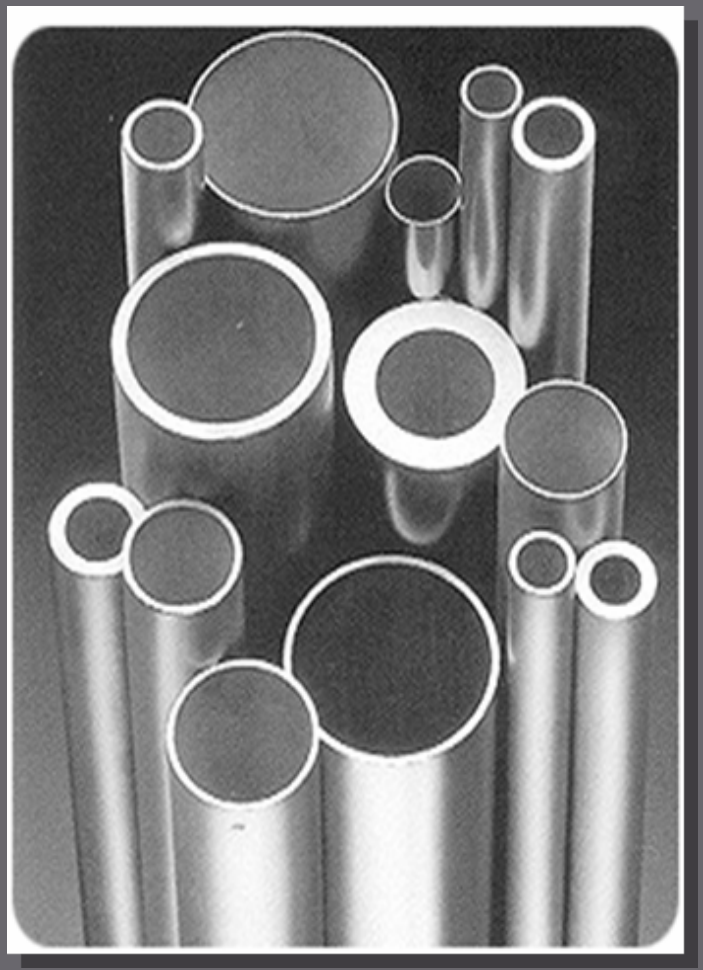
ECONOMICAL DESIGN OF BOILER PIPE

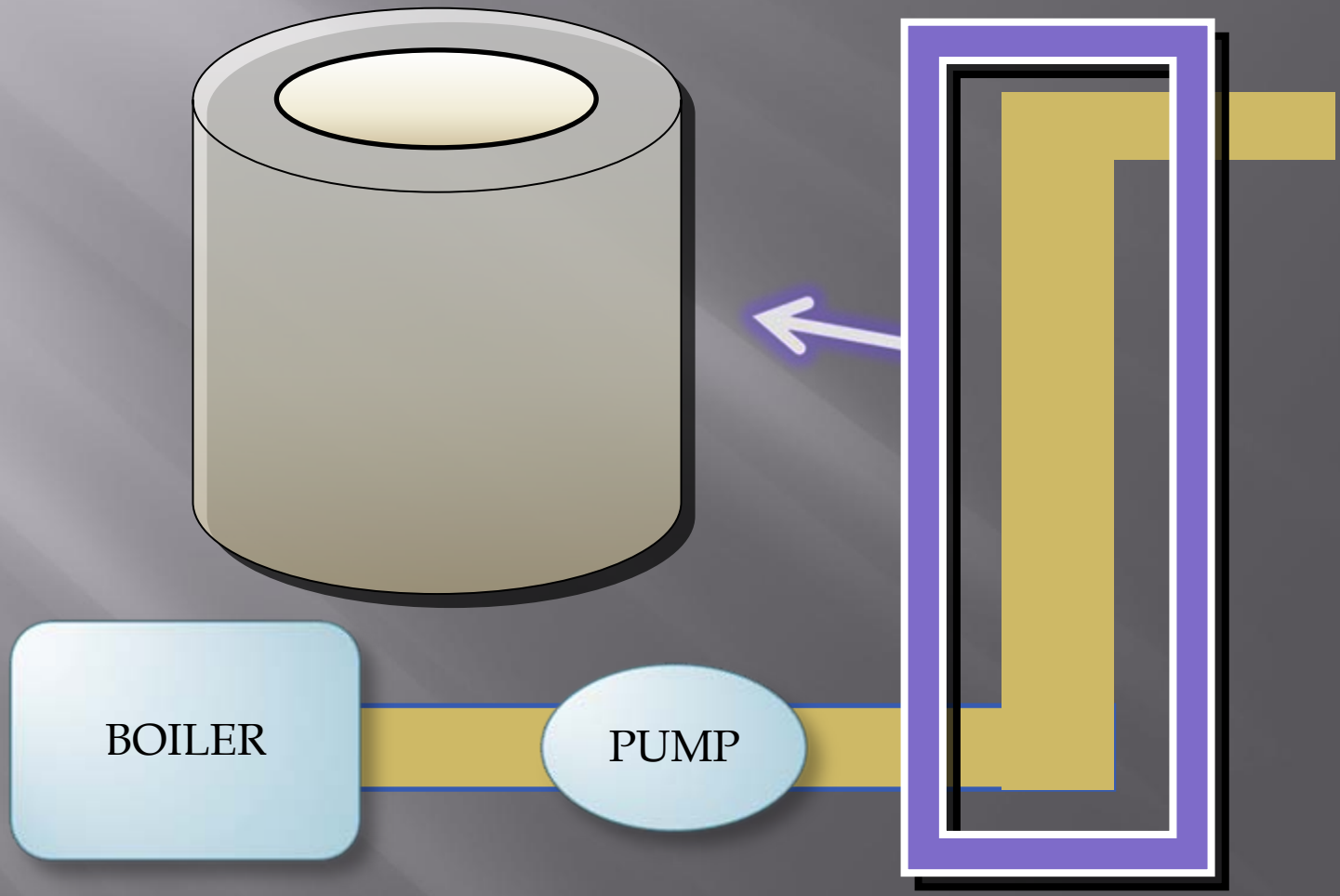


조 이름 :

Opti-dea

2003006449 최경민
2003007475 염동진
2003008122 오세혁

SIMPLIFICATION



Formulation of Project #1

Step 1. Project Statement

- 아파트 20층 보일러 온수 공급주관
- 주관은 일반적으로 사용하는 탄소강관(KS D 3562)
- 주관의 가격은 재질의 부피, 유체의 손실과 관련
- 주어진 구속 조건을 충족하는 보일러 주관
- 가격 효율 비 최적화

Formulation of Project #2

Step 2. Data and Information Collection

1. Darcy-Weisbach Equation – by Fluid Mech.

$$z_1 + \frac{p_1}{\gamma} + h_s + \frac{v_1^2}{2g} = z_2 + \frac{p_2}{\gamma} + h_L + \frac{v_2^2}{2g}$$

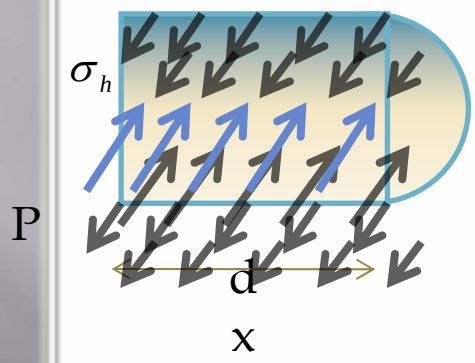
$$h_L = f \frac{L}{D} \frac{v^2}{2g} + K_L \frac{v^2}{2g}$$

$$f = \frac{0.3164}{N_{RE}^{1/4}} \qquad (N_{RE} \le 10^5)$$

$$f = 0.0032 + \frac{0.221}{N_{RE}^{0.237}} \qquad (10^5 \le N_{RE} \le 3 \times 10^6)$$

