Report on Current Film Cleaning Practices and Issues: AMIA Preservation Committee Film Cleaning Workgroup, June 2022

Susan P. Etheridge, Anne Gant, Diana Little, Julia Mettenleiter

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SUSAN P. ETHERIDGE, ANNE GANT, DIANA LITTLE, AND JULIA METTENLEITER

Keeping film clean is one of the most basic actions of film preservation. Small collections may clean exclusively by hand, and larger labs may have various machinery to clean films, but, for the most part, it is taken for granted that cleaning happens as a key component of good archival practice. Perhaps because it is so integral, it is not widely discussed. However, the techniques, solvents, and workflows employed vary widely among labs and archives and thus merit a closer look.

The AMIA Preservation Committee Film Cleaning Workgroup conducted a survey in 2021 to get a sense of this broad practice of film cleaning. We are grateful to the fifty-four participants[1] who answered. Their responses and comments prompted a longer phase of research, a panel presentation of some interesting case studies at the AMIA conference 2022 in Pittsburgh, and this resulting document.

The survey revealed three key areas of concern for organizations. The first area comprises health, safety, and environmental issues: what products are used for cleaning films, and what are practices for protecting the user and the air, land, and water? The second group of questions was about sharing knowledge: What are the best ways to clean certain films? What are best-practice workflows? Maintenance of machines was a third theme, in terms of both daily upkeep and long-term parts replacement and planning, and those questions also addressed the increasingly scarce supply of qualified maintenance technicians.

The AMIA Preservation Committee Film Cleaning Workgroup has responded to some of these questions within this article and also discovered how little has been written on these subjects. We strongly recommend further research into these topics of concern to the community.

SURVEY RESULTS

Our survey found that 40.7 percent of respondents did not have access to film cleaning equipment.

For those whose employing institution owned a cleaner, the overwhelming majority owned a Lipsner-Smith, with 77 percent of respondents reporting use of that brand. The other brands (CTM Debrie, Kodak, Photomec) were evenly shared across the remaining 23 percent.

Expense (36 percent) was cited as the primary reason for not having a cleaning machine, followed by logistical reasons (23 percent) and lack of knowledge (19 percent).

When Do Organizations Clean Their Films?

One hundred percent of the respondents cleaned films before digitization or duplication, although 68 percent did it immediately before scanning, and the rest did it in preparation for scanning.

Twenty-two percent of the respondents cleaned films before projecting them. Thirteen percent also cleaned films as part of their lending operations. Cleaning, in most organizations, is closely linked to preservation work like duplication or digitization. Possibly because of the time, expense, and additional handling involved, cleaning does not seem to be a priority during the accessioning and cataloging phase that precedes long-term storage but rather happens when a film is taken out for active preservation or screening.

What Cleaning Products Are Most Frequently Used?

The range of answers to this question was broad and reflects the continually changing options and regulations around these chemicals as new ones are created and old ones are discontinued or banned from the workplace. Further discussion follows. Isopropyl alcohol is still the leading liquid (46 percent of users) and is used in both hand cleaning and machine cleaning. HFE 7200/8200 is next in popularity, with 29 percent of users employing this modern

