Optimization of the #of Heat Sink Fin

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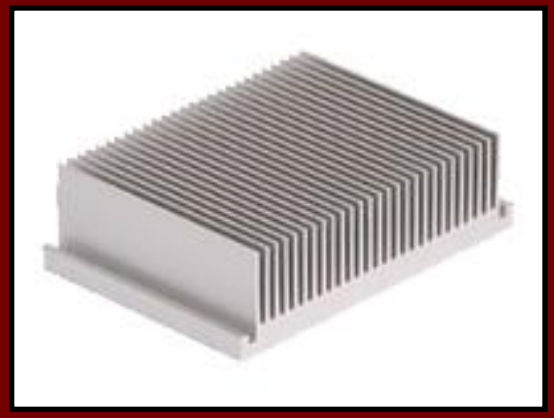
Contents

Problem Statement

http://www.dansdata.com/images/c3ezra/viasink220.jpg

- Design a heat sink in Natural convection



http://www.amatteroffax.com/images/inventoryimages/691916.JPG

- Heat sink must have the highest heat transfer rate (more than 100W)

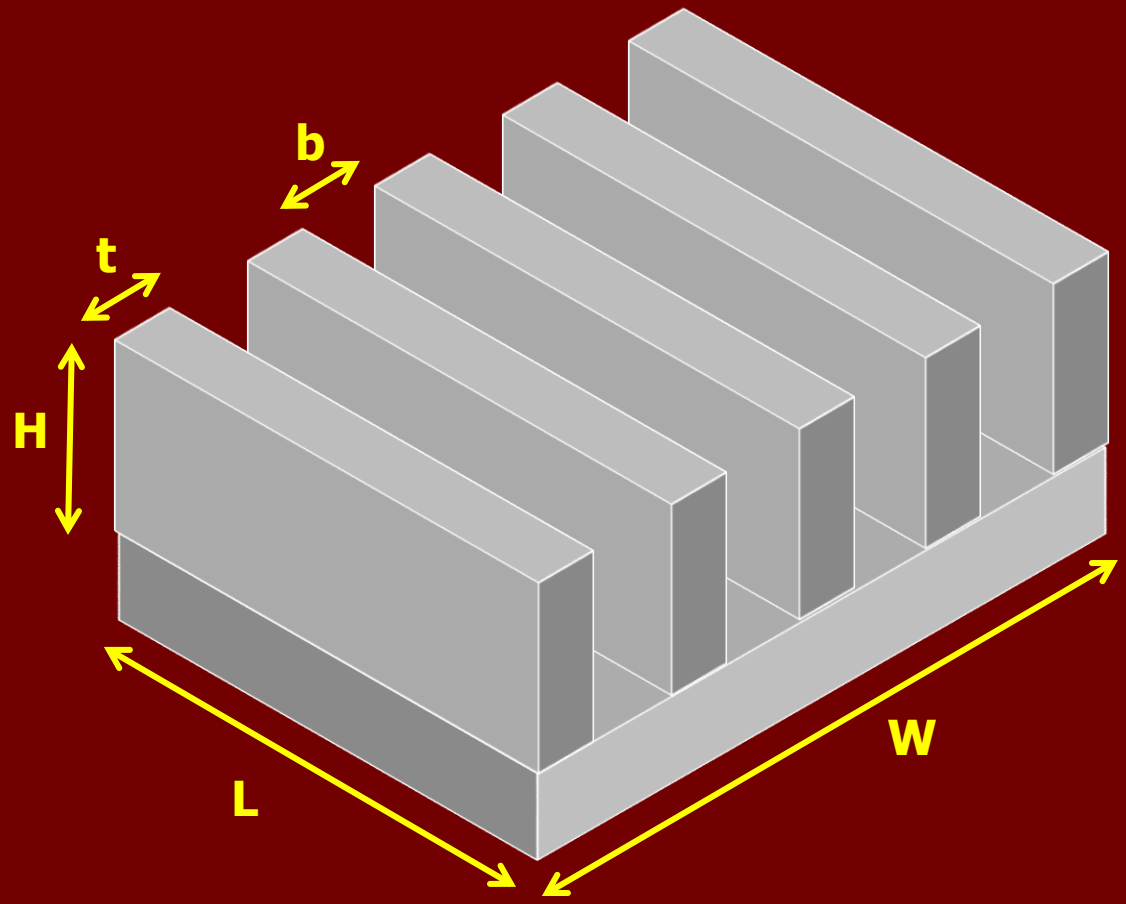
Problem Statement

- Assumption

1. The heat-sink has rectangular fins.
2. Total area of the plate is fixed.
3. $T_s = 75\,^{\circ}C$, $T_\infty = 25\,^{\circ}C$
4. The heat-sink is fixed for vertical direction.
5. The heat transfer through fin tip is negligible.
6. The heat-sink is made by aluminum(6063 or 6061).
7. Use ‘bilitzky correlation’

