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DOE-2 Parameter Estimation

Introduction

This application finds the parameters for a DOE-2 model of a YCWL0056SE chiller. Specifically, the parameters for the following equations are found

Capacity as a Function of Temperature	CAPFT	$a_1 + b_1 t_{cws} + c_1 t_{cws}^2 + d_1 t_{cws} + e_1 t_{cws}^2 + f_1 t_{chws} t_{cws}$
Energy Input Ratio as a Function of Temperature	EIRFT	$a_2 + b_2 t_{chws} + c_2 t_{chws}^2 + d_2 t_{cws} + e_2 t_{cws}^2 + f_2 t_{chws} t_{cws}$
Energy Input Ratio as a Function of Part Load Ratio	EIRFPLR	$a_3 + b_3 PLR + c_3 PLR^2$

The data sheet for this chiller (YWCS_R22_ChillerManual_0240.pdf) is attached to this Maple workbook. Data from the data sheet is entered into a spreadsheet (YCWL0056SE.xlsx)

Import Data

```
> restart :
  with( ExcelTools ) :
  with( Statistics ) :
> dataPowerTon := Import( "this:///YCWL0056SE.xlsx", "Sheet1" )
```

$$dataPowerTon := \left[\begin{array}{c} \text{19 x 4 Matrix} \\ \text{Data Type: anything} \\ \text{Storage: rectangular} \\ \text{Order: Fortran\_order} \end{array}\right] \quad (2.1)$$

```
> dataLoad := Import( "this:///YCWL0056SE.xlsx", "Sheet2" )
```

$$dataLoad := \begin{bmatrix} \text{"Load \%"} & \text{"Tons"} & \text{"kW"} \\ 100.0 & 51.6 & 37.9 \\ 75.0 & 40.4 & 25.6 \\ 50.0 & 28.4 & 15.1 \\ 25.0 & 13.9 & 7.3 \end{bmatrix} \quad (2.2)$$

> $Qref := dataPowerTon_{8,\,1}$

$$Qref := 48.1 \quad (2.3)$$

> $Pref := dataPowerTon_{8,\,2}$

$$Pref := 37.7 \quad (2.4)$$

> $COP\_nominal := \frac{Qref}{Pref}$

$$COP\_nominal := 1.275862069 \quad (2.5)$$

> $Q\_data := dataPowerTon_{2\,..19,\,1}$:

> $P\_data := dataPowerTon_{2\,..19,\,2}$:

> $t\_chws\_data := dataPowerTon_{2\,..19,\,3}$:

> $t\_cws\_data := dataPowerTon_{2\,..19,\,4}$:

> $load\_data := dataLoad_{2\,..5,\,1}$:

> $tons\_data := dataLoad_{2\,..5,\,2}$:

> $kW\_data := dataLoad_{2\,..5,\,3}$:

CAPFT Parameters

> $CAPFT := \frac{Q\_data}{\sim Qref}$:

> $CAPFT\_eq := a + b \cdot t\_chws + c \cdot t\_chws^2 + d \cdot t\_cws + e \cdot t\_cws^2 + f \cdot t\_chws\, t\_cws$:

> CAPFT_pars := LinearFit(CAPFT_eq, ⟨⟨t_chws_data |t_cws_data | CAPFT⟩⟩, [t_chws, t_cws],
output = parametervector)

$$CAPFT\_pars := \begin{bmatrix} -1.3756043000298939 \\ 0.1430761803480428 \\ -0.0011725324197917322 \\ -0.022658647838926925 \\ 0.00016805266908332715 \\ -0.00022720522735715556 \end{bmatrix} \quad (3.1)$$

```
> CAPFT_f := (t_cws, t_chws) ->
CAPFT_pars[1]
+CAPFT_pars[2]*t_chws
```

```
+CAPFT_pars[3]*t_chws^2
+CAPFT_pars[4]*t_cws
+CAPFT_pars[5]*t_cws^2
+CAPFT_pars[6]*t_chws*t_cws:
```

EIRFT Parameters

> $\mathrm{EIRFT} := \frac{\mathrm{P\_data}}{\sim\mathrm{Pref}\cdot\sim\mathrm{CAPFT}}$:

> $\mathrm{EIRFT\_eq} := a + b\cdot \mathrm{t\_chws} + c\cdot \mathrm{t\_chws}^2 + d\cdot \mathrm{t\_cws} + e\cdot \mathrm{t\_cws}^2 + f\cdot \mathrm{t\_chws}\cdot \mathrm{t\_cws}$:

