

Experimental Study of Different Filling Gases on the Stability of Metal-Sheathed Standard Platinum Resistance Thermometers

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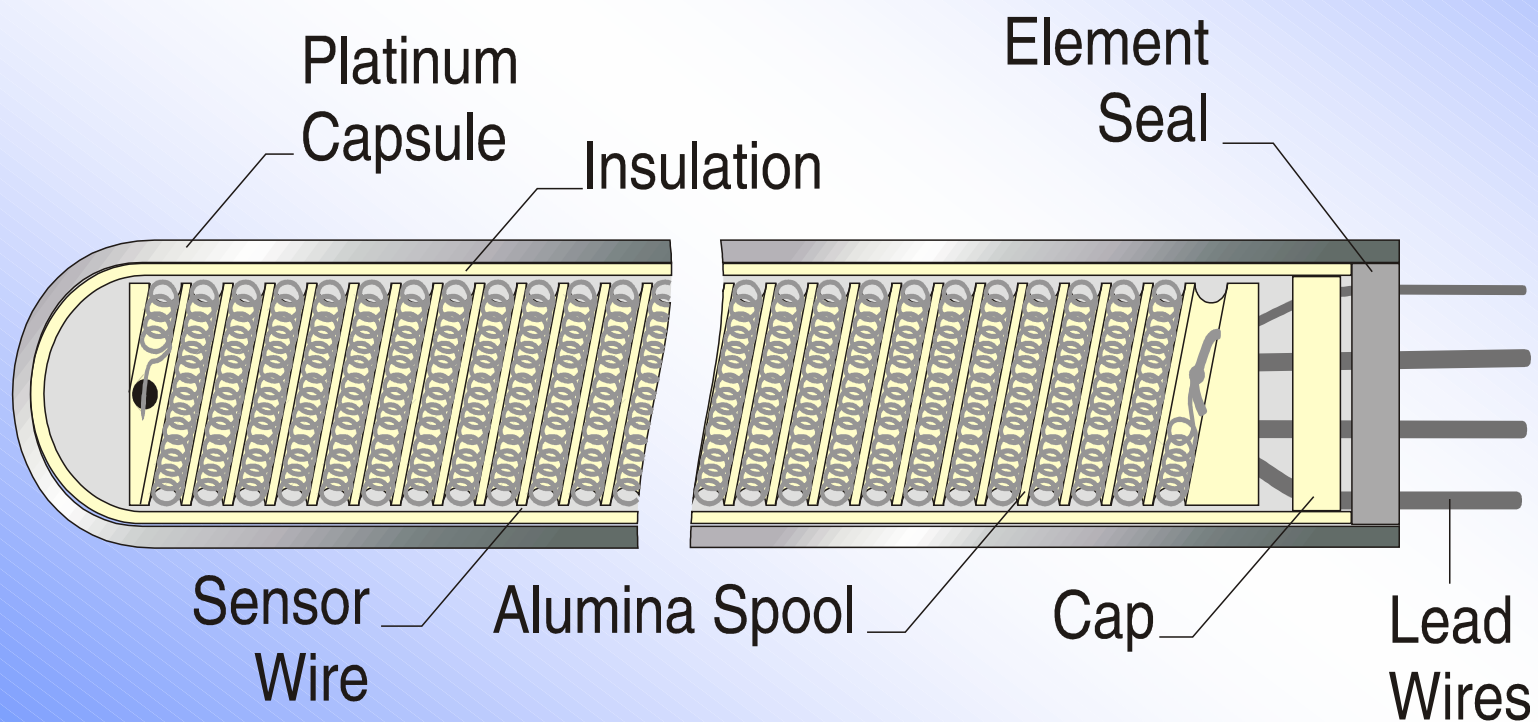
Introduction

- **MSPRTs are widely used as references**
- **Importance of a particular oxygen partial pressure in the SPRT sheath**
- **A trade-off between the oxidation effect and element contamination**
- **Loss of oxygen in an MSPRT sheath due to slow oxidation of the sheath alloy**
- **Higher oxidation effect in a new MSPRT and contamination after long-term operation**

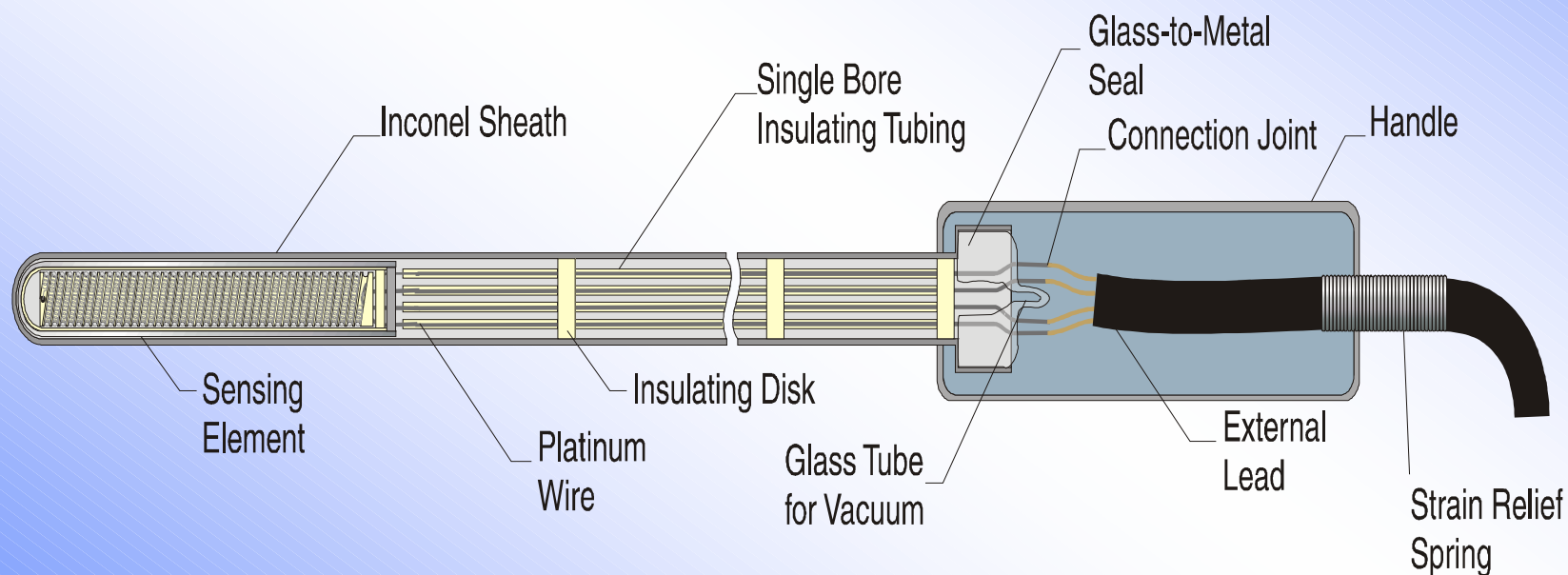
Contents of the Study

- **To improve the stabilities of Hart MSPRTs**
- **Eight MSPRTs with open elements and different filling gas mixtures were made**
- **Two MSPRTs with sealed elements were made**
- **Long-term stabilities and oxidation effects were compared**
- **A solution resolving the conflict between oxidation and contamination**