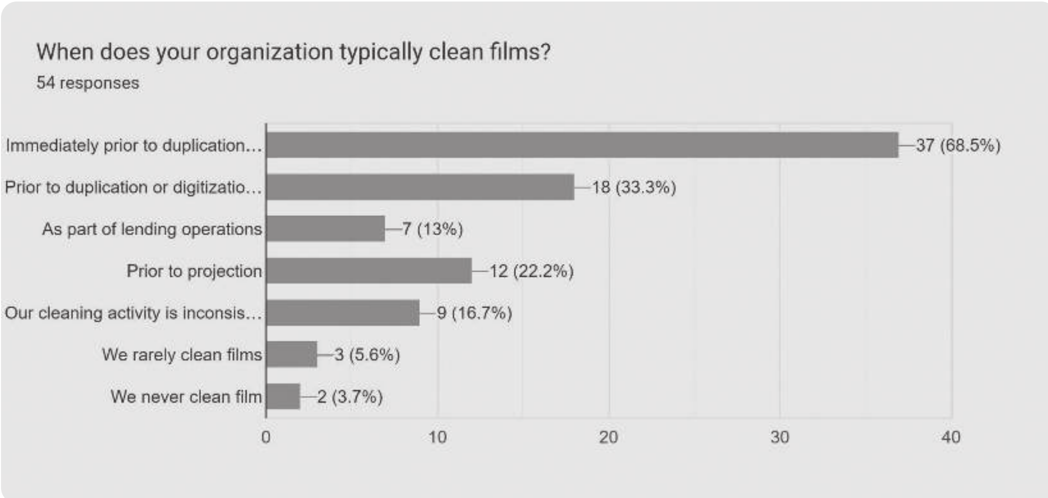

Figure 1. Results for the question "When do organizations clean their films?"

solvent. Eighteen percent of users are cleaning with perchloroethylene and 18 percent with FilmRenew. In many cases, labs use more than one solution, depending on the cleaning needs and the type of film being cleaned.

In the long view, a variety of solutions is being used, ranging from well-documented noxious chemicals to new products specifically marketed for film cleaning to household products not commonly seen in archiving: Solvon, Vitafilm, Goo Gone, 1-1-1 trichloroethane, UN 1280, Kodak Photoflo, Reliance Specialty Film Cleaner, Film Guard, Tetenal Graphic Arts Cleaner, Fluosolv, van Eyck, and hexane, to name several.

What Cleaning Solutions Have Been Replaced?

Eleven of the respondents have discontinued using perchloroethylene, and 1-1-1 trichloroethane has been discontinued in seven organizations. Other organizations listed isobutyl benzene, FilmRenew, Freon, and HFE 7200/8200 as solutions they have discontinued. This does not mean that other respondents have continued to use these; rather, they may have never used them. This part of the survey, in particular, generated many questions for us, about both the safety of the cleaning solutions and practices and protocols surrounding safe workplaces.

The primary reason given (57 percent) for discontinuing solutions was regulations or a legal requirement, for instance, new environmental laws. Concerns about health and safety came next at 28.5 percent, and 14 percent of respondents changed products because of availability.

These initial findings helped the workgroup pinpoint areas of interest for the archival community. Although each of these topics deserves much more research, following are our preliminary findings in the areas of machine maintenance, hand cleaning, health and safety, and environmental concerns. We have also included two case studies of novel solutions: for a cleaning machine and for a carbon capture system.

CLEANING MACHINE OPERATION AND MAINTENANCE

Cleaning machines vary in size, with full-immersion cleaners generally having a larger footprint than spray or roller-only systems. A small film cleaner may fit on a tabletop, whereas an ultrasonic machine weighs several hundred pounds and will require its own room or corner of a room. Depending on the solvent employed, air exchange must also be considered, even if the machine appears to be well sealed, for the health of operators. Power supply needs (amperage, voltage, and

