TRADE WASTE MINIMISATION THROUGH RECYCLING AND SUBSTITUTION

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ABSTRACT

This paper focuses on the waste minimisation achievements of Bulace Dyeing, including dye bath recycling and reducing salt loads in support of Central Highlands Water's effluent reuse objectives.

An explanation is given of the various risks associated with trade waste resulting from the dyeing of textiles, with an emphasis on mitigation techniques and technical solutions.

Wastewater recycling and potable substitution is discussed throughout the paper, with an explanation of pre-treatment and water handling systems. Chemical substitution of sodium and chloride salts with potassium sulphate and potassium carbonate is a key message.

With reference to an article in the September edition of the Australasian Textile and Fashion Magazine, the paper reinforces the importance of responsible trade waste management and demonstrates value to business and the environment as a whole.

KEY WORDS

Trade waste, waste minimisation, cleaner production, sodium, dye bath.

1.0 INTRODUCTION

In October 2003, Central Highlands Water approached Bulace Dyeing, a textile dyeing company located in Ballarat, with a request to sign an updated trade waste agreement.

Bulace Dyeing has been operating out of Ballarat for 30 years, servicing both local and international clothing manufacturers with a short run and quick turn around dyeing service.

In consultation with Central Highlands Water, Bulace Dyeing developed a comprehensive understanding of its environmental footprint, including the potential to impact on Central Highlands Water's "SmartCycle®" water reuse project through the use of sodium based products.

Importantly, it was noted that Central Highlands Water has committed to delivering a 15 % reduction in unrestricted potable water demand over the next 50 years, through its Demand Management Strategy. This initiative follows the release of the State Government's "Securing Our Water Future Together" white paper.

In September 2004, Central Highlands Water and the Environment Protection Authority established a cleaner production partnership in an effort to minimise trade waste generation and to maximise resource efficiency. Bulace Dyeing was invited to participate in the partnership in the hope of minimising the amount of sodium discharged into the sewer and reducing potable water demand through process optimisation.

Bulace Dyeing's participation as a cleaner production partner led to a major rethink of long-term historical practices and perhaps not surprisingly, a thorough review of processes revealed some exciting opportunities to significantly reduce the business's environmental footprint.

2.0 DISCUSSION

Following a period of investigation, three separate projects were identified as having potential to significantly improve Bulace Dyeing's water consumption and trade waste contaminant load.

Project 1, dye bath reuse

The first project involved the collection and reuse of wastewater from the business's largest dye bath.

This dye bath typically contains 100 kilograms of sodium chloride, 20 kilograms of sodium carbonate, 3 kilograms of sodium hydroxide and 1000 litres of potable water.

Initial trials indicated that the dyeing solution in this bath could be reused up to six times without affecting product quality; however it was apparent that the quality of the dyeing began to be compromised during each subsequent cycle.

In an effort to further dye bath recycling potential, a flocculation & filtering system was built to remove the hydrolysed dye from the dye bath prior to reuse, as this was causing lower colourfastness in the finished fabric. Although any number of "off the shelf" filters would have sufficed, a more sustainable option was sought. In keeping with the cleaner production theme, Bulace Dyeing constructed a purpose built filter, which comprised of a stainless steel gravity deck lined with recycled paper. Importantly, this system relied on gravity rather than pumps and filter paper that had already been used in production that was previously disposed of to landfill.

Filtering the recycled water prior to its reuse was profoundly effective; enabling the same water to be reused more than 100 times. This trial alone demonstrated capacity for reducing the total trade waste sodium load by up to 20% in addition to the obvious water savings.

Project 2, chemical substitution

During the cotton dyeing process, fabric will develop a negative electrical charge when immersed in water. Unfortunately most commercial dyes are anionic (negatively charged) and as a result most fabric will naturally tend to repel the dyestuff.

This is overcome on an atomic level by adding an electrolyte to the dye bath which floods the fabric with positively charged molecules. As a result, the dyestuff combines with the fabric to form covalent bonds which are then secured by the addition of a strong alkali.

Unfortunately, the most commonly used chemicals in this process contain large amounts of sodium, which is widely recognised for its ability to impact the sustainability of reclaimed water reuse schemes.

Encouraged by an obscure mention of potassium salt whilst researching alternative low salt dyestuff on the internet, Bulace Dyeing Managing Director, John Bulluss conducted laboratory trials to determine if potassium could be substituted for sodium and if so, how efficiently would it work in Bulace Dyeing's process?

While chemical substitution does not necessarily reduce total dissolved solids (TDS) loads, potassium is considered to be much less harmful than sodium and can benefit some land based irrigation schemes, i.e. vegetable crops.

Having previously used sodium chloride (**NaCl**) and sodium sulphate (**Na_2SO_4**) in reactive dyeing processes, John theorised that potassium chloride (**KCl**) and potassium sulphate (**K_2SO_4**) had equivalent chemical properties. In addition, as potassium is more electro-positive and molecularly heavier than sodium, it is reasonable to expect **KCl** and **K_2SO_4** to be more efficient than **NaCL** and **Na_2SO_4**.