Problem Statement

- Drawing of Heat sink



Data and Information Collection

Parameters		Value
Height of fin	H	35 mm
Thickness of fin	t	1 mm
Width of plate	W	225 mm
Length of plate	L	200 mm
Pr	Pr	0.7
$\Delta T = T_s - T_\infty$	ΔT	50°C
Thermal conductivity	k	0.028W/m°C
Thermal expansion	β	0.0031 $°C^{-1}$
Kinematic viscosity	ν	18.4×10^{-6} ㎡/sec

Data and Information Collection

Parameters		Value
hydraulic radius	r	2*((b+2*H)*L)/(2*(b+2*H+L))
Aspect ratio	a	b/H
El_r		(g*β*Pr*ΔT*b^4)/(ν^2*r/Pr)
유차원 상수	B	1.25*(1+b/(2*H))
Λ_1		$1-0.483e^{-0.17/a}$
Λ_2		$1-e^{-0.83a}$
Λ_3		$9.14a^{1/2}e^{-B}-0.61$
ψ_B		$\frac{24\Lambda_1}{\left[(1+B/2)(1+\Lambda_2\Lambda_3)\right]^3}$
Nu_f		$\frac{El_r}{\psi}\left[1-\theta^{-\psi(0.5/El_r)^{3/4}}\right]$
Coefficient of heat transfer	h	Nu_f*k/b

Data and Information Collection

$$Nu_f = \frac{hL_c}{k}$$ heat sink에서의특성길이 L_c; 핀사이거리

Bilitzky correlation

$$Nu_f = \frac{El_r}{\psi}\left[1 - \theta^{-\psi(0.5/El_r)^{3/4}}\right]$$

geometric parameter

$$\Psi_B = \frac{24\Lambda_1}{\left[(1 + a/2)(1 + \Lambda_2\Lambda_3)\right]^3} \text{ where } a = \frac{b}{H} = \frac{\text{핀사이거리}}{\text{핀높이}}$$

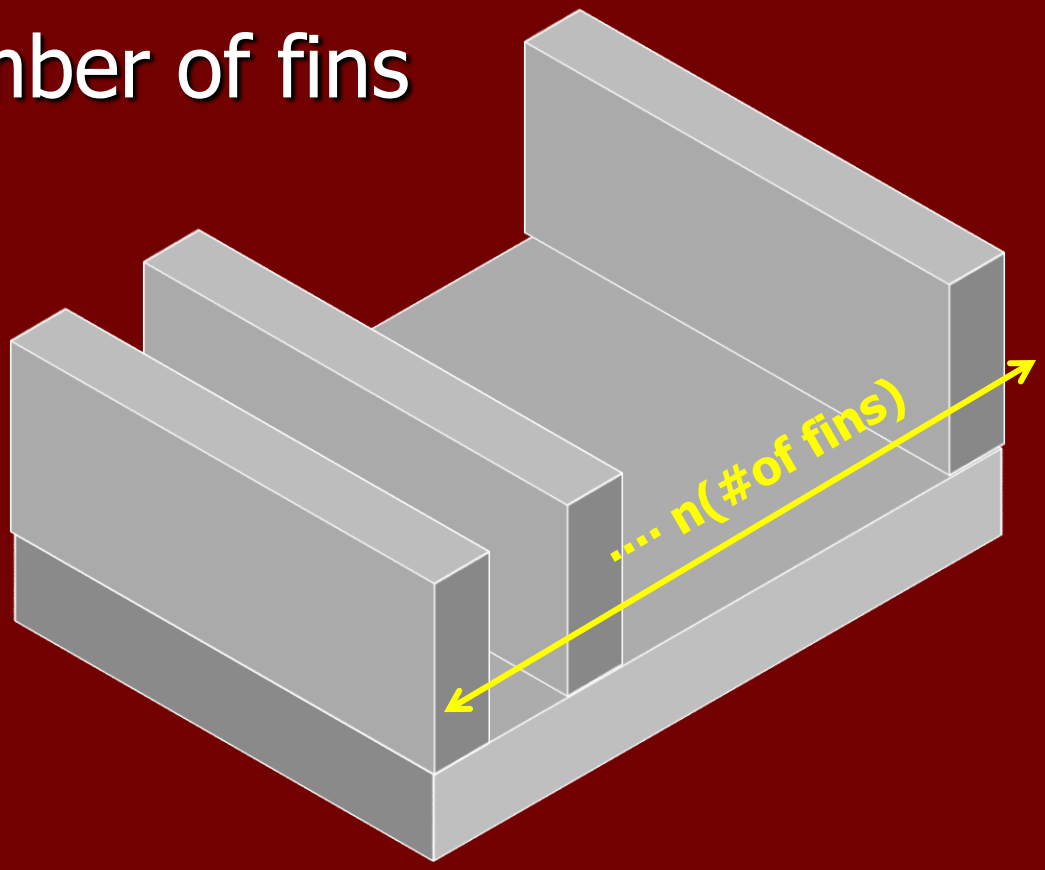
$$Nu_f = \frac{hL_c}{k} \text{ - > } h = \frac{Nu_f k}{L_c}$$

