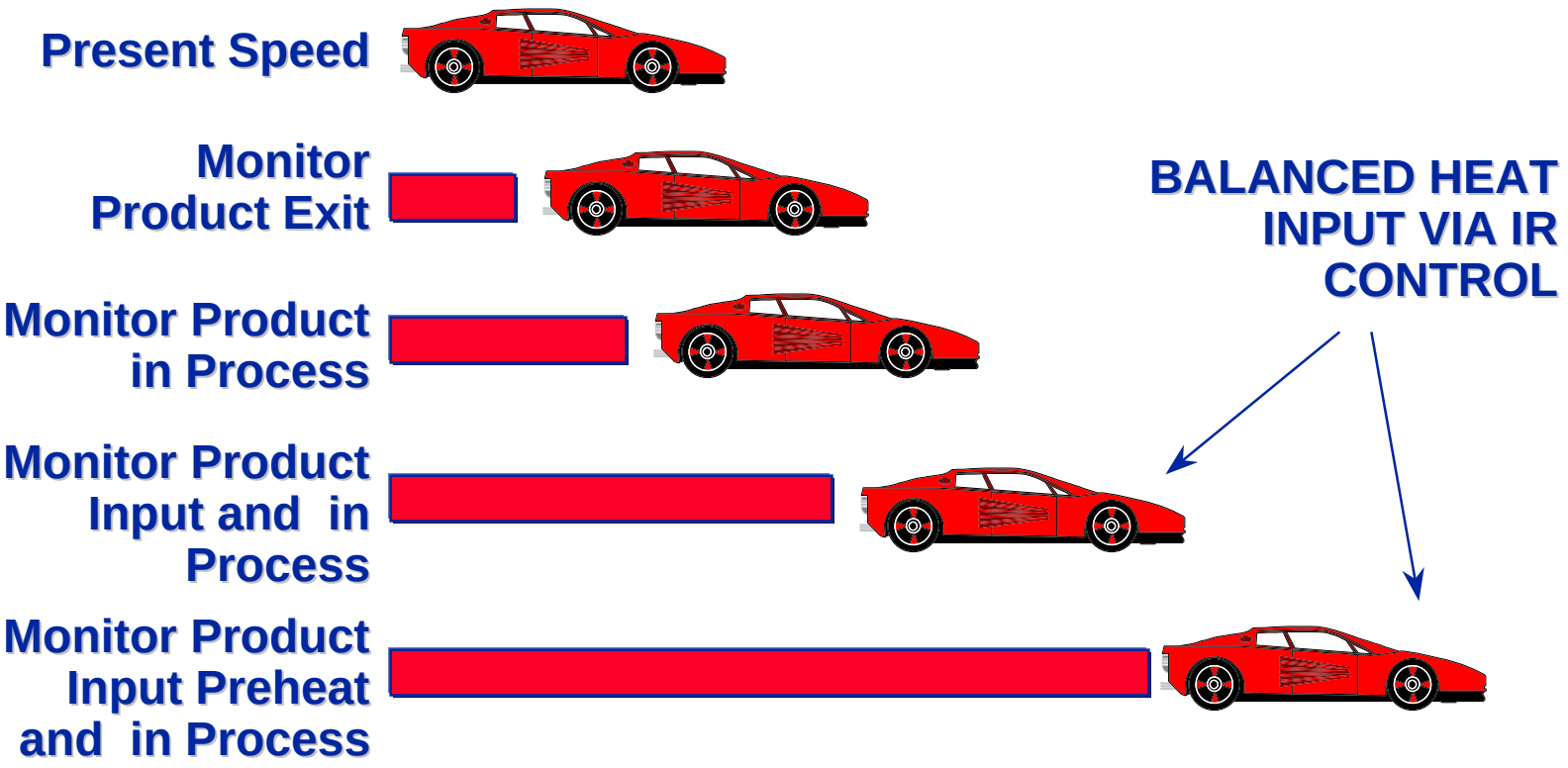
Increasing Production Speeds via Heat Balance Control With IR Sensing

From Fundamentals to Frontiers

EXERGEN CORPORATION

Speed Increase Stages



Increasing Production Speeds via IR -Controlled Heat Balance

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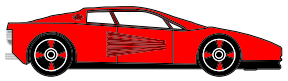
Speed Boost Equation

- General Equation for Non-Contact IR Temperature Monitoring of Internal Temperatures of Moving Materials is Combined with Surface Temperature
- Leads to Uniform Material Temperature When Controlled via the *Speed Boost Equation*
- Which Forces the Control System to Apply Heat at an Optimally *Balanced* Rate