To the delight of the cleaner production partners, trials showed that product quality using potassium is equal to that of sodium! In fact, the increased efficiency of **KCl** reduced the need to filter the recycled dye bath solution from one in every six cycles to one in every twenty cycles. This meant that despite **KCl** being around three times the price of **NaCl**, the cost benefits of using **KCl** meant that production trials could still be justified financially.

Table 1: ***Chemical substitution***

Chemical name	Empirical formula	Molecular mass	Chemical substitute	Empirical formula	Molecular mass
Sodium chloride	**NaCl**	58.43 g/mol	Potassium chloride	**KCl**	74.54 g/mol
Sodium sulphate	**Na_2SO_4**	141.98 g/mol	Potassium sulphate	**K_2SO_4**	174.20 g/mol
Sodium carbonate	**Na_2CO_3**	105.94 g/mol	Potassium carbonate	**K_2CO_3**	138.16 g/mol
Sodium hydroxide	**NaOH**	39.97 g/mol	Potassium hydroxide	**KOH**	56.08 g/mol

As a direct consequence of potassium substitution, Bulace Dyeing's trade waste sodium concentration has dropped enormously.

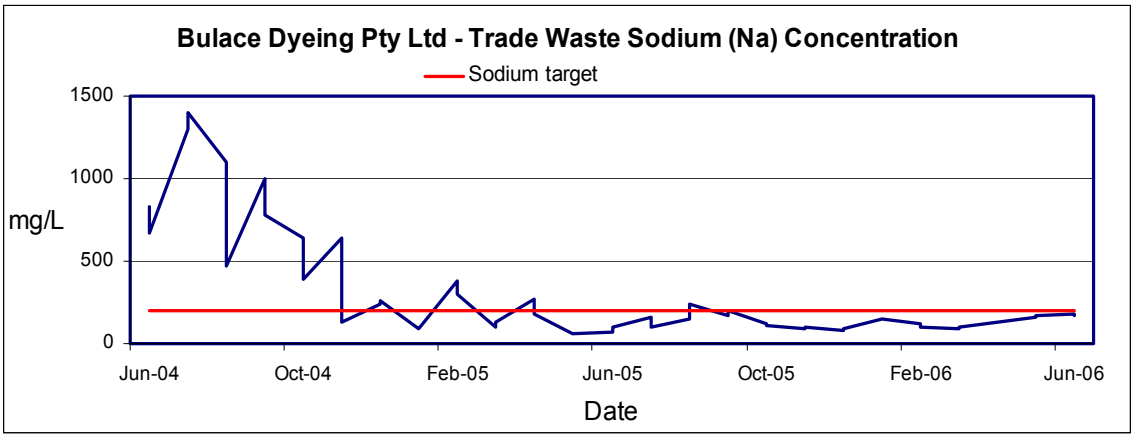

Figure 1: ***Sodium concentration***
Project 3, water conservation

After optimising the chemical processes throughout Bulace Dyeing's operations, and having clearly established the success of recycling within the dyeing process, the partnership focused efforts toward water conservation in the hope of being able to minimise demand on drought affected water resources.

Based on the results of Central Highlands Water's laboratory tests and onsite monitoring by Bulace Dyeing, it was estimated that up to 80% of the total daily volume of trade waste could be collected and treated to a quality suitable for onsite reuse. Of course the effective removal of residual colour is critical where light coloured fabrics may be impacted.

After another series of bench trials a chemical coagulant product was identified that would remove 100% of the residual colour for $3.00 per kilolitre, however it was agreed that this did not offer a financially sustainable outcome. Upon further investigation, it was found that by reducing the amount of coagulant that was added and utilising overnight dwell times, it was possible to reduce the cost to $1.00 per kilolitre. This provided an affordable substitute to potable water that was suitable for the majority of Bulace Dyeing's systems.

Together with support from its cleaner production partners and funding from the "Stormwater and Urban Water Conservation Fund", Bulace Dyeing designed and constructed a water recycling system capable of recycling 42 kilolitres of trade waste each day. Since commissioning its water reclamation system in September 2005, Bulace Dyeing can now recycle up to 80% of the water used in dyeing operations. This equates to a reduction of up to 80% in potable water demand.

