



Figure 6.4. The constrained loss function  $L(d)$  versus a single adjustable, the thermal resistance  $R_T$ .

Note that the hard parameter constraint  $R_T \geq 1 \text{ K/W}$  is satisfied by  $R_T^*$ . From the equality constraint, this corresponds to an optimal feed rate of  $r^* = 14.1 \cdot 10^{-3} \text{ m/s}$ . In summary, the optimal design  $d^*$  is

$$d^* = (u^*, p^*) = \left( \begin{bmatrix} r^* \\ v^* \end{bmatrix}, \begin{bmatrix} R_T^* \\ C_T^* \\ R^* \\ c_p^* \\ \rho^* \\ \delta^* \end{bmatrix} \right) \approx \left( \begin{bmatrix} 14.1 \cdot 10^{-3} \text{ m/s} \\ 24 \text{ V} \end{bmatrix}, \begin{bmatrix} 13.0 \text{ K/W} \\ 0.5 \text{ W} \cdot \text{s/K} \\ 20 \Omega \\ 1590 \text{ J/(kg} \cdot \text{K)} \\ 1240 \text{ kg/m}^3 \\ 1.75 \cdot 10^{-3} \text{ m} \end{bmatrix} \right).$$

This corresponds to a locally optimal output of

$$y^* = f(d^*) = \begin{bmatrix} T^* \\ r^* \\ t_C^* \end{bmatrix} \approx \begin{bmatrix} 200 \text{ K} \\ 14.1 \cdot 10^{-3} \text{ m/s} \\ 32.5 \text{ s} \end{bmatrix}.$$

If, in the loss function  $L$ , we had weighted the cooldown time  $t_C$  more, then  $t_C^*$  would have been shorter and  $r^*$  would have been slower. This type of tradeoff among soft constraints is common.

It is possible that another design with another set of input variables and parameters could achieve a lower loss than  $L(d^*) = 4.21$ . However, we have achieved an optimal design  $d^*$  given the single design set given here.

## 6.2 Representing Design Constraints

6.8  Presenting Design Problems  
N8  
v1 

6.8  Presenting Design Problems  
UF  
v1   
RT  
v1 