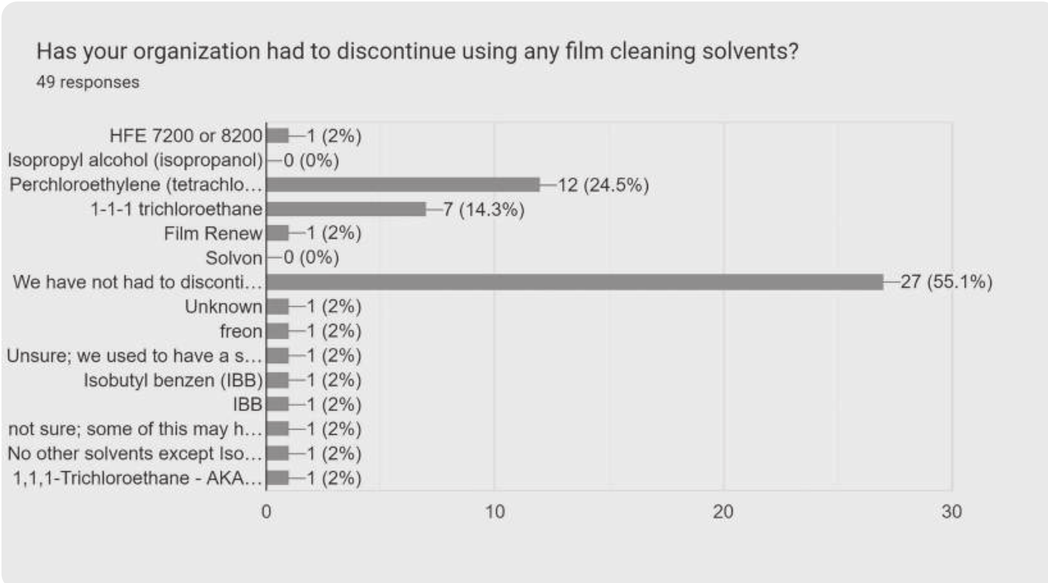

Figure 2. Results for the question "Has your organization had to discontinue using any film cleaning solvents?"

plug type) vary by model and country of origin.

Service requirements vary widely between cleaner brands and models, but any machine with moving parts will require regular maintenance. A cleaning machine's operation manual should include a maintenance schedule and troubleshooting suggestions. Archive or lab staff can perform most machine upkeep, and it is recommended to have a maintenance schedule for those operating the equipment, including roller changes, reclaiming solvent, and keeping the machine itself clean. Troubleshooting may require a deeper knowledge of electronics or engineering, and the manufacturer will probably need to handle major repairs. This is becoming a concern for many archives, reflected in the survey responses, as knowledgeable technicians, and even manufacturers, are quickly disappearing.

Film cleaner consumables can include filters, buffer rollers, and other cloth elements, in addition to the solvent that is specific to the machine. Perchloroethylene machines might require additional consumables like calcium chips and resin, which can only be sourced from the manufacturer or specialty industrial suppliers. Facilities that strive to minimize downtime may choose to keep spare parts, such as drive belts and capstan rollers, in stock.

Solvent reclaiming is the process by which used solvent is captured and distilled and/or filtered for reuse. A film cleaner's solvent reclaim capabilities are worth considering, both because of the cost of cleaning fluids and for environmental responsibility. Full-immersion ultrasonic cleaner manufacturers recommend reclaiming solvent in the tank on a schedule that may be based on hours of operation. Running a reclaim operation can take from one to several hours, and the need to reclaim solvent becomes more frequent when cleaning very dirty film.

Solvent availability and cost contribute to the expense of owning a film cleaning machine. Isopropyl alcohol is very easy to find, even at the 99 percent concentration recommended for cleaning film, because it has many industrial and health care applications. Small quantities can be purchased quite inexpensively. As of May 2022, Kodak charges US$640[2] for the five-liter (1.32-gallon) containers of HFE-7200 used with its P-200 Film Cleaning System, and the machine's brochure estimates that five liters of solvent will clean approximately fifty thousand feet of film. These containers are refillable, so solvent can be purchased in larger quantities to take advantage of bulk pricing. Perchloroethylene, HFE-7200, and isopropyl alcohol are all available in thirty- or fifty-five-gallon drums, at least in the United States, for institutions that can afford to purchase larger quantities. Purchasing a film cleaner means committing to a particular solvent, as none of the commercially available machines can accept a different type of cleaning liquid without significant modification. In an update from December 2022, the U.S. manufacturer 3M[3] announced its plan to discontinue production of PFAS chemicals by the end of 2025. In the official statement, 3M mentioned several reasons for this decision, among them the changing regulations designed to reduce or eliminate PFAS in the environment. PFAS (per- and polyfluoroalkyl substance) is a group term for more than ten thousand substances used in a wide range of applications that includes HFE.[4]

Survey respondents commented that contemporary, less hazardous solvents, namely, HFE-7200 and isopropanol, are not as effective at cleaning film that is particularly dirty or oily. There seems to be a trade-off between cleaning efficacy and safety, at least anecdotally. Respondents may be suggesting that "they don't make 'em like they used to" when considering the solvents perchloroethylene and 1-1-1 trichloroethane that were so commonly used to clean film in the past—but perhaps that is not a bad thing. Our priorities have changed as we have learned more about the long-term effects these chemicals have on humans and the environment.

