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"Hope" is the thing with feathers: how useful are cyclomethicones when cleaning taxidermy?

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Abstract

Silicone solvents have extreme hydrophobicity so they can be used as a temporary barrier to aqueous cleaning solutions. They are characterised as having low odour, moderately low toxicity, low polarity and surface tension. They are 100% volatile so will leave no trace behind. Silicone solvents could potentially be used to flood the skin of taxidermy specimens, to provide a barrier whilst fur or feathers are cleaned, and even permit the use of heat treatments without causing damage to the skin. They will not cause drying or swelling and will not dissolve or mobilise any skin components such as dyes or fats, which would normally be adversely affected by water or other solvents. They are also, in theory, safe to use on skin which has suffered so much deterioration that the shrinkage temperature is close to room temperature. Different classes of silicone solvents have different working times and this article explores 3 of these, and their practical applicability when cleaning taxidermy.

Keywords: Cyclomethicone, Silicone solvent, Taxidermy, Cleaning, Conservation, Skin, Fur, Feathers

Introduction

Cyclomethicones are a group of liquid silicones, a class of methyl siloxanes (cyclic polydimethylsiloxane polymers). Cyclomethicones consist of a polymer composed of a short monomer backbone of silicon and oxygen creating closed or almost-closed rings with their methyl groups. Cyclomethicone is a generic group name for chemicals such as cyclotrisiloxane (D3), octamethylcyclotetrasiloxane (D4), cyclopentasiloxane (D5), cyclopentasiloxane (D6) and cycloheptasiloxane (D7). These cyclomethicones differ by their number of methyl groups, which affects their volatility (and therefore evaporation time). Cyclomethicones are often incorporated in perfumes, lotions, creams, deodorants and hair-care products, but the effect of these man-made chemicals on health and the environment has been called into question, and natural alternatives are now being developed.

Within the field of object conservation, cyclomethicones are used as a solvent to solubilise silicone oils and silicone-based substances; for removing tape from paper objects; and for removing varnishes and waxes (when mixed with isopropanol) (Stavroudis 2020). Silicone solvents have been used in the conservation of works of art on paper for over a decade, as a hydrophobic barrier on paintings, to enable the use of aqueous cleaning systems on the surface (Stavroudis 2016). Although not previously used in the conservation of natural history specimens, the author considered that a similar method could form a useful technique for conservation of taxidermy and skins. The silicone solvent could provide a barrier to the fragile dried skin of a taxidermy specimen whilst conservation work is undertaken on the fur or feathers. In theory, if applied below the fur or feather layer (Figure 1), their low surface tension

Figure 1. Applying cyclomethicone to a fox skin using a pipette, to avoid wetting the fur.

would allow them to effectively flood the skin and their extreme hydrophobicity will create a water-resistant barrier. After the skin has been protected by flushing with silicone solvents, aqueous cleaning techniques could potentially be undertaken on the overlying fur or feathers. If successful, treatments could in theory even incorporate heat: under normal circumstances aqueous treatments at elevated temperatures would not be considered for fur or feathers due to the risk of collagen shrinkage within the adjacent skin. Some historic skin is so degraded that its shrinkage temperature is lower than standard room temperature and it would therefore shrink as soon as water is applied. In theory cyclomethicones will not cause swelling, dehydration or dissolve any components of the skin (Boschetti and Tortaro 2017) and should not cause damage to fur or feathers if accidental misapplication occurs, due to their chemical properties. Silicone solvents are 100% volatile so will not leave any residues behind (Lagalante and Wolbers 2017; Straehle et al. 2017).

The working time (depending on evapouration rate) of different cyclomethicones varies, but Moskalik-Detalle et al. (2017) report that 30 minutes is achievable with D4 (octamethylcyclopentasiloxane) when cleaning works of art on paper. This would provide a reasonable length of time to undertake aqueous cleaning of a small patch of feathers or fur on a taxidermy specimen. A very simple experiment was devised to determine whether this working time was achievable on skin. If successful, this would imply that cyclomethicones should be investigated further as a barrier technique when conserving taxidermy.

