The Modular Cleaning Program in Practice: Application to Acrylic Paintings

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ABSTRACT. The Modular Cleaning Program (MCP) is both a computer database system and an approach to cleaning using premixed concentrates that allows the rapid prototyping of cleaning solutions. The MCP is designed to assist the conservator in refining the cleaning of artworks by allowing more cleaning options to be tested in a fast and convenient way. Because the software component works from a database of physical and chemical properties and first principles, the MCP is well positioned to incorporate this newfound understanding of acrylic paint systems into its cleaning schema. As we gain insight into the cleaning of acrylic paint, we can tailor the range of variations offered by the MCP. The special considerations that are brought to the cleaning of acrylic emulsion paints are consequences of the complexity of the paints themselves. There are numerous components in an acrylic paint film. By examining the sensitivity and susceptibility of the various additives, we can anticipate which cleaning conditions may lead to swelling or damage to the paint film and which cleaning strategies will lead to more successful outcomes. By controlling the pH and the ionic strength (as indicated by conductivity), the conservator can minimize the aqueous cleaning systems' effect on the paint film.

INTRODUCTION

Recent progress in the cleaning of paint surfaces has been supported by a number of factors. Since the mid-1980s, Richard Wolbers at the Winterthur/University of Delaware Program in Art Conservation has been developing cleaning systems to assist conservators (Wolbers, 2000). These systems and his thought processes have been communicated to the conservation community through his workshops and lectures, his book and other publications, and a flow of students who have studied under him. His work brought, and continues to bring, a fresh focus on the intersection of conservation science with conservation practice.

Advances in chemistry and analytical instrumentation have allowed more subtle and nuanced conservation questions to be researched. We now possess tools that can be used to investigate details of the cleaning processes in ways that were inconceivable a generation ago. Also, advances in biochemistry, material science, and a number of the newly evolved hyphenated disciplines have supplemented our knowledge.

Industrial advances driven by increased sophistication in chemical engineering and manufacturing have created technologies and materials that have been repurposed and adapted in conservation. Concern for the environment also drives conservators to look for new approaches to old problems and to minimize the impact on their health and safety and the global environment.

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Cleaning traditional paint surfaces has a long history of practice, research, the occasional failure, and exciting new developments. In contrast, the cleaning of acrylic paint surfaces has been recognized only recently as a process distinct from the cleaning of historical and other modern paint systems (Jablonski et al., 2010). We are now beginning to look critically at acrylic paints, to investigate and attempt to understand their characteristic behavior, and to base cleaning systems on that understanding.

As research advances in the formulation, aging, and degradation of acrylic paints, cleaning systems used by conservators are evolving to incorporate these developments and related insights. As an adaptable tool designed to facilitate methods of cleaning, the Modular Cleaning Program is capable of integrating advances in our knowledge of acrylic paints and the practices for cleaning them.

DIFFERENT PARADIGMS IN THE CLEANING OF PAINTED SURFACES

Wolbers' work, along with work by numerous other conservators and conservation scientists, has led to a number of new approaches to cleaning. More significantly, these new approaches have encouraged a more nuanced consideration and understanding of cleaning.

Wolbers' concept of "recovering a surface" or "unpacking" layers of unoriginal materials on a painting's surface is driven by the desire to control the aesthetics of the cleaning. These phrases have evolved to describe a process in which the collection of materials that are to be cleaned from a painting's surface are considered both individually and as layers or a mixture, and they are selectively removed. They reflect a change in approach and an interest in subtlety that has entered conservation lexicon not because they are new concepts, but because new cleaning techniques have given conservators the ability to strive for this precision.