Respondents also cited various maintenance and performance issues with the cleaning machines in their institutions. Some respondents referred to quite specific mechanical or electrical problems that plague them, because of either the expense of parts and service or an inability to enlist help from technicians outside the institution. Other respondents reported very little difficulty in maintaining their cleaning systems, which could be due to the relative age of the machines and/or the size, staff, and maintenance budget of the institutions where they reside.

Some cleaning machine manuals have been scanned and uploaded by their owners to the internet, where they can easily be found. However, some of these machines have been around for decades, and their design may have changed significantly over versions and generations. Ensure that the manual matches the exact model number of the cleaning machine. Manufacturers should be able to provide digital or hard copy manuals to current and potential owners, even for legacy machines.

FEATURED CASE STUDY: DIY CLEANING MACHINE

One DIY machine is located at the Swedish Film Institute (Figure 3). It is a customized water-based cleaning machine constructed by an independent technician from Stockholm. The machine employs an aqueous solution to which a degreasing solvent and Photoflo are added during the different baths. Cleaning the film with water causes its gelatin layer to swell and therefore can reduce scratches while removing oil and dirt efficiently. The Swedish Film Institute only cleans viewing print material with this machine, not original negatives or preservation materials. On one occasion, this machine was used for recovery cleaning after flooding occurred in another Stockholm-based archive facility. This machine has advantages in its facility for cleaning dirty and oily projection prints better than other cleaning machines, its ability to reduce some scratches, and its use of cleaning solvents that are less hazardous for human health and the environment than other solvents (e.g., perchloroethylene). On the other hand, disadvantages include the high water consumption, which may not be environmentally sustainable, and the lack of access to service from the provider.

HAND CLEANING AND NON–MACHINE CLEANING

The cleaning method used depends not only on the film material[5] and its physical condition but also on the availability of in-house equipment and the budget for outsourcing services. Nearly half of the survey participants (41.5 percent) replied that they did not have a cleaning machine within their institution. This number seems to correspond to the fact that more than half of the respondents were working in smaller (zero to ten employees) archival or nonprofit film-holding institutions. Smaller institutions are likely not equipped with an in-house digitization or restoration facility and hence won't

Figure 3. DIY cleaning machine. Copyright Swedish Film Institute, 2022.

have the need to use a professional cleaning machine on a regular basis. In these cases, hand cleaning or cleaning with smaller equipment, like particle transfer rollers (PTRs), is a common practice.

Sixteen respondents stated that they would perform hand cleaning on a daily basis or at least several times per week. Besides being a labor-intensive and time-consuming activity, hand cleaning can carry health and environmental hazards. Solvents used for hand and spot cleaning are often the same as those used in professional equipment, for example, isopropanol or perchloroethylene. Because trichloroethane and perchloroethylene, which are highly hazardous for human health, have been subject to stricter regulation, institutions have looked for safer alternatives. Initially, n-propyl bromide (nPB or 1-bromopropane) was used by some organizations as an alternative cleaning solvent,[6] but in 2010, n-propyl bromide was also designated a higher-hazard substance (RY2016) under the Massachusetts Toxics Use Reduction Act.[7] Suggested replacement solvents from vendors for n-propyl bromide either have not been tested on motion picture film material or had unacceptable results, causing damage to the tested material.

Other hand cleaning solvents named by survey respondents included hexane, the UN 1280 film cleaner, and Graphic Arts film cleaner. Other degreasing solvents (often available in regular hardware or department stores) not specifically made and tested for film material have also been frequently used by archives and labs. Some institutions have cleaned with these chemicals for decades, because users have observed no damaging or decomposing effects on film over that time period.

In recent years, environmentally friendly options, such as eucalyptus and other essential oils, have found their way into archives and labs to use for spot cleaning. It should be pointed out, though, that the materials safety data sheet[8] (MSDS) for 100 percent eucalyptus globulus oil indicates that the substance can cause skin irritation and allergic skin reaction

Figure 4. Results for the question "How frequently does your organization clean films by hand?"

and may be fatal if swallowed or inhaled. It is therefore important to use eucalyptus oil only in well-ventilated areas, to avoid contact with the eyes and skin, and to wear protective gloves and safety glasses during use. A study on the effects of manual cleaning with essential oils on the material components of motion picture films has recently been conducted by Caroline Figueroa Fuentes in the master's study program in conservation and restoration of audiovisual and photographic heritage at HTW Berlin (University of Applied Sciences). Preliminary results of this research were presented within the film cleaning panel at the AMIA 2022 conference, and a more comprehensive publication is planned for spring 2023.