Method

A small range of materials were chosen for testing the working time of a selection of cyclomethicones: standard printing paper, archival printing paper, rawhide, bovine leather and a taxidermy fox. The fox is an unregistered historic taxidermy specimen that was going to be disposed of from the museum's learning collection but was rescued by the conservation team as a test subject for new techniques or chemicals before they are applied to registered specimens. 3 separate samples of each of the different substrates were flooded with the 3 selected types of cyclomethicone: D2 (hexamethyldisiloxane), D4 (octamethylcyclopentasiloxane) and D5 (decamethylcycopentasiloxane) which are easily available from VWR and Merck etc. A droplet of pure water was immediately applied to the upper surface of the sample (Figure 2). The time taken for the droplet to lose structural integrity (surface tension) was recorded, based on a visual assessment of when the contact angle between the droplet and substrate reached 90° (wetting-point).

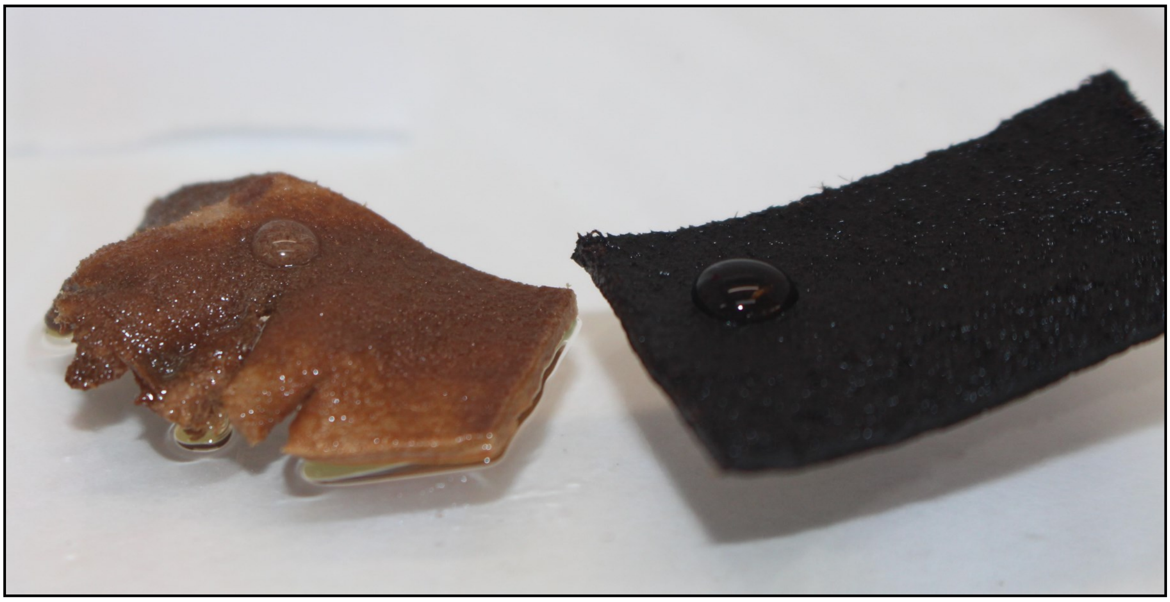

Figure 2. Cyclomethicone D5 being tested on rawhide and bovine leather. A water droplet can be seen resting on the surface of each substrate.

Results

The duration of droplet integrity varied considerably between substrates (Figure 3). Working time (the time before the water started to wet the substrate) was highest for the archival paper (80 minutes was reached before monitoring ceased) but was significantly lower for all other substrates. The bovine leather (recent, tanned) provided the next highest working times of 20-50 minutes, depending on which cyclomethicone was used. The rawhide (recent, untanned) showed a short working time of 20 minutes for D2 and D5, but the fox skin (historic, untanned) and standard printing paper both displayed extremely low working times of 10 minutes or less for all 3 of the cyclomethicones trialled. These results are presumably based on the porosity of the material, deterioration due to age, and differences in manufacturing processes (e.g. tanning or different paper sizes). Although the cyclomethicones were relatively easy to apply to the fox skin using a pipette, due to their low surface tension they rapidly spread out from the site of application and a large amount was required to achieve a water barrier. The longest working time on the taxidermy specimen was achieved by D5, but this was only 10 minutes and would not be long enough to allow for aqueous cleaning and drying of fur or feathers. The author would consider that 30 minutes should be the minimum amount of time required to undertake an unrushed aqueous treatment followed by drying, so even the 20 minute treatment time achieved on undeteriorated recent skin (rawhide) would be insufficient.

