# Dry cleaning methods for unfinished wood: a comparative research


## Abstract

*This comparative research investigates the effect of dry cleaning materials on untreated pinewood. An inventory of dry cleaning materials was compiled based on research, review and evaluation of relevant literature. Various properties of dry cleaning materials were evaluated. Based on this evaluation a selection was made of fifteen different materials.*

*After investigating the composition of surface dirt we concluded that the artificial soil recipe developed by Ormsby and Phenix can be used to reconstruct a soiled wooden surface. This reconstruction was used in the experiments that determined the effectiveness and controllability of the cleaning materials. With this reconstruction, and the naturally soiled aged test surface, tests were conducted to determine the effectiveness and controllability of the cleaning materials. Both were assessed by visual observation, and by utilising a Hirox digital microscope.*

*Furthermore, the effects of the cleaning materials on the surface were examined. In this series of experiments gloss change, colour change, degradation of surface topography and presence of residual material was tested. The aforementioned properties were examined by means of UV fluorescence microscopy. Tri-Gloss master (85°), the Minolta spectrophotometer, Scanning Electron Microscope and Hirox digital microscopy.*

*It was concluded that, based on the experiments carried out within the scope of this research, the most appropriate cleaning materials are Akapad White and Soft, Smoke sponge, Sofft tools and make-up sponges.*


**Figure 1.** Dry cleaning untreated pine wood with a rubber eraser (Big Galet).

## Introduction

Commonly, wooden objects have a finishing layer. Besides giving an aesthetically pleasing effect, a finish layer protects the underlaying wood against dirt and grime. Without this protective layer dirt and grime can deposit easily on the surface of an object. Due to the sensitive nature of an unfinished wooden surface, the removal of surface dirt using aqueous cleaning methods can increase the adhesion of loose dirt with the surface. This can result in uneven spreading of the dirt.

Surface dirt on bare wood surfaces can build up and attach to the surface over time. When combined with moisture or fatty substances, the dirt can form a resilient layer of surface dirt that is hard to remove. Cleaning the surface with a soft brush and a vacuum cleaner will not remove this kind of surface dirt. The build up of surface dirt can cause a loss of the aesthetic value of an object. The buildup of surface dirt can also cause further deterioration of the object.

Within the context of this research 'untreated' or 'unfinished' wood indicates a wooden surface without any protective coating or finishing layer (wax, paint, oil, shellac, etc.) When looking at furniture untreated wood can be found on the back, top or inside a cabinet, chest or drawers. Untreated wooden surfaces can be found in many varieties in diverse collections. For example, modern art and ethnographic collections contain a wide variety of objects with untreated wooden surfaces. Within ethnographic collections unfinished objects like tools, weapons, musical instruments, masks and other ritual objects can be found

Many modern artists used untreated wood or plywood to create their artworks. An example of two modern art pieces that were made with unfinished plywood can be found in the research of Esmay and Griffith (2004): a piece by Donald Judd (1978), consisting of sixteen Douglas fir plywood wall pieces and a work by Charles and Ray Eames made from moulded plywood with mahogany veneer. These two pieces sparked their investigation into cleaning methods for untreated plywood.

The object that provided the scope for this research is a modern art object by the Dutch artist Araun Gordijn. It is made from untreated pinewood, combined with untreated and painted wooden objects. The surface of the object is covered with a resillient layer of surface dirt, which affects the aesthetic value of the object. In its current state, it cannot be exhibited.

The research done so far, does not provide enough information to make a decision about an appropriate cleaning method or material.