Structure of the Element



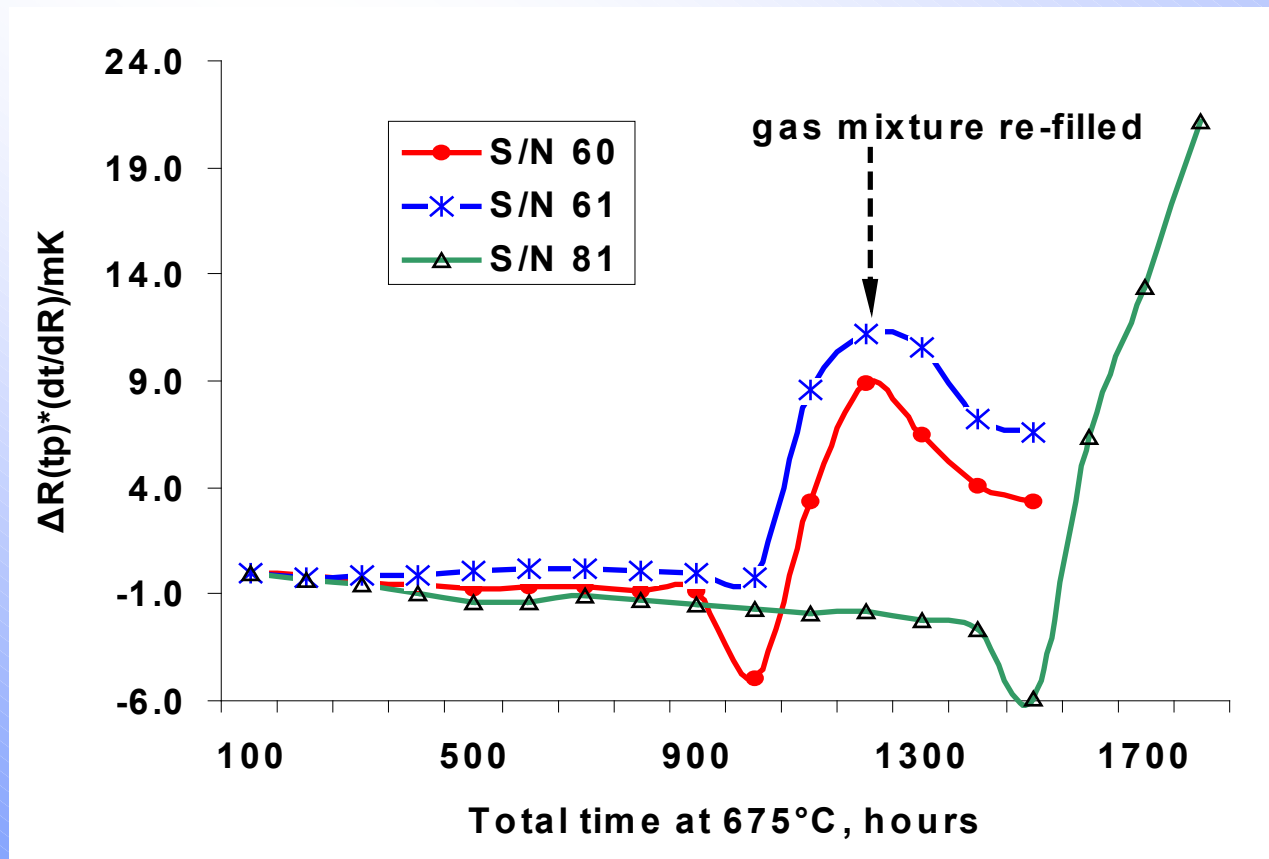
Structure of the Thermometer



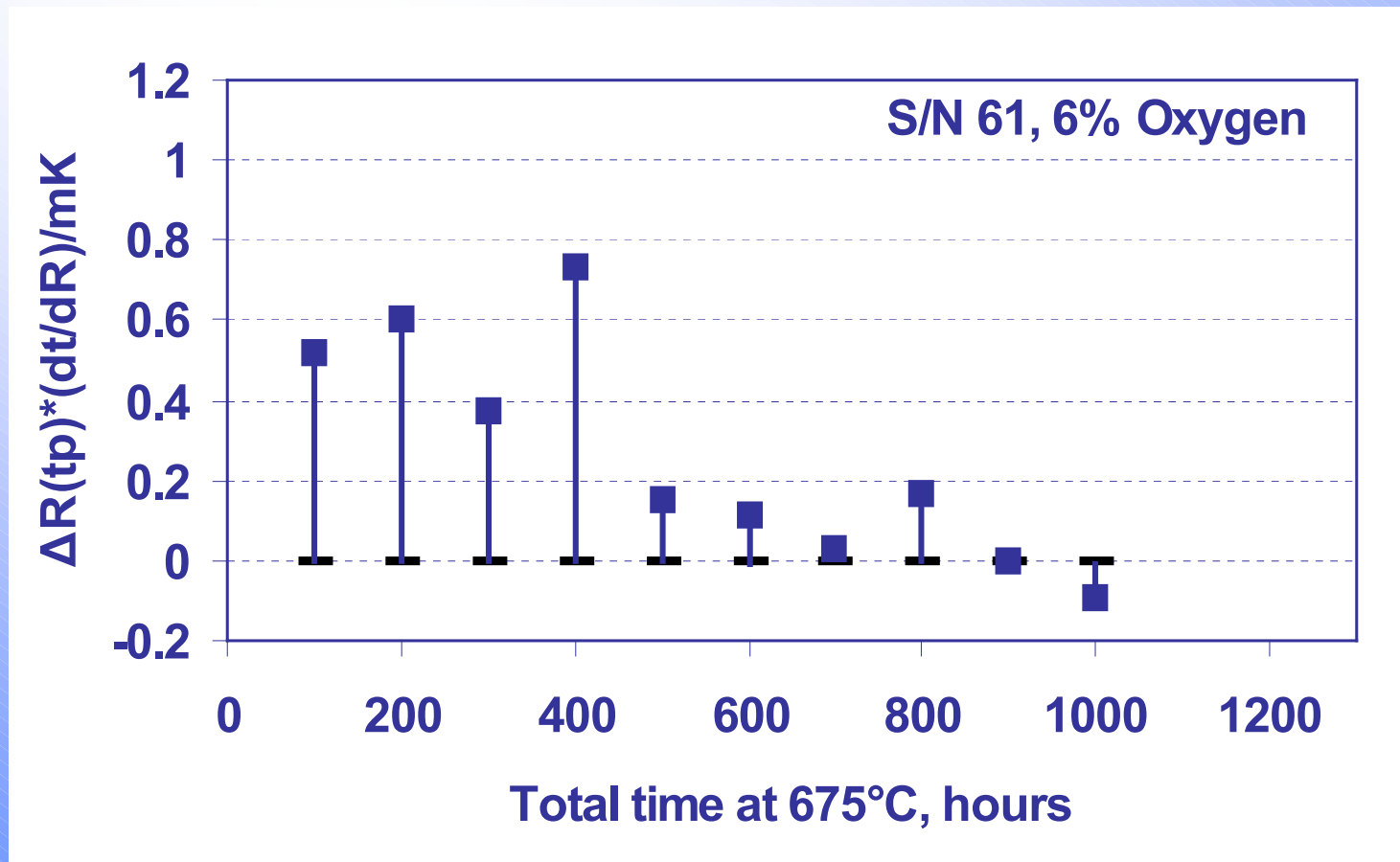
Stability test of MSPRTs with open elements and different filling gas mixtures

