

CHILLER PERFORMANCE IMPROVEMENT REPORT

FELDA BIOTECHNOLOGY CENTRE

**PT 23417 Lengkok Technology, 71760 Bandar Enstek,
Negeri Sembilan.**

1st Performance Improvement Measurement:

7 January 2015 – 10 January 2015

Report Date: 23 January 2015

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CHILLER PERFORMANCE IMPROVEMENT REPORT

1. Objectives & Background

To evaluate the performance improvement of the customer owned chiller **post** energy efficiency treatment solutions for the purpose **to buy-off the improvement demonstrated by the implemented solutions**. The data will be presented in kilo-watt per refrigeration ton (KW/RT) and coefficient of performance (COP).

Baseline performance data was measured (*1st measurement*) from 18 September 2014 – 25 September 2014. Improvement treatment was administrated on 6th December, 2014. Chiller performance improvement data was measured from 7 January 2015 – 10 January 2015.

This report provides comparisons between baseline performance data and the improved performance data for the treated chiller, represented in kilo-watt per refrigeration ton (KW/RT) and coefficient of performance (COP).

2. Customer Name & Site

Felda Biotechnology Centre, PT 23417 Lengkok Technology, 71760 Bandar Enstek, Negeri Sembilan.

3. Date of Measurements

Baseline Performance: 18 September 2014 @ 12:32 hrs – 25 September 2014 @ 14:10 hrs

Performance Improvement Measurement: 7 January 2015 – 10 January 2015

4. Chiller Details

Brand	SIZE(RT)	Refrigerant Type	Compressor Oil Volume	Installation Year
YORK	250	R134A	15 Gallon	2005

Average loading @ 95%

Average hours of loading per day = 13 hours during working weekdays, 6 hours on Saturdays and mostly not running on Sundays.

5. Measurement Methods

Refer to **Appendix 1**

SUMMARY OF DATA

6. Chiller Performance Improvements

a) Improved Performance After Treatment

Average Chiller Efficiency (KW/RT) = **0.669 (KW/RT)**

Average Coefficient of Performance (COP) = **5.26**

Date and Time				Measured Points (Temp in Deg C)						Calculated Points				
Date	Time Start	Time End		Chilled	Chilled	Condense	Condense	Chilled	Condenser	Qe, Chiller	Qc, Chiller	Chiller	Chiller	
				Water	Water	r Water	r Water	Water						Water
				(Deg C)	(Deg C)	(Deg C)	(Deg C)	(Usgpm)	(Usgpm)	kW	Reject, kW	Chiller kW	Check	Chiller
1/7/2015	11:36:15	17:44:15		6.644	9.509	29.093	31.790	797.944	1038.355	604.299	740.294	109.072	0.036	0.637
1/8/2015	6:53:15	8:32:15		7.094	10.016	28.763	31.499	798.090	1039.308	616.526	751.779	117.239	0.022	0.676
1/9/2015	8:40:15	19:11:07		6.649	9.086	28.657	30.961	756.076	910.981	486.934	554.994	95.977	-0.051	0.732
1/10/2015	8:42:07	13:53:07		6.672	9.419	28.882	31.443	798.282	1038.484	579.833	703.086	104.053	0.027	0.632
				6.765	9.508	28.849	31.423	787.598	1006.782	571.898	687.538	106.585	0.008	0.669

b) Baseline Performance (18 September 2014 – 23 September 2014)

