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Eddy current runout measurement in electrical machines

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Overview

Motivation

Background

Measurement setup

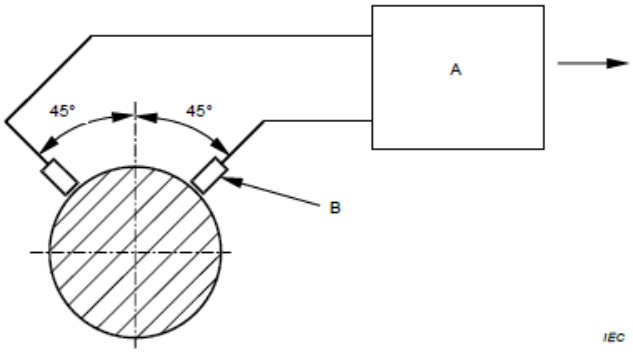
Results

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

Motivation

Image: Wikimedia commons

Measurement of relative shaft displacement



Key

A signal conditioner

B transducer

Figure 5 – Preferred circumferential position of transducers for the measurement of relative shaft displacement

IEC 60034

- Several IEC, API and ISO standards
- For condition monitoring, prevent excessive vibration
- Measurement of relative shaft displacement sensitive to roundness error
- Eddy current probes required in some standards

Limits defined in standards

API 546: 12.5 µm

2.4.5.1.7 When vibration and/or axial-position probes are furnished, or when provisions for probes are required as described in 3.8, the rotor shaft sensing areas to be observed by the radial probes shall be concentric with the bearing journals. All sensing areas (both radial vibration and axial position) shall be free from stencil and scribe marks or any other surface discontinuity, such as an oil hole or a keyway, for a minimum of one probe-tip diameter plus one half of the total end float on each side of the probe. These areas shall not be metalized, sleeved, or plated. The final surface finish shall be a maximum of 0.8 µm (32 µin.) R_a, preferably obtained by honing or burnishing. These areas shall be properly demagnetized to the levels specified in API 670 or otherwise treated so that the combined total electrical and mechanical runout does not exceed the following when measured in accordance with 4.3.3.1.

a) For areas to be observed by radial vibration probes, 25 % of the allowed unfiltered peak-to-peak vibration amplitude or 6.4 µm (0.25 mils), whichever is greater.

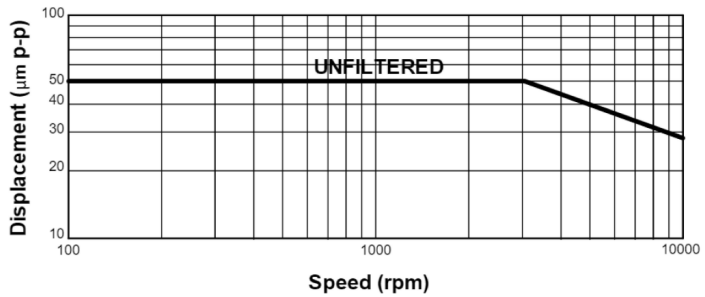
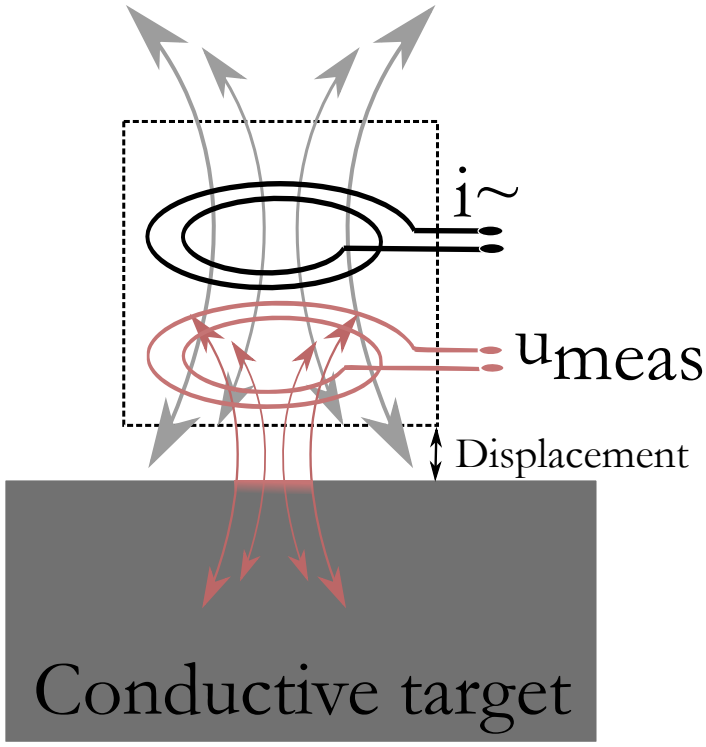


Figure 2—Shaft Vibration Limits (Metric Units, Relative to Bearing Housing Using Non-contact Vibration Probes) for All Hydrodynamic Sleeve Bearing Machines with the Machine Securely Fastened to a Massive Foundation

Eddy current probe

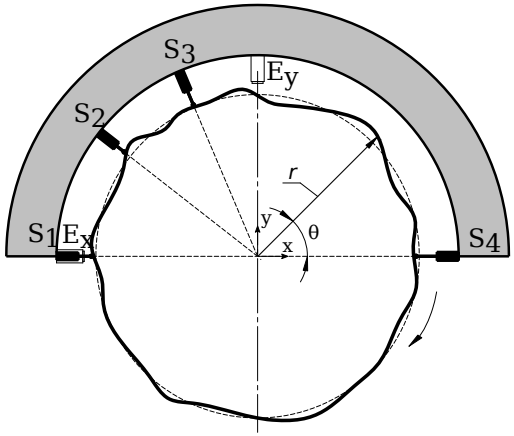


Obtained displacement value sensitive to:

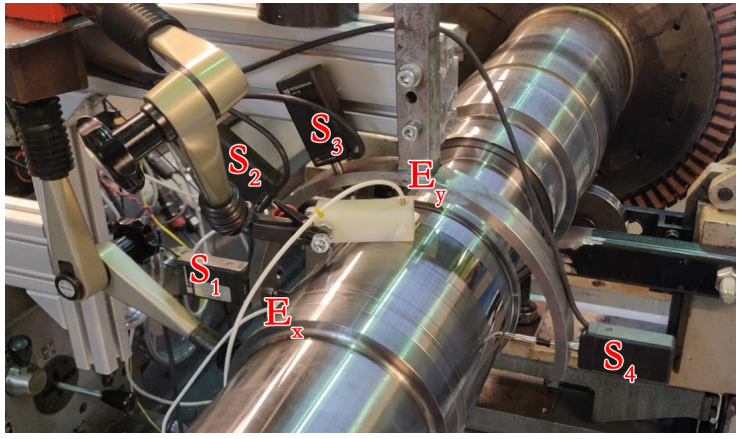
- Changes in surface roughness
- Resistivity of surface
- Magnetic permeability of surface

Electrical runout: Eddy current probe error due to material inhomogeneities

Measurement setup



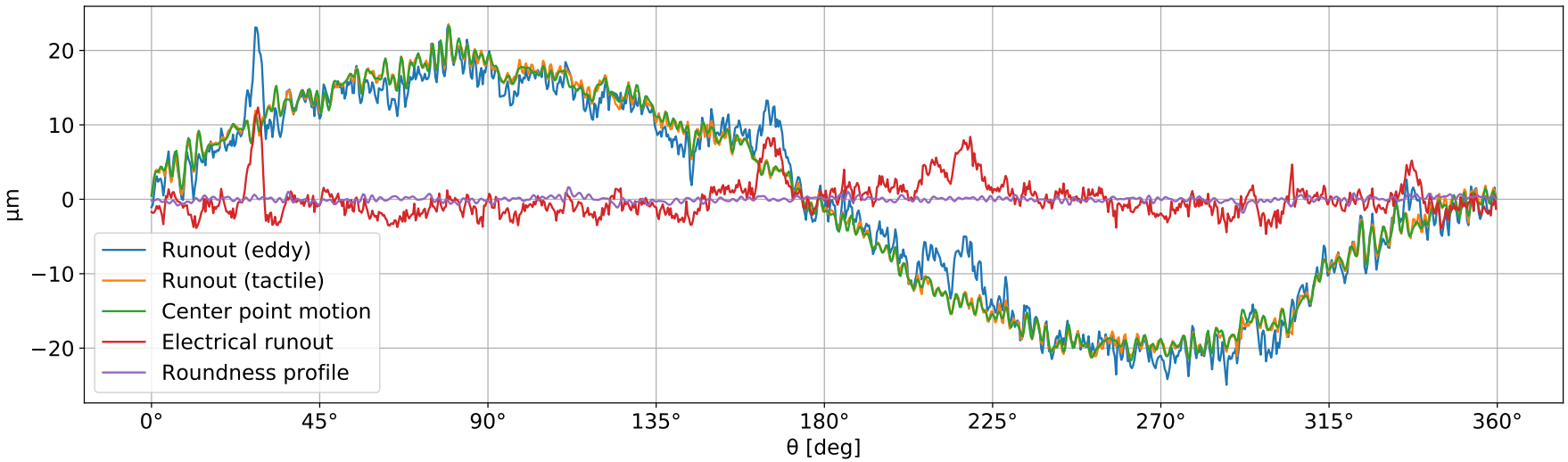
(a)



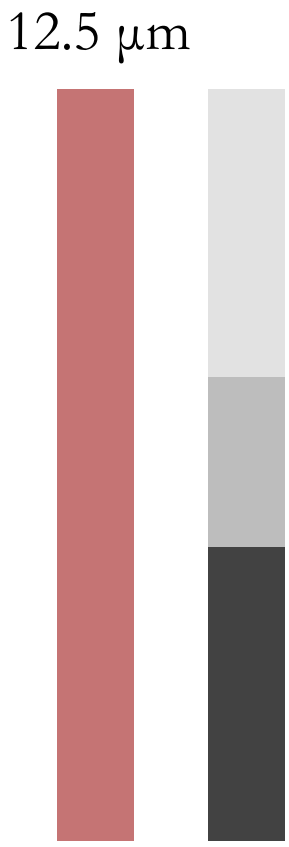
(b)

- Separate roundness profile and center point movement with tactile four-point measurement, determine eddy current probe error (*electrical runout*)

Results


20
10
0
−10
−20
µm
Runout (eddy)
Runout (tactile)
Center point motion
Electrical runout
Roundness profile
0°
45°
90°
135°
180°
225°
270°
315°
360°
θ [deg]

Conclusion



? Center point movement
(actual shaft displacement)

? Roundness error

? Electrical runout
(eddy current probe error)

Further reading

Article *Analysis of total rotor runout components with multi-probe roundness measurement method* currently in review in Elsevier Measurement.
Preprint available from author.
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