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Historical recipes for preparatory layers for oil paintings in manuals, manuscripts and handbooks in North West Europe, 1550-1900: analysis and reconstructions

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Figure 13.1 Lead white flakes in a stack-process corrosion pot from the Schoonhoven Factory

Archive of Old Holland Classic Colours, Driebergen, Netherlands.

Photo: HART Project, De Mayerne Programme, Amsterdam

Chapter 13 Lead white: the implications of the use of different qualities of lead white

Flake white is more white than ceruse, it could even match Krems [white] in whiteness, if one took more care during its preparation.

Mérimée 1830¹

13.1 Introduction²

Exact knowledge of historical lead white terminology is important for a correct interpretation of historical recipes for painting methods and materials. It is a first step in understanding the many recipes for preparatory layers that include lead white. Before a choice can be made regarding the quality of lead white employed in reconstructions of historical ground recipes, knowledge of its exact identity is of essential importance. As a first step towards such knowledge, terminology employed in historical recipes needs to be clarified. This chapter investigates lead white terminology as employed in a large group of European recipes dating from the fifteenth century onwards (Fig. 13.2).

Knowledge of lead white qualities in historical recipes may be important for an additional reason. Since lead white quality has implications for ageing characteristics of ground layers and may influence phenomena such as lead soap formation and the resulting increase in transparency or possible formation of lead soap protrusions, thorough knowledge of the nature of materials mentioned in recipes is crucial.³

A connection may exist between lead soap formation inside ground layers and the use of low-quality or less refined lead white.⁴ It would seem a logical assumption that for preparatory layers a lower quality may have been employed. They required relatively large amounts of material and lead white is not a very cheap pigment.⁵ In addition the visual characteristics of preparatory layers may have been considered of lesser importance, since the preparatory layers were covered by later layers of oil paint. Therefore the use of a cheaper material would be a logical method to save money. Indeed, the fact that many

¹ Mérimée 1830: 223

² This chapter is an updated version of Stols-Witlox 2011

³ Prior research on the chemical reactions leading to such paint defects (by amongst others: Boon et al. 2002, Van der Weerd et al. 2002, Noble et al. 2008), has identified a number of parameters that may influence their occurrence. Besides the role of moisture to facilitate transport of (metal) soaps through the paint layer, lead white analysis has revealed that the formation of a 'healthy' oil network may be influenced by the lead white quality employed. *See* for more discussion on this topic Chapter 14 on lead white processing by washing and decanting.

⁴ In Chapter 14, I will refer to the different chemical reactivities of different lead carbonates.

⁵ Van de Wetering 1997: 304, note 96 provides information on the price difference between lead white and ochres in seventeenth century Rotterdam and Dordrecht. Van de Wetering notes that in the inventory of the estate of Trijntge Pieters (1648), 246 pound of brown ochre costs 8 guilders and 12 stuivers while 28 pound of lead white costs 4 guilders, and he writes that in a 1667 estate in Dordrecht, yellow ochre costs 5 guilders per 100 pound while lead white costs 14 $\frac{3}{4}$ guilders per 100 pounds..

double grounds consist of a lower layer containing cheaper materials and a top layer of more expensive pigments,⁶ supports the validity of this thought.

If we suppose that ground layers do indeed contain cheaper lead whites, the following questions arise: What determines the quality of lead white, what distinguishes low and high quality lead whites and do historical recipes provide support for the hypothesis that cheaper lead whites were advised to be used in preparatory layers? The present chapter investigates these issues through a detailed examination of lead white production and cleaning recipes and relates the results with terminology used for lead white in preparatory layers.

This chapter is based on the study of a collection of recipes for lead white preparation, adulteration and use of lead white (Fig. 13.2a) that includes recipes from The Netherlands, France, Belgium, Germany, England, Italy (Fig. 13.2b).

13.2 Lead white making

Prior to the nineteenth century, lead white is produced mainly by methods that may be considered dry corrosion processes. Metallic lead is exposed to acetic acid (vinegar) in a carbon dioxide-rich environment. Elevated temperatures are used, so that the acetic acid evaporates and reacts with the lead to form lead acetate. This subsequently reacts with carbon dioxide to form (basic) lead carbonate, also known as lead white.⁷

As an important pigment in house paints and pharmaceutical products, lead white was produced in large quantities.⁸ Venice was an important production centre for lead white during the Middle ages and the sixteenth century.⁹ From the end of the sixteenth century, however, large-scale lead white production is introduced also in Holland. De Vlieger & Homburg (1992) believe that the introduction may be linked to the fall of Antwerp in 1585, when many craftsmen fled northward.¹⁰ As in earlier recipes, the Dutch use earthenware jars, filled with a layer of vinegar on top of which lead is placed. The jars are covered with ceramic lids or lead plates and buried in horse manure,¹¹ the fermentation of which raises the temperature and supplies carbon dioxide. Fermentation times vary between fifteen and fifty days (Fig. 13.3).

⁶ See Chapters 5 and 10.

⁷ Olby (1966) showed that lead white is a mixture of cerussite (PbCO_3) and hydrocerussite ($2\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$); other lead salts like plumbonacrite ($\text{Pb}_5\text{O}(\text{OH})_2(\text{CO}_3)_3$) may also be found on occasion. Plumbonacrite is reported to transform easily to hydrocerussite and is not always detected in lead white samples. Olby 1966: 2509-2512.

⁸ The total export through Amsterdam and Rotterdam around 1790 was c. 1.350.000 kg. De Vlieger and Homburg 1992: 10.

⁹ Berrie and Matthew 2011: 295-301.

¹⁰ De Vlieger and Homburg 1992: 13.

¹¹ Horse manure contains the lowest percentage sulphides of all manures, thus preventing the formation of black lead sulphide. Gentile, J., *Lehrbuch der Farbenfabrikation*, Friedrich Vieweg und Sohn, Braunschweig, (1860): 147

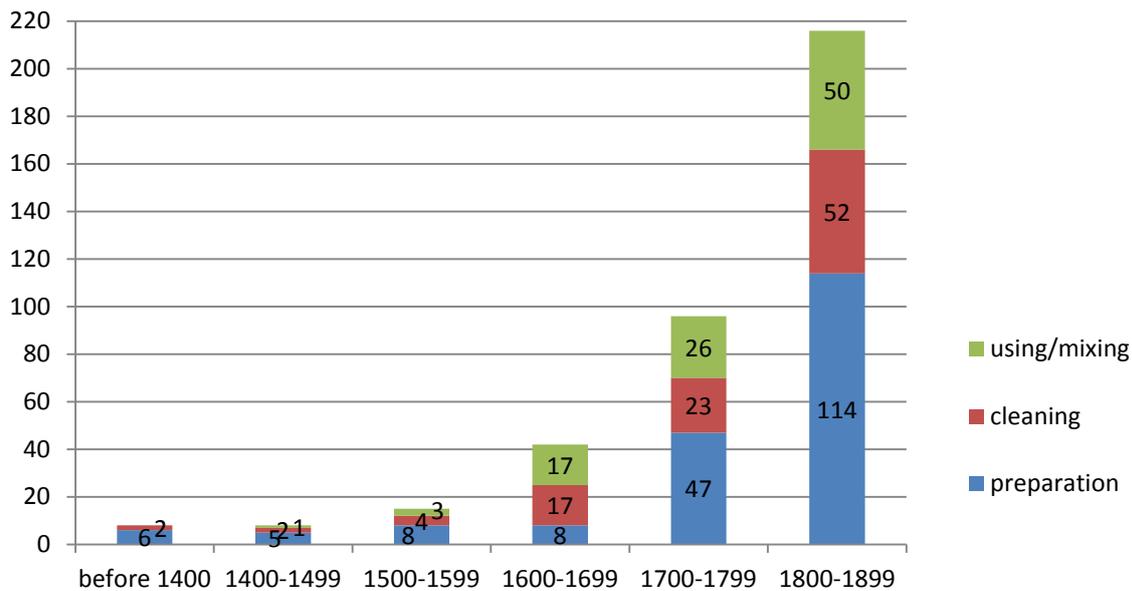


Figure 13.2a Lead white recipes grouped according to function

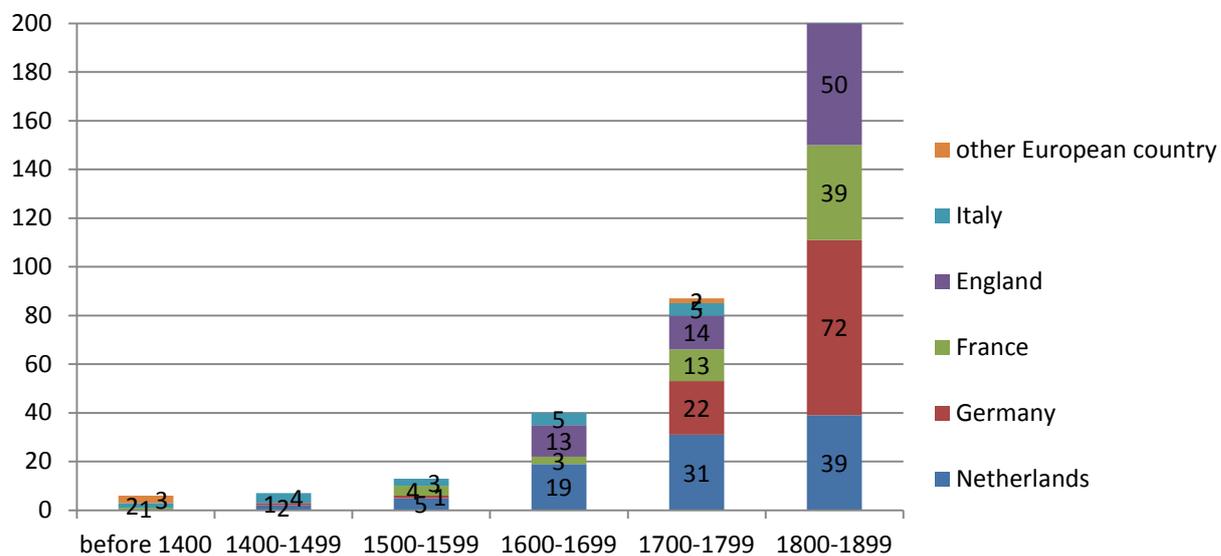


Figure 13.2b Lead white recipes grouped according to geographical origin

After fermentation, the corroded lead is removed from the jars, the rolls are flexed and crushed or the lead white is scraped off and the material is processed. Whatever is left of the coils and sheets after lead white removal can be re-used. Usually the manure is used only a couple of times, since its quality diminishes. It needs to be relatively fresh. Good quality horse manure is important, and should neither be too wet or too dry. Sometimes water or horse urine is poured on to ensure a moist manure.¹² Low quality manure would lead to black spots in the product,¹³ presumably because of the presence of sulphides, which react with the lead to black lead sulphide. After use, according to two nineteenth century sources the manure is sometimes sold as fertiliser (!).¹⁴