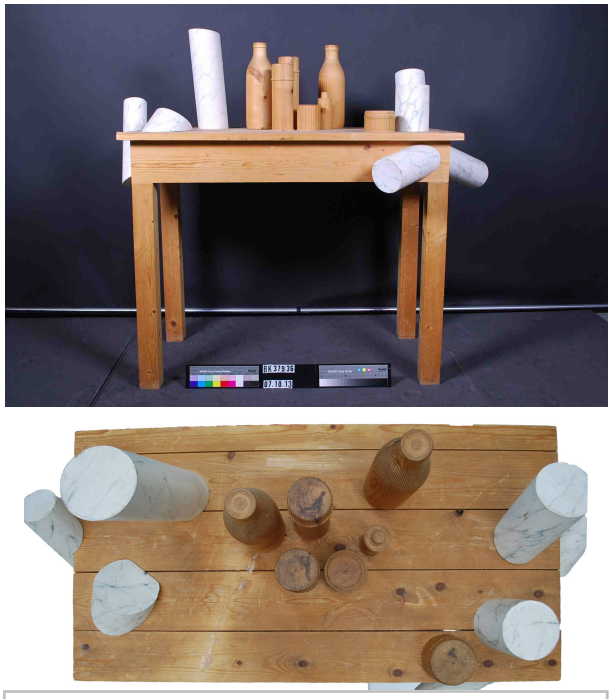


**Figure 2.** Object by artist Araun Gordijn, *Still Life with Cylindrical Object*, 1977, Cultural Heritage Agency of the Netherlands.

As mentioned before, Gordijn's object will define the scope of this research. The material (pinewood), surface dirt and patina of the wood will define the test material that will be used for testing the different properties of the dry cleaning materials.

*Surface dirt*

Important factors that are related to the formation of surface dirt are the precipitation of particulate air pollution on wooden surfaces and dirt formations created by direct contact with the object. The adhesion of dirt on wooden surface is further influenced by both the properties of the wooden surface (grain, structure, smoothness) and particulate matter (substance, particle size).

Particle size plays an important role in the adhesion of the dirt to the surface. For the bonding of larger particles (>1 µm) molecular interaction between particle and surface is the main bonding factor. Humidity plays an important role in the bonding of smaller particles (< 1 µm) due to the hygroscopic properties of the dirt, wood and fatty substances. The polarity of these materials is responsible for the bonding between the different molecules of the materials (Nazaroff 1993).

Another important factor is the composition of surface dirt. The exact composition of surface dirt depends on many different factors such as geographical location, outdoor pollution and indoor conditions such as air filtering systems and air-conditioning.

Generally speaking, dirt consists of 50-70% organic material, 20-30% inorganic material, fatty substances (oils from skin and pollution) and moisture (Nazaroff 1993, Wolf 1994).

This information was used for the construction of an artificially soiled wooden surface. The reconstruction is used in the experiment to determine the effectiveness and controllability of the cleaning materials.

Only one specific recipe to reconstruct soil/dirt was found, created by Ormsby and Phenix (2010). This recipe is commonly used in dry cleaning workshops in the UvA and RCE, for reconstructing an artificially soiled paint surface.

**Figure 3.** The reconstructed soiled surface created with the recipe of Ormsby on pine wood. (Hirox microscope, magnification 100x)
Artificial dirt recipe by Ormsby and Phenix (2010)
2,00 g Ivory black
0,50 g iron oxide
1,75 g silica
20,00 g kaolin
10,00 g gelatine powder
10,00 g water soluble starch
17,50 g cement
Demineralised water
10,00 ml olive oil

## Materials and experimental methods

### *Literature research*

First, a preliminary literature research was done. This showed that, although some basic research on dry cleaning wood has been conducted, the available literature is very limited and focuses mainly on materials such as paper, leather and painted surfaces.

The research of Francesca Esmay and Roger Griffith (2004) focuses specifically on the dry cleaning of wood. Two possible effects of dry cleaning were investigated. First, the potential for the wood to become abraded or burnished as a result of the mechanical action during cleaning. Second, the potential for cleaning product residue that can discolour over time. The publication *Holz Ohne Überzug: Mechanismen Der Verschmutzung, Reinigung, by Anngrit Wolf* (1994), describes the mechanisms of pollution and some cleaning procedures for untreated wood.

Another helpful study is the research done by Daudin-Schotte et al. (2013) on the dry cleaning of unvarnished paint surfaces. The experiments in this study were partially based on this research. The RCE (Cultural Heritage Agency of the Netherlands) researched the properties of dry cleaning materials and the effects they have on the cleaning of unvarnished paint surfaces. The dry cleaning materials have been tested and analysed to define the chemical content, ageing properties and the amount of residual material after cleaning (Keulen et al. 2012).

