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LONG TERM BEHAVIOR OF CONTACTING INDUCTIVE DISPLACEMENT TRANSDUCERS AT 600°C FOR UP TO ONE YEAR

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Summary:

Inductive and transformer displacement transducers with an armature available on the market were investigated at temperatures up to 600° C over long periods of time as long as one year. The results allow an essential improved estimation of uncertainty and application limits of displacement and deformation measurements of thermal stressed objects at such severe conditions.

Keywords : high temperature, inductive displacement transducer, deformation measurement

High Temperature Displacement Transducers are useful for the **supervision of components stressed by high temperature** such as turbine casings, tubes and tube bows and pressure vessels if these measuring systems are sufficiently stable for a long time. For displacement measurements at 600° C there are several contacting inductive transducers available. **Differential inductance transducers** with an armature (usually called inductive transducers) contain 2 coils (fig. 1a). The inductance of the coils is changed by moving the armature. The difference of the voltage drops over the coils is proportional to the displacement of the armature against the coil housing. **Differential transformer transducers** with an armature (usually called LVDT's = Linear Variable Displacement Transducers) contain a primary coil and 2 secondary coils (fig. 1b). The induced voltages of the 2 secondary coils change by moving the armature. Their difference is proportional to the displacement of the armature against the coil housing.

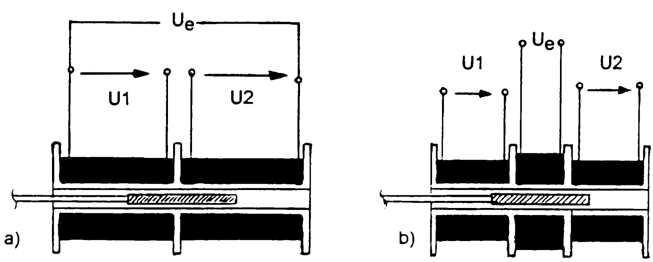

fig. 1:

Investigated high temperature displacement transducers

a) inductive transducer
b) LVDT

Inductive Transducers and LVDTs from two different manufacturers have been investigated within the last years [1] with the aim to determine their **temperature longterm behavior** (with several specimens from each type) and to recommend the best electronic adaptation.

Within **automatically controlled test devices** [2] the changes of sensitivity and zero point were measured not only during (short term) temperature alteration but also at constant temperature over long periods of time. Three **different excitation methods** (I_e = const., U_e = const. and U1 + U2 = const.) and three different working frequencies have been used, and **different methods of signal handling** (i.e.phase sensitive rectification and r m s rectification) have been tried with the aim to find out the optimal electronic adaptive circuit. Controlling and data - processing were done by means of personal computers.
After our investigations we **recommend the following adaptive circuits:** Inductive transducers may be used with a usual carrier frequency amplifier (U = const. , f = 2 ... 8 kHz). LVDT's should be used with a special carrier frequency amplifier commercially available (U1 + U2 = const. , f = 1....4 kHz).

Behavior at variable temperature (heating and cooling)

By varying temperature the amount and phase angle of the complex signal voltage U1 - U2 changes (see fig. 2 for LVDT). At the investigated transducers between room temperature and 600° C the signal amount (that means: sensitivity) changed by +5 to +30 % of the measuring range; the zero signal changed by -5 to -10 %. These variations during heating and cooling **are reproducible and might be predetermined** for each transducer within the laboratory. The predetermined data can be used to correct the field measuring data.

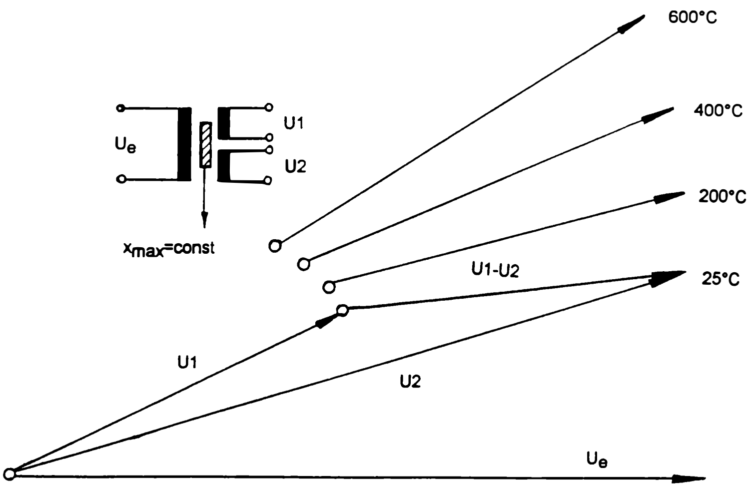

fig. 2: Temperature dedendence of the complex signal of a LVDT

Long term behavior at 500 and 600° C

At constant temperature the amount and phase angle of the complex signal voltage U1 - U2 changes, too (see fig. 3 for LVDT at 600° C and subsequently at 25° C). With a suitable transducer the long term changes over 300 days at 600° C (fig. 3) are smaller than the short term changes over the whole temperature range within one day (fig. 2).