The Dutch optimise the production process by building large stacks, using thin rolled plates of lead instead of thick sheets and increasing fermentation times. Hurst (1892) describes in detail how such large stacks are built and explains that they contain air channels through which 'steam' can escape.¹⁵ To prevent the stacks from collapsing, Gentele (1860) describes how in the stack process, the covering plates are supported by wooden beams.¹⁶ All these measures significantly reduce production costs and raise the turnover. The Dutch product is very successful, both inland and as export merchandise. The same process is introduced in several West-European countries, not always as successfully however, since at times technical knowledge fails. The Dutch product is generally considered to be the highest quality available, at least until the second half of

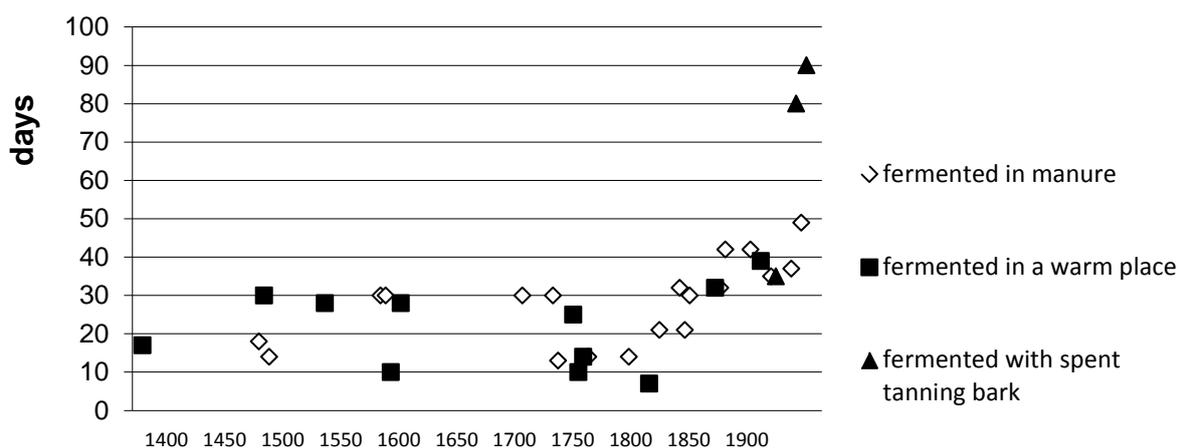


Figure 13.3 Fermentation times for stack-process lead white with different sources for carbon dioxide, according to historical sources

¹² Leuchs 1825: 39: 'Der Mist muß langes Stroh haben und so frisch als möglich sein, damit er im Stande ist, viel Wärme zu erzeugen.' Gentele 1860: 146-7: 'Es kann von vornherein bemerkt werden. daß wenn man diese materialien durch Luftung, Zerstreung oder durch ihre eigene Erhitzung trocken werden läßt. der proceß der Verwesung mit dem Trockenwerden derselben von selbst aufhört. Er beginnt aber wieder bei neuer Befeuchtung, doch geht die Verwesung, wenn sie einen gewissen Grad erreicht hat, allmählich in eine langsamere über, wobei weder so viel Wärme, noch ebensoviele Kohlensäure wie am Anfange erzeugt wird'

¹³ Wiener Farbenkabinet 1794, 149-50: 'In schlechtem Mist bekommt der Kalk schwarze Flecke, die man abnehmen muß'.

¹⁴ Sertzen 1801: 137. Schmidt 1857: 36-9: 'der Mist [wird] theils wieder mit frischem gemengt, verbraucht, theils als Dünger verkauft'.

¹⁵ Hurst 1892: 13.

¹⁶ Gentele 1860: 148-9.

the eighteenth century when competition from factories in Austria, Germany and France grows, sometimes helped by import taxes or other regulations encouraging local production.¹⁷

Just before 1800, spent tanning bark is introduced instead of horse manure, probably at first in England.¹⁸ Historical sources mention fermenting times between ca. ten days and fifty days, the corrosion period probably varying with the quality of the manure, as described by the 1794 *Wiener Farbenkabinet* and in the *Oeconomische Courant* of 1800.¹⁹ Although the reaction using tanning bark takes longer (Fig. 13.3) (see below for description of this material), it is said to provide a more even temperature. Also, the formation of black lead sulphide is prevented.²⁰ In general, there seems to be a slight rise in fermenting times towards the end of the nineteenth century.²¹

Hurst (1892) is one of a number of sources describing how stacks never yield a product of homogenous quality.²² Historical sources report collapsing stacks, inconsistent temperatures, insufficient air circulation and other problems. For instance when the glaze inside the pots is damaged, vinegar would evaporate too quickly and the process would be halted.²³

Thus, lead white quality differs depending on local circumstances inside the stack. Hurst (1892) explains that in some areas the lead white is crumbly and soft, whereas in other areas it is hard and flaky. The latter characteristics are considered a sign of a high quality lead white (Fig. 13.1).²⁴ The *Oeconomische Courant* of 1800 ascribes these differences to different intensities of fermentation within the manure. It also points to a difference in quality of the lead white formed inside the jars and the quality of corrosion product made from the lead sheets that cover the pots.²⁵

¹⁷ De Vlieger and Homburg 1992.

¹⁸ (*Oeconomische Courant* No 94, dec. 1799: 354-5) reports that the use of tanning bark was introduced 'recently' in England. (Bristow 1996: 9) mentions a patent being awarded to Fishwick in 1787. Mérimée is one of the sources who mention the use of moist straw instead of manure (Mérimée 1830: 225).

¹⁹ *Wiener Farbenkabinet* 1794: 149-150; *Oeconomische Courant*, no. 168, 1800: 89.

²⁰ (Schmidt 1857: 39) mentions that it is difficult to find constant quality manure, and that if the manure was old it is not possible to generate enough heat for the process to be entirely successful. (Mierzinski and Schmidt 1881: 51-2) write that spent tanning bark does not create as high a temperature as horse manure. (Pulsifer 1888: 283) describes how the 1787 patent awarded to Fishwick for the use of tanning bark claims that tanning bark provided 'a more certain and equal degree of heat'.

²¹ Hurst 1892: 15.

²² Hurst 1892: 14.

²³ Schmidt 1857: 39 describes the disadvantages.

²⁴ Hurst 1892: 14: 'The corrosions are not of a uniform character throughout the whole of the stack; in some places they are porcellaneous and flaky, are firm to handle, do not break up, and give the best quality of white lead; in other parts of the stack the corrosions are soft, easily crumble to a fine powder or dust when handled, and do not give a good quality of white lead. In some places the lead may be discoloured owing to a variety of causes, such as the presence of tarry matter in the acid (especially when crude pyroligneous acid is used), by droppings of coloured water from the layer of tan on to the lead, &c.'

²⁵ *Oeconomische Courant* No. 168., 15 oct 1800: 89: 'Zelden werken de potten allen even sterk, verwandelende het Lood in zommige volkomen in Loodwit, en in andere niet; dit komt natuurlyk daarvandaan, wyl de mist op de ééne plaats meer broeit dan op de andere'. On the same page, the *Oeconomische Courant* calls the lead white from the cover plates 'harder en dichter' ('harder and more dense').