### *Cleaning materials*

Based on the literature on different cleaning materials six categories of dry cleaning materials were made: kneadable materials, powders, sponges, make-up sponges, erasers and microfibre cloths. In each category a number of different materials were selected. Information about cleaning efficiency, composition of the material, effects on different surfaces (leather, paper, paint), residual materials and their potential damage after ageing was collected from the available literature. Manufacturers' information about the composition of most cleaning materials is either unavailable or insufficient. The fact that manufacturers might change the composition of the material has to be taken into consideration.

The selected dry cleaning materials were: Groom/stick (kneadable sticky rubber), Absorene (starch based paste), kneadable rubber eraser, Draft Cleaning powder, Akawipe (rubber based powders), Akapad White, Akapad Soft (both styrene butadiene rubber based sponges), Smoke sponge (isoprene rubber based sponge), Sofft tools, HEMA and Etos make-up sponges , Bic Galet, Staedtler Mars Plastic and two different microfibre cloths (LFYC yellow and Handy blue).

**Figure 4.** The cleaning materials that were tested during this research: Groom/stick, Absorene, Kneadable rubber eraser, Draft Cleaning powder, Akawipe, Akapad White, Akapad Soft, Smoke sponge, Sofft tools, HEMA and Etos make-up sponges, Bic Galet, Staedtler Mars Plastic and two different microfibre cloths (LFYC yellow and Handy blue).

*The reconstruction of a soiled surface*

One of the problems encountered during this research, was finding an appropriate test surface. Since the artwork of Araun Gordijn is used to define the scope of this research, the surface should more or less resemble the soiled surface of the artwork.

A naturally soiled and aged test surface (fig.6) was used for the experiment where the residual material and changes in gloss, colour and surface topography were examined. The wood, found at the RCE, was selected based on similarity with the object of Araun Gordijn.

To be able to test the effectivity and controllability, the soiled surface needed to be compared to a completely clean surface in order to measure the amount of dirt that is removed.

Based on the recipe of Ormsby and Phenix (2010) an artificial dirt mixture was created. For comparison, natural dirt was also collected and applied to a sample surface. The application method was not explained in the related literature, so different methods were tested.

After testing various methods of applying reconstructed and 'natural' dirt, the samples were artificially aged using a climate chamber with fluctuating RH and temperatures (Vötsch HC 0020 Climatic Test Chamber, 50°C, RH 30-80% for 21 days). After ageing, some tests were done with different dry cleaning materials which were compared with the cleaning process of naturally aged and soiled samples. Subsequently, the samples were examined with a Hirox microscope.

The artificial ageing process did not help the adhesion of the dirt to the wooden surface. Rubbing the dirt on the surface with a cloth and spraying the surface with moisture and fatty substances with a micro-sprayer resulted in a representable soiled test surface.

**Experiments**

*Effectivity*

When choosing a cleaning material, effectiveness is an important factor to take into consideration. Depending on the desired result, (e.g., partial or complete dirt removal), the requirements for the cleaning material can differ.

Two different test surfaces (naturally soiled and reconstructed) have been used to define the effectivity of a specific cleaning material. The results on both test surfaces were very similar. This

**Figure 6.** The tools that were used in the reconstruction of surface dirt. The dirt was filtered and applied using a fine sieve (1000 mesh). After this, the surface was sprayed with a mixture of liquids with a micro-sprayer.

confirms again the representativeness of the reconstruction. Before starting the experiment, a small test was done to define the average amount of pressure that needs to be applied to clean a soiled surface. Using a scale, timer and camera, these parameters were defined.

The effectiveness of a cleaning material is based upon the following parameters: the amount of dirt removed within a specific time (30 seconds of cleaning), the cleaning power for 'dry' dirt and greasy dirt, the evenness of the result, the amount of dirt removed and the total time necessary to completely clean a specific surface.

After cleaning the test surfaces with the different cleaning materials, results were photographed, analysed and compared. Akapad White, Akapad Soft en Bic Galet were very effective cleaning materials: they removed most of the dirt within the given amount of time. The dirt was removed equally, giving an even result. Groom/stick, kneaded rubber eraser, Akawipe, Smoke sponge and Staedtler Mars had an average score. The least effective materials were Absorene, Draft powder, Sofft tools and the two make-up sponges.

