Cost analysis of heating ventilation and cooling systems in the pharmaceutical industry

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Aim of the Project

The Aim of the project was to carry out a numerical analysis of heating ventilation and cooling systems within the pharmaceutical industry using the Life Cycle Cost Analysis (LCC) framework.

Background

The pharmaceutical industry is heavily reliant on HVAC systems, on average it can be assumed that 40% - 60% of all energy usage within most ISO regulated pharmaceutical plants can be attributed to their respective HVAC systems. Plants governed by ISO regulations can range from IS01 – IOS 9, ISO 1 cleanrooms have high air change rates and are almost entirely free from any contamination in the individual rooms.

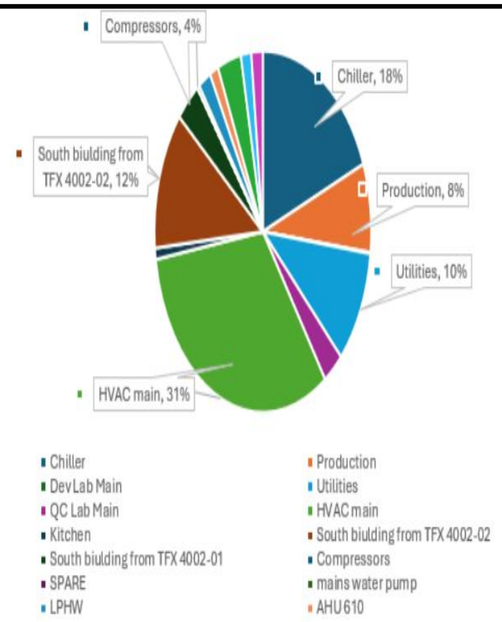

Figure 1 depicts a cost breakdown of the main case study used in this dissertation

The main plant used for this dissertation had a HVAC system which accounted for 52% of all energy usage. It had an annual HVAC operating cost of €617,760.45 from mains power usage consuming 2.7 million KWh of electricity.

Value Map of yearly Lifecycle cost analysis

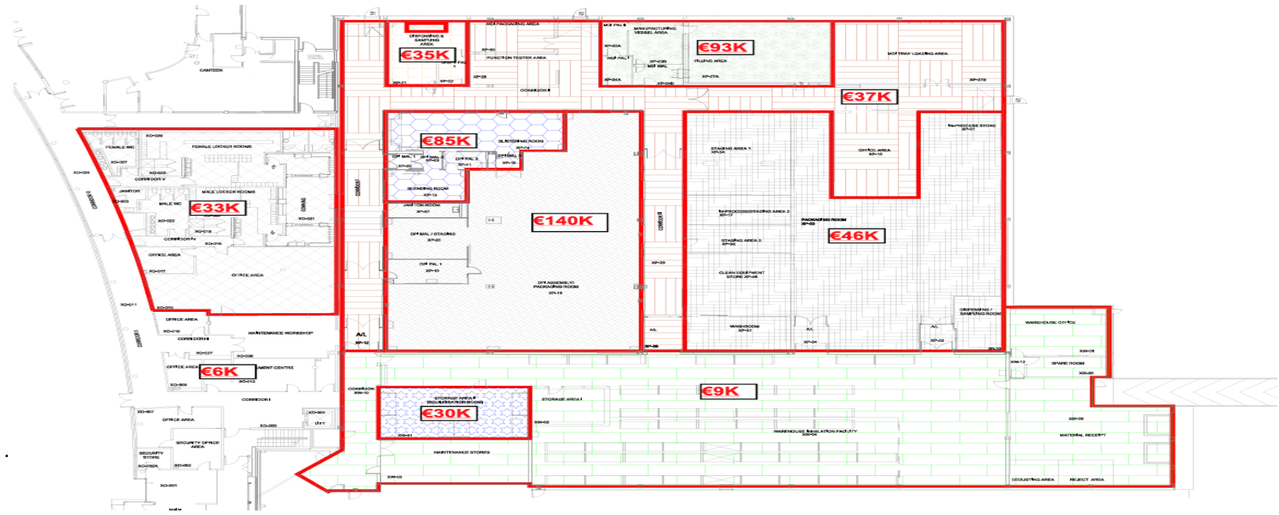

Figure 3 shows the total energy cost of each Air Handling Unit

Results

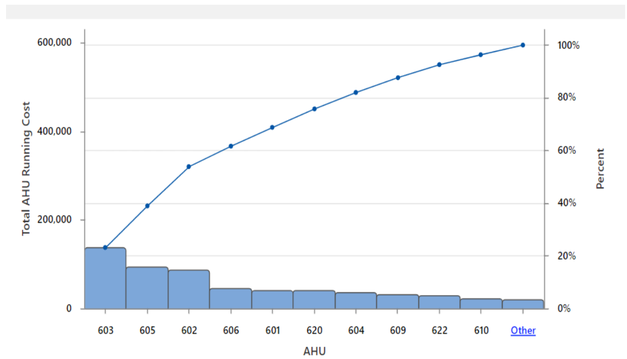

Figure 2 depicts the running cost of each individual AHU

The main findings of this dissertation were as follows:

- Strong correlation between cleaning costs and AHU running costs
- In the main plant there was a correlation of 0.917 between cleaning and AHU running costs
- ISO governed cleanrooms cost 25 times as much electricity to operate when compared to nonISO regulated rooms
- Air change rates lowered by 10-20 air changes per hour can result in a 15% - 25% drop in energy consumption

Life Cycle Cost Analysis

Type of Expenditure	Cost €	Life cycle (years)	Cost per annum €
Installation cost	2500000	20	125000
Energy	7792645.19	20	389632.2595
Operation and maintenance	3773000	20	188650
Cost of Repairs	400000	20	20000
Residual costs	100000	20	5000
Life time cost	14565645.19	20	728282.2595

Figure 4 depicts the LCC analysis financial breakdown

A lifecycle cost analysis aims to establish the overall cost of a system throughout its entire lifetime. It does this by considering the cost of Installation, Fuel, Operation, Maintenance, Repairs and End of life costs. In this project the average life cycle of HVAC system was set at 20 years. The total cost of the 20 year life cycle for the system was €14.56 million, with a yearly average cost of €728,282. energy costs remained the primary expenditure with an average yearly cost of €389,632

Air Handling Unit

Figure 5 shows an example of a typical Air Handling Unit

An air handling unit is the primary component within a HVAC system. It accounts for upwards of 55% of all HVAC energy usage

Conclusion

This dissertation found that HVAC related costs can be lowered by implementing a number of systems:

- Predictive maintenance
- Bio-LPG
- Lowering air change rates
- Lower the level of ISO classifications within cleanrooms

The results of this dissertation could be implemented in the future into multiple pharmaceutical plants with the goal of reducing HVAC energy consumption.

References

https://th.bing.com/th/id/OIP.b6UqY-pf9oxuiuZlNt5FHwHaE8?rs=1&pid=ImgDetMain

Ebirim, W., Usman, F.O., Montero, D.J.P., Ninduwezuor-Ehiobu, N., Ani, E.C., and Olu-lawal, K.A. (2024) 'ASSESSING THE IMPACT OF CLIMATE CHANGE ON HVAC SYSTEM DESIGN AND PROJECT MANAGEMENT'