Some historical sources pay attention to the hazardous working conditions of workers inside lead white production facilities and describe different inventions or improvements to prevent lead poisoning. These improvements are aimed mainly at minimizing exposure to lead white dust: workers increasingly remove and process the lead white in a wet state, in enclosed areas, some factories introducing lead cast in grilles instead of curled lead to eliminate unrolling by hand, workers are advised to wear gloves and cover their mouth with a wet cloth, and machine-driven rollers are introduced to remove and crush the lead white from the lead slabs.²⁶

In the late eighteenth century the existence of carbon dioxide is discovered. This leads to a better understanding of the formation of lead white and a more scientific approach to the stack-process becomes possible.²⁷ In the 'German' or 'chamber' process, lead is hung inside a heated box or chamber into which acetic acid fumes and carbon dioxide are introduced. A first attempt at this process is described in an English patent in 1749, awarded to Creed. However it is uncertain whether his system functioned, since, as Bristow (1996) notes, Creed fails to mention a source for carbon dioxide.²⁸ The first factory to use the 'German' process is opened by Franz von Herbert in 1792 in Wolfsberg, Austria. It employs fermenting wine lees as source for carbon dioxide. Von Herbert later modifies his existing factory in Klagenfurth according to the same principle, using wine lees as a source of carbon dioxide. The 'Krems white' produced there becomes known internationally as the highest quality obtainable.²⁹ Other factories follow Von Herbert's example, using variants of this process. The sources of carbon dioxide are sometimes coal fires, wine lees or additions of marble (chemically calcium carbonate) or potassium carbonate to the vinegar and the chamber construction varies.³⁰

Several wet processes for lead white precipitation are patented from the last quarter of the eighteenth century on in England, France and Germany, both using solid lead and solutions of different lead compounds. Clichy white is the most successful of these products.³¹ It is named after the location of the first large factory in France, established in the early part of the nineteenth century. Here, a particular wet process invented by Thénard is used.³² Litharge (lead(II)oxide) is dissolved in distilled vinegar to form a saturated solution of lead acetate. Carbon dioxide is blown through the liquid resulting in the precipitation of lead white. After collection, the pigment is washed thoroughly³³ to remove any remaining acetate.³⁴

²⁶ (Malepeyre, Riffault, Vergnaud and Toussaint 1874: 63-82) described the hazards of different stages of lead white production according to the stack-process in much detail. Lestel recounts how many such machines were unsuccessful, since they created more dust than they prevented. In the end, many factories went back to hand-removing the lead white. For a survey of process modifications to minimize worker's exposure to toxic materials in nineteenth century France *see*: Lestel 2002.

²⁷ De Vlieger and Homburg 1992: 32-3

²⁸ Bristow 1996: 11 describes the patent in 1749 for James Creed.

²⁹ Mérimée 1830: 228; Pulsifer [1888]: 305-307; De Vlieger 1989b: 465-9.

³⁰ De Vlieger and Homburg 1992: 36-9.

³¹ Jacobson 1855: 58-59; Malepeyre, Riffault, Vergnaud and Toussaint 1874: 78-85; Pulsifer 1888: 295.

³² Malepeyre, Riffault, Vergnaud and Toussaint 1874: 78-85.

³³ Mérimée 1830: 230-1.

³⁴ Jacobson 1855: 58-59; Malepeyre, Riffault, Vergnaud and Toussaint 1874: 78-85; Pulsifer 1888: 295.

Although a number of wet processes are patented and find their way into historical sources, hardly any seem to have made it to the production stage due to problems with manufacturing details, product quality or production costs (See Appendix 20, Table 13.1).³⁵ Around 1840-1860, some wet-process lead white is produced in England and in the Netherlands according to a process similar to the Clichy process.³⁶

During the nineteenth century attempts are made to find a white pigment that does not contain the toxic lead. This leads to the introduction of zinc white, antimony white and others. Unfortunately these pigments are not very popular with oil painters due to their low covering power, which leads the 1845 *Handbook* by Osborn & Bouvier to conclude: 'Thus lead still holds its ancient place of honor, and with little risk of being ousted'.³⁷



Figure 13.4 Drying pots for lead white

From the lead white mill 'De Rob', formerly in Koog aan de Zaan, The Netherlands, operating between c. 1700 and 1865.

The pots are 10 and 11 cm high and have diameters of 10.5 and 11 cm.

From the collection of the Molenmuseum.

Photo: Ineke Houter-Lautenbach, Vereniging De Zaanse Molen, Koog aan de Zaan, The Netherlands

Originally, lead white was available in lumps, drops, or as flakes. Professional manufacturers also sell ground lead white in pyramid-shaped cakes, created by drying the pigment in unglazed earthenware pots (Fig. 13.4). The pots are turned upside down and the lead white cakes are further dried in the sun or in a warm room. Some sources also describe 'loaves' or flat cakes.³⁸ Gentele describes how sometimes the cakes are scraped with a knife to remove the coarse surface left by the drying pot.³⁹ Lead white is often wrapped in paper, preferably blue, as it makes the pigment appear a cooler white.⁴⁰ Low quality lead white is sold in large loaves, packed in barrels of 300 to 500 kg. By the nineteenth century also ready-ground lead white in oil has become available.⁴¹

³⁵ Some examples of the processes described were: Pattinson's white, a lead carbonate containing a small proportion of chloride, it was produced by a wet process from lead chloride and calcium carbonate, a wet-process lead white using granulated lead, made by the Woolrich process, another wet process using a cylinder and granulated lead, called the Versepuy process, etc. See Pulsifer 1888, Hurst 1892, Bristow 1996: 10-11 and De Vlioger and Homburg 1992, for a full overview of different processes described in 19th century manuals and patents.

³⁶ Around the turn of the century, electrolytic processes for lead white production are introduced; their description is beyond the scope of the present chapter, which focuses on more traditional production methods. Hurst 1892; Eastaugh et al. 2008: 240.

³⁷ Osborn and Bouvier 1845: 8

³⁸ Eikelenberg, 1679-1704: 833-4; Weber 1781: 16; Vuurst 1819: 169-70.

³⁹ Gentele 1860: 159-160.

⁴⁰ Paper was described by amongst others the *Excellency of the pen and pencil* 1668: 70, Leuchs 1825: 22, blue paper by the *Dictionnaire portatif* 1770, vol 1: 518-9, Buys 1774, vol. 6: 754, Krünitz 1775, 1784, vol 5: 711-etc., Weber 1781: 16, *Wiener Farbenkabinet*; 1794: 151, Vuurst 1819: 171, Gray 1828: 647-8, Schmidt 1857: 36-9.

⁴¹ Malepeyre, Riffault, Vergnaud and Toussaint 1874: 63-72

13.3 Factors during production that influence lead white quality

Sources describe several production parameters that influence lead white quality. Naturally, the quality of the initial lead plays a role and is mentioned by several eighteenth and nineteenth century writers. The anonymous *Kostliches Büchlein* (1549) advises scraping the 'skin' off the lead before hanging the sheets inside a pot of vinegar, to which a hand of salt is added before it is heated and subsequently buried in manure.⁴² De la Hire (1730) explains how dirty lead will result in lead white covered with grey or yellow material that should be removed before use.⁴³ Gentele (1860) mentions that lead used in lead white production should be clean and indicates the purity of the metal as an important factor.⁴⁴ Mierzinski and Schmidt (1881) explain the effect of impurities in detail: metals like silver will influence the reaction speed of lead into lead white. The presence of copper or iron should be avoided, whereas bismuth will lead to better covering power and higher quality pigment.⁴⁵ Why copper and iron should be avoided is explained by Schmidt (1857), who states that copper will lead to a bluish product, while lead with a high iron content will impart a yellowish one to the pigment.⁴⁶ Apparently, the lead mined in Austria, in Villach, which was used in Klagenfurth, is of a particularly high quality. Ure (1853) explains that: 'The freedom from silver of the lead of Villach, a very rare circumstance, is one cause of the superiority of its carbonate'.⁴⁷

The choice of vinegar is also important, since the acid content has to be suitable for the process. Although the quality of wine vinegar is praised by many, De Vlieger & Homburg (1992) believe that beer vinegar is probably used more frequently in the Dutch stack process due to its low cost and suitability.⁴⁸ In particular nineteenth century sources describing large-scale lead white factories mention alternatives to wine vinegar. Not only beer vinegar, but vinegars made from treacle, hops or fruits (plum, apple, etc.) and other acidic liquids are described.⁴⁹ One seventeenth century source mentions urine.⁵⁰ Fermenting fruits are used in the stack process, as a source of carbon dioxide and of

⁴² *Kostliches Büchlein* 1549: no page nrs.

⁴³ De la Hire 1730: 665: 'quelques fois ces écailles sont couvertes d'une matiere grise ou jaune qu'il faut ratisser avant que de les broïer, ce qui peut venir des lames de plomp qui n'étoient pas bien nettes par dessus quand on les a enfermées dans le pot'.

⁴⁴ Gentele 1860: 28-29 and 141-2.

⁴⁵ Mierzinski and Schmidt 1881: 59.

⁴⁶ Schmidt 1857: 35-9: 'je reiner [da] Blei war, um desto schöner weiß, enthielt leztenes etwas Kupfer, bläulich, oder etwas Eisen, gelblich weiß gefärbt'.

⁴⁷ Ure 1853: 946: 'The high reputation of the white lead of Krems was by no means due to the barites, for the first and whitest quality was mere carbonate of lead. The freedom from silver of the lead of Villach, a very rare circumstance, is one cause of the superiority of its carbonate; as well as the skilful and laborious manner in which it is washed, and separated from any adhering particle of metal or sulphuret.'

⁴⁸ De Vlieger 1989a: 22; *Oeconomische Courant* No. 167, 1800: 82.

⁴⁹ (The *Oeconomische Courant* no. 167, 1800: 82) mentioned beer vinegar, oats-vinegar and brandy vinegar; (Leuchs 1825: 38) described the same materials but also vinegar from low quality sugar sirup, vinegar from starch sirup, from raising, from wild apples, from plums, acid milk, a mixture of vinegar and yeast, mixtures of wine vinegar, wine yeast and potash; wine lees is mentioned in the anonymous 1867 *Arts and Sciences*: 145.