*Controllability*

In the process of cleaning an art object it is important to have control on the amount of dirt that is removed in a specific area. While for some objects the desired result might be complete removal of dirt, other objects might require a more controlled cleaning process (removing the dirt layer by layer). Complete dirt removal might give an uneven result by revealing underlaying stains or damages in the surface. A layered dirt removal might be desired when a part of the dirt is


**Figure 7.** Left picture: on the left a naturally aged and soiled sample, on the right the reconstruction (before cleaning with Akawipe). Right picture: after cleaning with Akawipe.

considered to be part of the patina of the object.

The cleaning tests are performed on a reconstructed and a naturally soiled surface. The surfaces were cleaned three times in steps of five. The cleaning material was rubbed on the surface with a specific movement and amount of pressure. The result was photographed and visually judged on the amount of removed dirt. Another parameter that is taken into consideration is the possibility of local dirt removal. Is it possible to clean a very small part of the surface, or is it only possible to clean a larger less defined part?

Smoke sponge, Sofft tools and both make-up sponges have the highest scores for controllability of the cleaning process. The microfibre cloths have an average score but were limited in amount of dirt that could be removed. The kneaded rubber eraser, eraser powders, both Akapad sponges and Staedtler Gum, have an average score on controllability. After the three cleaning steps the dirt is completely removed. Groom/stick and Absorene have the lowest scores. After one step (5x cleaning) all the dirt is removed from the surface.

*Effects on the surface; changes in gloss, colour and abrasion of the surface.*

Besides the controllability and effectiveness of the cleaning method, it is important to know how a cleaning method can affect the surface of an object. With dry cleaning, the biggest risks are polishing (by flattering the wood fibres), abrasion (by removing fibres and roughening the surface) of the surface and a change in the colour of the surface resulting in a change in the surface gloss and damaging the patina of the surface (discolouration as a result of ageing of the wood). Any residual material embedded in the surface after cleaning might also change the appearance of the wood.

The effect of the cleaning method on the gloss, colour and surface topography was tested on naturally aged wood, comparable to the wood of the case study, described earlier. The test material has a similar gloss, colour and surface roughness as the object of Araun Gordijn.

*Gloss*

The test material is cleaned for 30 seconds with the specific pressure that was defined for each material in the previous experiment. The test boards are marked on the side to make sure the measurements were done in the same area and direction for each measurement. For each sample, ten measurements were taken with a gloss measurement device (Sheen Tri-glossmaster 260 [85°]). Two control measurements were done on two test samples of naturally aged pine wood.

Only on the surfaces that were cleaned with Smoke sponge and Staedtler Mars a small change in gloss was visually noticeable. These visual changes did not correspond with any of the values that were measured with the gloss-meter. In general there were no noticeable changes in gloss for any of the chosen cleaning materials.

*Colour*

Abrasion of the surface due to the mechanical action of the cleaning method might cause a change in colour. Naturally aged wood, in this case pine wood, darkens when it ages. This is considered to be the *patina* (desirable traces of ageing or use on the surface) of the wood. When scratching or abrading the surface, the underlaying (lighter) wood can become visible.

The same process of cleaning, as described above, was carried out for examining possible changes in colour. The surface colour was measured with a Minolta Spectrophotometer CM-2600d/2500d with a target mask of ø8 mm.