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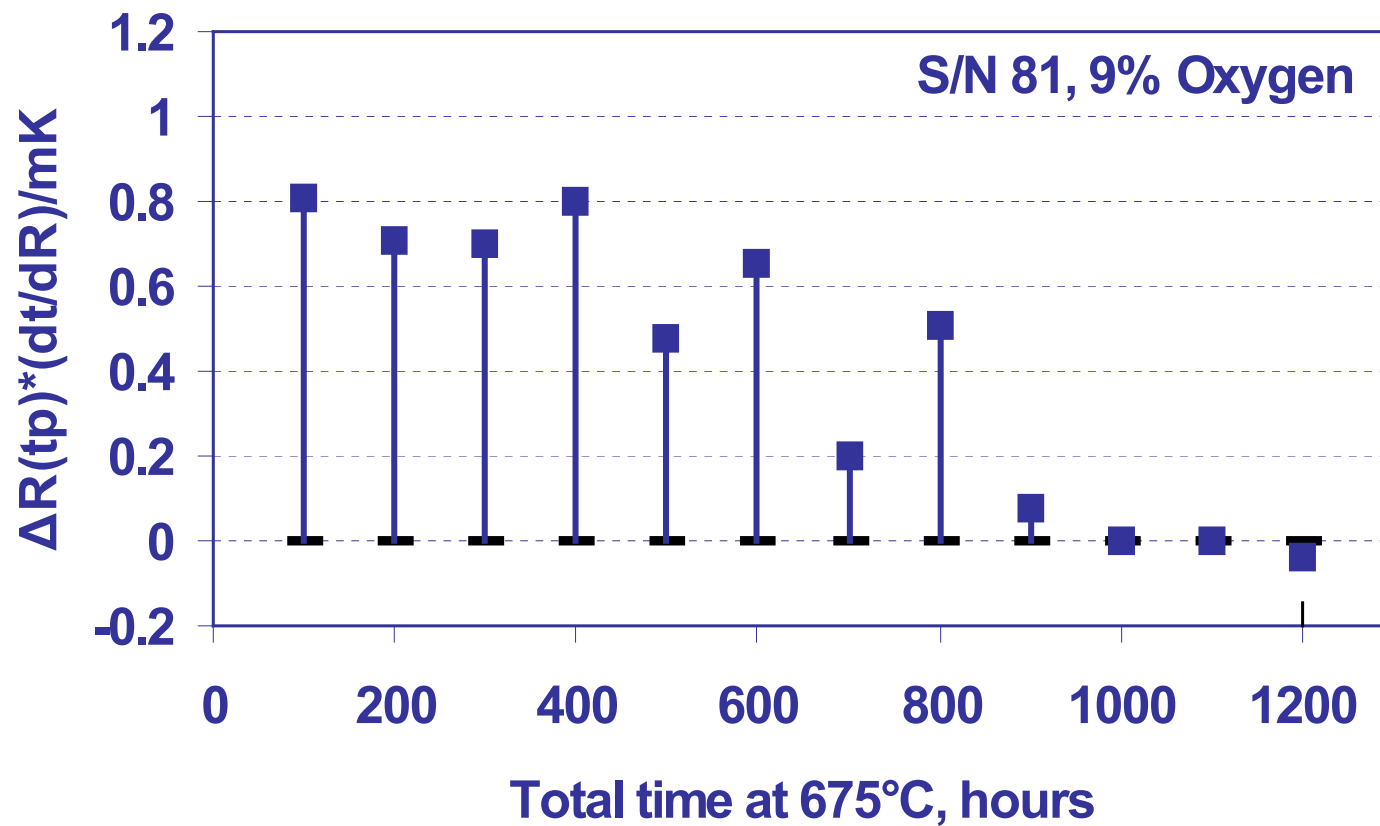
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Rtp changes after exposure to 232°C for 16 hours during long-term operation at 675°C