⁵⁰ Anonymous, Manuscript, Frans Hals Museum, 1650-1700: [43].

heat.⁵¹ An article in the *Oeconomische Courant* (1800) mentions that a mineral acid can be added to the vinegar, which will release carbon dioxide to speed up the process.⁵²

As discussed earlier, the importance of using the right proportions of all materials involved is emphasized by several authors. However the construction of the stack and resulting reaction temperature are thought to be no less important, as stressed by Ure (1853), who exclaims that ‘everything depends upon the construction of the bed [= one layer inside a stack], for it is this which regulates the production of white lead’.⁵³

13.4 Qualities compared

Throughout the nineteenth century, authors compare the quality of stack-process lead white with lead white produced by newer production methods. Although wet-process lead whites are chemically similar to stack-process lead white, their crystal structure differs considerably.⁵⁴ The differences in morphology result in different pigment to volume ratios, different rheological properties as well as a differences in hiding power.⁵⁵ Malepeyre et al. (1874) write that although wet process lead whites are brighter in colour and do not have the yellow tinge of ‘traditional’ stack process lead white, such pigments lack body and covering power in oil.⁵⁶ ‘Crystallinity’ is thought to be the reason why lead white produced by wet-process methods or through fast production processes, such as some chamber processes, lacks covering power, a fact corroborated by modern research.⁵⁷

Ure (1853) conducts his own investigation, which leads to the observation that:

all sorts of white lead produced by precipitation from a liquid, are in a semi-crystalline condition; appear, therefore, semi-transparent, when viewed in the microscope; and do not cover so well as white lead made by the process of vinegar and tan, in which the lead has remained always solid during its transition from the blue to the white state; and hence consists of opaque particles.⁵⁸

⁵¹ Sprong, 1738: 12-13: ‘azijn, uitgeperste druiven, rotte appelen, Zuir wey, enz.’; Leuchs 1825: 20-21, 38.

Sprong 1738: 12-13: ‘Maar dewyl nu de beste Azyn wat duur valt te weten voor degene die ze in grote menigte gebruiken zoo kan men in plaats van dezelve, uitgeperste druiven, rotte appelen, Zuir wey, enz. gebruiken, dat de onkosten vry wat vermindert. De uitgeperste druiven, worden in Duitsland, Itaalien en in Frankrijk, alwaar vele wijngaarden zyn, en een menigte van wyn geperst wordt, daar toe wel 't meest gebruikt.’ Dossie 1758: 121-2: ‘White flake is lead corroded by means of the pressings of the grape; and consequently in fact a ceruss prepared by the acid of grapes.’

⁵² *Oeconomische Krant*, 15 October 1800: 82: ‘Ter bevordering van het oprijzen der zuurdeelen van de Azyn, kan men daarby eene kleine hoeveelheid van eenig Mineraalzuur voegen. Men loopt geen gevaar, dat het Loodwit hierdoor van aart veranderen zal, wyl deze bymenging geene andere werking doet, dan de zuure geesten der Azyn spoediger van de aardachtige deelen te scheiden, en door verdunning beter te doen opstygen. Het Mineraalzuur zelve blyft in de Blaas hangen; en kan niet dan door een hevige vuur en sterker zuur worden overgehaald.’

⁵³ Ure 1853: 951.

⁵⁴ Carlyle and Witlox 2005: 55; Jacobson 1855: 60–1.

⁵⁵ Carlyle and Witlox 2005; *see also* Carlyle 2006.

⁵⁶ Malepeyre, Riffault, Vergnaud and Toussaint 1874: 78-85.

⁵⁷ Carlyle and Witlox 2005: 55. Jacobson 1855: 60-61 discussed crystallinity as the source of a difference in hiding power and of yellowing upon exposure to air and light.

⁵⁸ Ure 1853: 948.

The fact that lead white production is of considerable economic importance seems to have influenced written records of its production.⁵⁹ When Clichy white is introduced just before 1809, its introduction is supported by extensive tests by French scientists, aimed at proving the pigment's superiority over stack-process lead white. The pigment is simultaneously supported by several economical measures to ensure its place in the market.⁶⁰

This campaign for wet-process lead white finds its way into some sources. Clichy white is supported by the French government and consequently it attracts much attention in written sources who speak very highly of the pigment.⁶¹ In truth, the material is probably not very satisfactory, as Pulsifer (1888) states that, by his time, most French factories have reverted to stack-process production.⁶²

Criticism can be found in Pulsifer's (1888) and Hurst's (1892) complaints about the quality of modern lead white.⁶³ As Hurst says: 'notwithstanding all the labours of chemists and white lead makers to supersede it [= stack-process lead white], ... it still remains the best process for the manufacture of white lead'.⁶⁴

13.5 Washing and cleaning of lead white

Lead white produced in different manners requires different grinding and cleaning processes. Stack-process and chamber-process lead whites are coarse, flaky powders that still contain bits of unfermented lead, which needed to be removed.⁶⁵ Some material can then be kept aside and sold as 'flake white'; the remainder is ground, washed and processed. Wet-process lead white has been water-washed during production and does not require much grinding, since it already consists of a fine powder.⁶⁶

The number of recipes describing washing and cleaning methods show that throughout the centuries, lead white purification is considered an integral part of the pigment's preparation for painting. A comparison between manufacturing recipes and recipes aimed at artists, shows that although the former only mention washing or grinding with water,

⁵⁹ For instance, Pulsifer reports that in 1886 in Germany forty to fifty thousand tons of lead white were produced. Pulsifer 1888: 312. English production is estimated at fifty thousand tons. Pulsifer 1888: 291.

⁶⁰ See (De Vlieger 1989: 209-211) for a discussion of the introduction of Clichy white. (Pulsifer 1888: 296-300) describes supportive measures by the French authorities, extensive testing and the decreasing interest in Clichy white during the second half of the nineteenth century.

⁶¹ See for instance Vergnaud 1826: 244-5. Mierzinski and Schmidt 1881: 45, German authors, who nuanced this opinion. They agreed that Clichy white had a whiter tone, but however commented on its lower covering power.

⁶² Pulsifer 1888: 299-300.

⁶³ Pulsifer 1888; Vibert 1892: 280-1.

⁶⁴ Hurst 1892: 11-12.

⁶⁵ Andriessen 1552: 55: 'behouden dat ghi eerst wel uit gelesen hebt tblauwe loot datter in valt int wrijven / dat moetmen altijt wel waer nemen ende uit doen / oft dat Lootwit souder werckelijck af smetten.' Eikelenberg 1679-1704: 394: 'Alsmen dit lootwit wrijft zo moet men het loot datter gemeenlijk in is daar uyt zoeken of het zonder zonderlinge af besmet worden.' De la Hire 1730: 665: 'Il reste quelques fois au milieu de ces écailles de petites feuilles de plomp qui ne sont pas encore calcinées, & qu'il faut séparer du reste comme inutiles dans le blanc.'

⁶⁶ Mérimée 1830: 228-9: 'Comme le blanc de plomb formé dans cette opération [Krems white prep method] n'a pu acquérir la dureté de celui qu'on obtient par la méthode hollandaise, il n'est pas nécessaire de broyer; on l'obtient très divisé par la lévigation, au moyen d'un appareil extrêmement simple.'