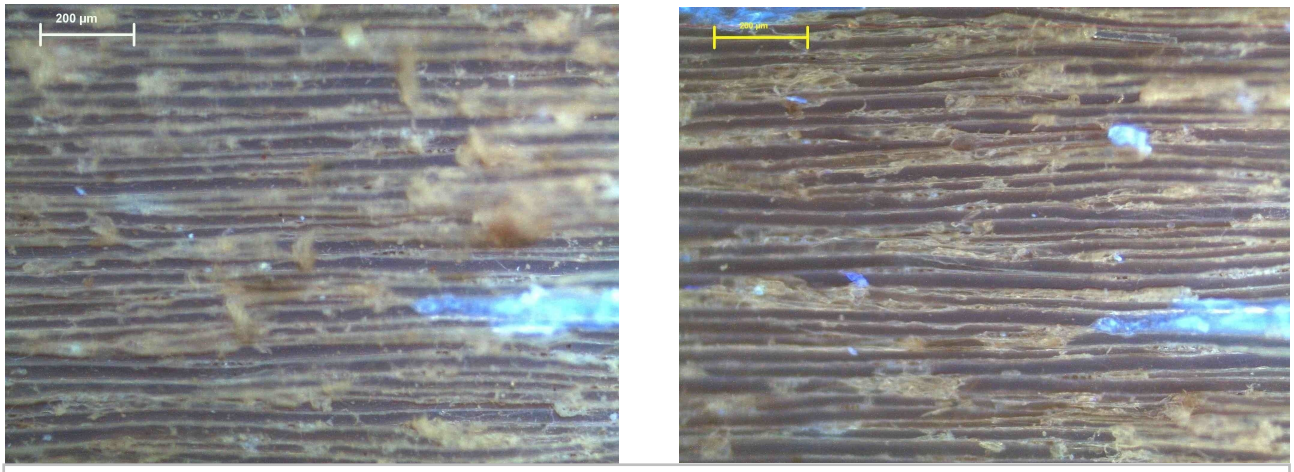



**Figure 8.** Left: wooden surface before cleaning, right: after cleaning with Sofft tools. The surface has been polished by flattening or removing the loose fibres on the surface. (LEICA microscope PM 2500M, UV-light, 100x)

Mars Staedtler Plastic caused the largest measured and visible change in colour. With other cleaning materials small changes in colour were measured but these colour changes are invisible to the human eye.

*Surface topography*

The abrasive properties of the cleaning materials, combined with the mechanical action could damage the surface of the wood. The mechanical action can result in a change in the roughness of the wood or in loss of material on the surface (wood fibres). The test surface is examined and compared, before and after cleaning, with the help of a digital camera, a Hirox digital microscope, a Scanning Electron Microscope. The surface is marked with copper tape, to be able to examine and compare the exact same point with the microscopes.

Groom/stick appears to cause some damage to the surface by removing sensitive fibres from the surface due to the stickiness of the material. The kneaded rubber eraser and Draft powder seem to roughen the surface. Other materials seem to slightly flatten the loose fibres on the surface, creating a smoother surface. Akapad white and Etos make-up sponge have no effect on the structure of the surface at all.

*Residual material*

It is important to know how much residual material is left on the surface after cleaning, how easy it is to remove this and what the long-term effects are on the surface. Upon ageing, plasticisers that are added to the cleaning materials, can cause stains on the surface (Daudin-Schotte et al. 2013).

After cleaning all test samples are cleaned with a soft brush to remove as much residual material as possible. The test samples will be examined, using UV-fluorescence microscopy and a digital Hirox microscope. The amount of residue is examined with 50 and 100 times magnification. The potential damage of the material is defined by information that is collected in the literature.

Smoke sponge, Sofft Tools, the two make-up sponges and both types of microfibre cloths have the best results. These materials leave no residual material on the surface at all. The Akapad sponges leave a very small amount of residue, even after brushing the surface. According to the literature (Keulen et al., 2012), these residues do not cause any damage upon ageing. Both the Staedtler Mars and Big Galet erasers leave a residue on the surface. This residue can potentially damage the surface, due to the plasticisers in the material. The malleable materials (Groom/stick, Absorene and kneadable eraser) and eraser powders leave a large amount of residue on the surface. These residues are difficult to remove and could potentially damage the surface.

**Figure 9.** Residual material after cleaning with Groom/stick. (Hirox, 150x)

**Figure 10.** Residual material after cleaning with Absorene (Hirox, 50x)

## Conclusion

The tests that were done for this research give an indication of the cleaning properties of the different dry cleaning materials that were tested. For this study, only pine wood was used as testing material. Pine wood is a soft wood, so the risks of damaging the surface are higher compared to hard wood. The reason for choosing this material was the problematic layer of surface dirt, found on the object of Araun Gordijn.

The usability of cleaning material depends on the desired result of the treatment. Each object will demand a different treatment. Depending on this treatment, the demands for the cleaning material can be decided. For one object, a very effective cleaning material might be desired, while for another object controllability might be more important.