Formulation of Project #3

2. Von – Mises criterion – by Mech. Of Materials

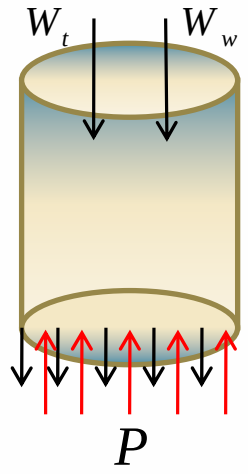


$$\sigma_1 = \sigma_h = \frac{PD}{2t}$$

$$P_{\max} \times \frac{\pi D^2}{4} - \sigma\pi\left(D+t\right)t - W_w - W_p$$

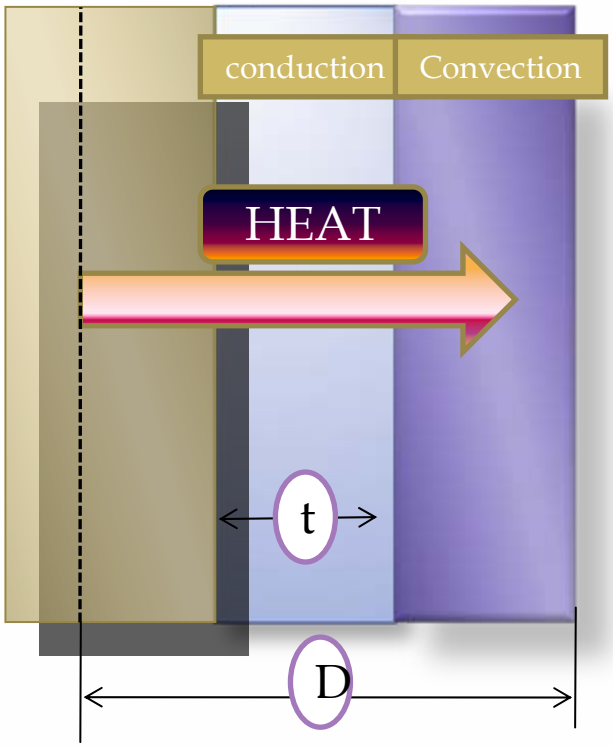
$$\sigma_2 = \sigma_a = \frac{D^2}{4t\left(D+t\right)}\left(P_{\max} - \gamma_w \ell\right) - \rho_p g \ell$$

$$\frac{S_y}{N} \geq \sqrt{\sigma_1^{\,2} + \sigma_3^{\,2} - \sigma_1 \sigma_3}$$



Formulation of Project #4

3. Heat Transfer Equation – by Heat Transfer.



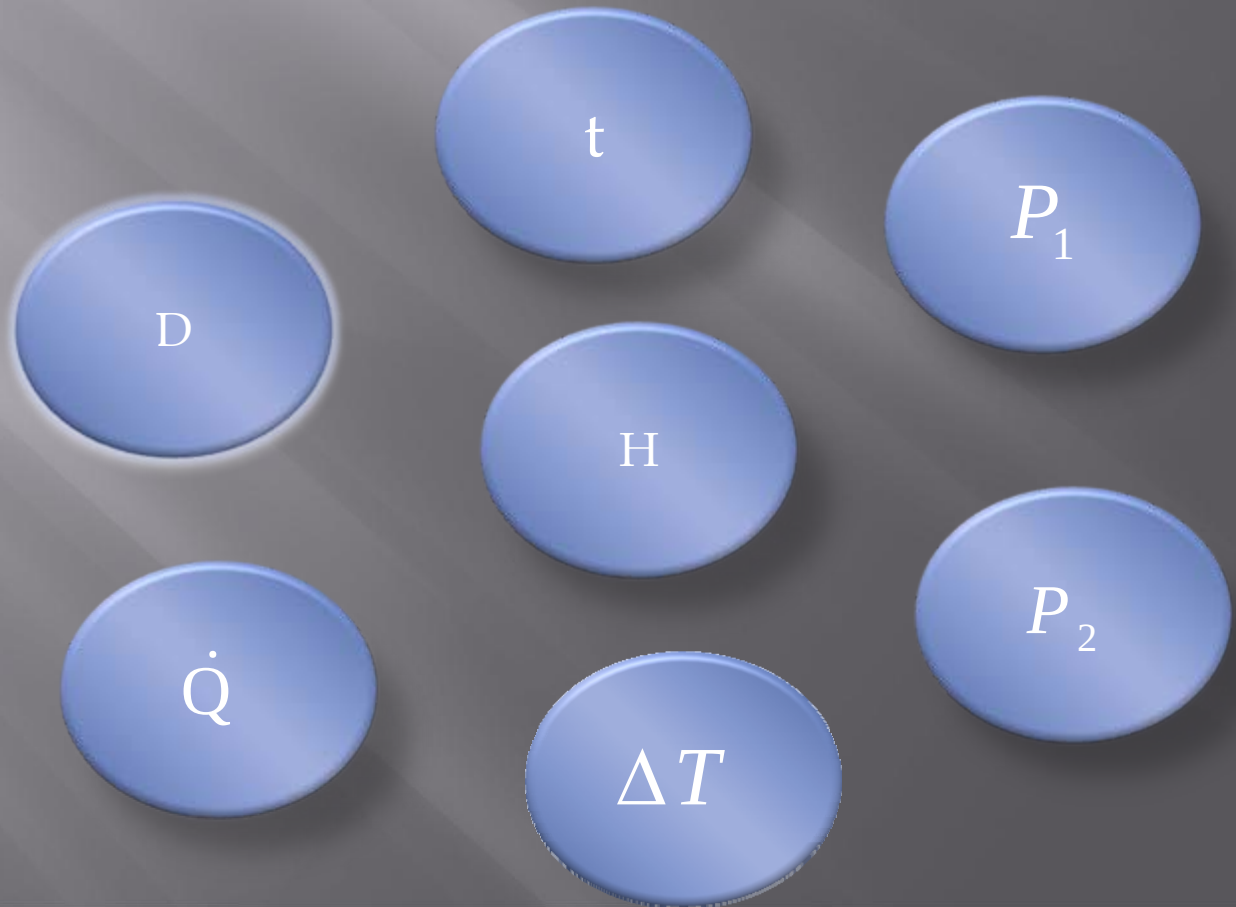
$$\dot{Q} = -kA\frac{dT}{dx}, \dot{Q} = hAdT$$