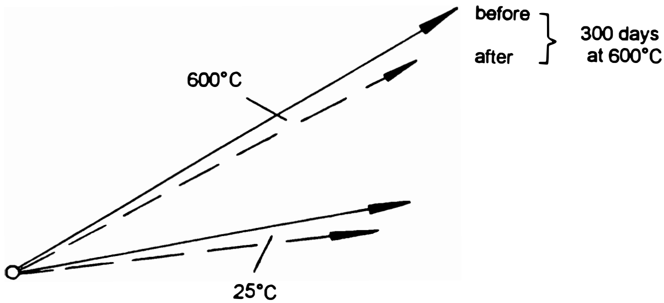

fig. 3:

High temperature drift of the complex signal of a LVDT

At 500° C six transducers were measured during 20 or 80 days (fig. 4) : **Long term measurements at 500° C are possible** ;one has to expect within 100 days changes of sensitivity at +/- 3 % with the LVDT's or as much as - 12 % with the inductive transducers and changes of zero signal at about +/- 4 %.

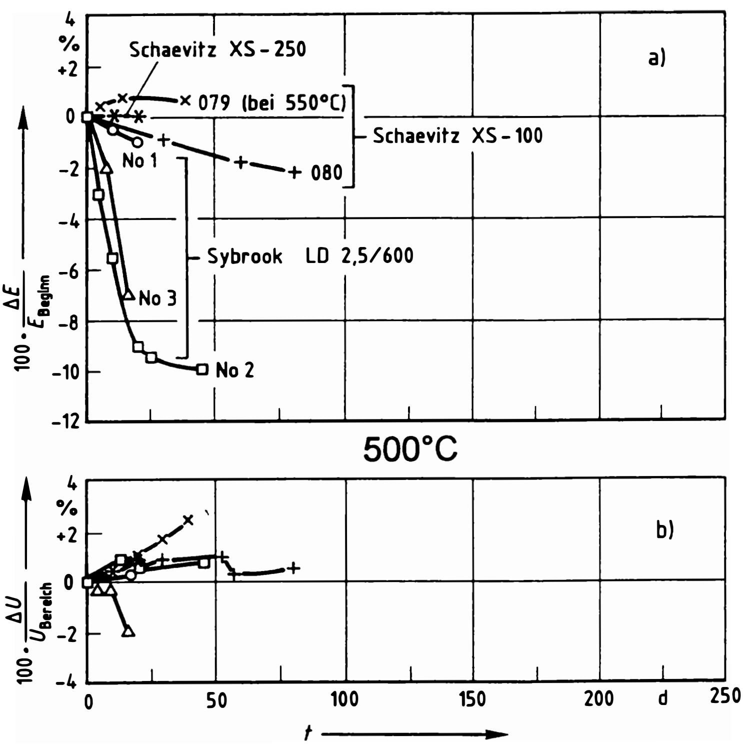

fig. 4:

Long term behavior of the investigated transducers at 500°C

a) changes of sensitivity

b) changes of zero signal

At 600° C five transducers were measured subsequently (fig. 5): Three inductive transducers failed after 45 or 95 days, one LVDT and one inductive transducer are still working without failure after one year at 600° C . **Long term measurements at 600° C are possible** with errors as shown in fig. 5, but one has to consider the possibility of faults.

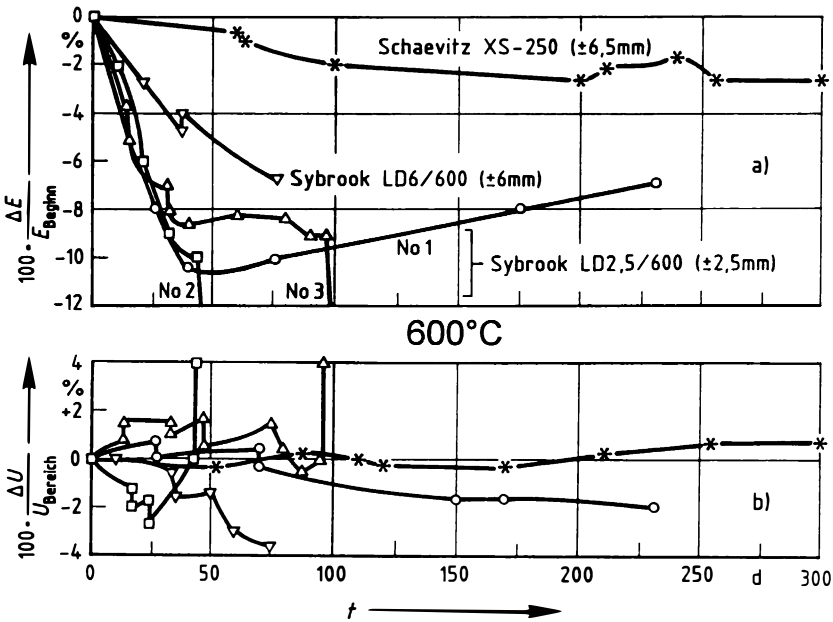

fig. 5: Long term behavior of the investigated transducers at 600°C
a) changes of sensitivity b) changes of zero signal

Comment

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References

[1] *Amberg, C. and M. Kammermeier : Entwicklung und Untersuchung einer elektronischen Anpasserschaltung zur Verbesserung der Einsetzbarkeit von Hochtemperatur-Tauchanker - Wegmeßsystemen für Überwachungsaufgaben bis ca. 600° C. Final Report ERP 2608, Jan. 1992, 36 pages, 72 figures.*

[2] *Amberg, C. and N. Mayer : Zur statischen Kalibrierung und Untersuchung von Hochtemperatur - Wegaufnehmern bei Temperaturen bis ca. 1000° C. VDI Berichte Nr. 679, 1988, S. 131 - 143.*

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