THE MODULAR CLEANING PROGRAM

The Modular Cleaning Program (MCP) is a direct outgrowth of the Gels Research Project, a collaboration between the Getty Conservation Institute; California State University, Northridge; the Winterthur/University of Delaware Program in Art Conservation; and the Conservation Division of the Winterthur Museum. The goal of the Gels Research Project was to systematically investigate the problem of residues left on surfaces after cleaning with a system that contained nonvolatile components. One portion of the project, represented by the publication by Stulik and Wolbers (2004), was an attempt to codify Wolbers' thinking process, his "logic tree," for choosing a cleaning system. In its initial phase, the MCP was an amplification of the material presented in that publication. Originally designed to manage aqueous cleanings, the system was expanded to work with free solvents, Carbopol-based solvent gels, and, most recently, Pemulen-based emulsions.

The MCP is an evolving tool to help the conservator achieve precision in designing a cleaning system. It does not direct the conservator on how to clean a surface, but rather organizes cleaning options in a logical and expandable way.

The MCP refers to two distinct aspects of the system. "Program" refers to a computer program built from databases of physical properties combined with software routines that model the interactions of components in a cleaning system. "Modular" refers to a set of concentrated stock solutions, with formulae generated by the database from the conservator's specifications, that can be mixed in various ways, allowing multiple cleaning systems to be formulated and tested quickly and easily.

Using the appropriate theory, the MCP models the chemistry of each broad class of physical and chemical interaction. The MCP has 19 internal databases, but the conservator interacts directly with only a few, one being the components database, an extensive repository of physical constants for each chemical entity used to build a cleaning system. A useful resource in and of itself, the components database includes various chemical names; Chemical Abstracts Service registry number; molecular weight; physical form; density; acid dissociation constants for weak acids and bases; formation constants for chelating agents; hydrophile-lipophile balance (HLB) number, critical micelle concentration (cmc), aggregation number, and cloud point for surfactants; and boiling point, Hildebrand, Hansen, and Teas solubility parameters, dipole moment, index of refraction, dielectric constant, and molar volume for solvents. There is also a separate database of binary and ternary azeotropes for solvent mixtures. The MCP accesses the relevant physical constants as it calculates cleaning formulations in the solutions database, another of the databases actively used by the conservator.

The solutions database models mixtures of chemicals from the components database from simple aqueous solutions to mixtures of acids and bases, mixtures of solvents, and Carbopol-based solvent gels. The entries in the solutions database are the stock solutions that are used to mix prototype cleaning systems.

Aqueous solution calculations are based on the appropriate physical constants from the components database and user-specified data. For pH buffer and chelating agent solutions, acid dissociation constants and user specifications of counterions, cleaning solution concentrations, and pH values are used to calculate the concentrations of ionic and molecular species in solution and the amount of the counterion necessary to set the solution to the specified pH. Solvent mixtures are modeled in Hansen three-dimensional space, although Teas and Hildebrand parameters are calculated as well. The solvent phase of Carbopol-based solvent gels and Pemulen-based emulsions are modeled as simple solvent mixtures. The gel phase of solvent gels is based on stoichiometric relationships between the Carbopol, the user-specified organic amine or amines used to neutralize the Carbopol, and the inferred stoichiometric amount of water necessary to form a gel. The aqueous phase of Pemulen-based emulsions is modeled as an aqueous cleaning solution thickened with Pemulen to which a solvent or solvent mixture is added.

Aqueous cleaning systems are modeled as a set of five orthogonal components in the MCP. That is to say, pH, ionic strength, the presence or absence of a chelating agent, the presence or absence of a surfactant, and the presence or absence of a gelling agent can each be manipulated as independent variables. (This is not strictly the case. For example, when a chelating agent is added to a solution, the ionic strength will increase dramatically. However, the computational model used in the MCP is flexible enough to account for these interdependencies.)

When building a pH buffer solution in the solutions database, the conservator chooses the working pH (through the selection of the buffer), the neutralizing base or acid, and the buffer's concentration in the final cleaning solution. Likewise, when building a chelating solution, the conservator specifies which chelating agent to use, the neutralizing base, the solution pH, and the working concentration. For surfactant solutions, the surfactant concentration can be specified by the conservator in terms of the cmc or, if the aggregation number is known, in micelle moles. In addition, recent modifications to the MCP allow the conservator to add an organic cosolvent to the aqueous cleaning solution.

