

Moventas Planetary Gearbox Advantage

Case Carburized Ring Gear

You've probably heard about case carburized ring gears but have you ever considered the benefits this brings to the whole planetary gear stage? Case carburized gears are well known within the gear industry to be the absolute strongest gears that can be made. **No other combination of materials or heat treatment comes close to the performance of a case carburized gear.**

Planet Gearing Information

- Case carburized gears are the strongest gears that can be made. AGMA, ISO and DIN standards support this.
- All wind turbine gear manufacturers recognise that case carburized gears are superior, and use case carburized gear technology to manufacture all their external gears.

In fact, all wind turbine manufacturers use case carburized gearing in all their designs however, very few use this combination of material and heat treatment in the construction of the ring gear. So if case carburized gears are so strong, then why don't more manufacturers use them in their ring gear design?

Here are some reasons:

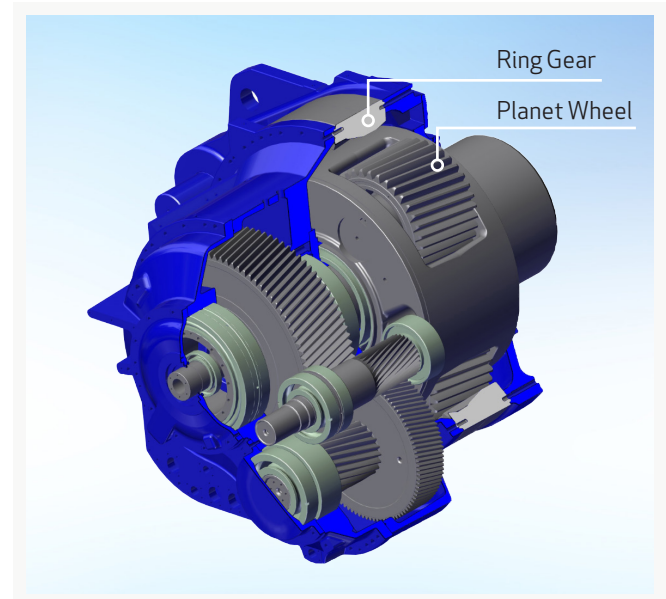
1. It costs much more to produce case carburized ring gears, typically 50% more.
2. Producing a case carburized ring gear of high quality is very difficult.
3. Gear calculations alone do not support the need to have such a strong ring gear.

So why would Moventas sacrifice its profit margins to manufacture such difficult expensive gears that aren't even necessary?

The reason is very simple, wear resistance.

Wear in the form of abrasion to be exact. Let's look at how the lubrication of a slow rotating, highly loaded planetary system works. The planet carrier is directly connected to the main shaft and therefore rotates at about 20 RPM. The planet wheels are connected to the planet carrier and will be rotating at about 30 RPM producing a pitch line velocity of about 0.8M/sec, far too slow to develop good hydrodynamic lubrication properties. This is called **Boundary Lubrication**.

Both the gears and the bearings in the planetary stage are simply rotating too slowly to allow for optimal lubrication properties. The



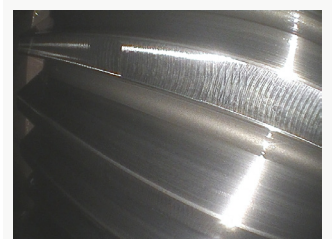
Typical wind gearbox structure up to 2MW + power class

metal surfaces of the gears profiles and the rollers and raceways of the bearings will have metal to metal contact especially when there are wearing particles combined with boundary lubrication conditions. Thru hardened gears simply don't have the same durability of case carburized gears and as a result, hard metal particles are removed from the tooth surface and released into the oil. These particles don't quickly evacuate the planetary stage and as a result get trapped between the gear mesh of each planet wheel as it rolls across the bottom of the gearbox. Due to the relatively small oil volume vs transmitted power, found in planetary gearboxes, the particles act as an abrasive thereby exacerbating the problem.

