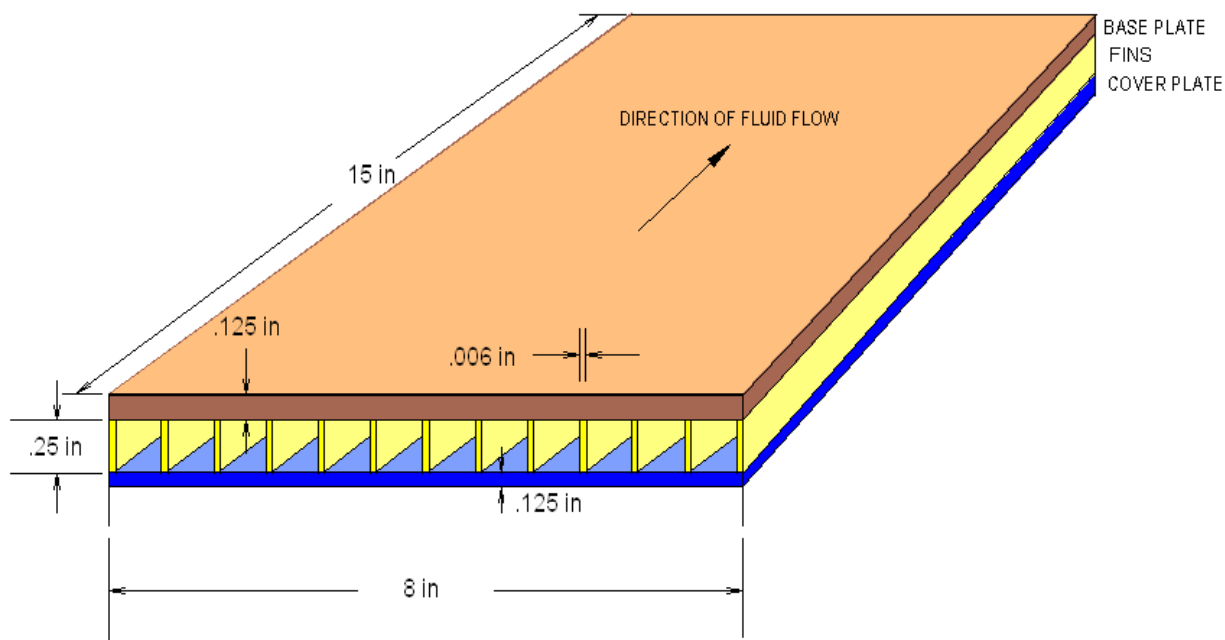


Kraus and Bar-Cohen Sample Problem 15.9 Comparison

Compare the results of sample problem 15.9 of Allan Kraus and Avram Bar-Cohen book “Thermal Analysis and Control of Electronic Equipment” to COLDPLATE results.

Below is a list of input parameters for their sample problem.

- Length L is 15 inches
- Width W is 8 inches
- Fin height H is .25 inches
- Fins are to be .006 inches thick
- Fin type is rectangular 11.1
- The fin density is 11.1 fins/inch
- Cover plate is .125 inches
- Base plate is .125 inches thick
- The inlet fluid temperature is 12.8C
- The inlet fluid pressure is 14.7 PSI
- Cooling fluid is air
- Mass flow rate is 1.56 lb/min
- 1000 Watts on one side, uniformly distributed
- Base, fins and cover are made of aluminum, $K = 5.14 \text{ W}/(\text{in}\cdot\text{C})$

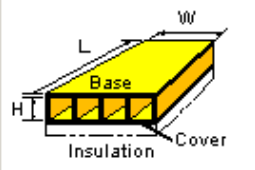


Input the geometry on this tab sheet.

Finned Cold Plate or Heat Sink

Geometry | Material | Fluid Properties | Power Dissipation | Pressure Drop | External Heat Transfer | Generate Plots

Geometry



Length (in.)

Width (in.)

Base Thickness (in.) Variable

Insulation Thickness (in.) Variable

Cover Thickness (in.)