One of the strengths of using a system that models the various solution interactions as the basis of the computational model is that the user can specify the demands of different types of cleanings. This flexibility built into the MCP allows the conservator to modify cleaning solutions and strategies on the basis of advances in conservation science as well as research from other industries. Thus, advances being made in the study of acrylic paints can be incorporated into a cleaning schema specific for these paint surfaces.

CONSIDERATIONS AND COMPLICATIONS IN THE CLEANING OF ACRYLIC PAINT SURFACES

The decision to clean an acrylic surface is never taken lightly by conservators, curators, or conservation scientists. Although acrylic paints are in many ways remarkably durable, the surfaces are rather fragile. This fragility, coupled with the tendency for the paintings to be quite large, leaves them vulnerable to damages from handling. Fingermarks and scuffs can be disfiguring and difficult to ameliorate. The gradual accumulation of surface grime is a more general concern. Druzik and Cass (2000) have shown that even in a presumably benign museum environment the slow accumulation of surface grime will lead to a discernible visual alteration of a paint surface after approximately 50 years. This means that the cleaning cycle for acrylic paint surfaces has begun.

Research by a number of conservators and conservation scientists has begun to identify some of the special properties of acrylic paints (Hayes et al., 2007; Ormsby et al., 2007; Ormsby and Smithen, 2008). That research, along with experience from treatments, both successful and less than successful, has advanced our understanding of the special challenges posed by the cleaning of acrylic paint surfaces.

Examination of acrylic paint formulations (such as Croll, 2007; Wolbers et al., this volume) provides clues about the variables that must be considered when devising a cleaning strategy for these paint surfaces. The base of an acrylic emulsion paint system is the acrylic emulsion itself. It is created from water, the acrylic monomer (or monomers), and materials to stabilize the monomer(s) into micelles, control the pH, initiate the polymerization reaction, and prevent foaming. Additional ingredients, thickeners and coalescing agents, among others, transform it into a successful paint binder (termed the letdown). Separately, pigments and extenders must be mixed with water, dispersing agents, and other components (termed the grind as this is what is actually dispersed in a roller mill as the acrylic binder cannot be milled) that are then added to the letdown forming the acrylic emulsion paint. All of these materials make for a far more complicated and interdependent system than any traditional paint system.

One can attempt to predict the potential sensitivity of the paint on the basis of the sensitivities and properties of each of these many components. These potential sensitivities can be categorized into broad classes of concern: the effects of pH, the effects of ionic strength, and the effects of surfactant migration.

Before discussing these concerns, it is important to consider the physical structure of the acrylic paint film. Acrylic emulsion paints dry differently from other paint systems (Figure 1). The initial drying is by evaporation of much of the water, leaving the pigments and spherical polymer containing micelles to form a close-packed matrix. (In the absence of other ingredients, the acrylic emulsion will form into a hexagonal close-packed arrangement.) The next stage in drying is for the water held by capillary forces between the polymer spheres and pigment particles to evaporate, pulling the spheres into intimate contact. Coalescing agents and the nature of the polymer itself allow the spheres to diffuse into adjacent spheres, forming a film (Zumbühl et al., 2007). Ideally, the resulting film would be continuous, but it is not.

A number of factors will affect the degree to which the coalescing of the polymer spheres occurs. The resulting structure of the film will fall somewhere between the solid membrane of a fully coalesced film and an inhomogeneous structure with pores, irregularities, and imperfections. This physical structure of the acrylic film has particular implications when considering surfactant migration and the ionic strength of cleaning systems.