Survey respondents also mentioned PTRs and Drypur cleaning rollers as alternative cleaning tools. PTRs have the disadvantage of not being very efficient at removing oil, adhesive residues, or embedded dirt, but they can reduce dust while winding a film.

HEALTH AND SAFETY

Survey results suggest an urgent need for answers and clarity on topics relating to health and safety. When asked what health and safety procedures and personal protective equipment organizations use for film cleaning, the most frequent replies from the survey included the donning of solvent-resistant gloves, protective masks and glasses, as well as having well-ventilated work areas available. Routines for those employees working with cleaning equipment and solvents included staff briefings and training on how to handle cleaning solvents safely, as outlined by the health and safety executive, along with occupational health monitoring or staff rotation systems designed to restrict the time spent working with hazardous solvents.

For many of the fluids used in cleaning, MSDSs are available and should be on file in the space where the machine is being used.

The Film Cleaning Workgroup would like to call special attention to the hazardous nature of trichloroethane, also known as perchloroethylene or perc. This chemical has, for many decades, been used primarily in dry cleaning and textile processing and as a vapor degreasing agent in metal cleaning operations. It is also widely used in ultrasonic film cleaning machines because it is noncombustible[9] and therefore safer to use than alcohol. Over the past decades, perc has replaced 1-1-1 trichloroethane, also known as trichlor, partially because trichlor was proven to damage the ozone layer.

Despite its widespread use, perchloroethylene has been known to have negative health effects on those who come in frequent contact with it. Short-term physical effects from high-level inhalation exposure can include irritation of the upper respiratory tract and eyes, as well as kidney dysfunction. The short-term neurological effects from exposure to the solvent include reversible mood and behavioral changes, coordination impairment, dizziness, headaches, drowsiness, and unconsciousness. Chronic long-term inhalation exposure can cause neurological effects, such as impaired cognitive and neurobehavioral performance. A study published in 2010 stated that people exposed to perchloroethylene had nine times the risk of developing Parkinson's disease.[10] By comparison, the use of hexane, a solvent that is used to clean film by hand, does not increase the risk of the disease, though hexane presents other health risks.

Perchloroethylene exposure can also have adverse effects on the liver, immune system, hematologic (blood) system, and reproduction system. Studies of exposed workers have found associations with several types of cancer, including bladder, non-Hodgkin lymphoma, and multiple myeloma.[11] Because of this, the U.S. Environmental Protection Agency has classified perchloroethylene as likely carcinogenic to humans.[12]

Because of the health and safety risks of perchloroethylene, the Occupational Safety and Health Administration (OSHA) in the United States indicates that the permissible exposure limit (PEL) for perchloroethylene is one hundred parts per million (ppm) over an average of eight hours. OSHA also states that peak exposure should not exceed two hundred ppm for five minutes in any three-hour period. The PEL in California and some other states is twenty-five ppm.

Because perchloroethylene is heavier than water and oxygen, it lingers on the ground. This property increases the hazard to workers who perform maintenance and repair on film cleaning machines, because such work tends to happen at the bottom of the machine. The molecular weight of perchloroethylene is 165.83 g/mol, while water's molecular weight is 18.01528 g/mol and oxygen's is 31.9988 g/mol.

Adequate ventilation must be provided to employees who work with perchloroethylene. If adequate ventilation is not available, a NIOSH respirator must be worn. In confined areas, a self-cleaning breathing apparatus must be worn. "A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area."[13] If the exposure limit is exceeded, workers should wear a "supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus."[14]

Aside from inhalation, perchloroethylene can also easily be absorbed into the skin. Workers should wear appropriate chemical-resistant gloves when operating a film cleaning machine. A nearby eyewash station is also advised. In addition, employees may want to wear chemical safety goggles or a full face shield where perchloroethylene splashing may occur. Protective chemical-resistant clothing may also be worn, but that is dependent on the potential exposure conditions (such as large spills).