$$\dot{Q} = hA(T_s - T_?) = h(2nHL)(T_s - T_?)$$

Identification/Definition of Design Variables

- Variable

n : number of fins



Identification of a Criterion to Be Optimized

- The heat transfer(열전달량)

$$f(n)=h(\mathbf{n})\times 2(\mathbf{n}\times H\times L)\times \Delta T$$

Identification of Constraints

- 1. g1 : Fin Cost ≤ 3000원

  g1 : **n*** (3200원/kg)*t*H*L(2670kg/m^3)

  ≤3000원

(*출처 : 원자재정보시스템원자재 키로 당 가격
250*200 방열판 핀 재료값 reference방열판에 관한
기술개발 및 사업화 결과보고서 from 한국산업기술평가원)

- 2. g2 : Fin heat transfer ≥ 100Watt

  g2 : h × 2(**n** × H × L) ×ΔT ≥ 100

Use of Excel Solver for Optimization

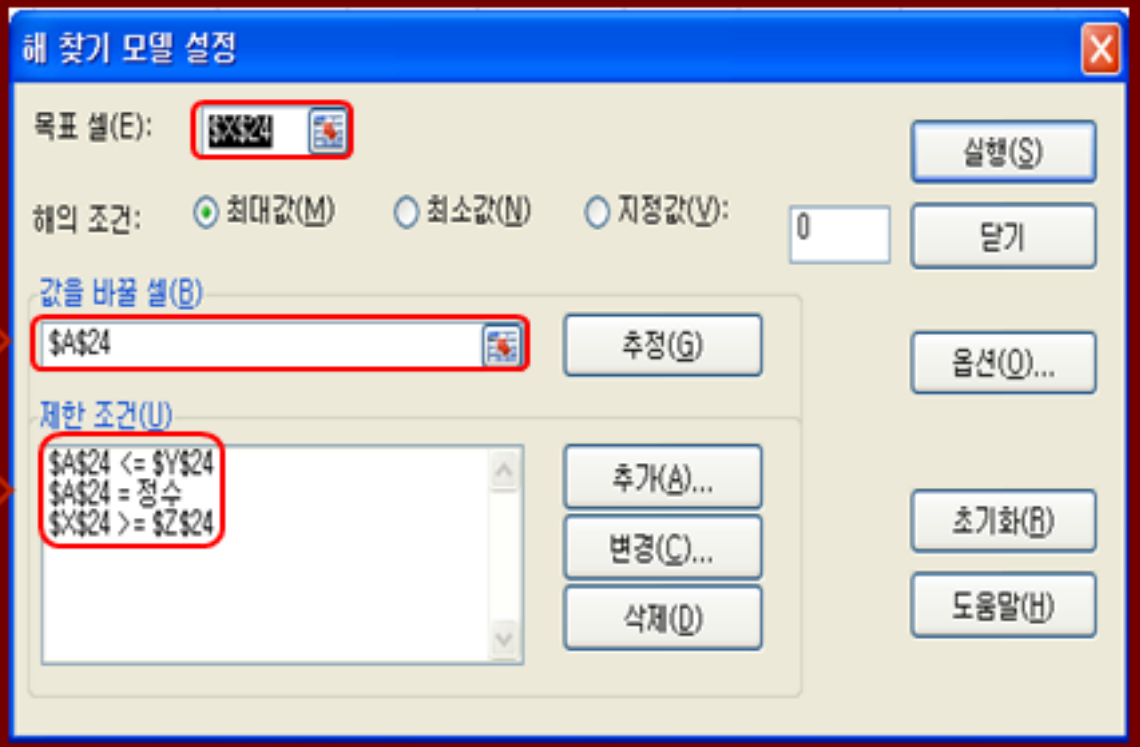
1	방열판의 형상, 공기의 물성치, 가동조건										
2											
3	핀수(n)	fin 높이(H)	fin두께(t)	plate폭(W)	plate길이(L)	fin사이의거리(b)	Pr수	중력(g)	온도차(ΔT)	열전도계수(k)	열팽창계수(β)	동점성계수(υ)
4	2	0.035	0.001	0.225	0.2	0.111500	0.7	9.81	50	0.028	0.0031	1.84E-05
				225	0.2	0.044000	0.7	9.81	50	0.028	0.0031	1.84E-05
				225	0.2	0.021500	0.7	9.81	50	0.028	0.0031	1.84E-05