THE PH OF CLEANING SOLUTIONS

Poly(acrylic acid) (PAA) thickeners, such as Primal ASE-60, a sodium salt of PAA, are added to acrylics to modify the consistency of the paint. Acrylic paints fresh out of the tube are formulated to have a pH around 9.5 (Learner, 2004:12), assuring that the PAA acid groups are deprotonated and fully elongated, forming a three-dimensional structure that gives the acrylic paint the creamy texture expected by artists. When the paint dries, the PAA hardens but retains the potential to respond to the pH of an aqueous cleaning system. In an alkaline (or even neutral) cleaning

The Drying of a Polymer Emulsion
(based on Keddie et al. 1995 as referenced in Learner 2004)

Polymer Emulsion: 40% solids, 60% water
for 25mm x 25mm x 2.5mm sample
about 1.5ml
polymer surface area: 37m²
1.2 x 10¹⁵ spheres

Evaporation of water

Close-packed
polymer spheres
with water-filling voids.

Loss of water and deformation of polymer spheres

Deformed
polymer particles.

Coalescence of polymer spheres

Ideal continuous polymer film
now 25mm x 25mm x 1mm dried film
polymer surface area: 6.3 x 10⁻⁷ m²

Polymer film with surfactant in interstitial space
and exuded onto the surface. Only 0.000002%
of surfactant is adsorbed onto surface while
99.9+% is distributed between the surface and
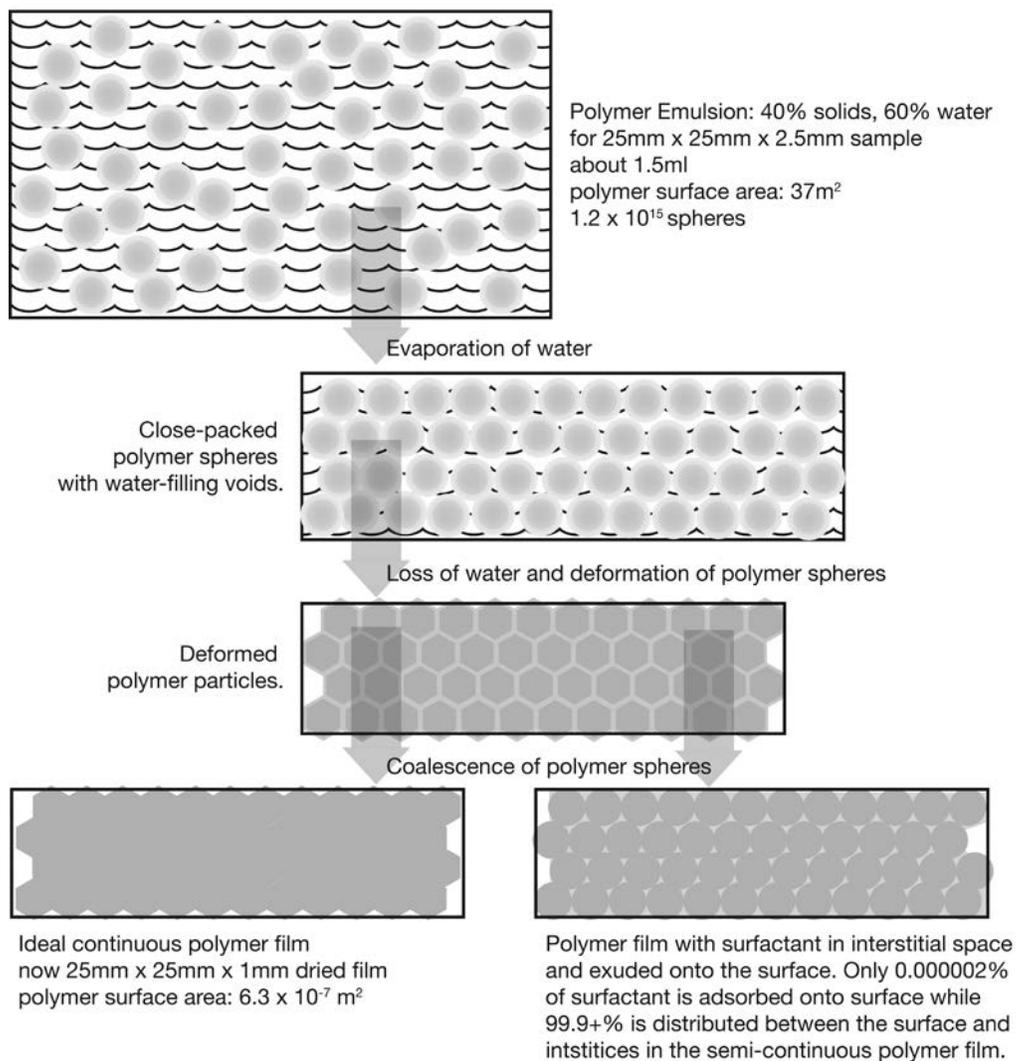intstices in the semi-continuous polymer film.