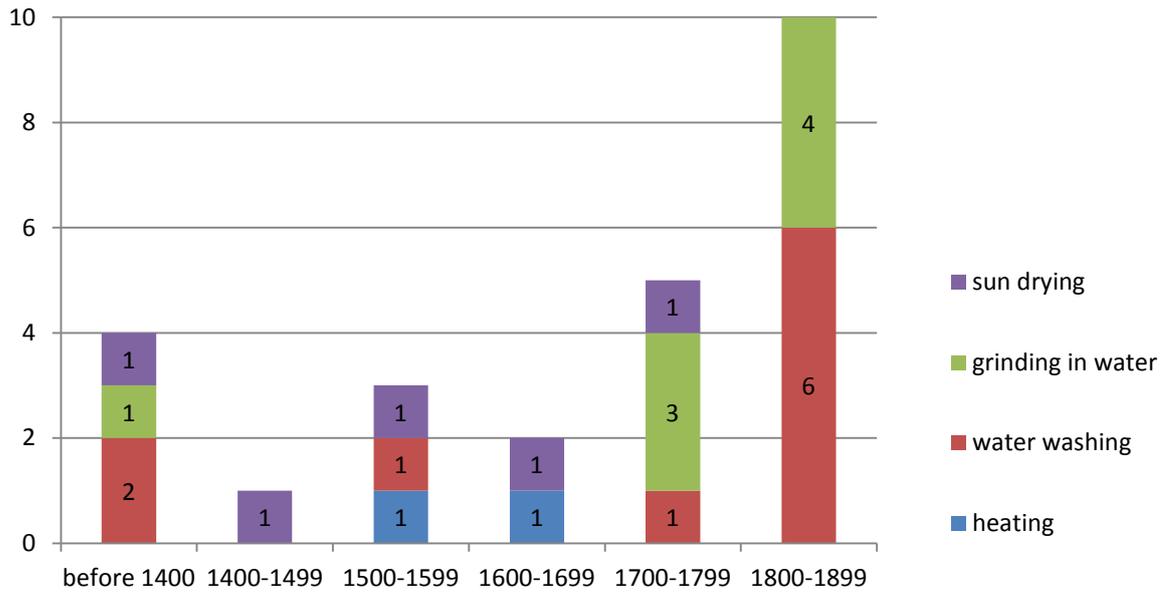


Fig 13.5a Washing treatments in lead white preparation recipes

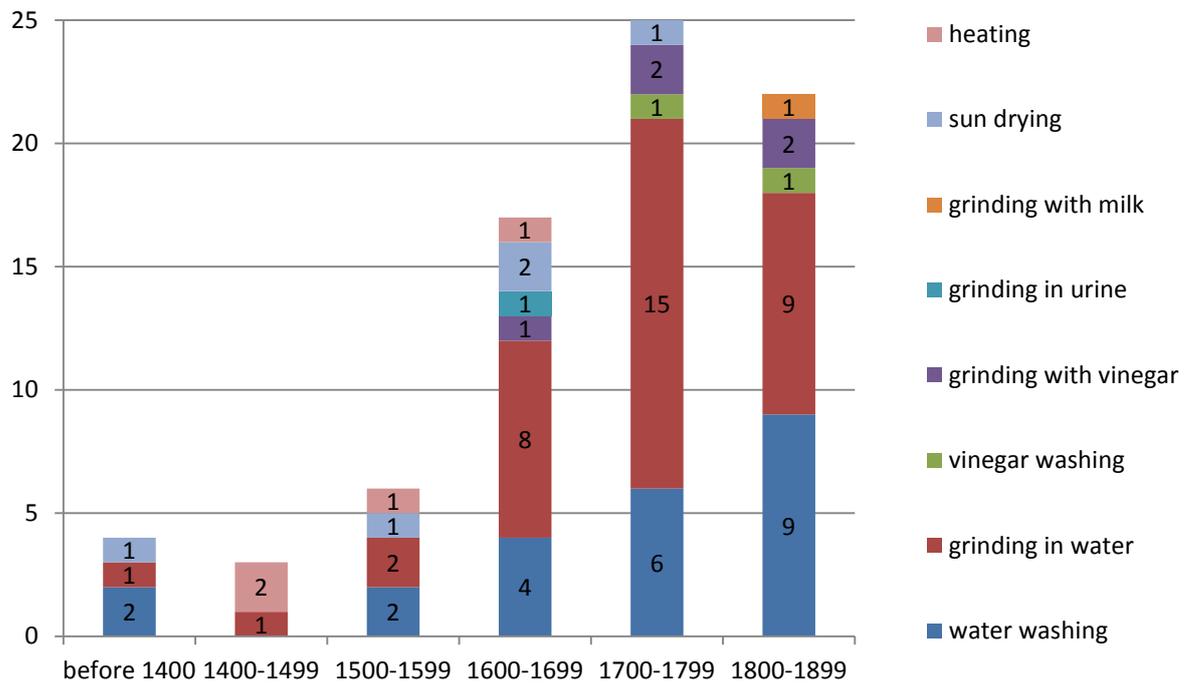


Figure 13.5b Washing treatments in recipes for the use of lead white by painters

the latter contain more diverse methods, listing vinegar, milk or even urine for washing (Figs. 13.5a and 13.5b).⁶⁷

Usually the paste of pigment and liquid is ground, dried and ground again, sometimes as often as five or six times.⁶⁸ Descriptions for water grinding usually speak of a thick paste of porridge-like consistency.⁶⁹ Sun drying of the pigment seems to have been particularly popular and is described by Andriessen (1552) as a means to enhance the pigment's whiteness.⁷⁰

Washing stock-process lead white is deemed necessary to obtain a high quality product without the high proportion of lead acetate which it would still contain after its synthesis. Artists would be alerted to its presence by the smell of vinegar, according to Osborn & Bouvier (1845).⁷¹ By 1857, Schmidt shows that it was known that the material being washed out contains lead acetate.⁷² Gentele (1860) describes how the presence of this lead acetate would lead to yellowing of the paint film.⁷³ Even before knowledge exists on the nature of the material being washed out, empirical methods are employed to check if washing has been successful: King (1653-7) recommends to taste the water and continue washing until 'you perceive that the water taste fresh as other water', a description to which he adds: 'probatissimum', freely translated as 'tested and approved'; not a healthy habit.⁷⁴

Some recipes describe how washing leads to a finer or softer lead white.⁷⁵ Gentele (1860) makes the distinction between 'hard lead white' and 'soft lead white', the former not having been washed thoroughly and the latter having undergone thorough washing and decanting to remove lead acetate.⁷⁶ Indeed it can be deduced from nineteenth century recipes that the presence of lead acetate would make the lead white harder. In fact, additions of lead acetate (and other materials such as starch, gum Arabic or dextrin) are mentioned as a trick of the trade to harden the lead white, and thus enable the producer to sell lower quality lead white as flake white.⁷⁷

⁶⁷ Eikelenberg 1679-1704: 161, D'Emery 1684: 278.

⁶⁸ *Excellency of the pen and pencil* 1668: 70.

⁶⁹ Eikelenberg 1679-1704: 833-4 'pap'. Pictorius 1747: 411-12: tot het wert als pap'. *Wiener Farbenkabinet* 1794: 148-9: 'Dicker Brei'. Bouvier 1827: 2-3: 'consistance d'une pommade'.

⁷⁰ Andriessen 1552: 55.

⁷¹ Osborn and Bouvier 1845: 7: 'Krems or Crems is a place near Vienna, in Austria (not to be confounded with Kremnitz, or Kremnitz, of lower Hungary). The white there made is prepared with vinegar, the smell of which is very perceptible in this pigment when new.'

⁷² Schmidt 1857: 44-45.

⁷³ Gentele 1860: 42; Gentele 1860: 159-60; Mierzinski and Schmidt 1881: 62.

⁷⁴ King 1653-7: 38-39.

⁷⁵ Pal. 796 1500-1600: 5v (transcription Pomaro 1991: 98): 'Ad conciare la biaccha sottilissima con aq(u)a'.

⁷⁶ Gentele 1860: 159: 'Daß das Bleiweiß hierbei eine große Härte annimmt, davon ist die Ursache ein Gehalt von Essigsauerm Blei, das, weil es nicht ausgewaschen worden ist, eingemengt bleibt.' *Idem* 1860: 160: 'Soll weiches Bleiweiß dargestellt werden, so kann man zwar sowohl bei reinem Bleiweiß, als den gemischten Sorten bis zum Fertigmahlen eben so verfahren; aber damit es nicht hart werde, ist ein sorgfältiges Auswaschen unumgänglich erforderlich.'

⁷⁷ Gentele 1860: 153: 'Das erstere [= hartem] Bleiweiß ist von Manchen aus dem Grunde beliebt, weil es bei einiger Vermischung mit Spath keinen glatten Bruch mehr annimmt, also ziemlich rein sein muss, wenn es diese Eigenschaft zeigt.' Mierzinski and Schmidt 1881: 62-3: 'je härter das Bleiweiss nach dem Trocknen sein soll, umsomehr wendet man von dem Bindemittel an; arabischen Gummi wie auch Bleizucker liefern ein weniger dichtes und hartes Bleiweiss, als Dextrin, wahrscheinlich nur desshalb, weil man mit letzterem

However the terms 'hard' and 'soft' lead white carry a different meaning with Schmidt (1857), who makes a distinction between hard lead white, the result of the chamber process, and soft lead white, the result of wet precipitation.⁷⁸

Unfortunately, reasons for washing with urine or milk are not given in recipes. Washing with vinegar, according to Le Pileur d'Apligny (1779), dissolves remaining lead particles and thus prevents blackening of the lead white.⁷⁹ Le Pileur d'Apligny makes a distinction between flake white, which should be ground in water, and lead white, which should be ground in vinegar and washed. In 1827, Bouvier still records vinegar washing to purify lead white, which he says will clean away all alien materials from Krems white: lead white and vinegar are stirred together frequently for one day, the vinegar is then decanted and the pigment is washed thoroughly with water.⁸⁰

Washing allows for particle size selection, which is mentioned in several sources.⁸¹ King (1653-57) describes miniature painter Hilliard's method of separating different qualities:

Having ground your ceruse in water without gum & put it into a viall glasse with a good quantity of faire water, and being well shaken together let it stand a while, and before it be settled poure off the third part of the water and let it settle. Then poure yet likewise one other third part out of the viall and reserve the last part in the viall still. This water third divided into three parts let stand still till all be settled and the water cleared, then dry it or make the colour being now settled in the bottome dry by evaporating, Then in tempering it with gumme use it at your pleasure. The first part of this colvin Mr Hilliard calls his sattin white, the second his linnen white. The last shines not at all but is reserved for carnations and complexions of pictures. The first shines most, the 2nd lessest.⁸²

Hilliard's method of repeatedly decanting the liquid whilst smaller particles are still suspended is mentioned by other authors as well. Some of these recipes result in several, others in only two different qualities of pigment.⁸³ After the last decanting, only

weniger sparsam umgeht. Nicht ausgewaschenes Bleiweiß wird wegen seines Bleizuckerghaltes beim Trocknen an der Luft von selbst hart.⁷⁸

⁷⁸ Schmidt 1857: 44-45: 'Unter hartem Bleiweiß versteht man solches, das sehr schwer zu zerbrechen, steinhart ist und im Bruche glatt oder sogar glänzend ist, wie es in den Niederlanden und am Rhein fabricirt wird. Unter weichem Bleiweiß dagegen versteht man dasjenige, das entweder als Pulver oderin ganz lose zusammenhängenden Stücken im Handel vorkommt, ungefähr wie die geschlemmte Kreide. Das erstere Bleiweiß ist von Manchen aus dem Grunde beliebt, weil es bei einiger Vermischung mit Spath keinen glatten Bruch mehr annimmt, also ziemlich rein sein muss, wenn es diese Eigenschaft zeigt. Das andere weiche ist zwar oft verunreinigt, was man aber leicht auf andere Weise ermitteln kann; es ist jedoch beim Zerreiben mit Oel viel leichter zu verarbeiten und meistens auch weisser als jenes.'

⁷⁹ Le Pileur d'Apligny 1779: 5-6. This recipe appears in the Austrian *Wiener Farbenkabinet* 1794: 152. Bouvier 1827: 4-5.

⁸⁰ Bouvier 1827: 2

⁸¹ See for instance: De Mayerne 1620-44: 96 v; *Excellency of the pen and pencil* 1668: 71-2; A.P.S. 1770: 27; Le Pileur d'Apligny 1779: 5-6; *Wiener Farbenkabinet* 1794: 152.

⁸² King, 1653-7: 39-40.