By researching effectivity, controllability, the residual material and its potential effect on the surface and specific effects on the surface (change in gloss, colour and surface topography), an overview of the different properties of cleaning materials was created. This overview can support a decision or decision making process, for a dry cleaning treatment for a specific art object.

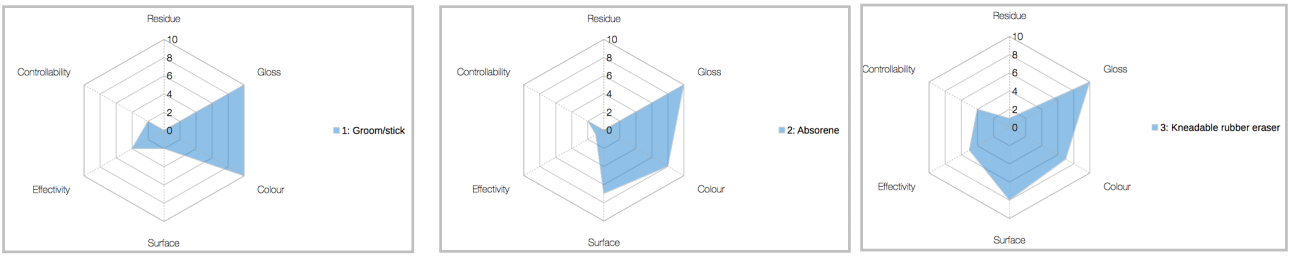
Materials that can be used without causing damage to the surface are Akapad white and Akapad soft, Smoke sponge, Sofft tools, microfibre cloths and both make-up sponges. The Akapad sponges are very effective cleaning materials and might be used for cleaning large, heavily soiled areas.

Smoke sponge, Sofft tools, microfibre cloths and make-up sponges are highly controllable cleaning materials. These materials leave no harmful residues on the surface. Non of the aforementioned materials have serious impact on the colour, gloss or topography of the surface.

Malleable materials such as Absorene, kneadable rubber eraser and Groom/stick leave a lot of potentially harmful residue on the surface. Due to the stickiness of the material, there is a high risk of damaging the surface. Erasers (Staedtler Mars and Big Galet) are very effective cleaning materials, but have a potential to harm the surface. The powdered erasers (Draft cleaning powder and Akawipe) are difficult to control and handle and leave large amounts of residue on the surface.

To be able to compare the different properties of the materials, all results are graded during the experiments (0-10). These grades are based on the different properties that were tested during the experiments. Each property was assigned a specific amount of points, depending on its importance for the total result. To be able to compare the different results, evaluation tables were created. In these tables, the different results are shown, for easy comparison.

**Table 1-15.** The results of the tests are show in a diagram: from the top, clockwise the score for residual material, change in gloss, colour and surface, effectivity and controllability are shown.