FIGURE 1. The drying of a polymer emulsion occurs in three stages: (1) evaporation of water from the bulk solution, (2) evaporation of water held by capillary forces, and (3) coalescence of the polymer spheres into the final film.

environment, the polymer will hydrate and swell, softening and disrupting the surface of the paint film. (This is a familiar process witnessed by conservators when working with Carbopol resins, also a PAA.) However, at a sufficiently low pH, the acid groups on the PAA molecules will remain in their less-soluble acid form and will be minimally affected by an aqueous cleaning system.

Recent research confirms this sensitivity. The results of high-throughput (HTP) testing conducted at the Dow Chemical Company in a collaborative project between the Getty Conservation Institute, the Tate, and Dow (Phenix et al., In press) have demonstrated that lower-pH cleaning systems are safer for acrylic paint surfaces. The HTP testing compared the degree of cleaning of artificially soiled and aged acrylic paint surfaces with different pH cleaning solutions. The greatest removal of the soiling was found to occur at a pH of 4 and 5. At a pH of 6, cleaning was less effective. At a pH of 7 and 8, the surfaces were found to have lightened closer to their original color; however, the cleaning was found to have removed a swollen layer of paint from the test surface and not simply removed the grime without affecting the paint.

To minimize the swelling of PAA thickeners, the pH of the cleaning system has to be kept as low as possible. Additionally,

maintaining the chosen pH of any cleaning solution while it interacts with a paint surface is of critical importance. With the MCP, this control is achieved by the inclusion of a buffer system in every aqueous cleaning system.

The choice of buffer is based on the acid dissociation constant (the pK_a) of the weak acid or base and the target pH of the buffer solution. The MCP provides the conservator with information on the effective buffer range of a given weak acid or base. After the conservator chooses the neutralizing base or acid to set the pH of the buffer solution, the MCP makes a first approximation calculation of the amount of neutralizing component to add to obtain the desired pH. Because the calculation is only a first approximation, the final pH of all of the stock solutions in the MCP need to be checked and adjusted as they are being made using a calibrated pH meter.

IONIC STRENGTH

As mentioned above, the dried acrylic paint film is not completely coalesced. It is an imperfect film that will have physical properties somewhere between those of an impermeable film, a semipermeable membrane, and a spongelike, microporous surface.

If an aqueous cleaning system is applied to paint that behaves like an impermeable membrane, we can reasonably expect nothing to happen to the paint film as the surface is cleaned. If a cleaning solution is applied to a semipermeable membrane, interactions between the paint and liquid will be driven by osmotic forces. If it is applied to a paint that behaves like a microporous surface, the interaction between the solution and components in the paint will be driven by simple diffusion.

When an aqueous solution is placed on the surface of a microporous paint film, the relative concentration of soluble salts in the paint will want to be in equilibrium with the ionic solutes in the cleaning solution. If distilled water is placed on the surface of the paint film, the higher ionic strength inside the paint film will cause the diffusion of the ionic species into the water, leaching original material out of the paint film. When the cleaning solution is of lower ionic strength than the paint, the cleaning solution is referred to as hypotonic.

