Appearances are deceptive

Often, the cause for increased vibrations is not visible at first sight. Only comprehensive investigations reveal the true cause!

In a new fertilizer plant in Turkmenistan a steam turbine with generator for the own power supply was installed. As the power supply is not comparable to the European standard and a breakdown in power supply would lead after a certain time to the breakdown of the whole fertilizer plant, such a system is quite reasonable.

During the commissioning of the generator the staff observed increased vibrations, especially at the generator (figure 1). The vibration analysis, which was then carried out by the operator with a FFT-analyser, showed that increased vibrations especially occurred at the bearing shield of the generator in axial direction (figure 5, initial situation). A more detailed analysis revealed that the dominant frequency of the vibration corresponded to the double-rotational frequency of the generator (figure 2).

From relevant literature and experience it is known that the existence of the double-rotational frequency with significant amplitude in axial direction is an indication for an insufficient alignment of the machines. Therefore, the operator tried to improve the vibration situation by changing the alignment. As this was not successful, KCE was asked to analyse the cause on-site. A detailed investigation of the vibrations, recorded simultaneously at different measuring points during start-up and shutdown of the plant, showed that the bearing shield of the generator in axial direction had a natural frequency of approx. 45 Hz (figure 3).

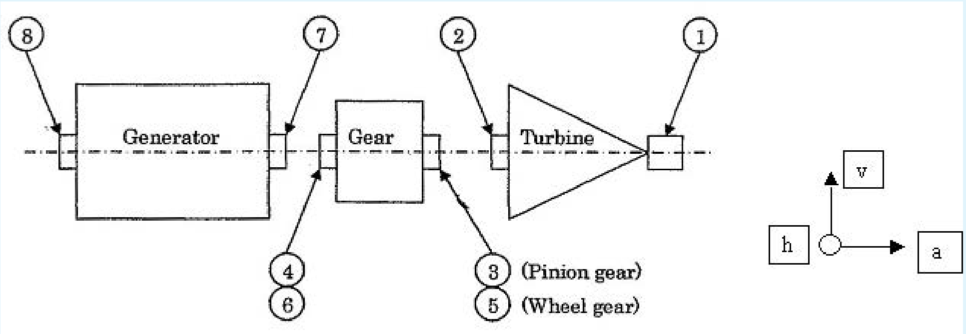
The FFT- analysis from figure 3 shows that at a speed of 1,590 rpm the double-rotational frequency at approx. 53 Hz has a smaller amplitude than the rotational frequency. With decreasing speed, the amplitude of the double-rotational frequency increases and reaches a maximum at t = 270 s resp. at a speed of 1,340 rpm.

However, the vibrations in vertical direction did not show any dominance. At the double-rotational frequency (figure 4), the vibration predominant amplitude lay on the single-rotational frequency of the generator, the predominant vibration amplitude lay always at the single-rotational frequency of the generator.

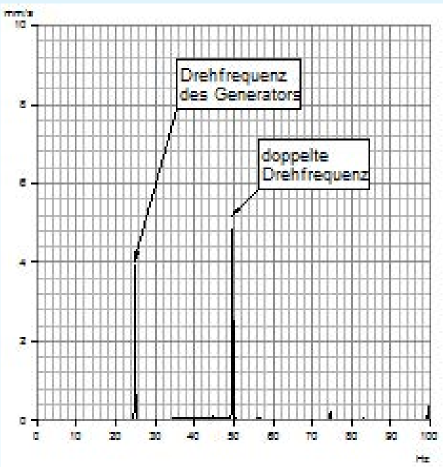
A change in the generator's alignment did not lead to a significant improvement of the vibration situation. It was decided to install a test mass at the rotor of the generator to determine the influence of the vibrations. This measure showed that axial vibrations at the generator were mainly excited by a residual imbalance in the rotor of the generator and not – as originally assumed – by an incorrect alignment. After test runs, an improvement of the vibration situation (shown in figure 5) was reached.

