

Weight-Efficient Powertrain Components – Steel, Heat Treatment and Performance

Hans Kristoffersen, Swerea IVF

hans.kristoffersen@swerea.se

Med stöd från:

VINNOVA

Energimyndigheten

FORMAS



STRATEGISKA
INNOVATIONS-
PROGRAM

LIGHTer





Project partners



Weight-Efficiency: Industry requirements

Concept	Heavy vehicle	Hand-held power tools
Increased component performance	Very important: Increased torque without redesign of components. Component size cannot increase.	Very important: Increased performance cannot be at the expense of weight.
Light-weight component design	Interesting, since components are heavy. However, redesign for light-weight is challenging, since process capability cannot be compromised.	Less interesting for current products. To maintain low weight in next generation products is critical.
Manufacturing cost	Very important	Very important
Materials cost	Important	Less important, since material usage is small.

Steel Grades and Heat Treatments

Carburizing	Q&T	Tool	Special	
Ovako 158Q	Ovako 277Q	Nimax	Böhler W720	 <p>Low-Pressure Carburizing</p> <ul style="list-style-type: none"> • Carburizing using acetylene • Nitrogen gas quenching
Ovako 159Q		Orvar		 <p>Plasma Nitriding</p> <ul style="list-style-type: none"> • Nitriding of high-alloyed steels • Compressive residual stresses
Ovako 253C	Ovako 398Q	Caldie	Ferrium C64	 <p>Induction Hardening</p> <ul style="list-style-type: none"> • Dual-frequency hardening • Produce hard case layer
Ovako 255Q		Vanadis 4E		 <p>Post Processing</p> <ul style="list-style-type: none"> • Double Shot Peening, PVD • Deformation hardening • Compressive residual stresses
Ovako 499Q	Ovako 497Q	Vanadis 10	Astaloy CrA	
		Vancron 40		

Performance Assessment



Hardness testing

- Surface hardness
- Case depth



X-ray diffraction

- Residual stresses
- Retained austenite



Optical metallography

- Microstructure
- Surface integrity



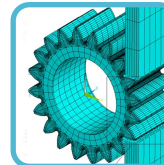
Cost analysis

- Best-practice cost analysis for manufacturing chain



Rotating bending fatigue

- Two test-bar geometries
- Staircase method



Tooth-bending fatigue

- Small gears, module 0.6
- Large gears, module 3.6



Contact fatigue

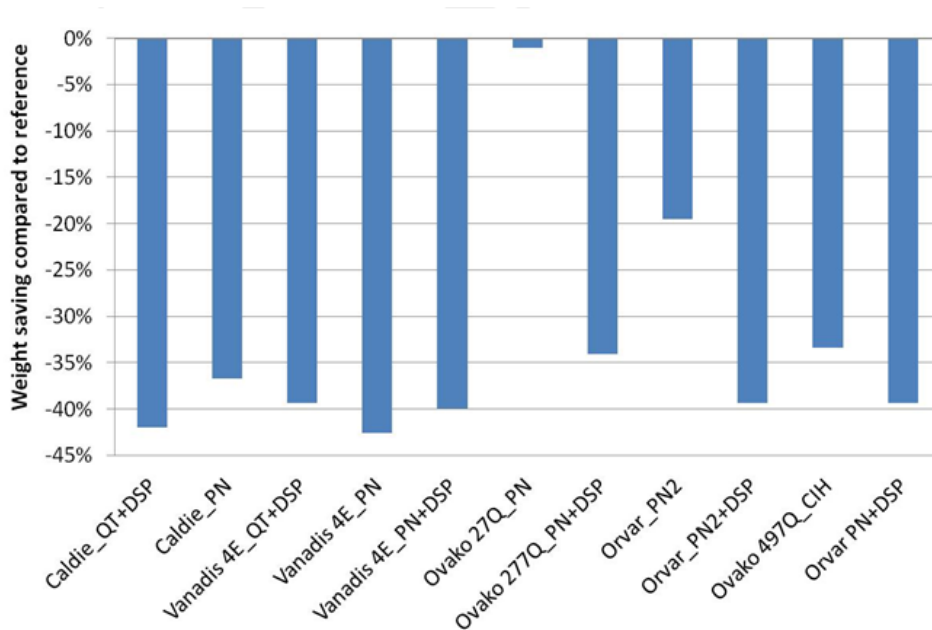
- Rolling contact fatigue
- FZG testing



Environmental analysis

- Simplified LCA
- Weight-savings-potential

Weight-saving-potential: Project results



Tooth-root bending fatigue:

- 57% of tested manufacturing concepts resulted in at least 40% performance increase.
- The top performer showed an 80% performance increase.

Project results and long-term impact

- **Knowledge database:** The project has resulted in database of knowledge on how high-performance steel grades can be combined with novel heat treatments. To be used and further developed by the individual project members.
- **Heavy vehicles:** OEM and subcontractors produce high-performance powertrains, which increase payload and fuel efficiency.
- **Hand-held power tools:** New lighter products, with increased performance and life-time, are marketed.