Fin Height (in.) Variable

Type of Fins

- ☐ 10.27T
- ☐ 11.44-3/8w
- ☐ 11.5-3/8w
- ☐ 17.8-3/8w
- ☐ 3/32-12.22
- ☐ PF4
- ☐ PF9
- ☒ PLANE FIN 11.1

[View fin description](#)

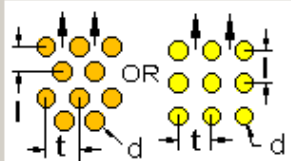
For Plate Fins Only



Fin Thickness (in.) Variable

Fin Density (fins/in.) Variable

For Pins Fins Only

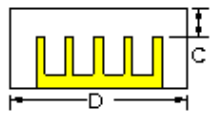


Lateral Spacing (in.) Variable

Transverse Spacing (in.) Variable

Pin Diameter (in.) Variable

For Bypass Flow Only



Duct Width (in.) Variable

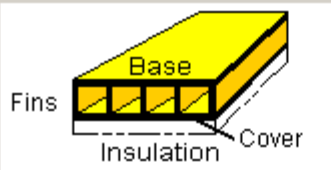
Cover Clearance (in.) Variable

[Model Description](#) [OK](#) [Cancel](#) [SaveAs](#) [Save](#) [Help](#)

Input the base plate, cover and fin conductivity on this tab sheet.

Finned Cold Plate or Heat Sink

Geometry | Material | Fluid Properties | Power Dissipation | Pressure Drop | External Heat Transfer | Generate Plots



Set/Reset Properties to Aluminum

Base

Material: User Defined Properties

Thermal Cond (W/in.-C): 5.14

Specific Heat (W-sec./lb-C): 424.20001

Density (lb/in.^3): 0.098

Fins

Material: User Defined Properties

Thermal Cond (W/in.-C): 5.14

Specific Heat (W-sec./lb-C): 424.20001

Density (lb/in.^3): 0.098

Cover

Material: User Defined Properties

Thermal Cond (W/in.-C): 5.14

Specific Heat (W-sec./lb-C): 424.20001

Density (lb/in.^3): 0.098

Insulation (if used)

Material:

Thermal Cond (W/in.-C):

Specific Heat (W-sec./lb-C):

Density (lb/in.^3):

Model Description | OK | Cancel | SaveAs | Save | Help

Input the temperature, pressure, flow rate and air as the fluid on this tab sheet.

Finned Cold Plate or Heat Sink

Geometry | Material | **Fluid Properties** | Power Dissipation | Pressure Drop | External Heat Transfer | Generate Plots

Fluid Temperature, Pressure or Altitude

Inlet Fluid Temperature (C)

Input one or more matching pressures/altitudes below:

Inlet Fluid Pressure (lb/in²)

Exit Fluid Pressure (lb/in²)

Inlet Fluid Altitude (ft)

Exit Fluid Altitude (ft)

Variable

Type of Cooling Fluid

☒ AIR

☐ COOLANOL20

☐ COOLANOL25

☐ EG_H2O_30/70

☐ EG_H2O_40/60

☐ EG_H2O_50/50

☐ EG_H2O_60/40

☐ ENGINE OIL

☐ FC75

☐ GALDEN-HT110

Fluid Flow Rate

Input one or more:

Mass Flow Rate (lb/min) Variable

Volume Flow Rate (gal/min) Variable

Predict Flow Rate That Results In:

Cold Plate Temperature (C) of

Fluid Exit Temperature (C) of

Pressure Drop (in.-H2O) of

Time Varying

Mil-Std-210 Environment And
Ram Air Cooling

Model Description

☒ OK ☒ Cancel ☐ SaveAs ☐ Save ☐ Help

Input the power dissipation on this tab sheet.

