Cartridge-Heater Design

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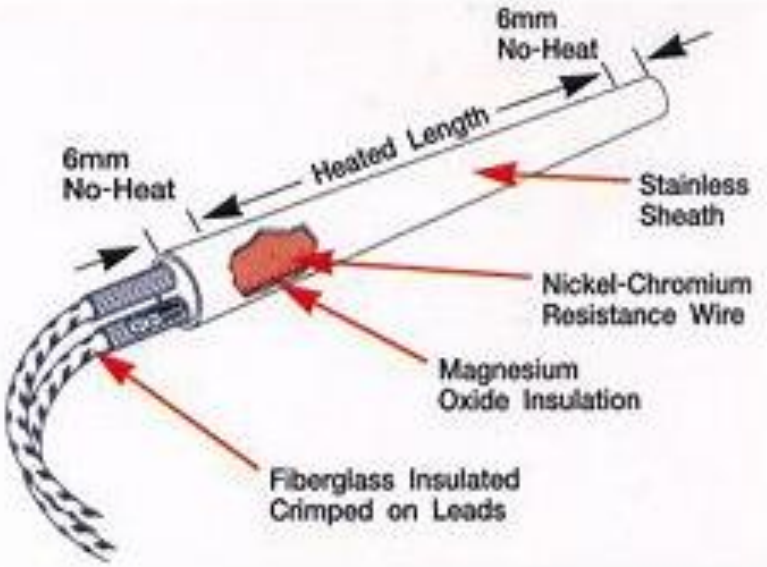
What is the Cartridge-Heater?



- Product Explanation
- Characteristics
- Use

How to design the Cartridge-Heater?

Step1 : Project/Problem Statement

Step2 : Data and Information Collection

Step3 : Identification/Definition of Design Variables

Step4 : Identification of a Criterion to Be Optimize

Step5. Identification of Constraints

Project/Problem Statement

- Minimize the Cartridge-Heater
- Cartridge-Heater is a cylinder
- Steady-State condition
- 1-Dimensional
- Constant Properties
- Negligible radiation effects

Data and Information Collection

- k=thermal conductivity of the material
- h=convection heat transfer coefficient
- q: heat generation rate per unit volume
- W: electric power
- p(min): minimun electric power density
- p(max): maximum electric power density
- T∞: air temperature

Data and Information Collection

Theory1 $$\text{e. power density} = \frac{W}{\pi \times r \times (L - 0.015)}$$

Theory2 $$T(r) = \frac{\dot{q} r_0^2}{4k}\left(1 - \frac{r^2}{r_0^2}\right) + T_s$$

Theory3 $$T_s = T_\infty + \frac{\dot{q} r}{2h}$$

Identification/Definition of Design Variables

- r: radius of the Heater
- L: the length of the Heater

Identification of Constraints

$$g_1 : \frac{W}{2\pi r(L - 0.015)} - p_{min} \leq 0$$

$$g_2 : -\frac{W}{2\pi r(L - 0.015)} + p_{max} \leq 0$$

$$g_3 : \frac{qr}{2h} + T_\infty - T_s \leq 0$$

$$g_4 : \frac{qr^2}{4k} + \frac{qr}{2h} + T_\infty - T_0 \leq 0$$

$$g_5 : -r + 0.01 \leq 0$$

$$g_6 : -L + 10r \leq 0$$

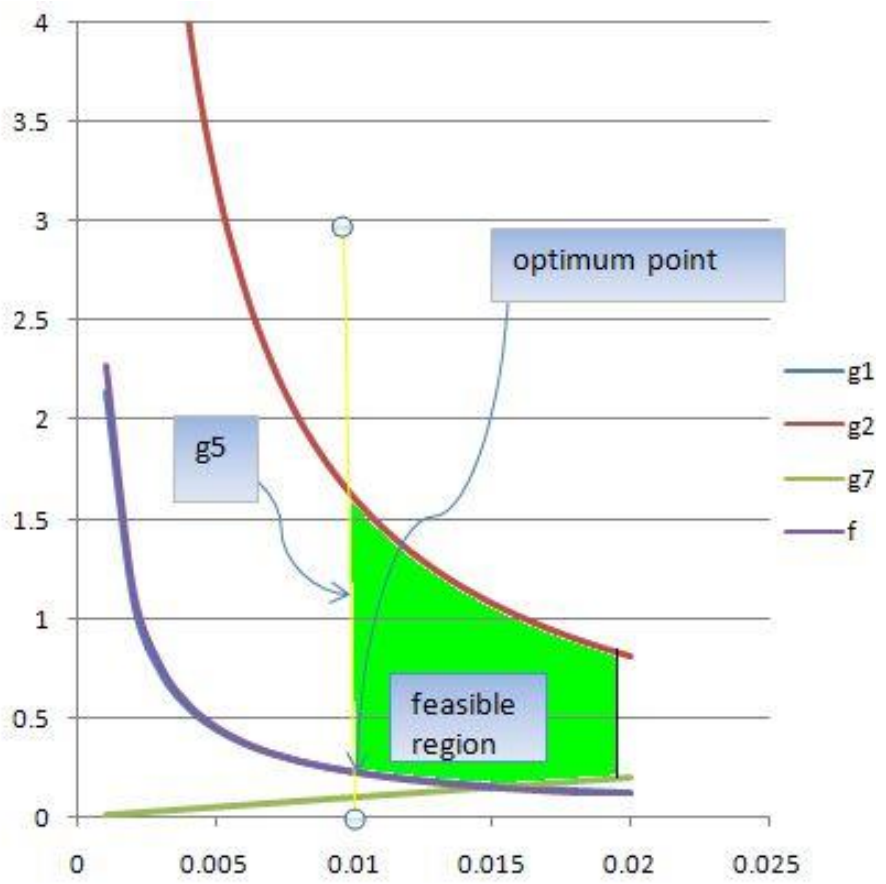
Solution of the project

- V=pi*r^2*L

Minimize the Volume of the Heater,

r =0.01m

L =0.2272m



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