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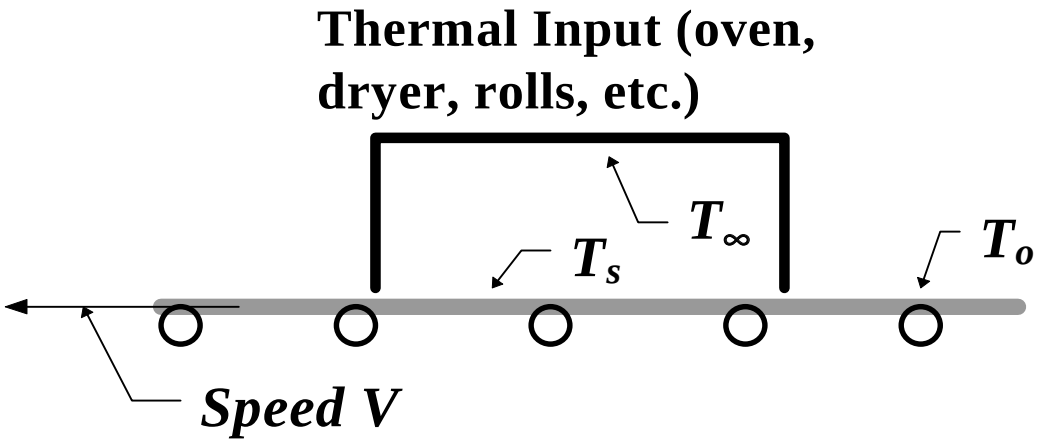
Speed Boost Equation

- **General Equation Reduces to:**

$$\frac{V_{new}}{V_{old}} = \frac{\left(\overline{\Delta T}\right)_{new}}{\left(\overline{\Delta T}\right)_{old}}, \quad where\ \overline{\Delta T} = \frac{T_\infty - T_s}{T_s - T_o}$$



Speed Boost Equation

$$\frac{V_{new}}{V_{old}} = \frac{\left(\overline{\Delta T}\right)_{new}}{\left(\overline{\Delta T}\right)_{old}}, \quad where\ \overline{\Delta T} = \frac{T_\infty - T_s}{T_s - T_o}$$

- **Above Can Be a Simplified Control Algorithm**

Product Surface - setpoint

$$T_\infty = \left(\overline{\Delta T} + 1\right)\left(T_s\right) - \left(\overline{\Delta T}\right)\left(T_o\right)$$

Heat Source Temperature

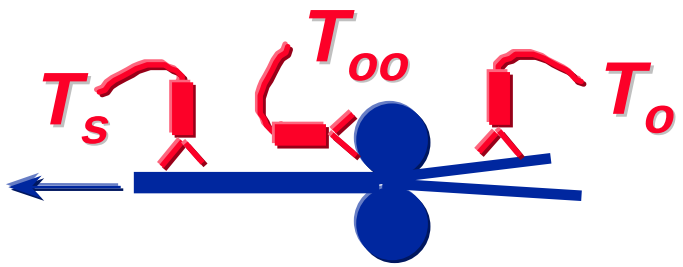
Control Loop Gain

Product Input

- **Keep Equation Balanced to Within a Few % to Avoid Non-Uniformity in Material Temperature**

Example Speed Boost: Laminating

- **Existing Set-up:**
  - T_{oo} = 105 C
  - T_s = 85 C
  - T_o = 25C
- **New Set-up:**
  - T_{oo} = 120 C
  - T_s = 85 C
  - T_o = 25C
- **Potential Speed Increase*:**
  - $\Rightarrow$ 25%



$$\overline{\Delta T} = \frac{T_\infty - T_s}{T_s - T_o}$$

*Assuming all other factors are permitting

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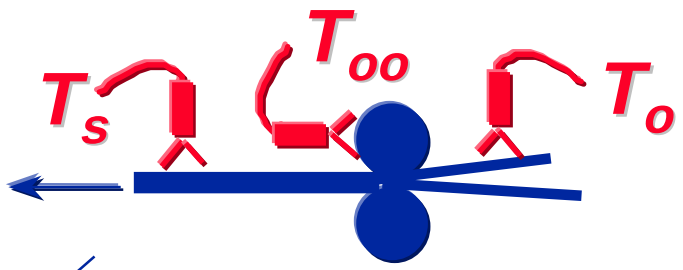
Example Speed Boost: Laminating