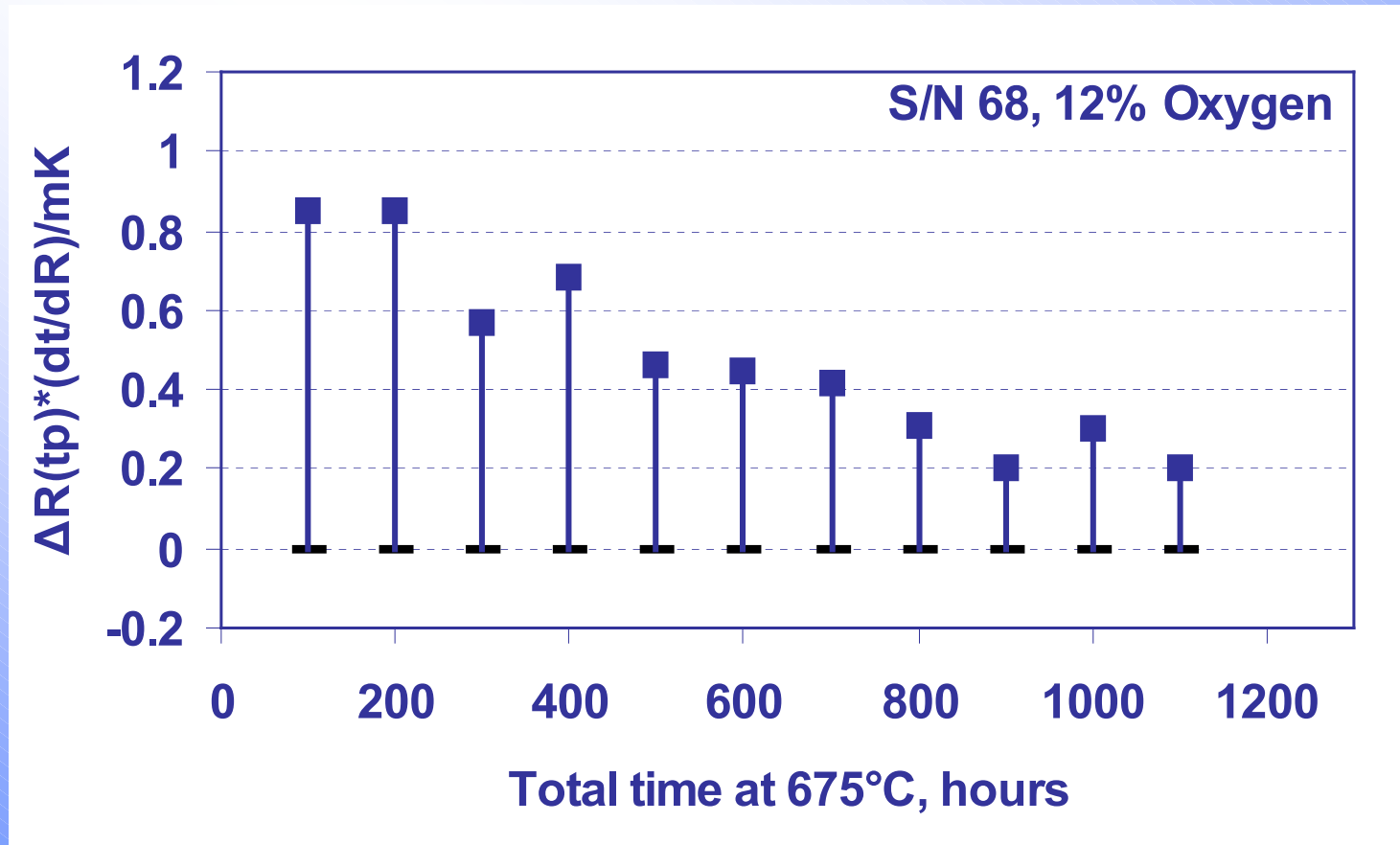
Rtp changes after exposure to 232°C for 16 hours during long-term operation at 675°C



Rtp changes after exposure to 232°C for 16 hours during long-term operation at 675°C

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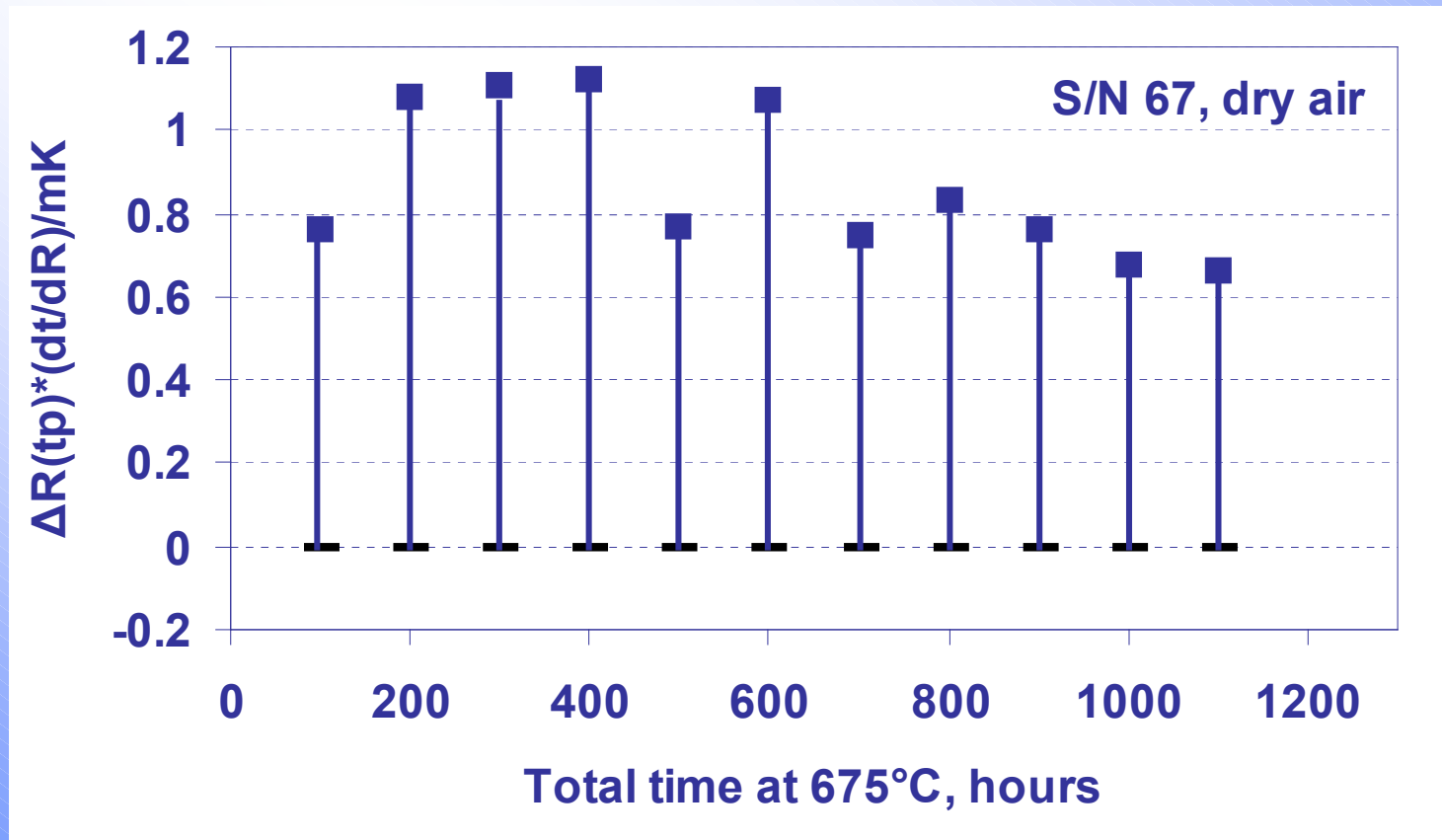
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Rtp changes after exposure to 232°C for 16 hours during long-term operation at 675°C