This lack of success halted any further testing, which would have included trials of different aqueous cleaning treatments (detergent and solvent mixtures) on a range of taxidermy animals and birds of different ages and stages of deterioration, and investigation into whether the cyclomethicones are safe to use on historic skin and leave no residues, as claimed.

At the time of publication, manufacturers' safety data sheets (SDS) imply that D2 and D5 pose very low hazards, but D4 is flammable, may damage fertility or the unborn child and may cause harmful effects to the aquatic environment. The most recent SDS from the manufacturer must always be checked before a chemical is used, especially since hazards can be reclassified over time as new data becomes available. Another disadvantage of some cyclomethicones is that they must be stored in a dry environment, although this can be achieved using dry silica gel or 0% relative humidity oxygen scavenging sachets in a microenvironment.

Conclusion

Cyclomethicones may be a useful tool within other branches of conservation, but this (extremely preliminary) trial found them unlikely to be a suitable barrier when treating water-sensitive natural history specimens. In the tests described herein, the working time on different substrates varied considerably. On the rawhide and taxidermy fox they proved too low for these cyclomethicones to be practically useful as a

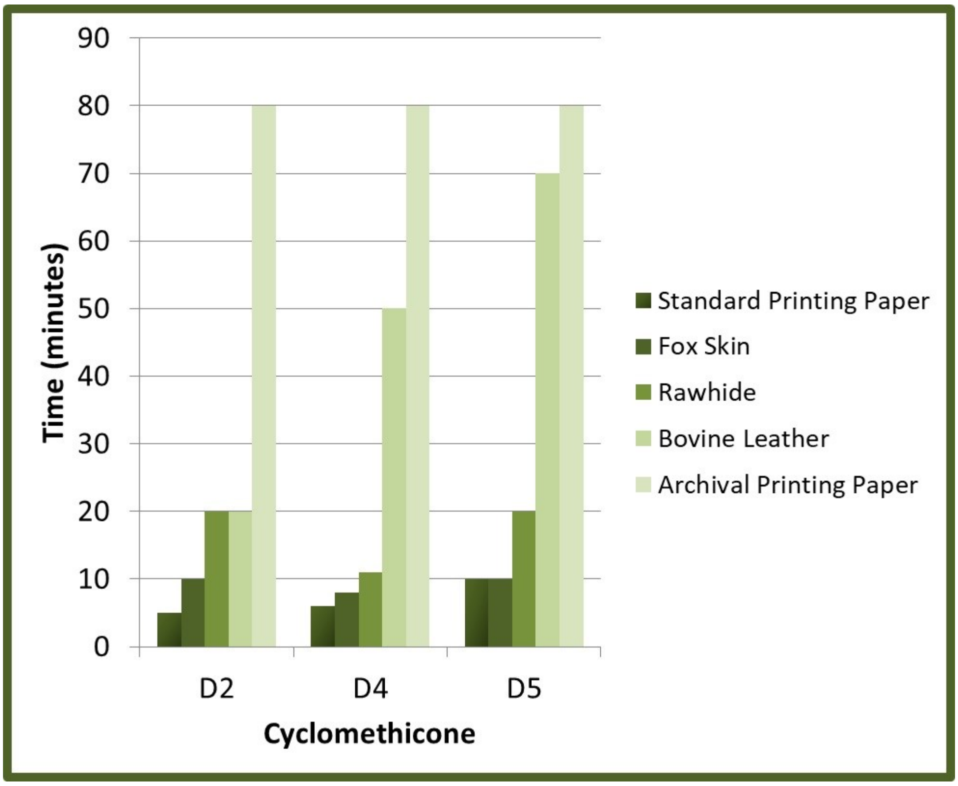

Figure 3. Water barrier duration times for the 5 substrates.

barrier during aqueous cleaning. No further tests were therefore undertaken to establish the suitability of cyclomethicones for the use on taxidermy.

Cyclomethicones are, however, an extremely interesting suite of chemicals, and have other uses which require consideration and testing: critical point drying (Carter 2018), microemulsions (Stavroudis 2012), solvent mixtures (Stavroudis 2015) and the cleaning of pyritic fossils stored in silicone oil.

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