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Investigations in the Use of a Rigid Hydrogel Gellan Gum in the Making of Cleaning Systems for Sensitive Acrylic Paint Surfaces

Abstract

Borrowed from the technology of food chemistry, the rigid KELCOGEL® CG-LA hydrogel gellan gum is a fairly new treatment material in the field of conservation. Until recently, its use was limited since the gum was losing its gelling properties when other materials including surfactants, chelating agents, and solvents were added. In the last years, innovations in the preparation of the rigid gum have led to an increase of its gelling capacity and have opened doors to new possibilities. As wet conservation treatments have proved to be problematic for sensitive acrylic paint surfaces, this research explored the possibility of incorporating a surfactant and a chelating agent into rigid gellan gum recipes to create cleaning systems that could provide an adequate and safe alternative to traditional aqueous treatments. The possible extraction of components from the paint film, as well as the presence of cleaning residues were investigated. Gloss, colour, and structural changes were also analysed.

Experimental

Samples

Burnt umber and ultramarine blue acrylic paint from W&N Finity, Dick Blick and Liquitex.

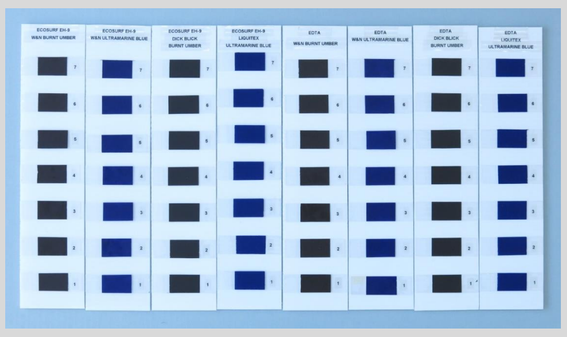


Fig.1 Seven coupons per paint colour type for each category of cleaning systems

Procedure

A 3% gellan gum concentration was assessed for the cleaning systems after measuring the wettability rate of the paint samples by performing contact angle tests.

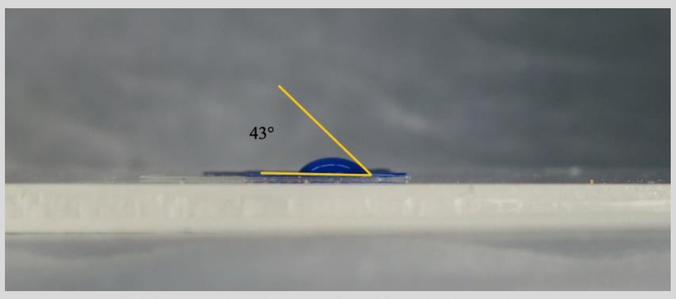


Fig.2 Contact angle testing was performed for each paint sample types

Cleaning systems

Two categories of cleaning systems were prepared using the rigid gel Kelcogel® CG-LA hydrogel gellan gum, one containing a 0.5% Dow ECOSURF™ EH-9 surfactant, and the other a 1.0% Sigma-Aldrich ethylenediaminetetra acetic (EDTA) acid chelator agent. A Sigma-Aldrich calcium acetate hydrate ReagentPlus® was added to both cleaning systems to act as a stabiliser to optimize the gel properties. Life brand citric acid and Sigma-Aldrich triethanolamine (TEA) were also added to adjust the cleaning systems to a pH 6 and a conductivity of 6 mS/cm.

- Each gellan gum cleaning system was tested on a total of seven coupons per paint colour type.
- A sheet of Mylar® was applied over the gellan gum and a gentle rubbing was performed in order to obtain an even contact between the paint surface and the gel.
- The cleaning systems were left on the paint samples for a period of two minutes.

