

Just how EFFICIENT are our Epicyclic Gearboxes?

COMPARISON ALLEN EPICYCLIC VERSUS PARALLEL SHAFT GEARBOXES

Reference: Gas Turbine Driven Generator
 Power: 6,500 kW
 Input / Output Speed: 14,571 / 1,500 rpm
 Rating Standard: AGMA 421.06 Oil Type: ISO VG 32
 Number of Auxiliaries: 0

| POWER LOSS IN | Parallel shaft | Epicyclic |
|------------------------------|-----------------------|------------------|
| Mesh | 45.4 kW | 39 kW |
| High speed bearings | 75.6 kW | 20.4 kW |
| Low Speed bearings | 7.1 kW | 2.0 kW |
| Total Power Loss | 128.1 kW | 61.4 kW |
| Efficiency of gearbox | 98.029% | 99.055% |

The epicyclic is 1.026% more efficient than the parallel shaft gearbox

Based upon 100,000 hours lifetime, the epicyclic will therefore generate an additional 6,670,000 kW

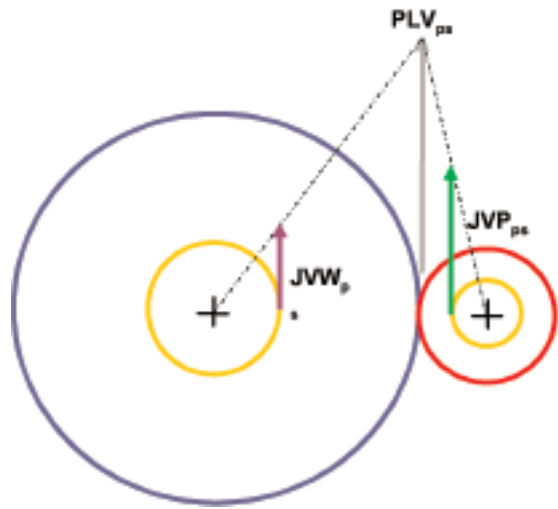
| Country of installation | USA | Germany | UK |
|--|------------------|------------------|------------------|
| Price of electricity per kW/hr in \$US | 0.09 | 0.13 | 0.11 |
| Value of additional electricity generated over lifetime | \$600,300 | \$867,100 | \$733,700 |

Why do GEARBOX LOSSES OCCUR ?

The losses produced in power gearing are generated by three main sources:

- Meshing Losses - Heat Generation due to friction (70-80% speed and 30-20% load dependent)
- Windage Losses - Acceleration of Air - Oil mixture (100% speed dependent)
- Bearing Power Losses - Oil film shear and heat generation due to friction (70-80% speed and 30-20% load dependent)

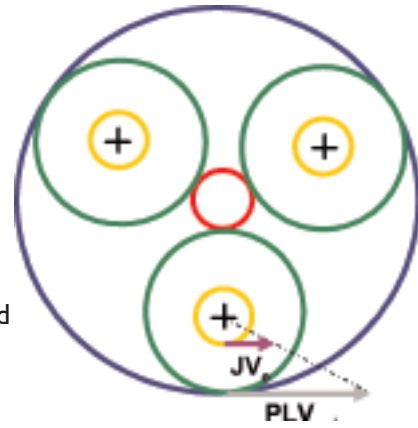
Meshing and windage losses



The diagrams show the basic velocities at the gear diameters and bearing journals.

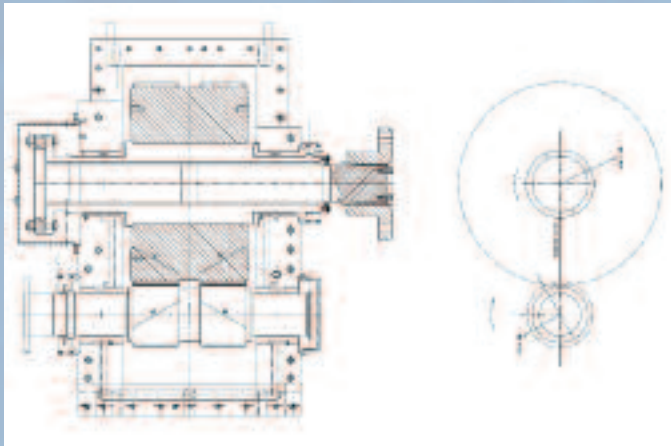
As the epicyclic gear shares the load between three or more meshes, the size of the annulus gear is significantly less than the diameter of the equivalent parallel shaft gear.

This effect reduces the pitch line velocity of the gearbox and hence associated windage and meshing losses



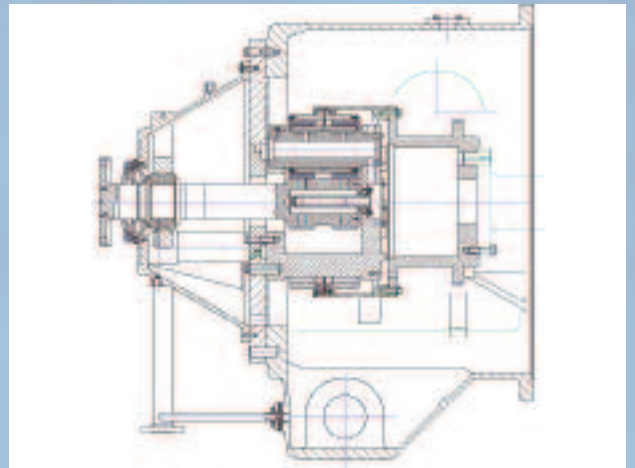
Bearing losses

As the epicyclic bearings are located within the star gears the rotational speeds are much lower than the parallel shaft high speed bearings. This, therefore, means that the associated bearing losses are significantly reduced.



The parallel shaft gear has two high speed bearings which have to take force created by the gears trying to move apart as they mesh

- These gear forces are high, and require large bearings to cope with the loads which are generated
- The large bearings produce a high shaft speed and generate a high power loss



The epicyclic gear has only one high speed bearing at the drive end.

- The other end of the shaft is supported between the star wheels (generally 3 to 5)
- The star wheels also take the force created by the sun wheel as it meshes
- This means the single high speed bearing only has to support the weight of the sunwheel at the drive end.
- This requires only a small diameter bearing with a low load, which generates a low power loss.



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