⁸³ Bouvier 1827: 114: 'Les marchands ou fabricans de couleurs les lavent dans de grandes caisses ou jarres de bois, où il en peut entrer des quintaux. Ils pratiquent deux robinets, à différentes hauteurs, pour laisser d'abord

unfermented bits of lead, other unwanted materials and some coarse flakes of lead white remain.

The same principle is exploited on a larger scale, as demonstrated by 19th century descriptions by Ure (1853) and Schmidt (1857) of commercial washing installations consisting of several interconnected water-filled vessels of different height. Lead white is sprinkled into the first vessel and stirred to suspend the fine particles in the water, which subsequently flows through the other vessels. Since the largest and heaviest particles settle first, they are deposited in the nearest vessel. Smaller particles travel farther and are deposited in subsequent vessels. According to both Ure and Schmidt, usually between seven and nine vessels are used, leading to the separation of the lead white into fractions of different quality.⁸⁴

One can easily imagine that lesser qualities of lead white do not undergo the same meticulous washing as more expensive qualities. This theory is supported by the anonymous *Excellency of the pen and pencil* (1668), who recommends to save the finest particles of thoroughly washed lead white ‘as the choicest and purest of all’, and advises that the remainder, ‘which is not altogether so pure, may be serviceable for some uses, though not for all’.⁸⁵ Whether preparatory layers are considered one of these uses, is not mentioned. Also Dossie (1758) feels that less care is required in the preparation of lead white for general use. He states: ‘There is no previous preparation necessary, in the case of white lead, to its use; except washing over where it is intended for more delicate purposes’.⁸⁶

Also Le Pileur d’Apligny (1779) pays attention to the influence of washing on pigment stability, stating that lead white first washed with vinegar and subsequently rinsed with water does not react with the air as it would otherwise.⁸⁷ Leuchs (1825) furthermore explains that if the painter suspects that his lead white still contains some acid, it should be washed thoroughly since otherwise it will yellow with age.⁸⁸ Lead acetate is indeed a highly unstable material, which easily reacts with oil to form lead soaps.⁸⁹

13.6 Adulteration

Although lead white is not one of the most expensive pigments, production costs combined with the large-scale use of the pigment considerably enhance the economic advantage of adding in other materials. Jacobson (1855) writes: ‘No paint material is as

écouler les premières eaux, sur lesquelles surnagent tous les corps légers; puis un autre, plus bas, pour séparer la bonne couleur d’avec le sédiment, qui est rempli de pierres et autres corps pesans.’

⁸⁴ Schmidt 1857: 44-45. A similar apparatus was described by Ure 1853: 946.

⁸⁵ *Excellency of the pen and pencil* 1668: 71-72.

⁸⁶ Dossie 1758: 123.

⁸⁷ Le Pileur d’Apligny 1779 : 5-6: ‘On obtient par ce moyen [= washing with vinegar and rinsing with water, including size separation] un blanc très-beau & très-fin, dépouillé de tout ce qui pourroit altérer sa blancheur; la raison en est que ce blanc n’est sujet à noircir qu’à cause des particules de plomb mal dissoutes qu’il contient, ou du moins très-disposées à se revivifier par le moindre contact de l’air’

⁸⁸ Leuchs 1825: 42: ‘Das Bleiweiß wird vorzüglich in der Oelmalerei gebraucht, da es vor allen andern weißen Farben den [Vorzug] hat, mit der Zeit als Oelfarbe nicht gelb zu werden. Doch ist dis nur der Fall, wenn es Säurefrei ist, was [...] bei dem mit Hülfe von Kochsalz bereitenen selten der Fall ist. Um das Gelbwerden an der Luft zu [verhüten] ist es daher gut, das bleiweiß mit Wasser eingemal [aus] zulaugen, wenn man noch etwas Säuregehalt in demselben vermuthet.’

⁸⁹ See Boon et al. 2007.

important for the painter as lead white, since it is the basis of most paints. It is still so generally used and in such large quantities, that adulteration can create much profit. No wonder that it is adulterated so often'.⁹⁰ Adulterants such as chalk are added during grinding, a process that is executed in commercial production facilities with a succession of millstones, as described in eighteenth- and nineteenth century sources.⁹¹

De Mayerne (1620-44) mentions that 'ceruse' contains half chalk.⁹² Large proportions of chalk will alter the paint properties, leading to a somewhat greasy paint which is difficult to manage when fresh linseed oil is used.⁹³ According to Leuchs (1825) the paint will also yellow more quickly.⁹⁴ For decorative painting, Leuchs (1825) considers a small addition of chalk beneficial because it facilitates spreading of the paint.⁹⁵

Simis (1801) states that by his time chalk from marine sedimentation is replaced with ground marble as an admixture to lead white. It is cheaper, heavier and whiter.⁹⁶ Leuchs (1825) mentions Champagne chalk, alabaster, as well as gypsum as adulterants.⁹⁷ Leuchs is also the first to describe barium sulphate, which becomes the most frequently used lead white extender from the second quarter of the nineteenth century, preferred to chalk because its high density complicates detection and it is supposedly more white in oil.⁹⁸

Gentele (1860) adds to these characteristics the fact that barium sulphate only requires a relatively small amount of oil to form a paint, which may have added to its popularity.⁹⁹ According to Gentele (1860), natural barium sulphate is used mainly as an extender, whereas synthetic barium sulphate, or *blanc fixe* is reserved for use as a watercolour pigment.¹⁰⁰ Around the turn of the century, ground glass or sand may have been added to the list of adulterants, since according to Kippel (1903), recently glass powder had been found mixed with lead white.¹⁰¹

13.7 Terminology

Whether or not additions function as improvements, recipes demonstrate that painters prefer clarity. Confusing terminology and the fact that some manufacturers offer cheaper

⁹⁰ Jacobson 1855: 55-56: 'Geene verwstof is zoo belangrijk voor den verwer als het loodwit, daar het de grondstof van de meeste verwen uitmaakt. Men gebruikt het nog zoo algemeen en in zulke groote hoeveelheid, dat het vervalschen ruime winst kan geven. Geen wonder dus dat het zoo dikwijls vervalscht wordt aangetroffen.'

⁹¹ For instance see *Oeconomische Courant* October 15, 1800: 89-91 and Gentele 1860: 153-160.

⁹² Mayerne 1620-144 : 11-12.

⁹³ See Carlyle 2006.

⁹⁴ De la Hire 1730: 665 'On peut pourtant reconnoître encore si elle est mêlée quand elle est broyée à l'huile & que l'huile n'est pas vieille, car le blanc est gras, ce qui ne doit pas être'; Field 1850: 18: 'The inferior white leads are adulterated with whitening or sulphate of barytes and other earths, which injure them in body and brightness, dispose them to dry more slowly, to keep their places less firmly, and to discolour the oil with which they are applied'.

⁹⁵ Leuchs 1825: 40: 'Immer verschlechtert aber ihr Zusatz das Bleiweiß da es als Oelfarbe bald gelblich wird. Doch verbessert ein Zusaz von etwas (1/12 Kreide) das Bleiweiß, wenn es zu Decorationsmalerei dienen soll, da es sich dann besser [mit] dem Pinsel zertheilen läßt.'

⁹⁶ Simis 1801: 15-16.

⁹⁷ Leuchs 1825: 39-40. (Leuchs 1825: 22) also mentions gypsum.

⁹⁸ Leuchs 1825: 22.

⁹⁹ Gentele 1860: 13-14: 'Von Oel nimmt er sehr wenig auf, wenn er einen dicken Brei vorstellen soll.'

¹⁰⁰ Gentele 1860: 14: 'Derselbe [= synthetic barium sulphate] hat alle die hier erwähnten Eigenschaften, er wird aber weniger zur Vermischung anderer Farben, als für sich als Wasserfarbe angewendet, obgleich er zur Vermischung mit ihnen alle die dem Schwerspath zukommenden Eigenschaften gemein hat.'

¹⁰¹ Kippel 1903: 13.

materials disguised as high quality lead whites hinder the artist's discernment. Published recipes provide painters with insight into the various qualities available, thus allowing association with inherent characteristics such as whiteness, weight, hardness and 'a clean break'.¹⁰² Contemporary sources also provide micro-chemical tests to unmask falsified products.¹⁰³

As early as the seventeenth century, those who wish for certainty are advised to purchase unprocessed flakes ('flake white') (Fig. 13.6). Mérimée (1830) claims that flake white is equal in whiteness to Krems white, and states that by using flake white the painter is certain of an unadulterated product.¹⁰⁴ However 'flake white' can be imitated: cheaper white mixed with starch paste dries as hard, brittle flakes resembling flake white. Additions of dextrin, lead acetate, gum Tragacanth and gum Arabic are mentioned for the same purpose.¹⁰⁵

The market is further confused when, from the end of the eighteenth century on, new production methods result in the addition of numerous variations on chamber and wet-process methods. Most innovations consist of slight improvements and differ little from the methods described above (Appendix 20, Table 13.1). Furthermore, some of the 'new' lead whites are actually standardised ratios of pure lead white and adulterants; these