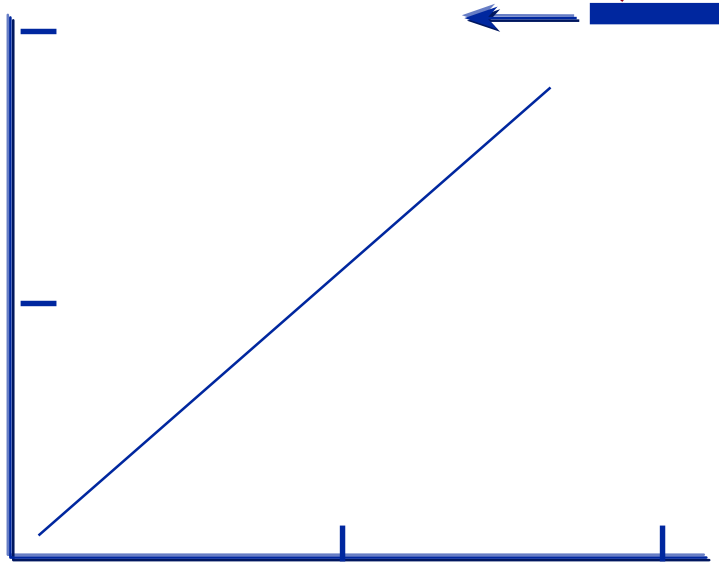


T

T

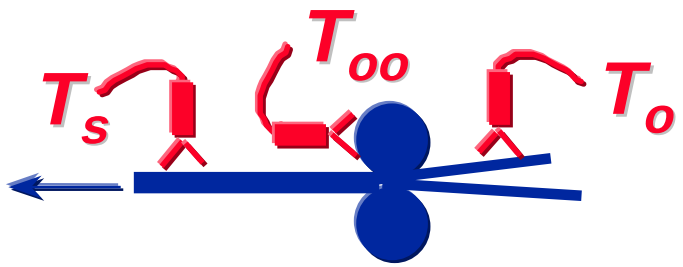
$$\overline{\Delta T} = \frac{T_\infty - T_s}{T_s - T_o}$$

% Increase



Example Speed Boost: Laminating

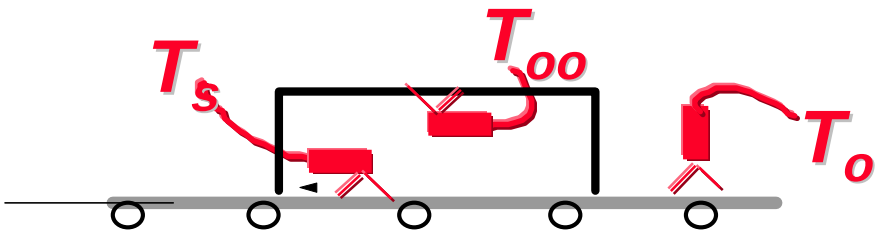
- **Existing Set-up:**
  - T_{oo} = 105 C
  - T_s = 85 C
  - T_o = 25C
- **New Set-up:**
  - T_{oo} = 120 C
  - T_s = 85 C
  - T_o = 25C
- **Potential Speed Increase*:**
  - $\Rightarrow$ 50%



$$\overline{\Delta T} = \frac{T_\infty - T_s}{T_s - T_o}$$

*Assuming all other factors are permitting

Example Speed Boost: Drying

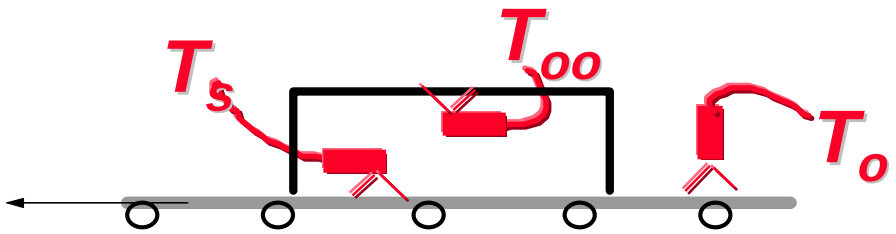


- **To Achieve 20% Production Speed Increase**

ratio $\Delta T = \dfrac{T_\infty - T_s}{T_s - T_o}$ **must increase by 20%**

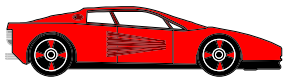
Example Speed Boost: Drying

- **Existing Set-up:**
  - T_{oo} = 260 C
  - T_s = 85 C
  - T_o = 25 C
- **New Set-up:**
  - T_{oo} = 260 C
  - T_s = 85 C
  - T_o = 40 C (with preheat)
- **Potential Speed Increase*:**
  - $\Rightarrow$ 38%