As one can see, the guideline values of DIN ISO 10816 - part 3, zone A, were met after the operational balancing so that the system could be used without restrictions in long-term operation. With the KCE experts still on-site, the system was accepted by the customer.
The case study described is a good example that increased vibrations can also occur in an untypical form of appearance, depending on the individual situation. The example makes clear how important it is for the analysis of the situation on-site to consider all appearances and possible causes. Thus, costly delays during the commissioning process can be avoided.

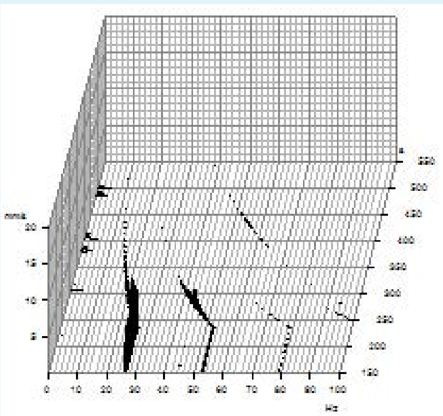
MACHINE DYNAMICS



Location of the measuring points: MP_1a: measuring point 1 in axial direction / MP_1h: measuring point 1 in horizontal direction / MP_1v: measuring point 1 in vertical direction (all other measuring points analog)



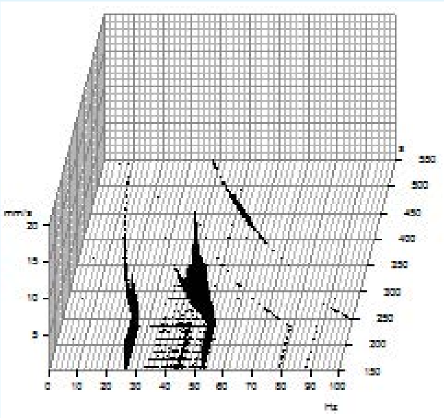
FFT-analysis of the vibration velocity at the measuring point MP_7a in axial direction at a speed of n = 1,490 rpm



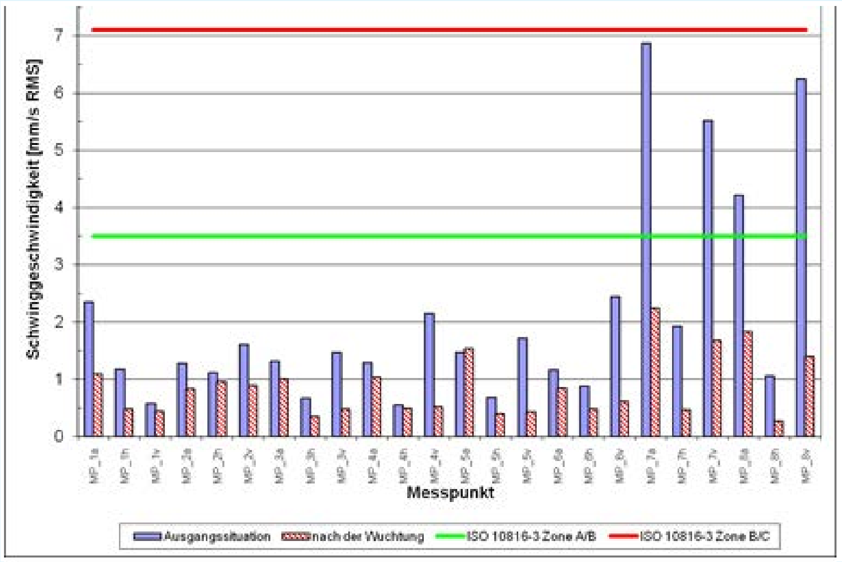
Waterfall display of the FFT-analysis of the vibration velocity at the measuring point MP_7a, shutdown of the system at n = 1,590 rpm

KÖTTER CONSULTING ENGINEERS

MACHINE DYNAMICS



Waterfall display of the FFT-analysis of the vibration velocity at measuring point MP_7v, shutdown of the system at n = 1,590 rpm



Effective vibration velocities measured in the initial situation and after operational balancing

Contact:
Dipl.-Ing. Robert Missal
Telephone: +49 5971 9710-25
r.missal@koetter-consulting.com