If the cleaning solution has more ionic species than the paint film, ions from the cleaning solution will diffuse into the paint film. The cleaning solution in this case would be hypertonic to the paint film.

If, however, the ionic strengths of both the cleaning solution and the paint film are more or less the same, although there may be some ionic exchange between the solutions, there will be no net movement of ions into or out of the paint layer. In the porous paint film model, a cleaning solution that is isotonic to the paint is clearly desirable.

Considering the acrylic paint film as a semipermeable membrane rather than a microporous film, we can expect to see osmotic effects when a cleaning solution is applied to the paint film. If distilled water is placed on the acrylic paint surface and the film acts like a semipermeable membrane, the water will be drawn into the paint film, causing rapid swelling of the paint. This hypotonic scenario is clearly not desirable.

If a cleaning solution with a high ionic strength is placed on the acrylic paint surface and that surface behaves only as a semipermeable membrane, static pressure could develop inside the paint film. However, as the dried acrylic paint film does not contain free water, the hypertonic solution presumably cannot drive transport through the film. If an isotonic solution is applied to the semipermeable surface of an acrylic paint film, osmotic pressure will neither drive water into the paint film nor attempt to draw water out.

Whether the paint in fact behaves as a microporous film or a semipermeable membrane, it is clear that a cleaning solution that is isotonic to the paint film is the safest way to approach an aqueous cleaning. Therefore, it is important that the ionic environment inside an acrylic paint film be understood and that cleaning as well as rinsing or clearing solutions be isotonic to the paint film.

It should be noted that osmotic pressure can also be caused by nonionic water-soluble species as well. Further research may show that both ionic and osmotic buffers will be required in cleaning solutions to control osmotic effects, ionic exchange, and cleaning efficiency.

An obvious difficulty, of course, is determining the ionic concentration of the paint film so that a cleaning solution can be formulated to be isotonic to it. Measuring the conductivity and pH of a drop of distilled water placed on the surface for a short period of time, but long enough to allow some sort of equilibrium with the acrylic paint to be reached, gives an imperfect indication of the ionic environment of the paint film. The drop of water is placed first into a single-drop conductivity meter and then into a single-drop pH meter, both of which are commercially available. However, it is to be remembered that a drop of water on an acrylic paint surface can leave an irreversible color or texture change. While this is an imperfect means of gauging the ionic environment of the paint surface it is the only practical option available to the practicing conservator.

By using the complex aqueous cleaning option in the program, the MCP allows the conservator to control the ionic strength of the test cleaning solutions along with all of the other solution parameters managed in a simple cleaning. (The MCP calculates the test solution conductivity on the basis of measurements of the stock solutions taken at various dilutions.) Ionic strength can be lowered by decreasing the amount of buffer and chelating agents added to the test cleaning solution. If a higher ionic strength is required, an ionic buffer (typically dilute NaCl, although other salts are being investigated) can be added to the test cleaning solution.

The original design of the MCP was for cleaning traditional paint surfaces. Research by Wolbers (2000:60–61) had shown that chelating agents were most effective at approximately 20–50 mM concentration range (measured at pH 4.8). On the basis of this finding, the normal working concentrations of

chelating agents in the MCP is 50 mM. Recent results of testing cleaning efficiency through HTP testing (Phenix et al., In press) show that for acrylic paints the optimum cleaning efficiency is achieved at a concentration of 0.7% triammonium citrate, or 29 mM. With this new information, the conservator can specify that chelating agents should be used at a 29 mM concentration when used on acrylic paints.

A QUICK TRICK

One attractive and effective way to maintain a low pH and a reasonable ionic strength is to use carbonated distilled water for surface cleaning. The dissolved carbonic acid, pK_a 6.35, gives the system a low pH, and the dissolved carbonate, bicarbonate, and hydrogen ions give the solution a moderate ionic strength. Carbonated distilled water can be produced in a soda siphon, which dissolves 8 g of CO_2 into 1 L of water. The carbonated water is stored under pressure in the siphon until it is dispensed for use. Adding 1% ethanol to the distilled water before adding CO_2 produces a low-pH, moderate ionic strength solution with the ability to reduce the effective HLB of surfactants washed off of the paint's surface (described below).