Despite precautions, spills may still occur. When a spill occurs, workers should don necessary personal protective equipment, such as chemical-resistant gloves and/or clothing. If a small spill occurs, workers should isolate the spill and stop its source, if it is safe to do so. Workers can absorb the spill using inert media and place the soiled media into a suitable container (airtight and leakproof). If a large spill occurs, workers should shut off or plug the source of the spill as long as it is safe to do so. They should dike the area to contain the spill and salvage as much liquid as possible into a suitable container. Any residual liquid should be absorbed onto inert media and placed into the suitable container. The perchloroethylene should not be allowed to enter a drain, a sewer, or any waterway.

The following first aid measures are for perchloroethylene. A person suffering from acute exposure to inhaled vapors should immediately be moved to fresh air. If they are not breathing, give artificial respiration, and if breathing is difficult, give oxygen to the person. Call a physician. If a person has ingested perchloroethylene, *do not induce vomiting* but instead give large quantities of water. Never give anything by mouth to an unconscious person. Perchloroethylene is an aspiration hazard.

If a person's skin comes into contact with perchloroethylene, the person should immediately wash with soap or a mild detergent for at least fifteen minutes. Any contaminated clothing and shoes should be removed and washed before being worn again. As with inhalation exposure, call a physician.

If a person's eyes come into contact with perchloroethylene, they should immediately flush their eyes with plenty of water for at least fifteen minutes while lifting their lower and upper eyelids occasionally to allow water to rinse the entire eye. Medical attention should be sought immediately.

ENVIRONMENTAL ISSUES

Hazardous waste[15] poses a greater risk to the environment and human health than nonhazardous waste and therefore requires strict control. Not all but some film cleaning solvents, for example, perchloroethylene, are classified as hazardous waste. In addition, packaging waste that contains hazardous substances is also considered hazardous waste and, like perchloroethylene, requires special disposal. Even if a cleaning solvent is not classified as hazardous, it may still be necessary to arrange for disposal only through organizations that specialize in hazardous waste.

State laws and regulations govern disposal of hazardous waste, which is often managed by local waste disposal authorities. Therefore specialized and licensed treatment, storage, and disposal facilities should be contacted to obtain professional information about disposal for hazardous wastes.

The solvent 1-1-1 trichloroethane, also known as methyl chloroform, is a popular solvent previously used as a film cleaner. It is clear, colorless, nonflammable, and nondamaging to film. Its use decreased rapidly after the signing of the 1987 Montreal Protocol on Substances That Deplete the Ozone Layer, a global agreement that sought to protect the ozone layer by phasing out substances that damaged it. The agreement went into force in 1989, and use of the solvent was banned in 1996, with possible use exemptions.

Over the years, perchloroethylene has become a popular replacement for 1-1-1 trichloroethane in film cleaning machines. Like 1-1-1 trichloroethane, perchloroethylene is clear, colorless, and nonflammable. It is one of the most widely found substances in hazardous waste sites in the United States. The solvent is mostly released as vapor directly into the air. When perchloroethylene gets into surface water or surface soil, it tends to evaporate quickly. However, it can potentially leach below surface soil into groundwater and the air space between soil particles, thus contaminating them.

A hazardous waste disposal company should be employed to get rid of unwanted perchloroethylene. Because it is a soil and water contaminant, perc should never be poured down a drain or onto soil. "Federal regulations prohibit land disposal of various chlorinated solvent materials that may contain tetrachloroethylene [perchloroethylene]. Any solid waste containing tetrachloroethylene must be listed as a hazardous waste unless the waste is shown not to endanger the health of humans or the environment."[16]

FEATURED CASE STUDY: PACKARD HUMANITIES INSTITUTE CARBON CAPTURE SYSTEM

The film lab at the Packard Humanities Institute (PHI) in Santa Clarita, California, takes precautions in its use of perchloroethylene and the operation of its cleaning machine to be as safe as possible to both its staff and the environment.

PHI uses a carbon capture system from Evoqua Water Technologies, the Vent-Scrub Adsorber VSC 200, to capture perchloroethylene vapors from the cleaning machine. This system is ideal for a small organization or lab (Figure 5).