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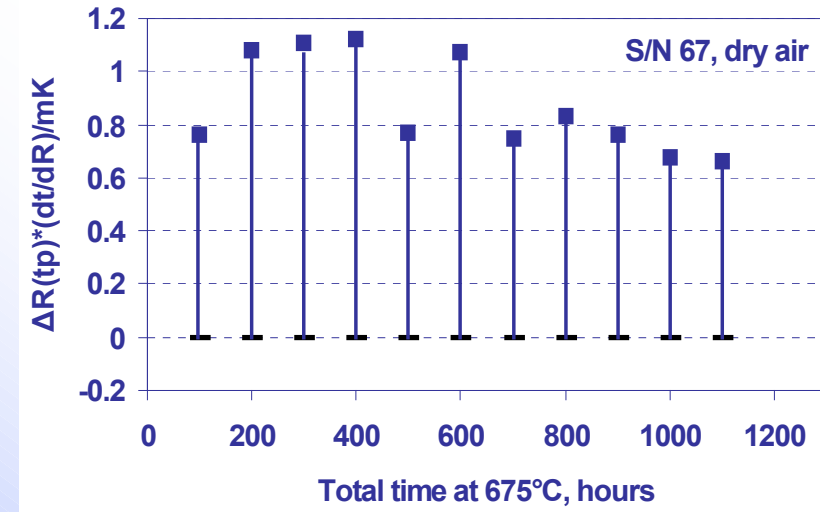
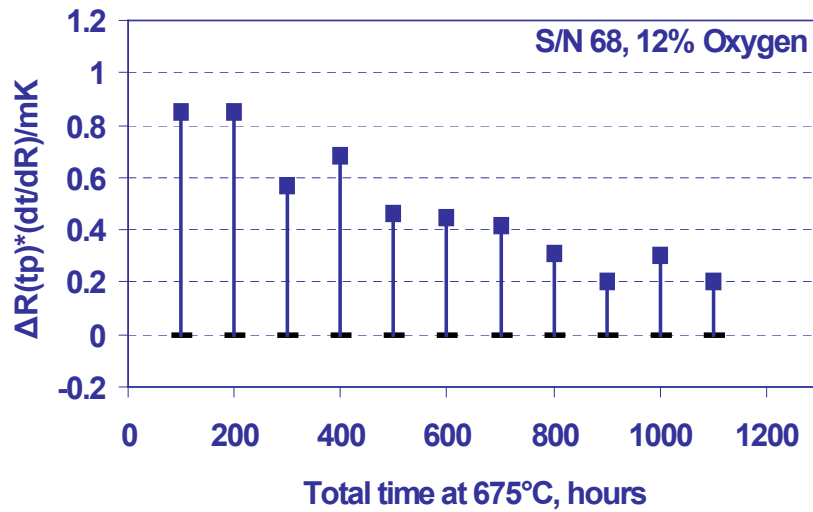
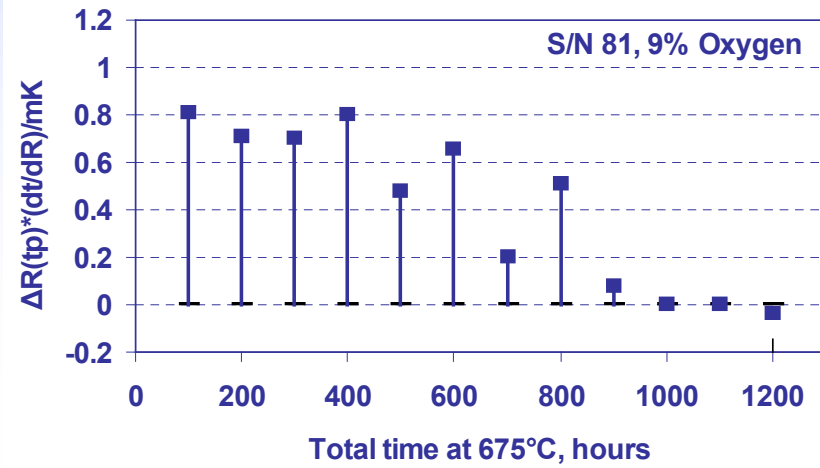
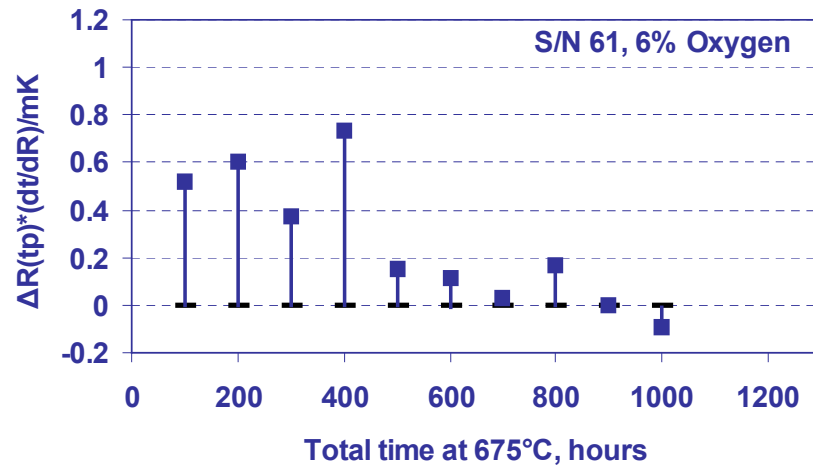
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Comparison of the four previous charts

