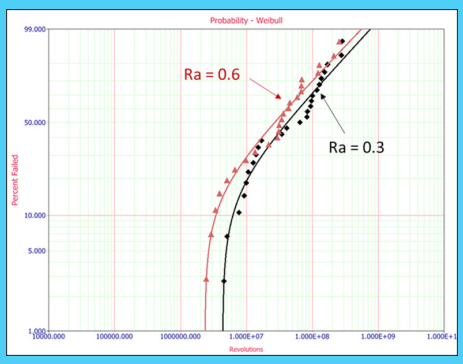


A 2-row arrangement integrated Cylindrical Roller Bearings (CRB) PL-gear bearings is used in the Extra Life gearbox instead of a 4-row arrangement that is used in the conventional gearbox. 2000 fatigue life simulations were conducted in DigitalClone to compare the Moventas 2-row planet gear bearing verses conventional 4-row bearings. The planet bearing showed better load carrying capacity against conventional bearings, due to lower contact stress The results showed an 8% reduction in contact stresses. Moventas planet bearing has superior fatigue life compared to conventional bearing mainly due to clean material quality and relatively lower contact stress.

Enhancement 3 - New Bearing Materials for High Speed Stage:

White etching resistance bearing material is used in the Extra Life gearbox instead of the black oxide or conventional bearing material. DigitalClone validated that the white etching resistance bearing technology was superior to the black oxide coating against white cracking due to heat treatment and improved microstructure. The black oxide coating showed a 3% probability of failure in less than 20 years at the HSS and HSIS positions due to non-metallic inclusions. DigitalClone verified the white etching resistance bearing used in the Extra Life gearbox is superior to other bearing material types in these positions. Moventas can do up-tower replacements for these bearing types, allowing for reduced O&M costs and downtime.

Enhancement 4 & 5 - Improved Material Specifications & Tooth Surface Roughness in Geared Components:



Moventas used clean material with the less non-metallic inclusions compared to conventional material with inclusions as large as 100µm on the IMS pinion to improve life in the Extra Life gearbox. Contact fatigue life simulations in DigitalClone showed enhanced material used provided an improved life by a factor of 2X compared to the original design.

RCF simulations demonstrated the Sun Pinion used in the Moventas Extra Life gearbox with 0.3mm increases L10 fatigue life by a factor of 2.2x compared to the original Ra of 0.6mm.

Conclusion:

The upgrades showed a factor of 4x life improvement for the GE 1.5. The life extension reduces the probability of future gearbox replacement. Compared to the legacy platform, the Extra Life gearbox has a lower cost of ownership. Due to the results and confidence in performance, Moventas is offering a 5-year warranty on the Extra Life gearbox.

Moventas designs all gearboxes in-house allowing for end to end manufacturing to ensure quality control to implement quality standards. These improvements can be reused in Moventas' future gearbox designs, rebuilds, and uptower repair services, to help reduce additional costs.

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