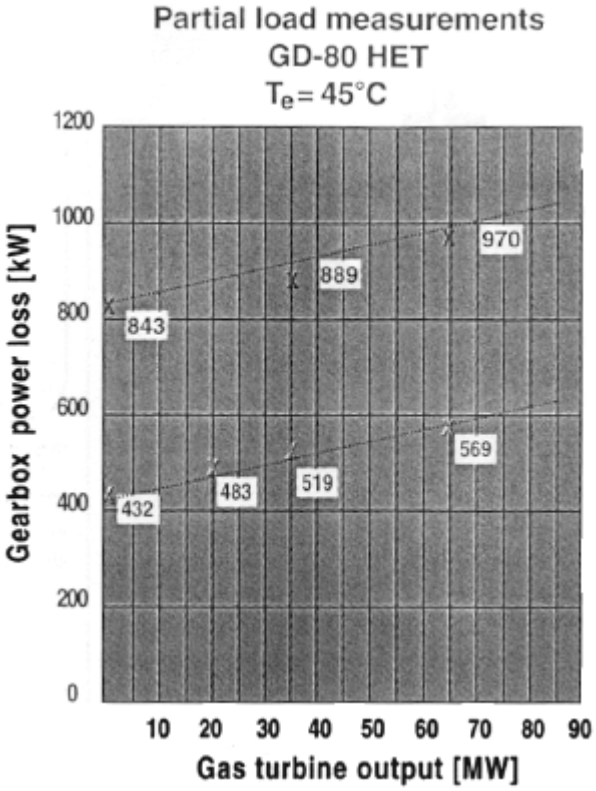
Gear Design to Improve Power Plant Efficiency

MAAG Gear AG (now Renk-Maag GmbH, May 2007) developed and patented an extremely efficient high-speed gearbox especially for the power market segment. This gearbox offers two operating modes:

1. *an optimized conventional design, with normal gear losses but minimized bearing losses*
2. *a vacuum design, with negligible gear losses.*

This dual-mode capability requires special correction of the gear teeth to ensure an optimum gear-tooth contact pattern in the two separate operating modes. This technology is one of the secrets of the new gearbox.

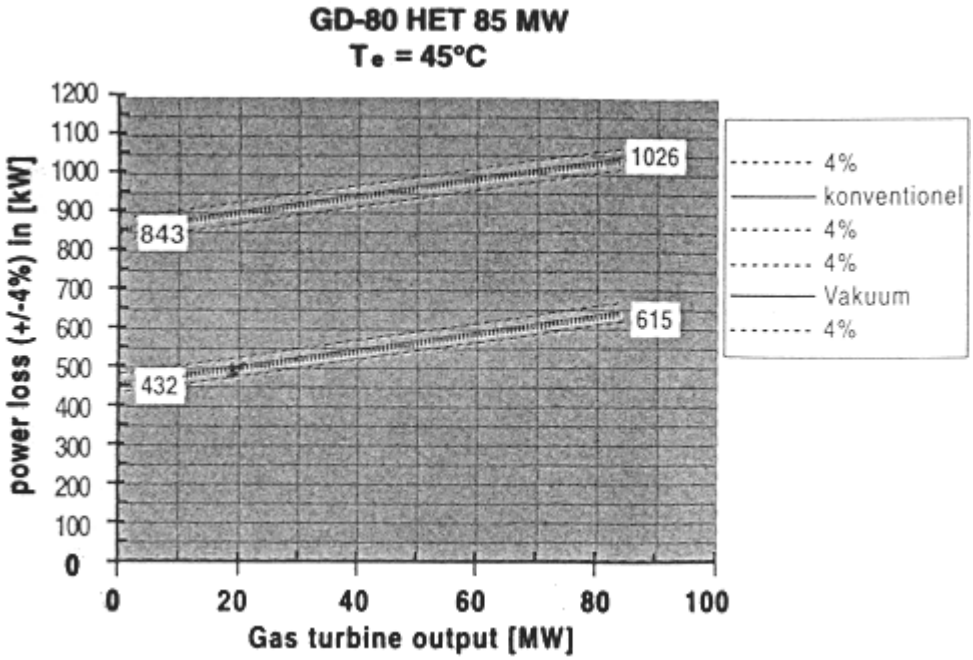
MAAG'S designers are justifiably proud of their development and the results that are being achieved with it is practice. The customers, Siemens and GE, have expressed complete satisfaction with its efficiency, availability, quietness, quality and measured performance in commercial operation.



HET gearboxes improve power plant efficiency and lube oil consumption, resulting in a cost-effective and environmentally sound product. A comparison of the power losses between a HET gearbox and a conventional unit connected to a 90 MW gas turbine, and considering an oil intake temperature of 45 degrees C, resulted in the following values: the power loss of a conventional gearbox is 1239 kW. The HET gearbox has a power loss of only 480 kW under full speed and no load. Under full speed and full load, the power loss will be 1407 kW respectively 628kW, which is a difference of 779 kW in favor of the HET gear. At a price of 0.04 Sfr/kWh and 8000 hr operating time, a utility company has a benefit of some 249 000 Swiss Francs per year due to the better efficiency of the HET gearbox in a 90 MW power plant.

How to measure gear losses

1. Determination of gear box performance loss at no load/full speed using a calibrated torque meter. Ideally, gearbox performance loss at no load/full speed should be measured during testing by the manufacturer. The torque meter can be used to determine effective gearbox performance losses to an accuracy of 0.5%. In addition, this measurement also takes account of gearbox heat radiation.



2. Determination of change in gearbox power loss under load. Gearbox power loss at full speed and increasing load can be assumed to progress linearly, because once full speed has been reached, only friction losses increase and the other loss factors (windage and churning) remain constant.

   Approach: Because frictional losses increase linearly in a particular ratio to the load, upon reaching full speed, the increase in power load loss can be determined with two measurements at different percent of loads. It is not the absolute value that is of interest, it is rather the angle of the straight lines between the two measured values.

3. Determination of gearbox power loss at full speed/full load. Effective gearbox power loss can now be calculated using the linear equation $P_V=ax+b$,

   Where:
   a = the relationship between full load and no load
   b = the power loss at full speed and no load measured on the test rig with the measuring shaft
   x= the power loss per load unit.

   This value is a purely arithmetical value based on the ratio of the power loss between full load and no load.

   The function thus derived is identical for every gearbox of the same system – i.e., it is now possible to predict the power loss of identical, series production gearboxes of the type commonly used for power generation.

   Measurements are made on the basis of the calorific balance. In each case, the measuring points are chosen to correspond to a normal operating condition (no-load, part-load or rated-load). This is very important, because a settling time of three to four hours is needed, depending on the operating condition.