KÖTTER CONSULTING ENGINEERS

Publication

The "Sommerfeld" Effect.

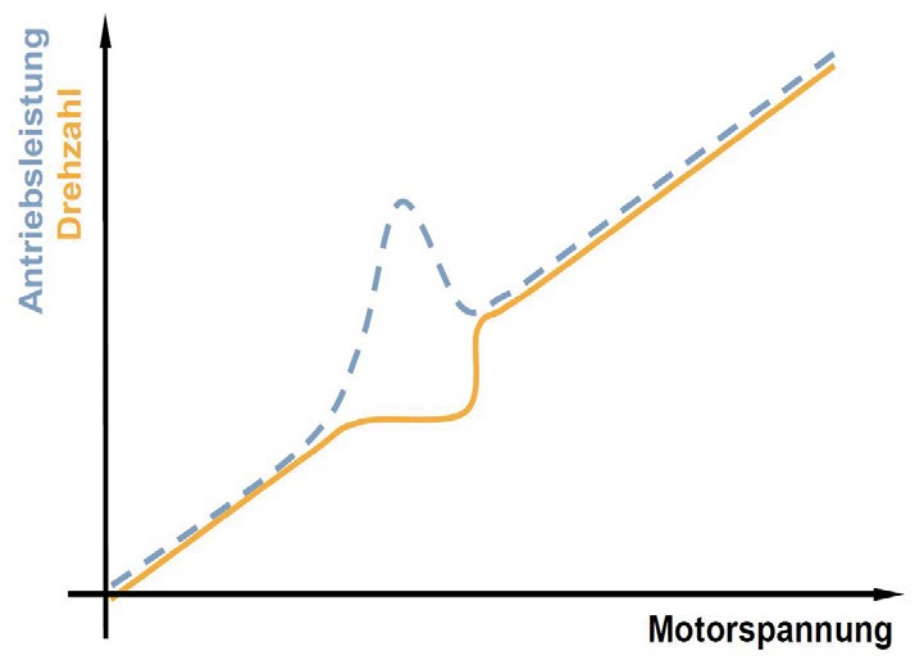
Saving energy through vibration reduction.

Arnold Sommerfeld (1868-1951) was a theoretical physicist, who is known to many engineers for his work on slide bearings (Sommerfeld number). In 1901, Sommerfeld demonstrated a small experiment for an astonished specialist audience:

He mounted an electric motor with unbalance mass on a flexible table plate. He was able to drive this motor to rotational speed with a voltage regulator. Sommerfeld had chosen the setup in such a way that a resonance existed in the excitation range of the unbalance mass. As now the motor voltage was increased continuously, one could observe a special effect (see figure 1): First, rotational speed and drive power increased with the voltage. In the range of the resonance, the system remained at the rotational speed while the drive power increased disproportionately. Motor and plate began to swing considerably. Above the resonance frequency, the rotational speed seemed to jump to a level that could be expected without resonance.

If one transfers this behaviour to a real technical machine, one can note that the operation in an installation resonance is associated with increased mechanical vibrations. These pose a load e.g. for the shaft bearings and lead to increased wear. In addition, this experiment clearly shows that one has to pay dearly for the evil of increased vibrations, because a part of the drive power is not transferred to the desired rotation of the shaft, but serves the perpetuation of the vibration.
How significant the loss in effective power can be, was demonstrated by a current project of a natural gas compressor plant: a newly built reciprocating compressor was installed on a foundation. Its first natural frequency was excited by the operation of the fixed speed compressor. As a consequence of the increased vibrations entire buildings in the vicinity were excited. A combined metrological-theoretical investigation showed reduction possibilities by a foundation renovation. After this was completed, the determination followed of the power consumption of the motor before and after the renovation. At a rated power of about 4.2 MW, a reduction of the necessary drive power was found of about 100 kW by this optimisation of the set-up. On the basis of 2,000 full load hours and an assumed price of electricity of 150 Euro/MWh, the financial advantage is 30,000 Euro per year.

If you now see the vibrations at the foundation of your machine with different eyes, you are welcome to give us a call.



Drive power and rotational speed of a motor with an unbalance mass as a function of motor voltage at a resonance set-up

Contact:
Dr.-Ing. Christian Jansen
+49 5971 9710-30
c.jansen@koetter-consulting.com