



Autogyro

Rotor balancing

case study

The challenge for VibroMatrix®

Strong vibrations not only impair flight comfort, but also pose a considerable safety risk. The cause can primarily be found in rotors that are poorly balanced or not balanced at all. Unequal rotor blade weights and a center of gravity offset (eccentricity) of the main rotor in relation to its axis of rotation generate circulating centrifugal forces, ($F = \epsilon m \Omega^2$) which can be felt very unpleasantly as periodic vibrations over the frame in the entire cabin and over the rotor head control on the stick

At rotor speeds between 200 and 400 rpm, frequencies in the range from 0.3 to 6.6 Hz result. These frequencies are particularly harmful to the human body and lead to reduced performance and an increased risk of accidents.

The aim of balancing is to compensate for these forces. By attaching additional masses to the rotor blade tips and by centering the rotor using set screws or shims, vibrations are reduced to a minimum.

The Solution - InnoBalancer Pro®

The InnoBalancer Pro® software from the VibroMatrix® vibration measurement system offers the possibility of balancing with specified fixed locations precisely for this purpose. The program guides the user step by step through the balancing procedure and gives precise instructions on how to attach test and balancing weights. The software automatically logs the entire balancing process and is then available as a finished report for distribution.



Effects of vibrations as a function of frequency on the human body (Dupuis, Zerlett 1984)

Frequency range - reaction

0,5 Hz	nausea, vomiting (motion sickness)
3-7 Hz	pain (skeletal)
4-8 Hz	obstruction of breathing
10-18 Hz	urge to urinate and defecate
13-20 Hz	headache, distortion of language
20-25 Hz	reduction in visual acuity (oscillating image on the web skin)

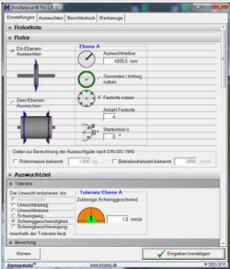
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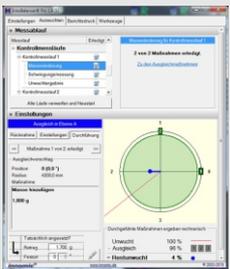


Mounting the accelerometer on the rotor head

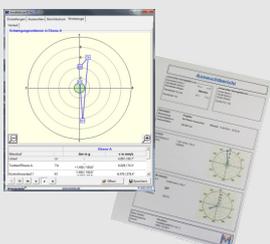
The InnoBalancer Pro[®] clearly displays all parameters for recording the rotor and the presettings and also offers quick and easy handling for occasional users.



Four fixed locations are set for the compensatory measures. 2 of them for centering the rotor blades and 2 for setting the balance weights of the rotor blades. After a so-called initial run, the system is specifically modified by attaching a test mass to a fixed location. From these two vibration measurements, the InnoBalancer Pro[®] software calculates the direction and amount of the imbalance and which balancing weights are to be placed where. In a first step, only the balancing measures are carried out at the fixed locations, which were determined for the balancing by mass on the rotor blades. After a control run, the residual imbalance points in the direction of a fixed location, which was chosen for the centering of the rotor blades. The position of the rotor is now corrected by the targeted selection of shim discs or adjustment using set screws and the result is checked by another control run.



Putting a test weight (adhesive tape) on the rotor blade ...



The final balance report can be made available immediately as a PDF file or in printed form. Templates can be created with your own logo and design.

Benefit for the customer

- No removal of the rotor blades
- Applicable for rotor and propeller
- More safety and flight comfort
- Reduction of vibrations
- Extension of the own service offer
- In-depth knowledge of the vibration behavior of various rotors
- Multiple use for one time acquisition cost

Measurement during flight

Installed on a small notebook, VibroMatrix[®] provides you with all measured values even during the flight under real conditions. The time signals of the accelerometer can also be recorded as raw data and then examined with other instruments, e.g. the InnoAnalyzer Pro[®] for analyzing the frequency spectrum. All of the sensors and the AD converters InnoBeamer[®] X2/LX2 are supplied with power during the flight via the USB connection.

