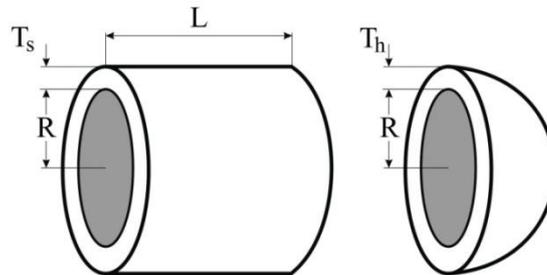


PRESSURE VESSEL DESIGN CASE STUDY

This well known optimization case study considers design of a pressure vessel that has to have a given working pressure and volume. The goal is to design a pressure vessel so as to minimize the total cost, including the cost of the material, forming and welding. Design a pressure vessel considers four variables:

- thickness of the shell (T_s) - discrete variable (integer multiples of 0.0625 in),
- thickness of the head (T_h) - discrete variable (integer multiples of 0.0625 in),
- inner radius (R) - continuous variable, and
- head length (L) - continuous variable.



Pressure vessel design variables

After considering geometric constraints and other pressure vessel requirements, mathematical formulation of the pressure vessel design optimization problem is:

$$\begin{aligned} \text{Minimize: } f &= 0.6224 \cdot T_s \cdot R \cdot L + 1.7781 \cdot T_h \cdot R^2 \\ &+ 3.1661 \cdot T_s^2 \cdot L + 19.84 \cdot T_h^2 \cdot L \\ \text{Subject to: } g_1 &= -T_s + 0.0193 \cdot R \leq 0 \\ g_2 &= -T_h + 0.00954 \cdot R \leq 0 \\ g_3 &= -\pi \cdot R^2 \cdot L - \frac{4}{3} \cdot \pi \cdot R^3 + (750 \cdot 1728) \leq 0 \\ 0.0625 &\leq T_s, T_h \leq 99 \cdot 0.0625 \\ 10 &\leq L, R \leq 200 \end{aligned}$$

SOLUTION

The pressure vessel design optimization problem was solved while considering the following search steps:

- x1: [0.0625 , 6.1875] step 0.0625
- x2: [0.0625 , 6.1875] step 0.0625
- x3: [10 , 200] step 1
- x4: [10 , 200] step 1

In BRUTOMIZER© the calculation of all 357550281 possible combinations lasted 30 sec and the determined optimization solution and calculated constraints were obtained as follows:

x1	x2	x3	x4	Objective	g1 <= 0	g2 <= 0	g3 <= 0
0.8125	0.4375	42.0000	178.0000	6074.99836015625	-0.00189999	-0.03682	-774.04917826596

Note that the best known optimization solution $f=6059.714335$ can be reached in BRUTOMIZER© after repeating a few optimization searches while diminishing search steps for design variables:

x1	x2	x3	x4	Objective	g1 <= 0	g2 <= 0	g3 <= 0
0.8125	0.4375	42.0984455958549	176.636595842424	6059.71433504808	-4.443E-16	-0.0358808290155443	-4.66E-10