	f	g1	g2
핀수(n)	총열전달(q)	3000원 경우의 n	기준방열량
2	9.09	50.16051364	100
5	24.31	50.16051364	100
10	50.38	50.16051364	100
15	76.41	50.16051364	100
20	101.67	50.16051364	100
25	125.08	50.16051364	100
30	145.07	50.16051364	100
35	159.62	50.16051364	100
40	166.68	50.16051364	100
45	164.73	50.16051364	100
50	153.66	50.16051364	100
55	135.30	50.16051364	100
60	113.13	50.16051364	100
65	91.02	50.16051364	100
70	71.74	50.16051364	100
75	56.28	50.16051364	100
80	44.32	50.16051364	100
85	35.09	50.16051364	100
90	27.92	50.16051364	100
95	22.29	50.16051364	100
100	17.83	50.16051364	100

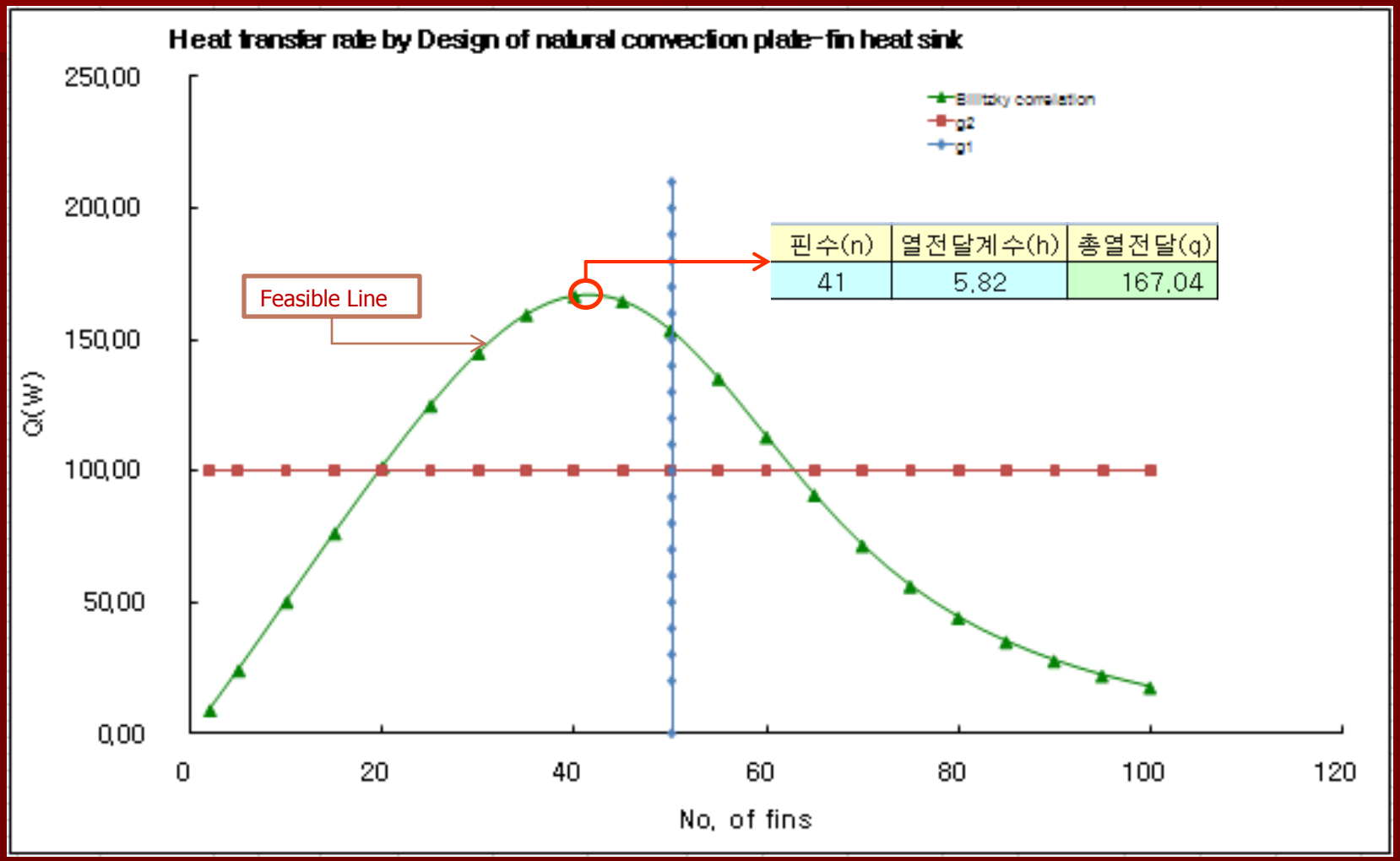