Average Chiller Efficiency (KW/RT) = **0.723 (KW/RT)**

Average Coefficient of Performance (COP) = **4.86**

Date and Time				Measured Points (Temp in Deg C)						Calculated Points				
Date	Time Start	Time End		Chilled	Chilled	Condenser	Condenser	Chilled	Condenser	Qe, Chiller	Qc, Chiller	Chiller	Chiller	
				Water	Water	Water	Water	Water	Water					Heat
				(Deg C)	(Deg C)	(Deg C)	(Deg C)	(Usgpm)	(Usgpm)	kW	Reject, kW	Chiller kW	Check	Chiller
09/18/2014	12:32:34	19:00:34		6.678	9.489	29.781	32.625	766.792	892.380	567.178	671.068	111.407	-0.011	0.781
09/19/2014	7:01:34	19:00:34		6.795	9.806	29.971	33.010	768.636	892.461	609.818	716.828	114.317	-0.012	0.746
09/22/2014	7:01:12	19:00:12		6.765	9.768	29.364	32.474	759.706	893.586	601.449	734.010	114.806	-1.262	0.697
09/23/2014	7:01:12	19:00:12		6.716	9.657	29.025	32.024	754.211	889.067	586.497	705.080	111.479	0.015	0.723
09/24/2014	7:01:34	19:00:47		6.740	9.692	29.132	32.131	752.936	908.182	587.526	719.940	113.606	0.028	0.741
09/25/2014	7:00:47	14:10:17		6.833	10.013	29.261	32.455	753.235	908.949	633.195	767.459	116.839	0.022	0.650
				6.754	9.737	29.422	32.453	759.253	897.437	597.610	719.064	113.742	-0.203	0.723

Remarks:

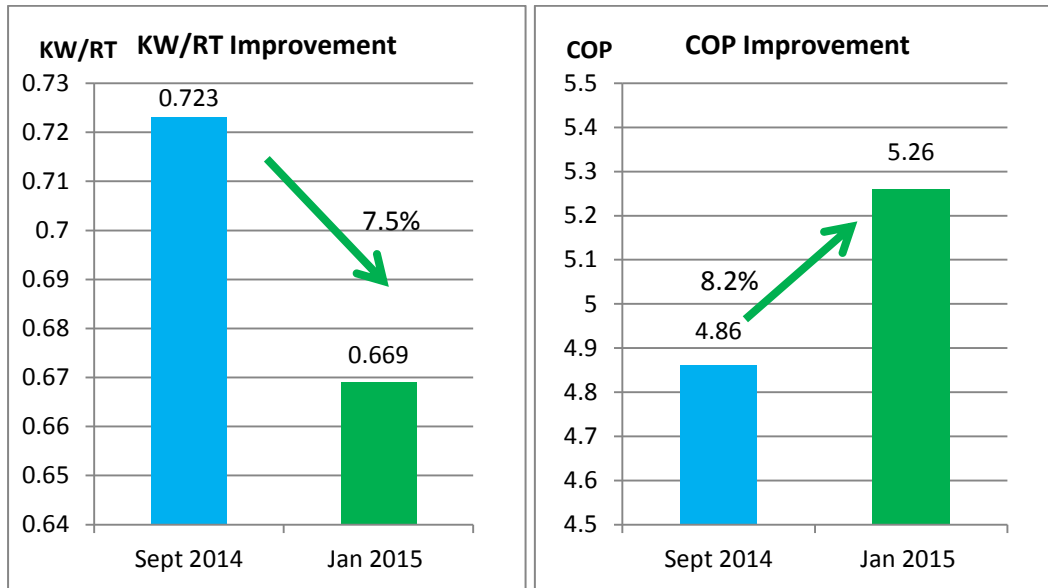
The heat balance shows data to be above the required 80% which indicates flow and temperature measurements are within the expected accuracy range.

c) Post Treatment Improvement %

<p>Average Chiller Efficiency Improvement (KW/RT) = 0.723 - 0.669 (KW/RT) = 0.054 (KW/RT) = 0.054 (KW/RT) / 0.723 (KW/RT) = 7.5%</p>

d) Conclusion on Improvement

KW/RT for the treated chiller is lowered by 7.5% while COP improved by 8.2%



The project of “Chiller Energy Saving Solutions” for FELDA Biotechnology Centre is completed with exceeding minimum guarantee performance of 5% COP improvement.