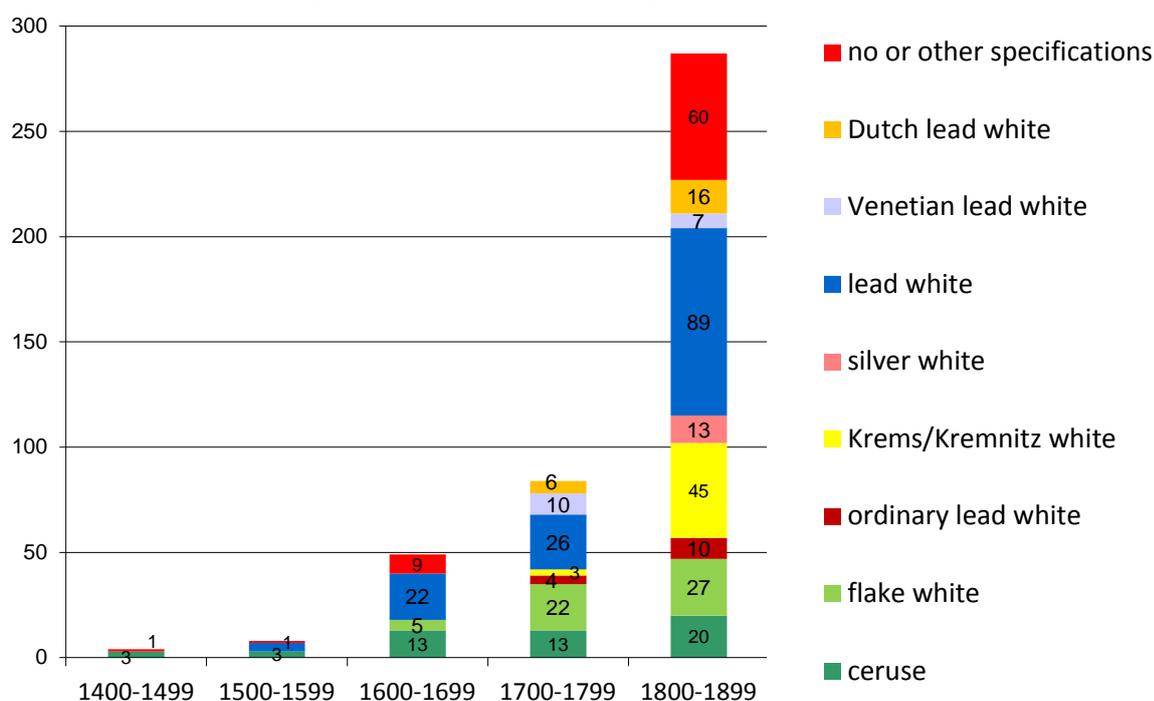


Figure 13.6 Most frequently used lead white names in recipes from North West Europe, 1400-1900

¹⁰² Field 1850: 17-18: 'the heaviest and whitest of these are the best, and in point of colour and body are superior to all other whites.' Bouvier 1827: 1-2: 'Le meilleur doit être fort lourd et d'un blanc pur, ne tirant ni sur le gris, ni sur le bleu, ni sur le jaune. Il faut qu'il soit dur, non friable, et qu'à la cassure il soit franc; il faut de plus qu'en le portant sur la langue il la happe, c'est-à-dire qu'elle s'y colle un peu'.

¹⁰³ Quality tests for lead white are too numerous to mention. They vary from weighing to wet chemical tests and heating methods. Examples are found in: Sprong 1738: 14; *Wiener Farbenkabinet* 1794: 151; Thomson 1839: 276-78; Malepeyre, Riffault, Vergnaud, Toussaint 1874: 127-134; Hurst 1892: 42-44.

¹⁰⁴ Mérimée 1830: 223.

¹⁰⁵ Dossie, 1758: 122; Weber 1781: 14; Mierzinski and Schmidt 1881: 62-63; Pulsifer 1888: 311.

often acquire a proper name (Appendix 20, Table 13.2). Some significant name changes do, however, take place and some new names are introduced.

Venetian lead white has an unblemished reputation before the nineteenth century (see Fig. 13.7). Its use is advised for miniature painting by Verly (1759) on account of its high quality and Dossie (1758) prefers it over 'inland' (i.e. English) lead white.¹⁰⁶ Two eighteenth century sources claim that unlike many other lead whites it is not mixed with chalk or other adulterants.¹⁰⁷ The 1794 *Wiener Farbenkabinet* even states that Venetian white is at that time the only unadulterated lead white, which explains its high price in comparison to other lead whites.¹⁰⁸

Terminology seems to have changed around 1825, when Leuchs writes that Venetian lead white consists of a mixture of one part lead white and one part barium sulphate, a comment repeated by numerous later sources. Confusingly, Pulsifer (1888) maintains that the Venetians resist adulteration until 1862, after which date they 'yielded to the universal practice in Europe of sophisticating white lead'.¹⁰⁹ Despite Pulsifer's comment, the pigment's general reputation seems to have decreased dramatically during the nineteenth century because cheaper products made elsewhere are put on the market under the name Venetian white.

'Ceruse' is often used as a generic term for lead white which is further specified, for

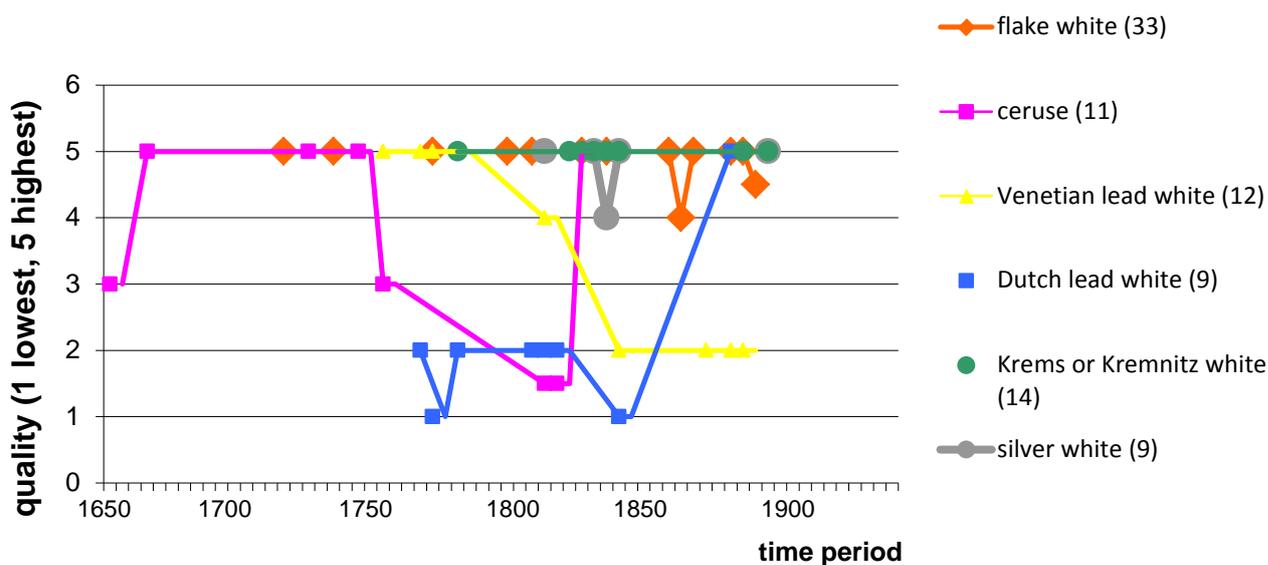


Figure 13.7 Lead white qualities as provided in the recipes that were investigated.

(between brackets: the number of recipes on which each line is based)

¹⁰⁶ Verly 1759: 33-34; Dossie 1758: 121-22.

¹⁰⁷ Le Pileur d'Apligny 1779: 5; Weber 1781: 16.

¹⁰⁸ *Wiener Farbenkabinet* 1794: 148: 'Nur das in Venedig verfertigte Bleiweiß wird unverfälscht gelassen, daher auch solches vorzüglich gefucht und in viel höherm Preise bezahlt wird.'

¹⁰⁹ Leuchs 1825: 40-41; Montabert 1829: 200; Jacobson 1855: 60; Pulsifer 1888: 274, Kloes 1903: 5 all refer to Venice white as containing 1 part adulterant to 1 part of lead white.

instance as ‘Dutch ceruse’, ‘Venetian ceruse’, or ‘common ceruse’. Simultaneously, however, some sources use the term in a more narrow sense, stating for instance that ‘ceruse is the most pure and clear part of the lead white’, or the opposite, that ‘ceruse is more coarse than lead-white’.¹¹⁰ During the nineteenth century its reputation becomes rather dubious, as Mérimée states in 1830 that ‘ceruse, especially that from Holland, which for a long time was considered the best of its kind, is a mean white’. Mérimée does however modify this strong statement by saying that first quality ceruse from Holland is without admixtures.¹¹¹ This must have been the material that Thompson refers to in 1842 when he claims that ‘ceruse is the most pure and clean part of white lead’.¹¹²

Sources contradict each other regarding the nature of Krems white, a lead white included in a substantial number of historical recipes. Lead white is produced in Krems as early as the 17th century, probably using the stack-process.¹¹³ However Krems is one of the towns that switches to the German chamber-process and its product becomes synonymous with a very high quality lead white, which according to the *Wiener Farbenkabinet* even surpasses the then still highly esteemed Venetian lead white.¹¹⁴

During the nineteenth century the name loses its original link to the town of Krems and becomes synonymous with high quality lead white, no matter where it is produced. High quality lead whites made by different methods are all called Krems white, even including wet-process lead white.¹¹⁵ That much is clear from Leuchs 1825, who uses the term Krems white to designate the finest lead white, which settles last during washing.¹¹⁶ Simultaneously however, other sources still use the term in a more narrow – and different – sense: both Malepeyre et al. (1874) and Hurst (1892) describe a Krems or Kremnitz white made with a process that can be placed in between the dry chamber process and a wet process: a paste of a lead oxide such as litharge and vinegar is placed on a lead tray in a chamber and exposed to the fumes of carbon dioxide.¹¹⁷

Clichy white, probably the best known wet-process lead white, is praised for its whiteness. However as stated above, many sources allude to its lack in hiding power, which makes it less economical in use.¹¹⁸ The monopoly created for the French wet-process lead white by the government is not appreciated by all, which is clear from Vibert’s complaint that the

¹¹⁰ *Excellency of the pen and pencil* 1668: 70; ‘Ceruse, or White-lead, there is little difference between them, only one is refined, the other not.’ Smith 1753: 15: ‘Of this Colour there are two Sorts at the Colour-Shop, the one called Ceruss, which is the most pure and clean Part; the other is called by the plain Name of White-Lead’. Dossie 1758: 123 explained that white lead or ceruss was made in England, and that it was cheaper than white flake but inferior in whiteness and other qualities. *Nieuwen verlichter* 1777: 164: ‘Ceruyze-wit grover als het lood-wit’ Leuchs 1825: 14: ‘In Engeland: ungemalene Bleiweiß heißt Ceruse’.