Even heavy particles that would normally settle down in the gearbox sump area are continuously churned up as the planet wheels roll through the oil and over the bottom of the ring gear. These fine, suspended particles work their way into the bearings and eventually cause premature failure. Case carburized gears offer the strongest resistance to wear due to their incredibly hard surface. This can be seen in the photographs of both the planet gears and planet bearings that have been in service for many years.

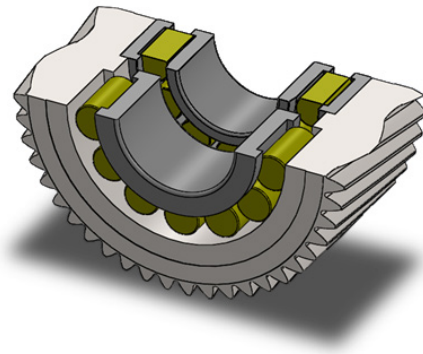
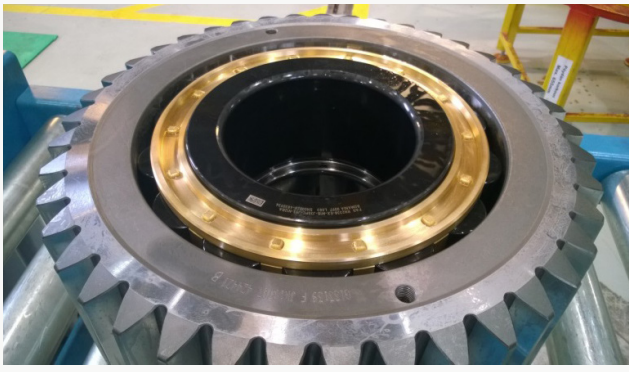


Working Flank - 8 year old thru hardened ring gear



Working Flank - 8 year old case carburized ring gear

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Moventas Integrated bearing vs traditional bearing design

Integrated Planet Bearings

When designing a planetary gear system, designers are always faced with the same problem. How can we fit a large enough bearing into the planet wheel without reducing the rim thickness of the planet gear below an acceptable limit? The integrated bearing is a hybrid bearing where the rollers run on the inside diameter of the planet gear. This adds to the cost of manufacturer as the gear will need to be manufactured with a very precision bearing journal ground into the inside diameter. The advantage is that a larger bearing can be utilized to handle the high loads it will be submitted to. In addition there is no outer bearing race that can spin inside the planet bearing.

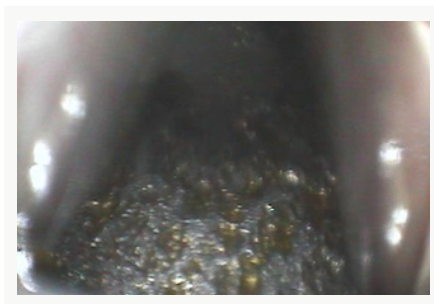
These benefits result in a bearing with higher load ratings making them much more resistant to wear and failure. In most cases the

L10 life of the bearing will double. In addition, the larger roller diameter of the integrated bearing has more resilience to oil contamination. Moventas has been using integrated bearings since the development of the PLH-400 series in 2000. After **35 years in service**, we can clearly see the benefits that case carburized gears and integrated bearings bring to the durability of the system. Moventas units simply don't have the planetary failures that other manufacturers are experiencing. Combine this advantage with modern up tower repair capabilities and you have a gearbox that won't be coming out of the nacelle anytime soon.

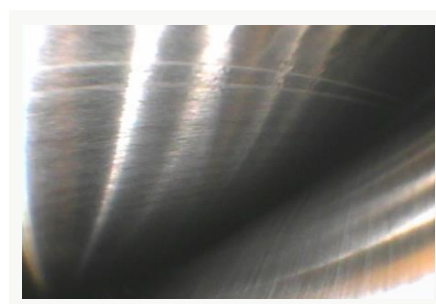
Contact the Moventas Gear Experts

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Planet Bearing - 8 year old thru hardened ring gear



Integrated Planet Bearing - 8 year old carburized ring gear