7. Calculations

Refer to **Appendix 2** for formulas and calculations.

8. Usable Data Range

The continuous data logging has taken measurements of the chiller at **a one minute intervals** from 11:36:15 hrs of 7 January 2015 to 13:53:07hrs of 10 January 2015.

Due to the chiller is only operating at approximately 13 hours during weekdays, data range close to 7:00 hrs to 19:00 hrs were used for the calculations and data presentation.

The entire data set is supplemented in **Appendix 3** in this report.

9. Data Presentation

Date and Time				Measured Points (Temp in Deg C)						Calculated Points				
Date	Time Start	Time	End	Chilled Water Supply (Deg C)	Chilled Water Return (Deg C)	Condenser Water Supply (Deg C)	Condenser Water Return (Deg C)	Chilled Water Flow (Usgpm)	Condenser Water Flow (Usgpm)	Qe, Chiller Heat Gain, kW	Qc, Chiller Heat Reject, kW	Chiller kW	Chiller Heat Balance Check	Chiller KW/RT
1/7/2015	11:36:15	17:44:15		6.644	9.509	29.093	31.790	797.944	1038.355	604.299	740.294	109.072	0.036	0.637
1/8/2015	6:53:15	8:32:15		7.094	10.016	28.763	31.499	798.090	1039.308	616.526	751.779	117.239	0.022	0.676
1/9/2015	8:40:15	19:11:07		6.649	9.086	28.657	30.961	756.076	910.981	486.934	554.994	95.977	-0.051	0.732
1/10/2015	8:42:07	13:53:07		6.672	9.419	28.882	31.443	798.282	1038.484	579.833	703.086	104.053	0.027	0.632
				6.765	9.508	28.849	31.423	787.598	1006.782	571.898	687.538	106.585	0.008	0.669

Remarks:

The data logger is taking chiller measurement points at every 1 minute intervals. The data presented above is the average of calculated chiller KW/RT for each set of measurement at the particular 1 minute interval for the measurement start and end time as indicated at the table above.

C = Chilled Water Supply (deg C)	Heat Gain = $m \times Cp \times \Delta T = G \times 4.19 \text{ kJ/kg} \cdot ^\circ\text{C} \times [(D) - (C)]$
D = Chilled Water Return (deg C)	Heat Rejected = $m \times Cp \times \Delta T = H \times 4.19 \text{ kJ/kg} \cdot ^\circ\text{C} \times [(F) - (E)]$
E = Condenser Water Supply (deg C)	Convert Usgpm to l/s = 0.06309
F = Condenser Water return (deg C)	Chiller Heat Balance Check = $1 - \frac{Qe \text{ (KW)} + \text{Chiller KW}}{Qc \text{ (KW)}}$
Qe = Chiller Heat Gain (KW)	
Qc = Chiller Heat Reject (KW)	Chiller KW/RT = $\text{Chiller KW} / (Qe / 3.517)$

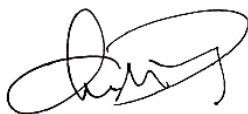
Average Chiller KW/RT = **0.669 (KW/RT)**

If a chiller efficiency is rated at 1 KW/ton, the COP = 3.5, OR COP = $12 / (\text{KW/ton}) / 3.412$

Average Coefficient of Performance (COP) = **5.26**

This report consists of ten (10) printed pages excluding twenty six (26) pages of data log details as described in **Appendix 3**, and shall not be reproduced either partially or fully without written consent from the Evaluator.