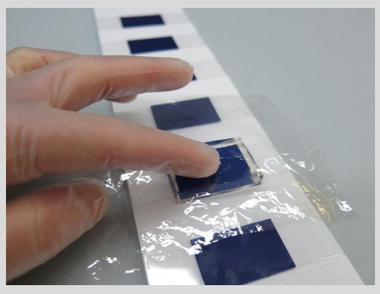


Fig.3 Testing of gellan gum cleaning system on a coupon

Additional Analyses

- The interaction of the gellan gum containing EDTA with the surface of the paint film was confirmed with XRF analyses
- The analyses were performed using two different cleaning system recipes and different substrates containing metal ions

Fig.4 Gellan gum soaked with a 1% solution of EDTA dyed with blue food colouring

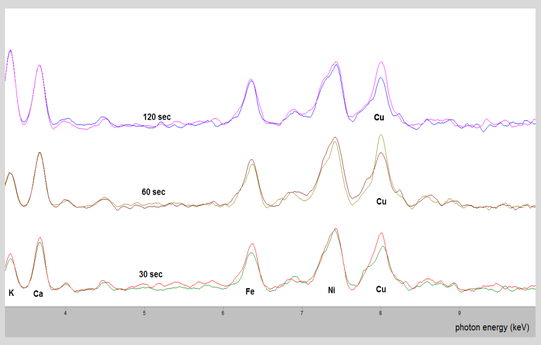


Fig.5 XRF spetra showing that copper metal is extracted after contact between gellan gum containing EDTA and a copper foil

Method of analysis

- Colourimetry measurments
- Glossimetry measurments
- Light microscopy observations and pictures
- Attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR)
- X-ray fluorescence (XRF)
- Scanning electron microscopy-energy dispersion spectrometry (SEM-EDS)

Rigid KELCOGEL® CG-LA hydrogel gellan gum

KELCOGEL® gellan gum is an anionic hydrocolloid produced by the microorganism *Sphingomonas elodea.* It has a straight polysaccharide chain molecular structure consisting of repeated units of glucose, rhamnose, and glucuronic acid. Gellan gum is used in conservation in its low acyl form, which is obtained by the removal of the acyl groups from the primary structure of the high acyl form (native gellan gum) through alkali treatment. Low acyl gellan gum is a firm, non-elastic, brittle gel that works by capillary action to provide a controlled diffusion of aqueous solution. It can accept additives such as an ECOSURF™EH-9 surfactant and an EDTA acid chelator agent, which can help draw out degradation products from the surface of the substrate.

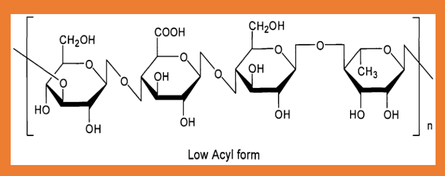


Fig.6 Straight polysaccharide chain structure consisting of repeated units of glucose, rhamnose and glucuronic acid

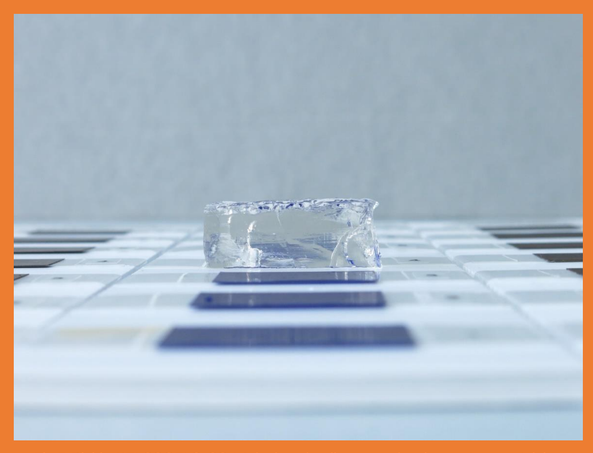


Fig.7 Rigide KELCOGEL® CG-LA hydrogel gellan gum cleaning system containing ECOSURF™ EH-9 surfactant; application of the gel cut to size on a W&N Finity ultramarine blue acrylic paint coupon

Results

Colour

- Observation under microscopy confirmed that all colours, with the exception of burnt umber from Dick Blick which did not undergo any change, presented an improved, more even paint and surface texture.

