7-MAR-22

ECODYST HYDROGEN ROTARY EVAPORATOR

TESTING NEW ROTOVAP TECHNOLOGY

ANDY EVANS - GREEN LIGHT LABORATORIES LTD

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INTRODUCTION

Rotary evaporators (rotovaps) are an essential piece of equipment for chemists both in research and industry. These popular items of lab equipment allow for the efficient removal of solvents from samples.

The condenser of the rotary evaporator has traditionally been cooled in three ways; single pass water, recirculating chiller or dry ice (cardice). Using water is both wasteful (units can use 0.5L to 4.0L/minute) and can results in flooding. Recirculating chillers offer an alternative to wasting tap water, however, when end users require their condenser to be at colder temperatures (< -20C) dry ice is used.

Figure 1. Existing rotovap set up used at the University of Oxford, tested during the case study.

ALTERNATIVES TO DRY ICE

Dry ice has a surface temperature of -78.5C. When placed in a dry ice condenser the surface of the glassware which is met by chemical vapor is at -32C (+/- 1C). Recently Ecodyst have developed their own patented chiller technology. This technology has been used in the Ecodyst Hydrogen, a rotovap which has its own, self-contained chiller capable of reaching temperatures ≤-34C.

Figure 2. The Ecodyst Hydrogen.

Working with Dr Katherine England from the Nuffield Department of Medicine, University of Oxford, the Ecodyst Hydrogen was compared to their existing rotary evaporator set up comprised of a Heidolph MX07R-20-HD2E recirculating chiller filled with an ethylene glycol solution, a Buchi R-200 Rotavapor and Buchi B-490 heating bath (figure 1).

	Unit Set Up		
Equipment Set Points	**Rotovap with Chiller**	**Ecodyst Hydrogen**	**Ecodyst Hydrogen**
Chiller Set Temperature	**-10C**	**-10C**	**-34C**
Rotovap RPM	**180**	**180**	**180**
Vacuum Set Point	**120mbar**	**120mbar**	**120mbar**
Water Bath Set Temperature	**40C**	**40C**	**40C**
Water Bath Fill Volume	**3.5L**	**3.5L**	**3.5L**
Preparation Data			
Chiller Energy/Ecodyst Hydrogen Pull Down Time	**70 minutes**	**1 minute**	**5 minutes**
Chiller Energy Pull Down Energy (kWh)	**0.225**		
Water Bath Warm Up Time	**5 minutes**	**7 minutes**	**7 minutes**
Water Bath Warm Up Energy (kWh)	0.063		
Ecodyst Chiller Pull Down & Bath Warm Up Energy (kWh)		0.107	0.132
Energy Used to Reach Set Points (kWh)	0.288	0.107	0.132
Distillation Data			
Duration	20 minutes	30 minutes	20 minutes
Chiller Energy (kWh)	0.101		
Water Bath (kWh)	0.027		
Rotovap (kWh)	0.012		
Ecodyst Hydrogen Energy (kWh)		0.067	0.083
Total Energy Consumptions			
Distillation Total Energy/kWh/Hr	**0.140**	**0.067**	**0.083**
Preparation + Distillation Energy (kWh)	**0.428**	**0.174**	**0.215**
Preparation Time + Distillation Time	**90 minutes**	**37 minutes**	**27 minutes**

Figure 3. Comparison of the Ecodyst Hydrogen to the existing rotovap set up.

All items of equipment were monitored using the Logicall Wireless Solutions energy monitors and online platform. The vacuum pumps were used at the same set points and were not included in the energy calculations. The two systems were compared by carrying out a distillation of 100ml of cyclohexane. It was observed that when the Ecodyst Hydrogen was set to -10C approximately 10ml of cyclohexane was found in the vacuum pump vapor trap. This did not occur when during the distillation for the existing rotovap set up nor when the Ecodyst Hydrogen was used at the -34C set point. The chiller in the Ecodyst Hydrogen was also operated in isolation to compare performance and running costs to the existing chiller. The existing chiller would be switched on and then left on for the working day so that cooling would be available upon command. This usage is reflected in the testing shown in figure 4.

	Unit Set Up		
	Chiller	**Ecodyst Hydrogen**	**Ecodyst Hydrogen**
Chiller Set Temperature	**-10C**	**-10C**	**-34C**
Pull Down Time	**70 minutes**	**1 minute**	**5 minutes**
Pull Down Energy (kWh)	**0.225**	**0.025**	**0.043**
Chiller Energy/Ecodyst Hydrogen Energy (kWh/hr)	0.303	0.012	0.109
Pull Down + 8 Hours Usage/Day (kWh)	2.649	0.121	0.915
Yearly Cost (240 days use/year)	£ 120.79	£ 5.52	£ 41.72
TCO2e/Yr	0.1481	0.0068	0.0512

Figure 4. Chiller running cost comparisons (£0.19/kWh electricity, 0.000233TCO2e/kWh).

DISCUSSION

When comparing the data shown in figure 3 for the cyclohexane distillation the first significant difference is the time taken for the two systems to be ready for usage. The Ecodyst Hydrogen was **10 times faster** compared to the exiting rotovap set up with the Ecodyst having all components ready within 7 minutes whilst the chiller for the existing rotovap set up took 70 minutes to reach the -10C set point. The Ecodyst Hydrogen also saved energy. When comparing the energy used to set up and then carry out the 100ml cyclohexane distillation the Ecodyst used **49.8% less energy** when set to -34C (24C colder than the existing chiller). The chiller component of the Ecodyst Hydrogen (figure 4) used **80.8% less energy** to reach it's -34C set point compared to the recirculating chiller pulling down to -10C. When at the -34C set point the Ecodyst chiller used **64% less energy** than the recirculating chiller at -10C. End users would also be able to make further energy savings simply by switching the Ecodyst Hydrogen on only when it's required. With the chiller being ready in 5 minutes the rotovap can be used on demand instead of being left on so to be ready when needed.

AKNOWLEDGEMENTS

Special thanks to all those who made this study possible in particular:

Dr Katherine England, Nuffield Department of Medicine, University of Oxford

Miss Charlotte Houghton, Sustainability Project Manager – Laboratory Optimisation, University of Oxford

Mr. George Adjabeng, CEO & Founder, Ecodyst

Mr. Paul Withers, Scientific Laboratory Supplies Ltd.

Mr. Ian Morris and Mr. Tom Hunt, Logicall Wireless Monitoring

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