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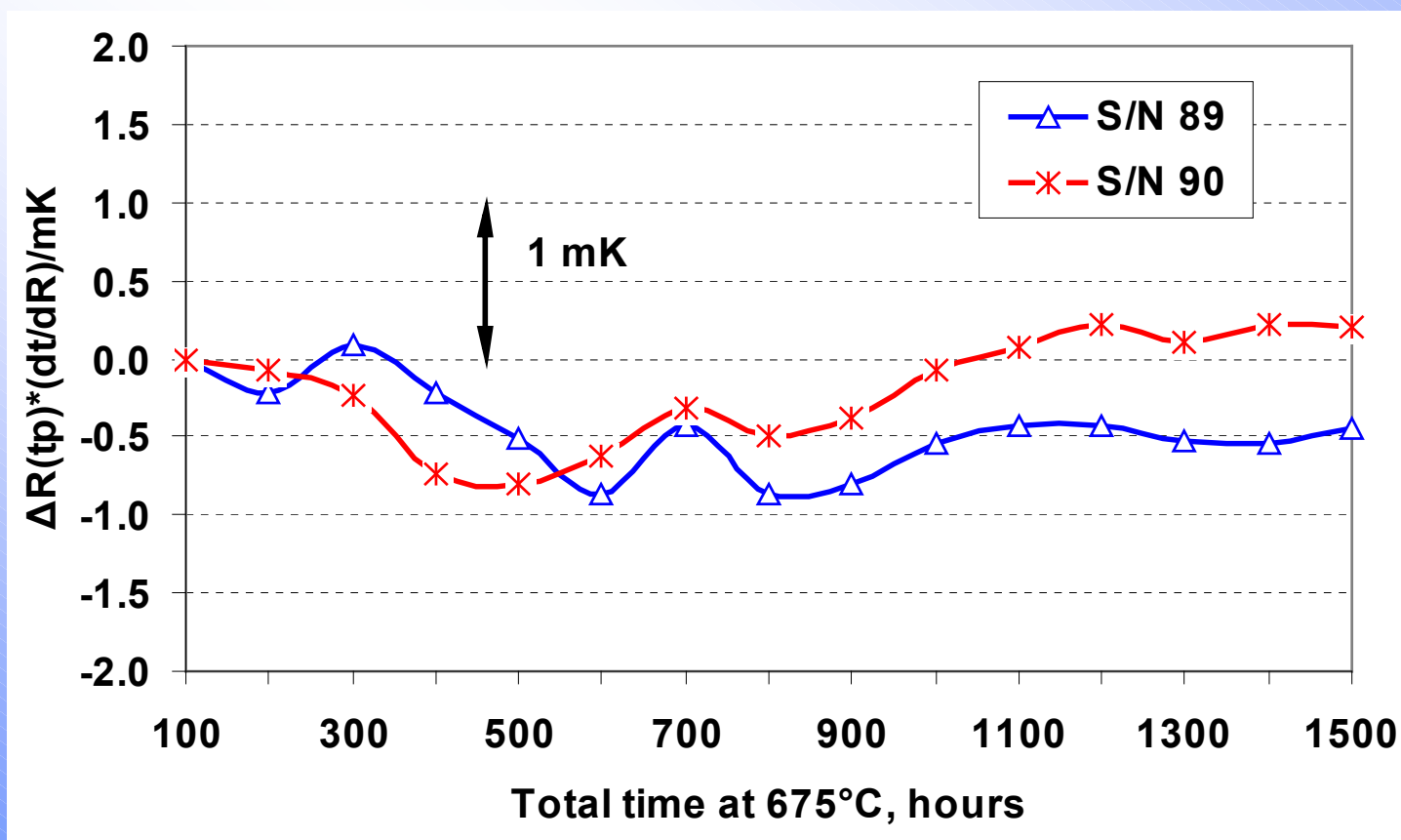
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Long-term stability test at the triple point of water for MSPRT with sealed elements