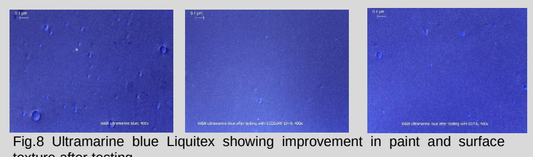
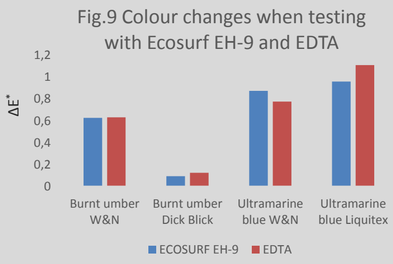


Fig.8 Ultramarine blue Liquitex showing improvement in paint and surface texture after testing

- The colourimetry measurements also demonstrated that burnt umber from Dick Blick was the less affected by the cleaning system.
- All sample colour types showed a change of delta E (ΔE*) colour lower than one, except for ultramarine blue Liquitex tested with EDTA that had a colour change slightly above one (1.1).



Gloss

- The gloss measurements demonstrated a decrease in glossiness for both W&N colours.

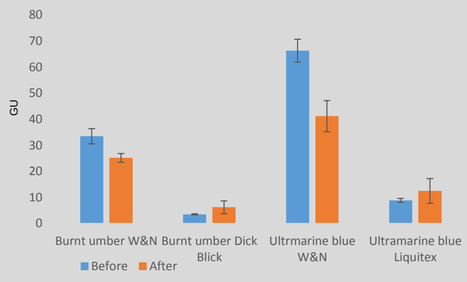


Fig.10 Gloss before and after testing with ECOSURF EH-9 gellan gum cleaning system

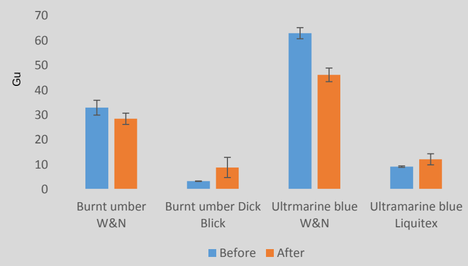


Fig.11 Gloss testing with EDTA gellan gum cleaning system

ATR-FTIR and XRF

- Triton X-405 surfactant was extracted from the surface of the burnt umber Winsor & Newton paint film tested with ECOSURF EH-9 and EDTA and from the surface of the ultramarine blue Liquitex tested with ECOSURF.
- Magnesium and calcium were extracted from the burnt umber W&N coupon after testing with EDTA.

ESEM-EDS

- In some cases a minimal decrease of magnesium and/or calcium was measured.
- No significant morphologic changes were observed.
- No cleaning residues were detected.

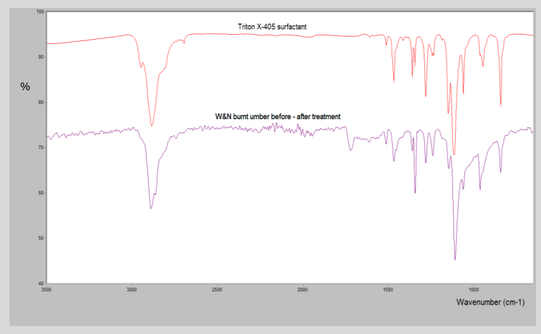


Fig.12 Extraction of Triton X-405 surfactant

Preliminary Conclusions

- It was determined that a surfactant and a chelating agent can be added to the rigid gel KELCOGEL® CG-LA hydrogel gellan gum to create cleaning systems. The pH and conductivity of the cleaning systems could successfully be adjusted. It was demonstrated that minimal amounts of certain materials including calcium, magnesium and Triton X-405 could be extracted from the paint film. No significant morphologic changes were observed and no cleaning residues were detected. Further analyses will be required to determine the efficacy of the cleaning systems in regard to the removal of dirt, grime and other materials commonly found at the surface of acrylic paint film.

Acknowledgements

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