> EIRFT_pars := LinearFit(EIRFT_eq, ⟨⟨t_chws_data|t_cws_data|EIRFT⟩⟩, [t_chws, t_cws], output = parametervector)

$$\mathit{EIRFT\_pars} := \begin{bmatrix} -121.53335994171032 \\ 0.9238408392487029 \\ -0.011626635778422842 \\ 2.489474579899911 \\ -0.014516886890083354 \\ -0.00018366398907199177 \end{bmatrix} \quad (4.1)$$

```
> EIRFT_f := (t_cws, t_chws) ->
  EIRFT_pars[1]
  +EIRFT_pars[2]*t_chws
  +EIRFT_pars[3]*t_chws^2
  +EIRFT_pars[4]*t_cws
  +EIRFT_pars[5]*t_cws^2
  +EIRFT_pars[6]*t_chws*t_cws:
```

EIRFPLR Parameters

> $\mathrm{PLR\_data} := \frac{\mathrm{load\_data}}{\sim 100}$

$$\mathit{PLR\_data} := \begin{bmatrix} 1.000000000 \\ 0.7500000000 \\ 0.5000000000 \\ 0.2500000000 \end{bmatrix} \quad (5.1)$$

> $\mathrm{EIR\_data} := \frac{\mathrm{kW\_data}}{\sim\mathrm{tons\_data}}$

(5.2)

$$EIR\_data := \begin{bmatrix} 0.7344961240 \\ 0.6336633664 \\ 0.5316901409 \\ 0.5251798561 \end{bmatrix} \quad (5.2)$$

> $EIR\_normalized := \frac{EIR\_data}{\sim EIR\_data[1]}$

$$EIR\_normalized := \begin{bmatrix} 1.000000000 \\ 0.8627184619 \\ 0.7238842024 \\ 0.7150205957 \end{bmatrix} \quad (5.3)$$

> $EIRFPLR\_eq := a + b\,PLR + c\,PLR^2$

$$EIRFPLR\_eq := c\,PLR^2 + b\,PLR + a \quad (5.4)$$

> $EIRFPLR\_pars := LinearFit(EIRFPLR\_eq, \langle\langle PLR\_data | EIR\_normalized\rangle\rangle, [PLR], output = parametervector)$

$$EIRFPLR\_pars := \begin{bmatrix} 0.73748511115 \\ -0.2445806680400007 \\ 0.5136717256000009 \end{bmatrix} \quad (5.5)$$

```
> EIRFPLR_f := PLR ->
  EIRFPLR_pars[1]
  +EIRFPLR_pars[2]*PLR
  +EIRFPLR_pars[3]*PLR^2:
```

Calculations

Chilled Water Supply Temperature

```
> t_chws := 45:
```

Condenser water supply temperature

```
> t_cws := 75:
```

```
> CAPFT_val:=CAPFT_f(t_cws, t_chws);
  EIRFT_val:=EIRFT_f(t_cws, t_chws)
```

$$CAPFT\_val := 1.16752569889757$$

$$EIRFT\_val := 0.928779145831557 \quad (6.1)$$

```
> QEva_flow_nominal := Qref:
> QEva_flow_ava := CAPFT_val * QEva_flow_nominal
```

$$QEva\_flow\_ava := 56.1579861169731 \quad (6.2)$$

```
> QEva_flow_set := 30:
> PLR := QEva_flow_set / QEva_flow_nominal
```

$$PLR := 0.6237006237 \quad (6.3)$$

```
> EIRFPLR_val := EIRFPLR_f(PLR)
```

$$EIRFPLR\_val := 0.784759564948708 \tag{6.4}$$

Compressor Power

```
> compressor_power := Pref * CAPFT_val * EIRFT_val * EIRFPLR_val
```

$$compressor\_power := 32.0816629809417 \tag{6.5}$$

COP

```
> QEva_flow := QEva_flow_set
```

$$QEva\_flow := 30 \tag{6.6}$$

```
> COP_val := QEva_flow / compressor_power
```

$$COP\_val := 0.935113619821443 \tag{6.7}$$

Condensor heat flowrate

```
> QCon_flow := QEva_flow + compressor_power
```

$$QCon\_flow := 62.0816629809417 \tag{6.8}$$