Integrated Melt-Stream Heating

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Integrated Melt-Stream Heating

Melt-stream heating technology evolutionary timeline

- ~ 1950: Mica band-heaters
- ~ 1960: Ceramic band-heaters
- ~ 1970: Insulating blankets
- ~ 2003 to now: Integrated Heating
  - Induction
  - Infrared

40+ years with minimal innovation

Conventional band-heaters
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Typical band-heater IR camera temperature profile

Band-heater heat flow illustration

Environment, $T_E$

Heat loss to environment, $Q_L$

Efficiency = $Q_P / (Q_P + Q_L)$

Heat transfer to process, $Q_P$

Heating element, $T_H$

Heater outer casing, $T_O$

Heater inner casing, $T_I$

Contact resistance, $R_C$

Process component, $T_P$
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Potential electricity cost savings from thermally insulating hot plasticating machine surfaces

For blended electricity rates from 5 to 20 cents/kW-hour and based on 8000 operating hours/year

Example:

Heat loss of 4.8 kW/m² (450 watt/ft²) of un-insulated surface, combined with an electricity rate of $0.10/kW-hr and 8000 hours of operation, translates to a significant thermal-insulating savings of $3900/m²/year ($360/ft²/year).
Plasma-spray application of heater coating

Integrated technology heat flow illustration

Efficiency $\approx 100\%$

$$Q_p / (Q_p + Q_L)$$

Heater coating, $T_H \approx T_P$

Heat transfer to process, $Q_p$

Thermal insulation

Process component, $T_P$

Environment, $T_E$
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Comparison of process temperature response

Standard Bayonet Thermocouple in Cylinder Wall

Temperature (°C)

Time (minutes)

Integrated Technology -- Insulated
Band-Heaters -- Uninsulated

Comparison of heater temperature response

Average of Four Thermocouples on Heater Surface

Temperature (°C)

Time (minutes)

Integrated Technology -- Insulated
Band-Heaters -- Uninsulated

- 90mm OD cylinder with 36mm ID (3.54” OD, 1.42” ID) with 38mm thick thermal insulation
- 23% less amperage, 30% faster to target, stabilizes 75% faster
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Comparison of heating uniformity

Band-heater IR camera temperature profile

Integrated heating IR camera temperature profile

90mm OD cylinder with 36mm ID (3.54” OD, 1.42” ID)
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Thermal cycling tests

Extreme testing to 1093°C (2000°F) with 40 watts/cm² (260 watts/inch²)
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Injection molding barrel with tightly wrapped thermal insulating sheet secured with standard Velcro straps

Transfer pipe with integrated heating technology
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Resin bonding and contamination tests

Stainless steel 15-amp threaded terminations

Low-profile connections with ring terminals and high-temperature (538°C/1000°F) hook-up wire
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Technical advantages of Integrated Melt-Stream Heating

- Eliminates heater-to-process contact resistance to minimize heater temperature elevation
- Prevents heater oxidation
- Virtually eliminates heater thermal inertia
- Ensures extremely uniform heating that never degrades or changes
- Provides a smooth contour that is easily wrapped with high-performance inexpensive insulation

Practical benefits of these technical advantages

- Extended heater life (design expectation is infinite life) for reduced downtime and maintenance
- Minimized temperature control response time for better process recovery and stability
- Improved process and product uniformity
- Maximized energy efficiency
- Improved operator safety