The carbon capture system consists mainly of a steel drum containing two hundred pounds of carbon that is attached to the bottom of the cleaning machine and an exhaust fan at the top of the drum. The carbon acts as a scrubber for the perchloroethylene fumes, and the small amount of remaining fumes goes through the exhaust fan via a tube that leads outside the building. Before the perchloroethylene vapors enter the carbon drum, the concentration of perchloroethylene is approximately three hundred ppm. After the vapor is scrubbed, the concentration can be as low as one ppm—far below the California and OSHA PELs.

As the vapor enters the exhaust tube, it is measured with a handheld photoionization gas detector or "sniffer." When the sniffer reads

Figure 5. PHI carbon capture system.

approximately five ppm, that is when breakthrough is about to occur—when the carbon is saturated and can't scrub as well as it did when it was first attached to the cleaning machine. When the reading is ten ppm or higher, the drum is changed.

The carbon capture system can absorb an average of five gallons of perchloroethylene vapors before the carbon is saturated and unable to scrub as well as it did when it was new. Approximately forty thousand to fifty thousand feet of film can be cleaned per gallon of perchloroethylene. It is important to note that the carbon can still absorb perchloroethylene after breakthrough, but not nearly as well as it does prior to breakthrough.

CONCLUSION

Film cleaning practices seem to be a matrix of suboptimal solutions. Some options take a great deal of time or are technically demanding. Some options present health hazards, or they may be too expensive. Each practitioner must weigh the trade-offs between time, safety, cost, performance, and maintenance issues to find the best cleaning option for the films, while considering the environment and the humans who are doing the work.

We hope that the survey and this article encourage further investigation into film cleaning in the archival community. During this project, we found many questions that deserve a more thorough review. We would like to know more about the long-term effects of various cleaning methods on films, with special attention to their effects on nitrate, tinting/toning, and stencil films. We would like to know more about the chemical composition of some of the branded and proprietary film cleaning solvents for which no MSDSs were available.

As part of this research, we contacted the Image Permanence Institute (IPI), which confirmed that it has not conducted any kind of research or study on the long-term effects of cleaning solvents on different film base materials.[17]

It may benefit the AMIA community to start user groups for specific cleaning machines, especially as knowledge about maintenance and parts is likely to become more scarce.

As Janice Allen stated in her survey response, “proper cleaning is a very important part of the preservation process and is a step that should not be taken lightly. Film elements need to be cleaned responsibly, as those elements are often the best remaining preservation element, keeping in mind that much of such remaining film elements may very well outlive the digital data being generated from them.”[18] Cleaning carefully and thoughtfully, knowing how to avoid damaging the element, is a critical step for long-term film preservation.

GENERAL INFORMATION ABOUT FILM CLEANING

The National Film and Sound Archive of Australia offers a detailed guide to film cleaning[19] in its online *Technical Preservation Handbook,* with specific suggestions for how to spot clean with a cotton swab, information on PTR rollers, and lists of solvents. Brian Pritchard’s website also provides a lot of useful information about motion picture film cleaning.[20]

Susan P. Etheridge works as a film technician for the Hearst Newsreel Project: a joint effort between the Packard Humanities Institute (PHI) and the University of California, Los Angeles (UCLA) to digitize 27 million feet of UCLA’s Hearst Newsreel Collection. Susan obtained her master’s degree in moving image archive studies at UCLA in 2014. Prior to the Hearst Newsreel Project, she worked as a film technician at the motion picture labs Colorlab and Fotokem.

Anne Gant is head of film conservation and digital access at Eye Filmmuseum, Amsterdam, the Netherlands. She is the current head of the FIAF Technical Commission and a member of the AMIA Preservation Committee.

Diana Little directs the Film Department at the MediaPreserve, a laboratory outside of Pittsburgh, Pennsylvania, that specializes in the digitization of archival audiovisual materials. Prior to her time at the MediaPreserve, Diana spent most of a decade working on film restorations at Cineric Inc. in New York City. She holds a bachelor’s degree in film production, history, and theory from Vassar College and completed the certificate program at the L. Jeffrey Selznick School of Film Preservation at George Eastman Museum. She currently serves on the board of the Al Larvick Conservation Fund and has participated in Home Movie Days in New York and Pittsburgh since 2003.