열 전달률

핀 개수

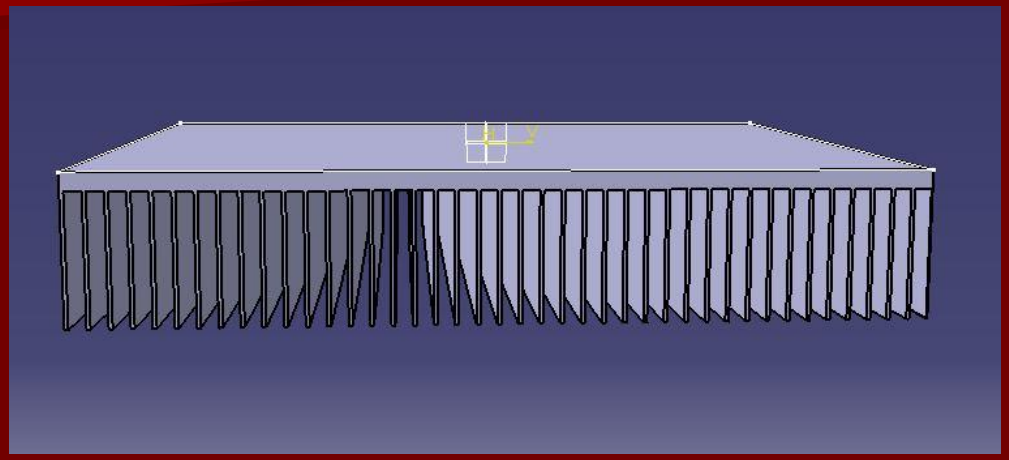
Cost 고려한 fin 개수 제한
핀 개수 정수
최소 열전달률 고려한 fin 개수 제한

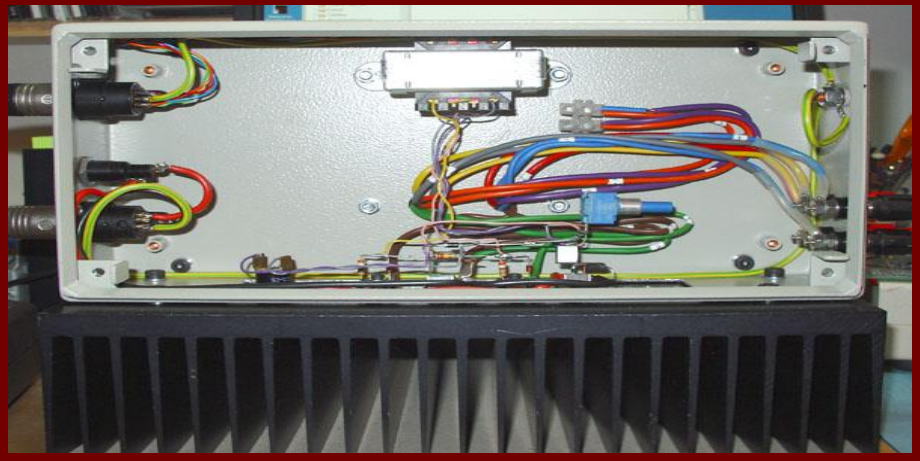


Use of Excel for Graphical Optimization



Modeiling





Future Work

- 1. Make various Variable

 - L , t, H,…

- 2. Further study about various correlation

- Yovanovich correlation

- Elenbaas correlation

Reference

- **Extended surface heat transfer**

  -(공)저: Allan D. Kraus,A. Aziz,James R. Welty,James Welty

- 원자재정보시스템 : 원자재 키로 당 가격

- **reference** 방열판에 관한 기술개발 및 사업화 결과보고서 **(**한국산업기술평가원 **)**

  : 250*200 방열판 핀 재료값