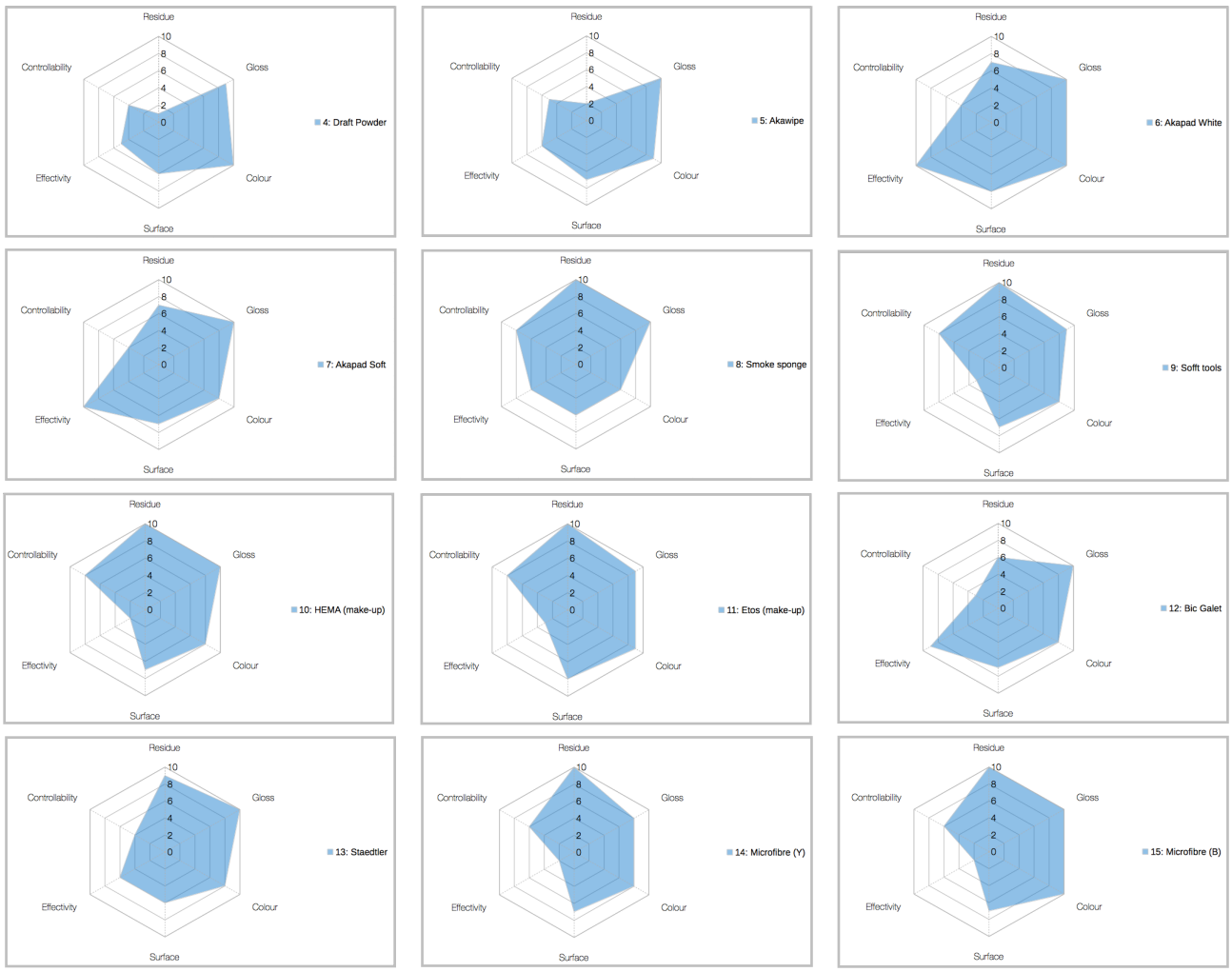



**Table 16.** The total results of the different experiments that were conducted for this study.

| Cleaning material | Residue | Gloss | Colour | Surface | Effectivity | Controllability | Total |
|---|---|---|---|---|---|---|---|
| 1: Groom/stick | 0 | 10 | 10 | 2 | 4 | 2 | 5 |
| 2: Absorene | 0 | 10 | 8 | 7 | 1 | 2 | 5 |
| 3: Kneadable Eras. | 1 | 10 | 7 | 8 | 5 | 4 | 6 |
| 4: Draft Powder | 1 | 9 | 10 | 6 | 5 | 4 | 6 |
| 5: Akawipe | 2 | 10 | 9 | 7 | 6 | 5 | 7 |
| 6: Akapad White | 7 | 10 | 10 | 8 | 10 | 4 | 8 |
| 7: Akapad Soft | 7 | 10 | 8 | 7 | 10 | 4 | 8 |
| 8: SmokeSp. | 10 | 10 | 6 | 6 | 6 | 8 | 8 |
| 9: Sofft tools | 10 | 9 | 8 | 7 | 3 | 8 | 8 |
| 10: HEMA | 10 | 10 | 8 | 7 | 2 | 8 | 8 |
| 11: Etos | 10 | 9 | 9 | 8 | 3 | 8 | 8 |
| 12: Bic Galet | 6 | 10 | 8 | 7 | 9 | 3 | 7 |
| 13: Staedtler | 9 | 10 | 8 | 6 | 6 | 4 | 7 |
| 14: Microfibre. (Y) | 10 | 8 | 8 | 7 | 2 | 6 | 7 |
| 15: Microfibre. (B) | 10 | 10 | 10 | 7 | 2 | 6 | 8 |

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