THE UNIVERSITY OF BRITISH COLUMBIA

Effects of EndoTherm on an Energy Transfer Station - UBC District Energy System

Site Location – UBC Horticulture Building

The main campus of the University of British Columbia (UBC) is connected to a large district energy system (DES) powered by 3 x 15MW boilers to meet the heat demand of the entire UBC campus. The wider network includes over 11km of insulated pipes and 100 energy transfer stations.

One of these energy transfer stations supplies heat to UBC Horticulture through a 190.52kWh heat exchanger linked to a secondary circulation pump with a rating of 4.21L/s. The building, which is home to the botanical / horticultural departments of UBC also includes growing space for student projects.

The Horticulture Building system was chosen as a trial location because it has a history of consistently struggling to reach temperature set-points. Proposed solutions for this issue include a deep-retrofit by replacing the current heat-exchanger with a larger unit. The EndoTherm additive was selected as an attempt to improve heat transfer and reach temperature set-points without the need for deep-retrofits.

What is EndoTherm

EndoTherm is an award winning additive for wet heating systems. Traditionally installed in closed-loop boiler systems the recorded improvements in delta (Δ) temperature (T) due to improved heat transfer efficiency makes it a viable option for district energy systems.

The improvement in ΔT allows for a lower % setting on the variable flow valve OR an improvement in performance at a set % to help buildings get to previously inaccessible set points or internal comfort conditions.

Glossary of Key Terms

District Energy System (DES); A heat network that utilises a central boiler plant to delivery heat to surrounding buildings through a network of pipework. Each building extracts heat using a heat exchanger based on its demand.

ΔT (Delta T): The difference in temperature between the water leaving the heat exchanger and the water returning back to heat exchanger having passed through the buildings pipe network.

Variable Flow Valve: A valve that controls the flow of water to meet the heat demands of a building. A fully open valve is 100%. This valve allows system to be hydraulically balanced

Hydraulic Balance: When the heat delivered meets the buildings heat demand.

Methodology

The buildings within the UBC DES system are set up with 15-minute monitoring on flow/return temperatures, internal comfort conditions and external ambient air temperatures to allow the variable flow valve to open/close dependent on the demand and weather conditions.

These measurements were compared from the 16th January 2018 to the 7th February 2018 (before period) with the 9th February 2018 to the 15th March 2018. These time periods are ALL term times with no holidays and similar average temperatures making it an ideal trial site under similar operating conditions. With 15-minute interval data the comparison has access to over 5500 data points for each measured variable.

The aims of the trial are;

Hypothesis 1: EndoTherm increases the ΔT of the secondary system

Null Hypothesis 1: There is no change (or reduction) in ΔT of the heating system

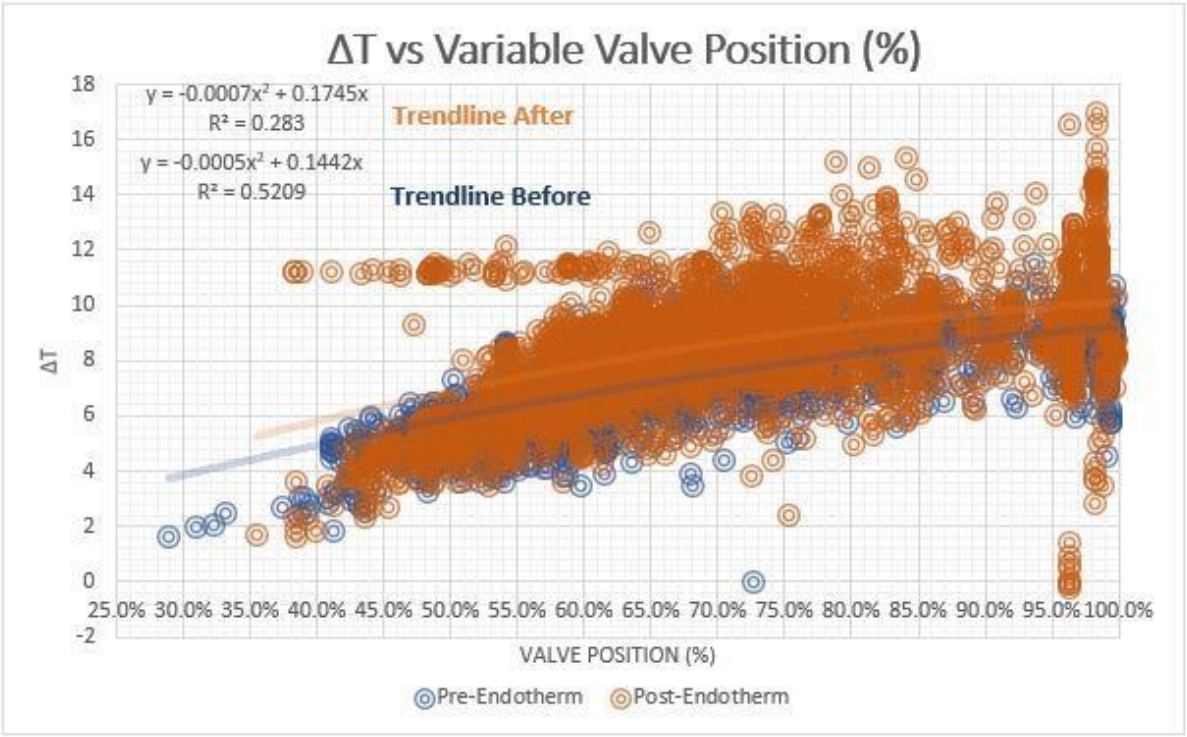
Hypothesis 2: The DES Valve (%) should be lower on average at comparable temperatures