Julia Mettenleiter is an archivist and restorer at the archival film collections of the Swedish Film Institute and a current cochair of the AMIA Preservation Committee. In addition to her MA degree in literature and film studies from the University of Munich, she graduated from the L. Jeffrey Selznick School of Film Preservation in 2018. Previously, Julia held the position of assistant project manager at the film restoration laboratory L’Immagine ritrovata and worked for the Il Cinema Ritrovato festival in Bologna, Italy.

NOTES

Thanks to all the survey respondents, and a special thanks to Janice Allen for her extensive information.

1. Participants: fifty-four archives and practitioners responded, with the majority (thirty-nine) from North America, but there were also respondents from Europe (nine), Asia (three), South America (two), and Africa (one). Respondents came from a variety of institutions: some were from large university archives or national archives, as well as a few commercial labs. The Austrian Film Museum, the British Film Institute, Bundesarchiv, Michigan State University, Pro-Tek Vaults, the Swedish Film Institute, the MediaPreserve, the UCLA Film & Television Archive/Packard Humanities Institute, and the University of Toronto were among the respondents.

More than half of the responses (53.9 percent) came from places with fewer than ten employees. The rest of the respondents came from institutions of varying size: ten to fifty employees (twelve respondents), fifty to one hundred employees (nine respondents), and more than one hundred employees (four respondents).

The respondents also came from a range of institutions, both not-for-profit and for-profit, and several identified as self-employed and/or consultants: archival film holding institution (thirty-two respondents), for-profit film preservation company (ten), not-for-profit entity providing film preservation services (six), consultant or self-employed/volunteer provider of film preservation services (four).

2. Per email correspondence with Kodak sales staff.

3. https://pfas.3m.com/pfas_uses.

4. https://www.kemi.se/en/chemical-substances-and-materials/pfas.

5. The cleaning method is mostly dependent on the material (nitrate, acetate, polyester) and also whether the film contains applied color techniques (tinting, stencil or hand coloring, etc.).

6. https://www.turi.org/Our_Work/Policy/TURA_List/Higher_Hazard_Substances/n-Propyl_Bromide_nPB.

7. https://www.mass.gov/doc/complete-list-of-tura-chemicals-august-2021.

8. According to OSHA HCS (29CFR 1910.1200) and WHMIS 2015 regulations.

9. https://www.cdc.gov/niosh/npg/npgd0599.html.

10. Thomas H. Maugh, "Industrial Solvent Linked to Increased Risk of Parkinson's Disease," *Los Angeles Times,* February 7, 2010.

11. http://www.atsdr.cdc.gov/ToxProfiles/tp18.pdf.

12. https://www.atsdr.cdc.gov/ToxProfiles/tp18.pdf.

13. http://www.ciscochem.com/assets/perchloroethylene-sds.pdf.

14. http://www.ciscochem.com/assets/perchloroethylene-sds.pdf.

15. The U.S. Environmental Protection Agency (https://www.epa.gov/hw) has defined four different hazardous waste characteristic properties. "A waste may be considered hazardous if it exhibits certain hazardous properties ('characteristics') or if it is included on a specific list of wastes EPA has determined are hazardous ('listing' a waste as hazardous) because we found them to pose substantial present or potential hazards to human health or the environment. EPA's regulations in the Code of Federal Regulations (40 CFR) define four hazardous waste characteristic properties: ignitability, corrosivity, reactivity, or toxicity (see 40 CFR 261.21–261.24)." https://www.epa.gov/sites/default/files/2016-01/documents/hw-char.pdf.

16. http://www.atsdr.cdc.gov/ToxProfiles/tp18.

17. IPI's executive director confirmed in an email conversation from March 2022 that no research on this topic has been done.

18. Janice Allen, email correspondence with the authors, November 29, 2022.

19. https://www.nfsa.gov.au/preservation/guide/handbook/conservation.

20. http://www.brianpritchard.com/FAOL/contents/2604200faol/Foncd/TEXTS/sect_6/filmcleaidx6.html.