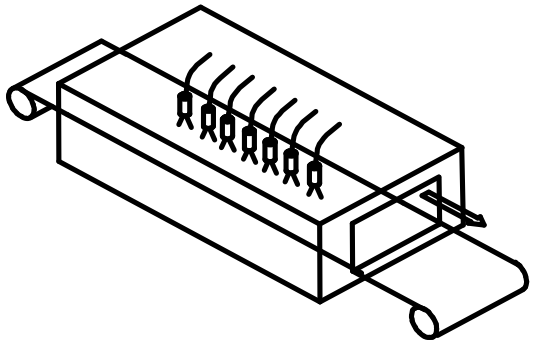


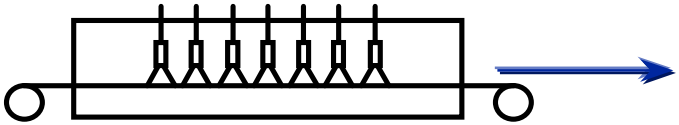
$$\overline{\Delta T} = \frac{T_\infty - T_s}{T_s - T_o}$$

*Assuming all other factors are permitting

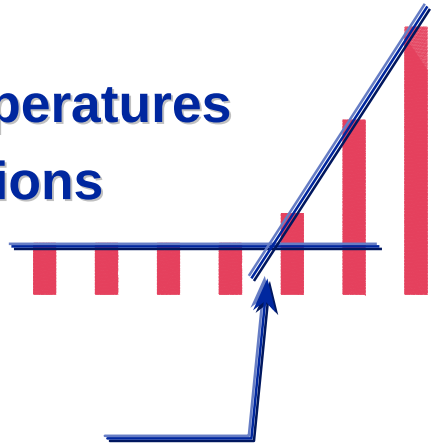


Precision Drying Control for Maximum Production Speed





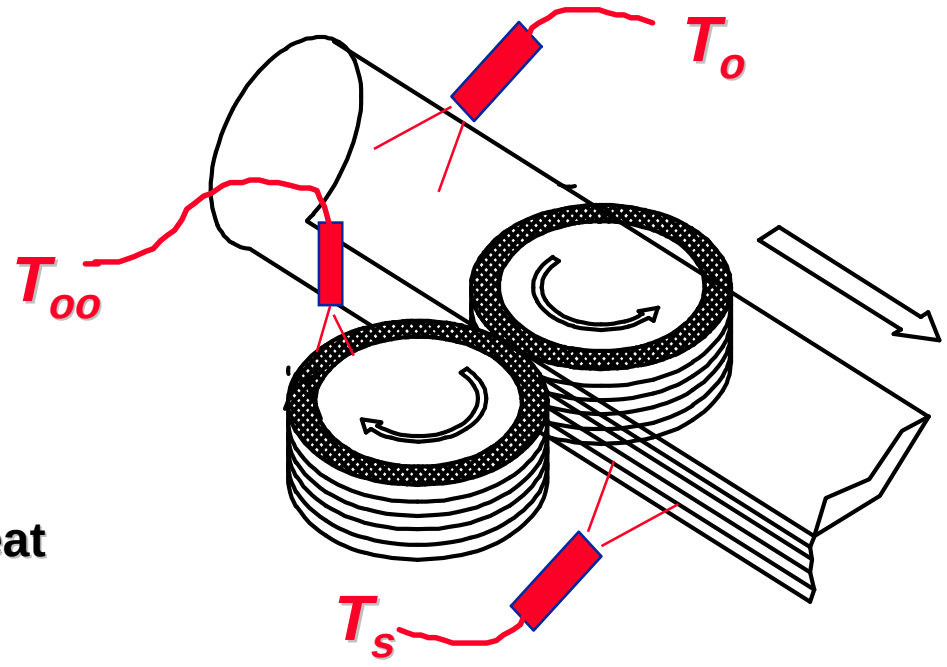
Relative Temperatures at IRt/c Locations



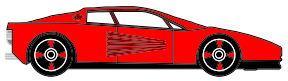
Dry-Out Point (Phase Change)

Example Speed Boost: Heat Sealing

- **Existing Set-up:**
  - T_{oo} = 150 C
  - T_s = 120 C
  - T_o = 25 C
- **New Set-up:**
  - T_{oo} = 150 C
  - T_s = 120 C
  - T_o = 45 C (with preheat added)
- **Potential Speed Increase:**
  - ⇒ 20%



$$\overline{\Delta T} = \frac{T_\infty - T_s}{T_s - T_o}$$



The Exergen Creed

We are the best in the world at what we do,

And our products and services must be commensurate with our mission of supplying our customers with the best,

To help them be the best in the world at what they do.

F. Pompei
President and Founder