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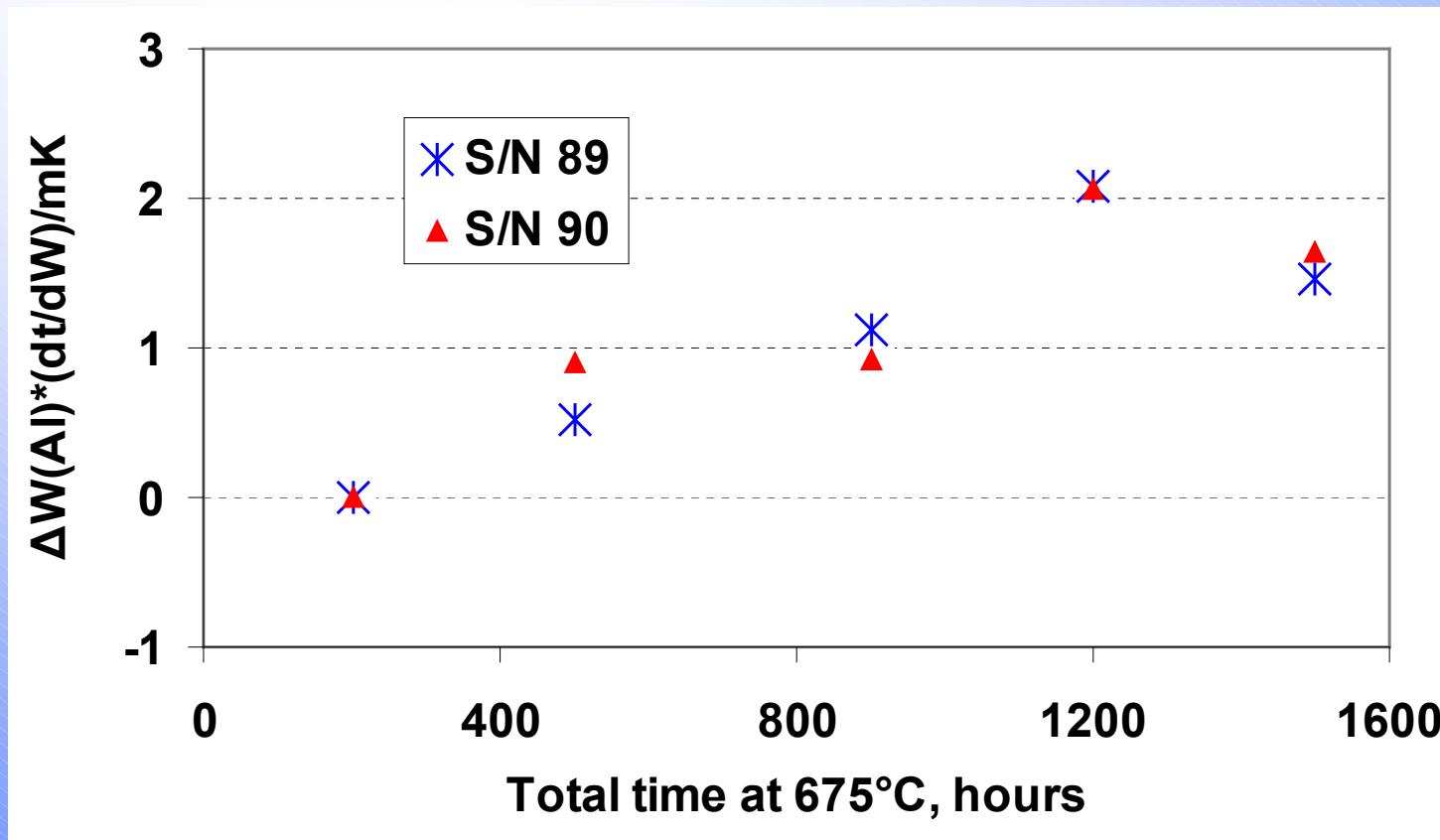
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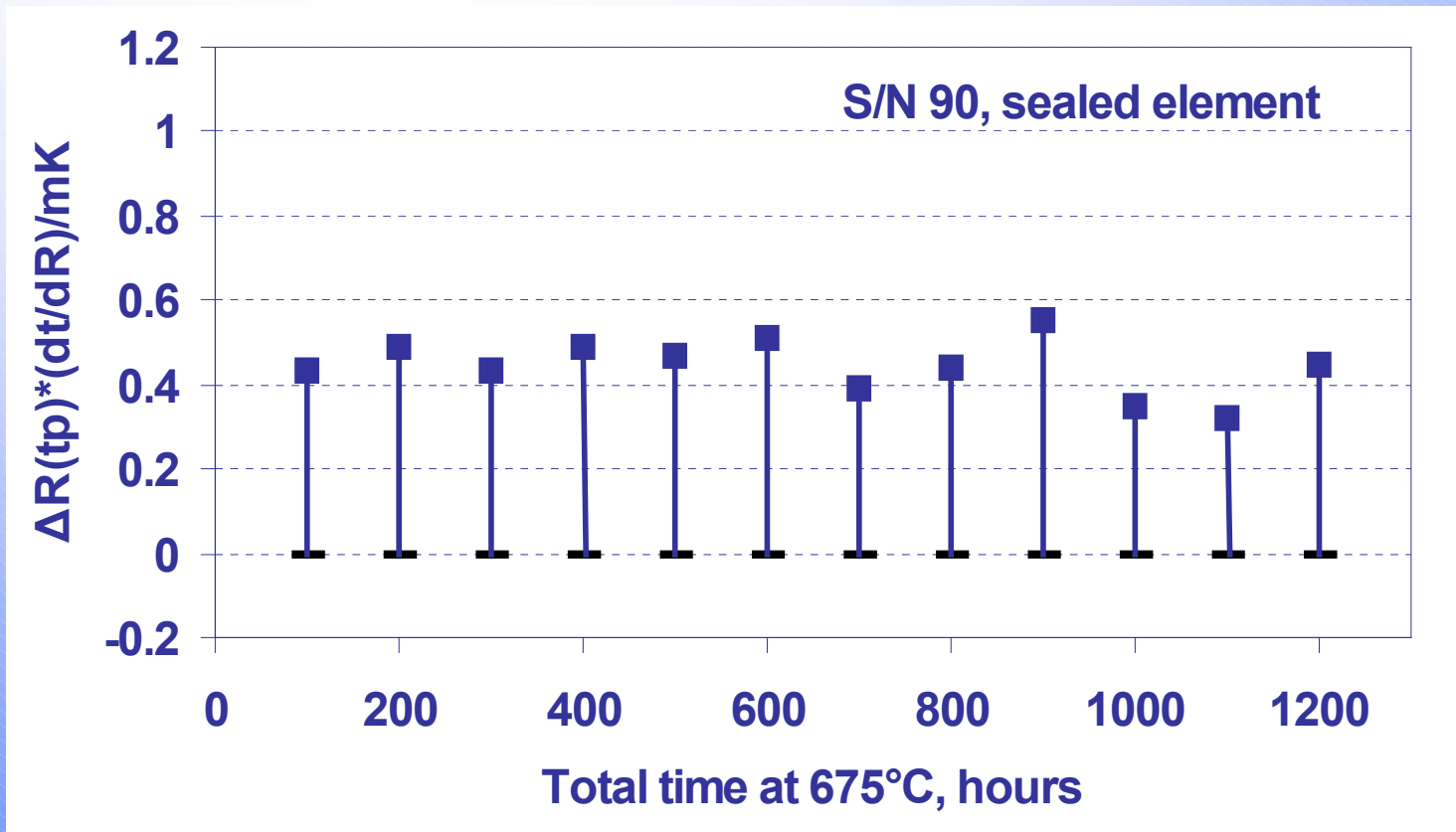
Long-term stability test at the FP of aluminum for MSPRTs with sealed elements