Null Hypothesis 2: There is no change (or increase) in DES Valve % at comparable temperatures

Results

1. **Comparing DES Valve and ΔT**

The first comparison looks at the recorded ΔT and relating variable valve position for the two comparative time periods.



Graph 1: comparing ΔT's at different valve positions before and after EndoTherm

Based on the recorded data-sets a trend line was calculated. Using the equation of this trend line we can compare the differences in ΔT at different valve positions.

Valve Position (%)	Pre-EndoTherm ΔT (°C)	Post-EndoTherm ΔT (°C)	Difference ΔT (°C)	Improvement in ΔT (%)
30	3.88	4.61	0.73	18.81
40	4.97	5.86	0.89	17.95
50	5.96	6.98	1.02	17.03
60	6.85	7.95	1.10	16.02
70	7.64	8.79	1.14	14.93
80	8.34	9.48	1.14	13.72
90	8.93	10.04	1.11	12.40
100	9.42	10.45	1.03	10.93
Average			**1.02**	**15.23**

Table 1: Comparing ΔT at different DES valve positions before and after EndoTherm.

The data set shows a clear increase in ΔT at different valve positions after the EndoTherm has been installed. The average improvement in ΔT has been recorded at 1.02 (°C) which is a 15.23% improvement on the pre-EndoTherm baseload.

2. Comparing DES Valve Position against External Temperature.

During each 15-minute interval the external temperature is recorded and compared with the valve position. During any day the DES Valve will open and close during the individual boiler cycles. The combined averages of the time periods show;

	21st Nov – 7th Feb	16th Jan – 7th Feb	9th Feb – 15th Mar
Temperature (°C)	4.2	4.3	2.1
DES Valve (%)	81.1	67.7	71.8

Table 2: Comparing the average DES Valve position and external temperatures.

Table 2 show that the average DES Valve position in the post-EndoTherm period (71.8%) was similar to that in the specific pre-EndoTherm period (67.7%) despite the temperature being over 2°C colder. If we expand the criteria back to the 21st November, the valve position (81.1%) is higher than the post-EndoTherm period despite the weather being warmer.

Conclusion

Hypothesis 1: EndoTherm increases the ΔT of the secondary system

Graph 1 & Table 1 which look at in ΔT at various % valve positions shows the installation of EndoTherm improved the recorded ΔT by 15.23% which amounted to more than 1°C.

Hypothesis 2: The DES Valve (%) should be lower on average at comparable temperatures

Table 2 shows that the valve is generally lower after EndoTherm has been installed (once compensated with the average temperature). This is either the valve restricting flow due to an increased ΔT or the set points being met quicker thus the valve is able to close sooner.

These hypotheses are supported by ancillary evidence from UBC's energy team who noted the buildings 'high set points' were constantly being reached where previously it had failed to be achieved.