Finned Cold Plate or Heat Sink

Geometry | Material | Fluid Properties | **Power Dissipation** | Pressure Drop | External Heat Transfer | Generate Plots

Cold Plate Power Dissipation

One Side Only

Base Plate Power (Watts)

Both Sides

Base Plate Power (Watts)

Cover Plate Power (Watts)

Fan/Pump Power Dissipation

☒ None ☐ Inlet Fan ☐ Exit Fan

Fan Inlet Power (Watts)

Fan Exit Power (Watts)

Model Description

Here are the results with power on both sides

FINNED MODEL WITH HEATING ON ONE SIDE ONLY

```
***** VARIABLE INPUTS *****
THE TYPE OF FINS SPECIFIED ARE:                PLANE FIN 11.1
FIN HEIGHT, INCHES                             0.250
BASE THICKNESS, INCHES                         0.125
FIN THICKNESS, INCHES                          0.0060
FIN DENSITY, FINS PER INCH                     11.1
STATIC INLET FLUID TEMPERATURE, DEG C          12.8
INLET PRESSURE, LBS/IN2                        14.70
MASS FLOWRATE, LBS/MIN                         1.56
THE POWER APPLIED TO ONE SIDE ONLY, WATTS      1000.00
THE COOLING FLUID IS:                          AIR

***** INTERMEDIATE CALCULATED PARAMETERS *****
FREE FLOW CROSS SECTIONAL AREA, IN2            1.867
HYDRAULIC DIAMETER, INCHES                     0.126
COLDPLATE WEIGHT, LBS                          3.14
TOTAL VOL FLOWRATE, [GAL/MIN] FT3/MIN [ 170.99] 22.858
COLDPLATE VOL FLOWRATE, [GAL/MIN] FT3/MIN [ 170.99] 22.858
COLDPLATE VELOCITY, FT/SEC                     29.39
AVERAGE DENSITY, LB/FT3                       0.068
AVERAGE CONDUCTIVITY, W/(IN-C)                0.00072
AVERAGE SPECIFIC HEAT, W-MIN/(LB-C)           7.622
AVERAGE DYNAMIC VISCOSITY, LB/(MIN-IN)        0.000066
PRANDTL NUMBER                                0.702
REYNOLDS NUMBER                               1596.
EQUIVALENT FRICTION LOSS COEFFICIENT, KFRICITION 7.00
INLET LOSS COEFFICIENT, KINLET                 1.10
EXIT LOSS COEFFICIENT, KEXIT                  -0.07
FILM COEFFICIENT, [BTU/(HR-FT2-F)] W/(IN2-C) [ 9.74] 0.0357
THE FIN EFFICIENCY WITH HEAT ON ONE SIDE ONLY IS 0.938

***** PRESSURE *****
INLET PRESSURE, [LB/IN2] INCHES-H2O [ 14.700] 407.077
INLET PRESSURE DROP, INCHES-H2O               0.293
ACCELERATION PRESSURE DROP, INCHES-H2O        0.093
FRICTIONAL PRESSURE DROP, INCHES-H2O          1.233
EXIT PRESSURE DROP, INCHES-H2O                -0.173
TOTAL PRESSURE DROP, INCHES-H2O               1.446
EXIT PRESSURE, [LB/IN2] INCHES-H2O [ 14.648] 405.631
DENSITY RATIO TIMES PRESSURE DROP, INCHES-H2O 1.2896

***** THERMAL RESISTANCE *****
THERMAL RESISTANCE FROM INLET FLUID TO COLDPLATE, C/W 0.091
THERMAL RESISTANCE FROM LOCAL FLUID TO COLDPLATE, C/W 0.033

***** TEMPERATURES *****
STATIC INLET FLUID TEMPERATURE, DEG C         12.8
STAGNATION FLUID TEMP RISE ALONG COLDPLATE, DEG C 84.1
TOTAL STAGNATION FLUID TEMP RISE, DEG C       84.1
STATIC EXIT FLUID TEMPERATURE, DEG C          96.9
ISOTHERMAL COLDPLATE TEMPERATURE, DEG C      104.2
MAXIMUM COLDPLATE TEMPERATURE, DEG C         130.2
```

Comparison of results between Kraus and Bar-Cohen, and COLDPLATE:

	Kraus and Bar-Cohen	COLDPLATE
Isothermal Temp - C	103.6	104.2
Pressure Drop - in H ₂ O	1.46	1.45