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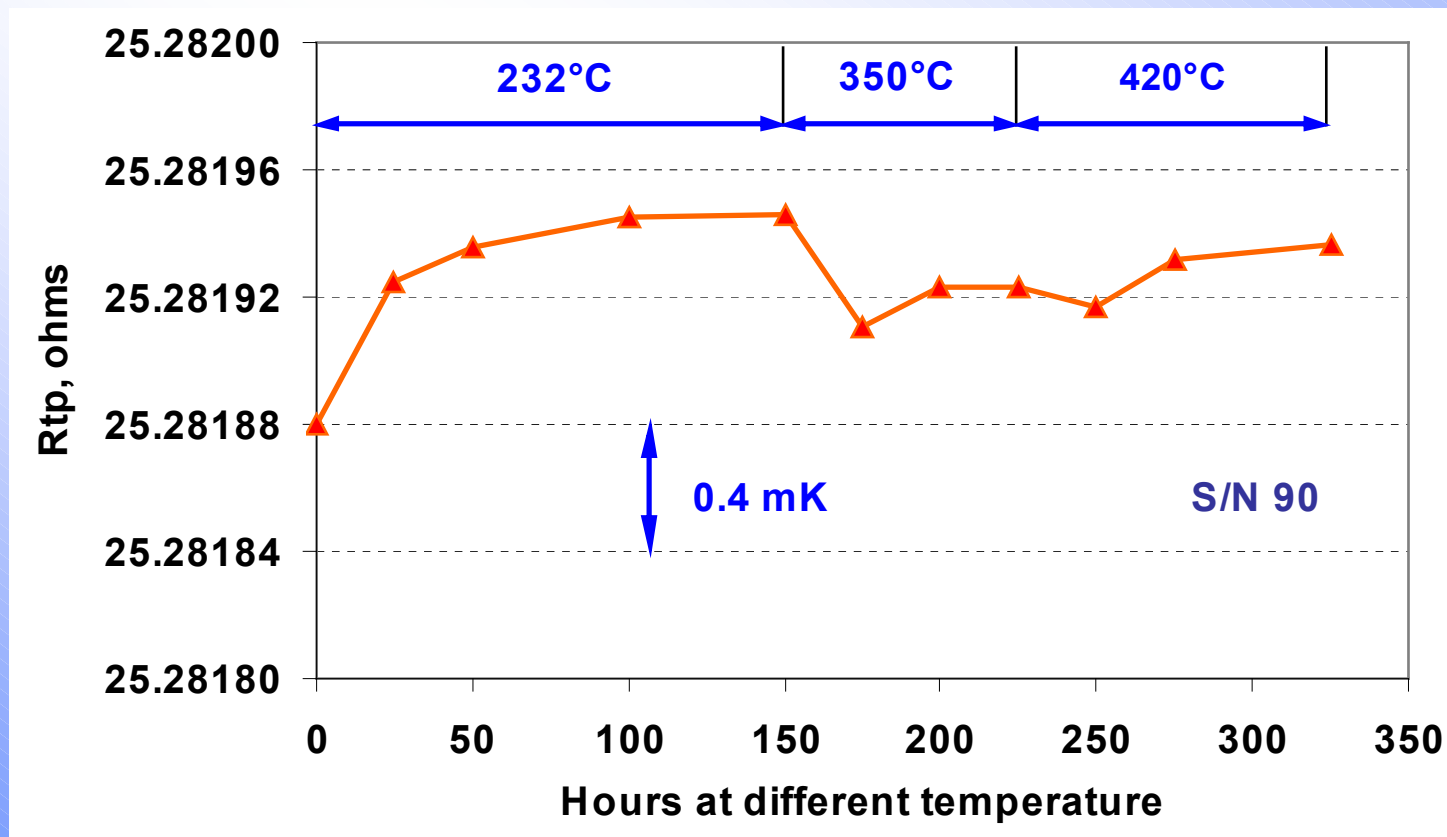
Rtp changes after exposure to 232°C for 16 hours during long-term at 675°C



Rtp changes after exposure at different temperatures from 232°C to 420°C

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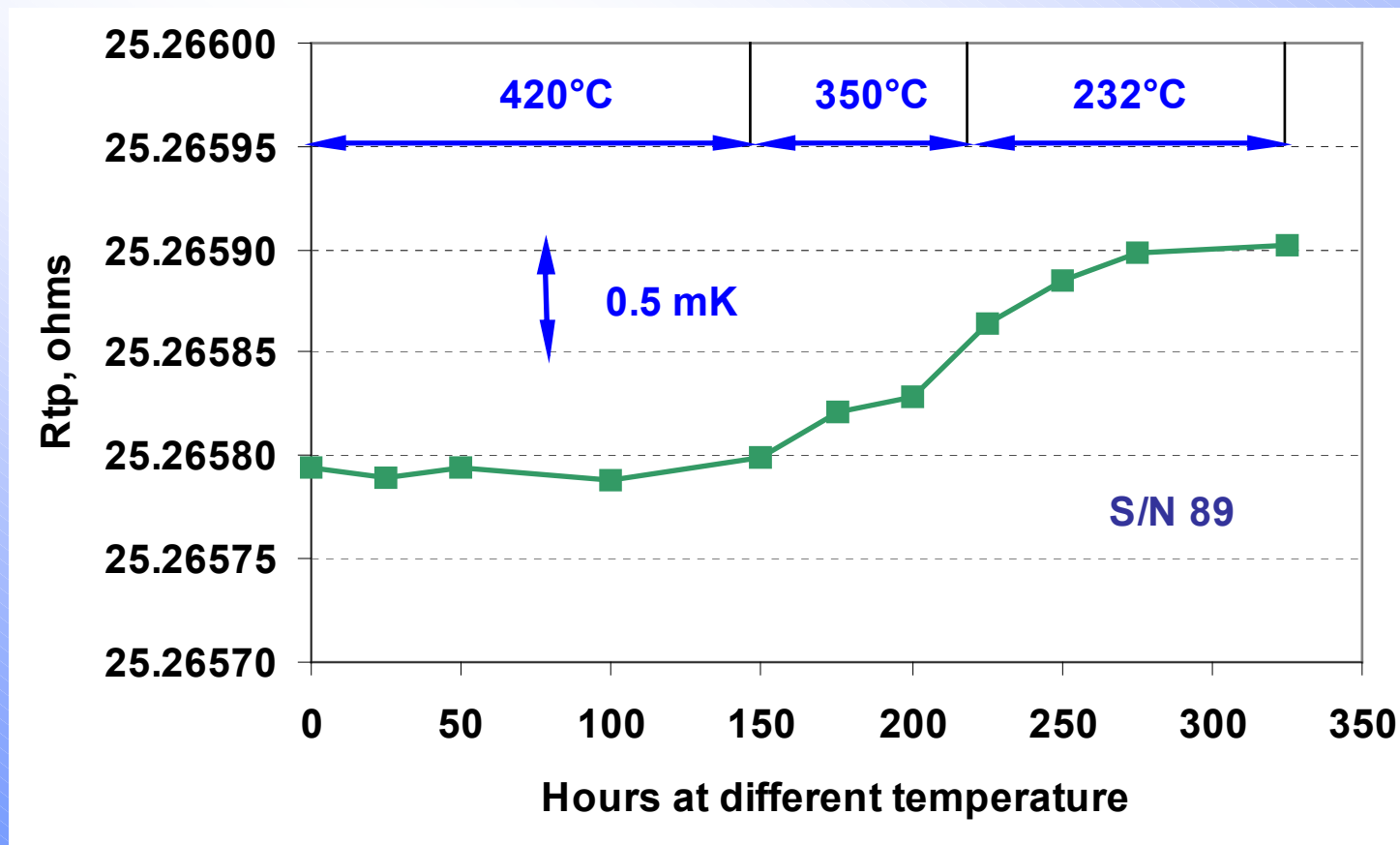
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Rtp changes after exposure at different temperatures from 420°C to 232°C

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Conclusion (1)

- **Loss of oxygen in an MSPRT sheath due to slow oxidation of metal was confirmed**
- **The stability of an MSPRT with an open element could be affected by oxidation and contamination, since the oxygen content in the thermometer can vary during operation**

Conclusion (2)

- **Using a sealed element may be a solution to resolve the conflict between oxidation and contamination**
- **Rtp and W(AI) stabilities of an MSPRT with a sealed element can be as good as 1 mK and 2 mK respectively after 1000h at 675°C**