THE SURFACTANT PROBLEM

As discussed above and illustrated in Figure 1, the surfactants present in the acrylic emulsion are concentrated into two areas in the dried paint film. Surfactants, which stud the surface of the dispersed emulsion, are pushed to any interfacial surface as the polymer spheres coalesce. Depending on the efficiency of the coalescing phase of drying, the surfactant must go either to the film surface or accumulate in interstitial spaces left between the coalescing polymer spheres. In pure acrylic medium this excess surfactant can be seen as cloudiness that develops on the surface of the film as the surfactant crystalizes (Hayes et al., 2007). In the actual paint it is reasonable to assume that the surfactant accumulates in discontinuities created by pigment particles and extenders as well as between incompletely coalesced polymer spheres. Considered from just the physical relationship between an acrylic emulsion and the dried paint film, the change in surface area between millions of 100 μm surfactant-studded polymer spheres to a solid slab of paint is revealing. A quick calculation comparing the surface area of the polymer spheres (1.5 mL of acrylic emulsion has a polymer surface area of approximately 37 m²) to the dried emulsion film (approximately $25 \times 25 \times 1$ mm, a surface area of 6.3×10^{-7} m²) shows that more than 99% of the surfactant used in the original acrylic polymerization reaction will have no surface on which to adsorb. (This assumes that the surfactant monolayer found on the emulsion particles is comparable to the adsorbed surfactant on the dried film.)

Of the surfactant that has accumulated in voids in the acrylic matrix in the final film, some will be squeezed out of the

paint film to a surface by drying forces and compaction during coalescence. Research has shown that this surfactant can affect the paint in a number of ways.

Surfactant accumulating on the surface of an acrylic film can alter the gloss or saturation of the paint film (Ormsby et al., 2007). This accumulation may be a gradual process. This alteration, although inherent to the acrylic paint, can in no way be considered part of the artist's intent. However, the surfactant is original to the material of the artwork.

Surfactant has been shown to decrease the glass transition temperature T_g of an acrylic film (Smith, 2007). It is reasonable to expect that the exuded surfactant, by lowering the glass transition temperature, will function as a plasticizer of the acrylic surface. The lower T_g can facilitate the irreversible migration of grime into the acrylic film, which makes a case for the removal of the surfactant layer.

On the other hand, Ormsby and Smithen (2008) have shown that surfactant continues to be exuded from the interstitial reservoirs to the surfaces of the paint film. Further, this migration can be exacerbated by aqueous cleaning systems (Ormsby et al, 2009). It is generally presumed that the evaporation front of water, which has penetrated into the body of the acrylic paint film, carries the surfactant to the surface. This makes a contradictory case for not removing the surfactant from the surface of the paint and, in particular, not removing it in an aqueous treatment.

Although many conservators feel that removal of the surfactant layer is acceptable, the decision to remove the surfactant layer is something that must be evaluated by the conservator for each cleaning on the basis of the painting and the conditions necessitating the cleaning treatment. It is worth noting that acrylic paint manufacturer Golden Paints recommends that artists remove or reduce the excess surfactant from the surface of their paintings by rinsing with deionized water two to four weeks after the painting is finished (Hayes et al., 2007:64).

Research into cleaning has demonstrated that an aqueous cleaning will, not surprisingly, remove the surfactant layer from the surface of the paint film, whereas a low-polarity aliphatic solvent will not disrupt the surfactant layer (Ormsby et al., 2007). Unfortunately, a low-polarity solvent will rarely do anything to remove surface grime, finger marks, or accretions.