$$\dot{Q} = \frac{1}{\frac{\ln(\frac{D+2t}{D})}{2\pi kL} + \frac{1}{2\pi(D+2t)Lh}}$$

$$\Delta T = \frac{\dot{Q}}{\rho C_p Q} \le T_{allow}$$

Formulation of Project #5

Step 3. Identification of Design Variable



Formulation of Project #6

Step 4. Identification of a Criterion to Be Optimized

$$f = \frac{\text{유효가격}}{\text{공급가격}} = \frac{\left(C_p \rho_w Q \Delta T - \dot{Q}\right) \mathrm{t} \times \alpha}{a \rho_p \pi (D+t) t \ell + C_p \rho_w Q \Delta T \times \mathrm{t} \times \alpha}$$

유효공급연료비

총공급연료비

초기설치비

$$\alpha = \left| \frac{won}{Jule} \right| = 3.05 \times 10^{-6} won / Jule$$

a : 강관가격/질량

Formulation of Project #7

Step 5. Constraint.

- $g_1 : (z_2 - z_1) - H + h_L + 60 \le 0$

$$h_{1-1} = 7.783(10^{-4})\frac{Q^{1.75}}{D^{4.75}} + 0.0879\frac{Q^2}{D^4} \quad (\text{at } \frac{Q}{D} \le 0.0786)$$

$$h_{1-2} = \frac{Q^2}{D^5}\left[2.644(10^{-4}) + 6.527(10^{-4})\left(\frac{D}{Q}\right)^{0.237}\right] + 0.0879\frac{Q^2}{D^4}$$

$$(\text{at } 0.0786 \le \frac{Q}{D} \le 2.357)$$

- $g_2 : \sqrt{\sigma_1^2 + \sigma_2^2 - \sigma_1\sigma_2} - 33.33(10^6) \le 0$

- $g_3 : \dfrac{22600(D + 2t)\Delta T}{(D + 2t)\ln\left(\dfrac{D + 2t}{D}\right) + 8} - 1 \le 0$

Formulation of Project #8

Step 5. Constraint.

- $g_4 : 0.393D^2 - Q \le 0$
- $g_5 : Q - 1.571D^2 \le 0$
- $g_6 : -D \le 0$
- $g_7 : -t \le 0$
- $g_8 : -Q \le 0$
- $g_9 : -P_{1,2} \le 0$
- $g_{10} : -H \le 0$

$$h : Q = VA \rightarrow V = \frac{Q}{A} = \frac{4Q}{\pi D^2} = 1.273\frac{Q}{D^2}$$

Estimate by Matlab

GRAPHIC METHOD