Acknowledgements:



Choon Pang

Evaluator, on behalf of
Earth Wise Technology Sdn Bhd
Digital Release Sdn Bhd

Encik Mohd Salim

Customer, on behalf of
Felda Biotechnology Centre

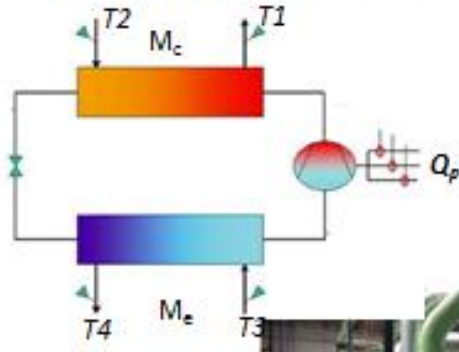
Appendix 1 Measurement Method

Non-invasive Chiller C.O.P. Measurement Instruments & Locations:

- a) Real time, automated data capturing
- b) Dual loop synchronized data collector.

Data to be captured :

- M_c : condenser water flowrate
- M_e : chilled water flowrate
- $T1$: condenser water outlet temperature
- $T2$: condenser water inlet temperature
- $T3$: chilled water inlet temperature
- $T4$: chilled water outlet temperature
- $T5$: Ambient Temperature
- Q_p : compressor input power in KW



Flow Rate sensor



Ultrasonic Flow Meter



Power Meter



Chilled Water, Condenser Water Temperature & flow rate sensors

Appendix 2 Formulas & Calculations

C = Chilled Water Supply (deg C)

D = Chilled Water Return (deg C)

E = Condenser Water Supply (deg C)

F = Condenser Water return (deg C)

Qe = Chiller Heat Gain (KW)

Qc = Chiller Heat Reject (KW)

Heat Gain = $m \times Cp \times \Delta T = G \times 4.19 \text{ kJ/kg} \cdot ^\circ\text{C} \times [(D) - (C)]$

Heat Rejected = $m \times Cp \times \Delta T = H \times 4.19 \text{ kJ/kg} \cdot ^\circ\text{C} \times [(F) - (E)]$

Convert Usqpm to l/s = 0.06309

Chiller Heat Balance Check = $1 - \frac{Q_e \text{ (KW)} + \text{Chiller KW}}{Q_c \text{ (KW)}}$

Chiller KW/RT = Chiller KW / (Qe/3.517)

Appendix 3 Data Log



2nd
Measurement_Improv

Appendix 4 – Baseline Report Reference

a) Chiller Performance

Average Chiller Efficiency (KW/RT) = **0.723 (KW/RT)**

Average Coefficient of Performance (COP) = **4.86**

Remarks:

The heat balance shows data to be above the required 80% which indicates flow and temperature measurements are within the expected accuracy range.

b) Data Presentation

Date and Time			Measured Points (Temp in Deg C)						Calculated Points				
Date	Time Start	Time End	Chilled Water Supply	Chilled Water Return	Condenser Water Supply	Condenser Water Return	Chilled Water Flow	Condenser Water Flow	Qe, Chiller Heat Gain, kW	Qc, Chiller Heat Reject, kW	Chiller kW	Chiller Heat Balance Check	Chiller KW/RT
			(Deg C)	(Deg C)	(Deg C)	(Deg C)	(Usgpm)	(Usgpm)					
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09/24/2014	7:01:34	19:00:47	6.740	9.692	29.132	32.131	752.936	908.182	587.526	719.940	113.606	0.028	0.741
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Remarks:

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D = Chilled Water Return (deg C)	Heat Rejected = $m \times Cp \times \Delta T = H \times 4.19 \text{kJ/kg} \cdot ^\circ\text{C} \times [(F) - (E)]$
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Qe = Chiller Heat Gain (KW)	
Qc = Chiller Heat Reject (KW)	Chiller KW/RT = $\text{Chiller KW} / (Qe / 3.517)$

c) Average Chiller KW/RT = **0.723 (KW/RT)**

If a chiller efficiency is rated at 1 KW/ton, the COP = 3.5, OR COP = 12/ (KW/ton)/ 3.412

Average Coefficient of Performance (COP) = **4.86**

d) A total of 118 pages of baseline data are supplemented in the file below.



Felda 1st
Measurement Report