If the conservator decides to remove the surfactant layer, there is an inherent problem described by Wolbers (University of Delaware, personal communication). Consider that the surfactant from the acrylic emulsion was sufficiently powerful to form a stable emulsion of acrylic monomers in water. As this and other surfactants are pulled into solution during the cleaning, they will have an intrinsic detergency, and we can assume that this detergency will have the capacity to wash away pigment particles as well as degraded medium.

The research of the Tate-AXA project surveyed cleaning systems used by conservators (Ormsby and Smithen, 2008). One of the systems that was found to work particularly well was a solution of 1% ethanol in water. In addition to being a solvent,

ethanol is a very low HLB surfactant. (This property is exploited when it is used to lower the surface tension of water.)

Wolbers's observation is that the presence of the alcohol in the cleaning solution lowers the effective detergency of the cleaning solution. When two surfactants are mixed together, the effective HLB is the weighted average of the individual HLBs. The presence of the low-HLB ethanol in the cleaning solution will reduce the effective HLB of surfactant that is washed up from the surface of the acrylic paint and thus reduce the ability of the surfactant to assist in the suspension of pigment particles and degraded binding medium. (A 1% solution of ethanol in water with Triton X-405 added at the critical micelle concentration [HLB = 17.6, cmc = 0.16%] will have an effective HLB of 9.2, which can be expected to be far less detersive than the Triton X-405 on its own.)

By modifying the MCP to allow the incorporation of co-solvents into the aqueous cleaning system, small percentages of water-soluble organic solvents can be added to the conventional cleaning systems as formulated by the MCP. The addition of an alcohol or another surfactant will be reflected in the HLB value of the cleaning solution. This modification as well as aqueous solution sets designed specifically for use with acrylics will be available in version 4 of the MCP, which is still under development.

CONCLUSION

Although acrylic paintings can be cleaned without the use of the Modular Cleaning Program, the MCP can serve as a tool for comparing the most current theories on the cleaning of acrylic paint surfaces with the real-world results of cleanings by conservators. Functioning as a lingua franca between research and practice, the MCP can provide precise formulae and solution specifics to standardize the chemical conversation on the cleaning of acrylic surfaces.

Information on the background and use of the Modular Cleaning Program can be found in the references (Stavroudis et al., 2005; Stavroudis and Doherty; Stavroudis, 2007). The MCP software can be obtained from Conservation OnLine (CoOL; http://cool.conservation-us.org/byauth/stavroudis/mcp/). The program is freely available to professional conservators, runs under Windows or Macintosh operating systems, and does not require ownership of FileMaker Pro.

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Stephan U. and Tom Learner The Modular Cleaning Program in Practice: Application to Acrylic Paintings Chris Stavroudis and Tiarna Doherty Cleaning of Acrylic Emulsion Paints: Preliminary Extractive Studies with Two Commercial Paint Systems Richard Wolbers. Charles S. Scherrer. and Irma Passeri MODERN PAINTS Characterization and Stability Issues of Artists€™ Alkyd Paints Rebecca Ploeger and Oscar Chiantore The Nonideal Action of Binary Solvent Mixtures to Oil and Alkyd Paint: Influence of Selective Solvation and Cavitation Energy Stefan ZumbÃ¼hl. (2010), "The Modular Cleaning Program in Practice: Application to Acrylic Paintings". Proceedings from Cleaning 2012, New Insights into the Cleaning of Paintings. Wolbers, R., A. Norbutus and A. Lagalante. Â Cleaning Service Payments. Law of Conservation Of Mass Lab. Vassar College Resource Conservation Fund Project Application- Draft. Personal Hygiene Facilities Cleaning Log Items to Inspect For. (Energy Alternatives and Conservation. Download. Application methods vary for acrylics just as they do for other painting mediums. Every artist will find an approach that best suits the effects that they are after in their own painting. It is a good idea to experiment to find the process that best suits you. In this lesson, we'll look at creating a small still life painting of an apple by layering colors on the surface. We'll begin with an underpainting to develop the values before moving on to layering the local colors of the apple. (More on this lesson can be found further down this page, after the video.)