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Temperature Control Recommendations

for solid material heating

Technical recommendation by Elektron-ETTO s.r.o.

This recommendation also applies to other types of heating. However, with contact heating of solid materials (conduction), it is common practice to operate at higher working temperatures with a requirement for relatively precise control. For these reasons, the correct method of temperature control has a significantly greater impact on the service life of heating elements than with the heating of liquids or gases.

1. Effect of control method on heating element service life

- **Long switching cycles (40–60 s)** cause repeated full expansion and contraction of the resistance wire. The result is high mechanical stress and progressive oxidation of the heating wire inside the heating tube, which shortens the service life.
- **Capillary and bimetallic thermostats** have an excessively large switching differential (hysteresis) and are not suitable for demanding applications requiring precise control and long service life.

2. Recommended solutions

To extend the service life of heating tubes and ensure precise temperature control, we recommend:

Electronic control with mechanical relay	ON/OFF or PID controller + mechanical relay. To extend the heating element's service life, we recommend switching times **under 10 s**. *Note: This is a compromise – at shorter cycles, the relay contacts wear out faster, but the heating element's service life is significantly extended. The mechanical relay should therefore be considered a wear part.*
SSR control (ideal solution)	Temperature control + **SSR (solid-state relay)** with controlled voltage in time intervals typically **0.1–1 s**. SSRs have no moving contacts, withstand hundreds of millions of switching cycles, and enable very short cycles without wear. This solution offers **the highest control accuracy** and **maximum heating element service life**.

3. Temperature sensor placement

Place the temperature sensor as close as possible to the heating tube – **maximum 10 mm**, ideally **2–3 mm**. A greater distance prolongs the controller's response, increases temperature fluctuations, and may cause overheating of the heating element before the controller can react.

4. Heating element sizing

For maximum service life, the heating element should operate at **approximately 80 % of its rated power** in steady-state operation. An undersized element constantly runs at maximum, leading to higher wire surface temperatures and accelerated oxidation. Oversizing, on the other hand, worsens control and increases switching frequency.

Summary

Control switching times	mechanical relay: **< 10 s** | SSR: **0.1–1 s**
Controller type	PID controller + SSR (ideal)
Not suitable	capillary and bimetallic thermostats
Sensor distance	max. **10 mm**, ideally 2–3 mm from the heating tube
Operating power	approx. **80 %** of the element's rated power

*If you have any questions regarding the choice of a suitable control system or the technical design of a heating element, please do not hesitate to contact us at **info@etto.cz** or **+420 581 626 366**.*