Designing sustainable colour: *lowering the environmental impact during the wool dyeing process*

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Abstract:

Synthetic dyeing has been used in the production of coloured textiles since the late 1800s. However, today there is growing awareness that the dyeing process has a huge impact on the environment, causing damage to the earth's climate from high carbon emissions and damage to ecology through discharge of toxic wastewater. Carpets and Rugs of New Zealand Limited (CRONZ) is a small manufacturer of bespoke tufted carpet based in Christchurch, New Zealand who wanted to help combat these environmental problems by offering a sustainable dyeing process as part of their business. They applied for and successfully gained Ministry for Science and Innovation funding for a postgraduate student fellowship to enable this project. The methods of life cycle analysis, traceability, sustainable certification and labelling, along with running many small-scale experiments, including exploration of the new technology of ultrasound waves in the dye bath, are used here to discover strategies to lower energy and chemical use during the hank dyeing process for wool yarns. By gaining an understanding of the hank dyeing process for wool yarns through interviews with industry experts, and documenting energy and chemical use during experiments, the following key solutions for reducing energy and chemical use were found: reducing dye bath time by dyeing lighter colours, as these process faster than dark colours; use of eco-friendly chemicals that do not contain harmful heavy metals; use of agitation of the dye bath as a method to produce level colour, eliminating the need for a chemical levelling agent; and the use of blended un-dyed yarns as an alternative to dyeing the wool fibres. By employing solutions such as these the carpet manufacturing industry would lessen its environmental impact by lowering carbon emissions and discharging fewer chemicals into wastewater streams.

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Notes:

Ethics: This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher, please contact Professor John O'Neill, Director (Research Ethics), telephone 06 350 5249, e-mail humanethics@massey.ac.nz.

Paper: ECO100 paper stock has been selected to print this research on due to the environmentally friendly manufacturing process that includes using 100% waste paper in a chlorine free process. Environmental accreditation includes; Blue Angel, Nordic Swan and the Austrian Environmental Label.

Referencing: APA Referencing Style (6th Edition) used throughout

Glossary:

Acid dye: There are three main types of acid dye: levelling dye, milling/super milling dye and pre-metalized dye. Acid dye is usually used on protein fibres lowering the pH of the water in the dye bath so it is slightly acidic (Dharma Trading Co., 2012).

Levelling acid dye creates good strong bright colours but is not totally water fast so cold water wash or dry-clean only is recommended. It creates very even colour and is an excellent dye for wool. Gluabers salt is added as a levelling agent. It is the most acidic dye bath *(Ibid.).*

Milling/Super Milling acid dye (also called Neutral Acid Dye) has excellent wash fastness however the light fastness varies. Does not dye as evenly as levelling acid dyes. Vinegar or Ammonium Sulphate can be added to slow the dyeing process down to allow for a more evenly dyed result *(Ibid.).*

Pre-metalized acid dye uses metals in very small amounts in the dye. These dyes are the most wash fast and lightfast of all acid dyes. Care must be taken to apply very evenly in the dye bath. Ammonium Sulphate is added as a levelling agent. Works best on wool and silk *(Ibid.).*

Auxiliaries: textile auxiliaries describes any chemicals or additives that are used in the pre-treatment of fabric or yarn, added to the dye bath or used as after-treatments. An example of an auxiliary is a chemical that may be added to the dye bath of a wool yarn to stop it from felting while submerged in water at high temperatures during the dyeing process (R. Wittinger, personal communication, March 22, 2012).

Cavitation: This happens when ultrasound is applied in a dye bath. Tiny bubbles are generated and which then collapse causing small ‘hot spots’ where high pressure and temperatures are formed. Cavitation is capable of breaking chemical bonds (Techspan Group, n.d.).

Environment Canterbury Regional Council: Often referred to as ECAN, amongst other things, offers information to businesses on ways to become more sustainable and energy efficient (Environment Canterbury Regional Council, 2009).

Environmental Choice New Zealand: ECNZ is the official environmental labelling system. Offers its own standards and licensing system that businesses can apply to obtain. ECNZ sits under the umbrella of Global EcoLabelling Network, this network adheres to ISO 14024 standards (The New Zealand Ecolabelling Trust, 2012).

Entrophication: This is a problem in agriculture where runoff from the land can sometimes build up in lakes or other bodies of water. This causes high amounts of nutrients resulting in dense plant life, effectively killing animal life due to lack of oxygen (Lyons, 2009).

EPA: Environmental Protection Authority. Lists hazardous chemicals and substances and lists regulations for safe use (Environmental Protection Authority, n.d.).

ETAD: The Ecological and Toxicological Association of Dyes and Organic Pigments Manufacturers. Represents these industries on matters relating to health and the environment (ETAD, n.d.).

Hank dyeing: Hank dyeing is where a fibre is dyed in spun yarn form, rather than as a fibre before it is spun (M. Ingram, personal communication, August 3, 2012).

Mordant: This term is used to describe a substance that is added to dye baths to help the dye adhere to the fabric, rather than wash off when the textile is washed. Examples of this are salt – most commonly used on cellulose fibres or vinegar – most commonly used on silk. Metals are often added to dye baths as a mordant, especially when using natural dyes (Collier & Tortora, 2001).

ISO: International Organisation for Standardisation

Oeko-Textile Standard 100 (Oeko-Tex 100): This is an international certification process that tests for harmful substances and looks at production methods and human contact with textiles (Oeko-Tex Standard 100, n.d.).

Pigment printing: The pigment printing process begins with a paste that is coloured with powder pigments; this paste is then screen-printed onto the fabric (Collier & Tortora, 2001).

Pre-treatment: All yarn dyed in industry is pre-treated often with textile auxiliaries to increase the yarn's ability to take up dye or improve properties of the finished yarn. Pre-treatment includes scouring or bleaching yarn (BASF, 2009).

Reactive dye: These are usually water-soluble dyes that work best on cellulose fibres (although it is possible to get some reactive dyes that work well on either wool or silk). These are used in full emersion dye vats and are alkaline dyes (Collier & Tortora, 2001).

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