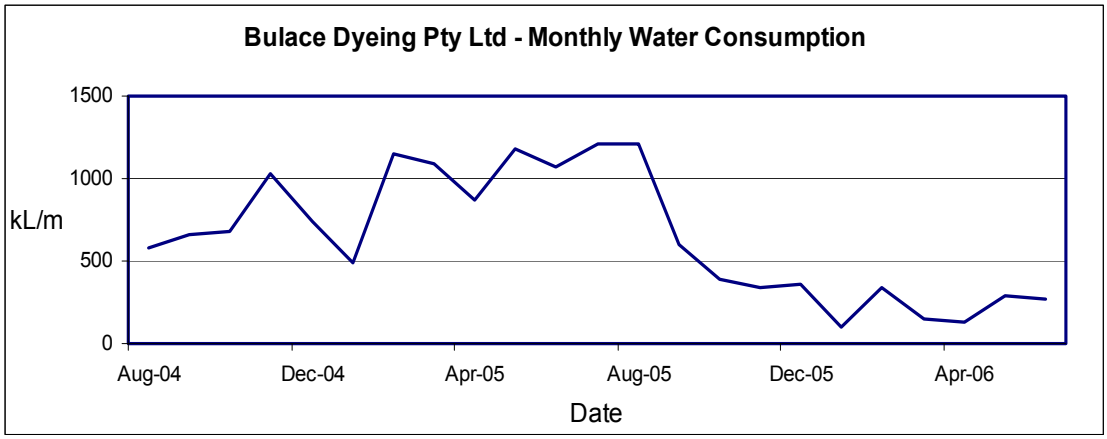

Figure 2: ***Potable water demand***

3.0 CONCLUSION

Since June 2004, with support from a both EPA and Central Highlands Water, Bulace Dyeing has reduced its trade wasted sodium concentration from a maximum of 1400 mg/L, to less than 200 mg/L. This equates to an 86% reduction in sodium load. Importantly, these reductions were achieved through genuine cleaner production methods

and did not result from an increase in dilution.

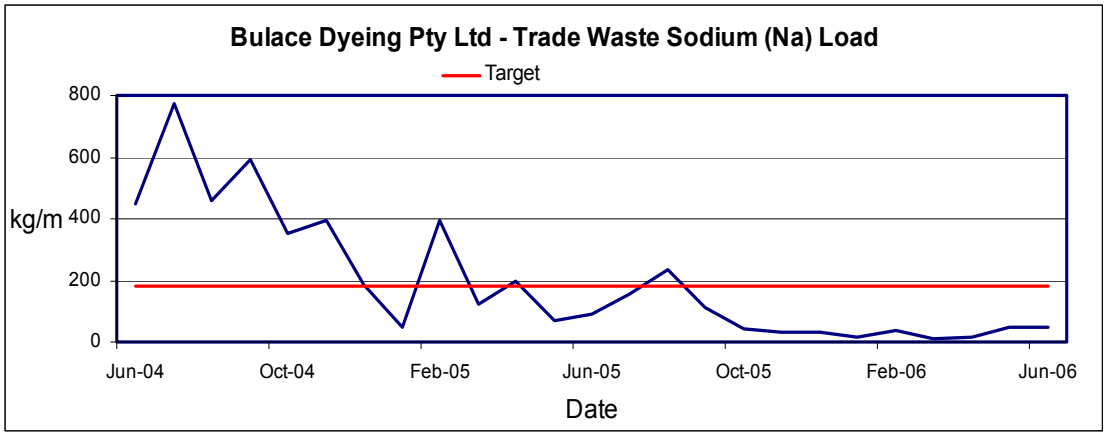

Figure 3: ***Sodium load***

3.1 Challenges

With only 18 employees, Bulace Dyeing could have easily argued that the business lacked the resources necessary to investigate and implement innovative environmental solutions. Fortunately, the combination of Bulace Dyeing's enthusiasm, limited government funding and a cleaner production partnership, all resulted in significantly improved environmental outcomes.

The cleaner production partners strived to reduce Bulace Dyeing's environmental impact by remaining true to the EPA's waste hierarchy.

Various commonly available methods of reducing the amount of salt discharged as trade waste were looked at, however most of these methods hinged on some form of treatment, such as reverse osmosis, or membrane filtration.

With a view to minimising consequential power consumption, operating costs and concentrated waste disposal issues, the three projects described above have culminated in a flexible, efficient and financially sustainable alternative.

Further information can be obtained from the September - October 2005 edition of the "Australasian Textiles & Fashion Magazine".

4.0 ACKNOWLEDGEMENTS

I would like to thank Bulace Dyeing for its commitment to the cleaner production partnership and its unwavering enthusiasm towards resource efficiency and environmental improvement. In particular, I would like to sincerely thank Mr John Bulluss for his ongoing assistance and support.

I would also like to acknowledge Central Highlands Water and the Environment Protection Authority for establishing the cleaner production partnership.

5.0 REFERENCES

Victorian Legislation and Parliamentary Documents, Environment Protection Act 1970, effective date - 1st July 2006, version 151, page 4, section 1I. "Principle of wastes hierarchy".

Merck & Co., Inc., "The Merck Index", 2001.

Australasian Textiles & Fashion, "Australasian Textiles & Fashion Magazine", Volume 25, No.5, September – October 2005, page 22 & 23.