¹¹¹ Mérimée 1830: 223 ‘La céruse et surtout celle de Hollande, réputé pendant long-temps la meilleure de l’espèce, est d’un blanc sale, et par cette raison, n’est employée que dans la peinture en batimens et dans l’impression des fonds sur lesquels on exécute les tableaux. Elle est aussi très souvent mélangée de craie’.

¹¹² Thornton 1842: 125.

¹¹³ Pulsifer 1888: 301-11.

¹¹⁴ *Wiener Farbenkabinet* 1794: 153: ‘ist im Grunde nicht anders, als ein mehr gereinigtes und feiner zubereitetes Schulpweiß, welches daher in der Malerei allen übrigen weißen Farben vorzuziehen ist.’

¹¹⁵ Compare Hurst 1892: 24-5, who states that Krems white was a wet process using a litharge/acetic acid or lead acetate paste; and Pulsifer 1888: 288, 301, 311, who identifies Krems white as high particular grade of lead white made in a chamber-process, probably the Dutch stack-process.

¹¹⁶ Leuchs 1825: 22: ‘Das feinste Bleiweiß, welches sich beim schlämmen zuletzt absetzt, gibt Kremser Weiß.’

¹¹⁷ Malepeyre, Riffault, Vergnaud, Toussaint 1874: 61-63; Hurst 1892: 24-5.

¹¹⁸ Schmidt 1857: 35-36.

large French industries are monopolising the trade, and since 'their only goal is to produce as cheaply as possible to kill the competition and they are monopolizing the production in only a few factories, ... the artist has to be satisfied with a white without consistency he is given because nothing else exists'.¹¹⁹

The name 'Clichy white' is not encountered very often in the sources, more frequently the pigment is called 'silver white', or 'blanc d'argent'. However this name, which focusses on the whiteness of the precipitated lead white, is not reserved solely for this material either. Like 'Krems white' it has a more general meaning and is used for any lead white of particular brightness and softness: The term 'silver white' is first used by Montabert (1829), who uses it in the wider sense that includes all high quality lead whites.¹²⁰ Mérimée (1830) however talks about 'blanc d'argent ou de Krems'.¹²¹ This shows that its meaning is by no means certain. Jacobson (1855) uses it to describe Krems white with a small addition of black, mixed with gum and pressed into a cake¹²² and Malepeyre (1874) provides a recipe for a silver white that involves dissolving lead acetate in boiling water and adding a hot solution of soda.¹²³ Since all these authors claim that their silver white is first quality, it seems therefore that the term 'silver white' is reserved for lead white with a great degree of whiteness, which because of its whiteness is often identified as Krems white.

The abundance of terms such as 'fair', 'whitest', 'very white' and the number of recipes for bleaching lead white show an overall preoccupation with obtaining the whitest white possible.

As early as the seventeenth century, admixtures of smalt and vermilion to counteract the yellow tinge of stack-process lead white are mentioned. An anonymous seventeenth century Dutch manuscript in the Frans Hals museum advises an admixture of smalt and vermilion, Eikelenberg (1679-1704) adds indigo to lead white and the *Hedendaagschen Albert* (1773) mentions a small addition of unspecified blue to the white, which would 'otherwise with time turn yellow'.¹²⁴ By the early nineteenth century, colourmen

¹¹⁹ Vibert 1891: 280-281: 'mais ceux-ci n'ont pour but que de produire au meilleur marché possible pour tuer la concurrence et ils sont arrivés ainsi à monopoliser la production en quelques fabriques, de sorte que l'artiste doit se contenter du blanc sans consistance qu'on lui donne on n'en trouve plus d'autre.'

¹²⁰ Montabert 1829: 199: 'Les modernes donnent divers noms au blanc de plomb, selon les modifications qu'ils lui font subir; ils l'appellent blanc d'argent, lorsqu'il est très-purifié, très-raffiné; blanc de plomb, lorsqu'il n'a pas subi ces purifications; ils l'appellent blanc de céruse, lorsqu'il est mélangé avec de la craie (carbonate calcaire).'

¹²¹ Mérimée 1830: 222-223: 'blanc de Krems ou blanc d'argent'. Osborn and Bouvier 1845: 7: 'Krems, or Silver White. The finest preparation of the oxyd or subcarbonate of lead.' ... 'A Silver White has of late years been manufactured at the establishment at Clichy, near Paris ... It is said to be fully equal, if not superior, to the Austrian.'

¹²² Jacobson 1855: 61: 'Kremserwit of zilverwit is de witste soort van loodwit, waaraan de geelachtige tint, die het loodwit somstijds bezit, door toevoeging van eene zeer geringe hoeveelheid zwart is ontnomen en dat, met eene oplossing van gom zeer fijn gewreven, in vormen gedrukt en gedroogd is.'

¹²³ Malepeyre, Riffault, Vergnaud, Toussaint 1874: 127.

¹²⁴ 'Recepten-boeck' Frans Hals Museum 1650-1700: 9: 'Dhr de Jong zeide mij dat hij om 't geverwde van Lootwit te mogen hebben dat niet geel en werdt, van de beste smalt en wat formilioen in t'loodwit doet; want zonder dit, twyl de olie altyt naa den gelen treckt, besterft het wit anders altyt geelachtig' Eikelenberg 1679-1704: 161: 'Alsmen verwen wrijven wil zo neemt eerst / wat loot-wit om den steen wat zuyper te / maken en als 't gewreven is zo doeter wat / indigo bij, want dit wit dan niet zuyper / genoeg is om alleen te gebruyken, daer na / neemt ander loot-wit en die zal zuyper zijn' *Hedendaagsche Albert* 1773: 28: 'Voor de witte kleur; vryf loodwit met vette olie, en doet daar een weinig blaauw onder, om de witte kleur te behouden, die anders met den tijd geel wordt.'

introduce a standard pigment mixture called 'pearl white'. Pearl white is first mentioned by Leuchs (1825), who explains that it consists of lead white with a small addition of Berlin or Prussian blue.¹²⁵ Leuchs and others also mention additions of black, ashes, soot or indigo for the same purpose of counteracting the yellow tinge or yellowing of lead white.¹²⁶

13.8 Lead white in preparatory layers

Through careful reading of historical lead white recipes it seems possible, at least in a number of cases, to link lead white names with qualities. Looking at the lead white qualities mentioned in historical grounds recipes, it becomes clear that the lead white names which we now know represent a particularly high quality, such as 'flake white' or 'silver white', are not often in mentioned ground recipes (See Appendices 5 to 12). If we add to this the fact that a number of ground recipes mention specifically that lead white should be mixed with chalk for use as a preparatory layer, the hypothesis that lower quality lead whites were used in preparatory layer recipes seems to gain support.

For ground layers, absolute whiteness would probably not have been as crucial as in final paint layers. Indeed the question arises why colourmen or artists would ever choose the more expensive, pure lead whites for underlayers if cheaper alternatives are available. The function of lead white in preparatory layers is to provide colour and bulk, and use is also made of its siccative properties. This combination of requirements does not necessarily need the most pure, white and expensive grade available. Although not frequent, some comments in historical recipes support this hypothesis. An anonymous recipe in a Dutch manuscript from the second half of the seventeenth century titled 'slecht wit tot een gront' ('bad white for a ground') advises to grind a mixture of one part of lead white and one part of chalk in oil as a painting ground.¹²⁷

Beurs (1692) describes two qualities of lead white: flake white and lead white, the latter of a lower quality and suited for larger surfaces. This lower quality lead white is less white and also considered less stable in colour by Beurs than flake white.¹²⁸ Bouvier (1827) mentions something called 'second quality lead white', which is prepared less 'carefully and precisely', and which he considers suited only for large sized paintings, for preparatory layers or for sketches ('l'ébauche').¹²⁹ Mérimée (1830) describes lower quality lead white, which he calls a 'dirty white' and says that it is suited only for buildings and for

¹²⁵ Leuchs 1825: 14, repeated by Jacobson 1855: 62, who added indigo to the list of blue additions, Schmidt 1857: 36-39 mentioned 'Eschel' as well.

¹²⁶ Leuchs 1825: 39 mentioned bone black; Kloes 1903: 5: 'Berlijnsch blauw, indigo of roet, om de eenigszins geelachtige tint te niet te doen.'

¹²⁷ 'Recepten-boeck' Frans Hals Museum 1650-1700: 1: 'Om slecht wit tot een gront. Neemt ceruys en krijt wit van elc even veel vrijft het in lijn olij getempert van pas strijkt het gelijk.'

¹²⁸ Beurs 1692: 8: 'T Goede ongemalen Lootwit bereidmen op de zelve wyze, als het Schulp-wit; dog 't is gemakkelijker om vryven; en alzoo het mede onkostelijker is, daarom is 't meest in gebruik, en wel in min keurige en in grootere schilderyen, zijnde anders in witheid en bestendigheit van verwe beneden het schulpwit zekerlijk te stellen.'

¹²⁹ Bouvier 1827: 3-4: 'il est fait avec moins de soin et de précautions: aussi est-il moins blanc et moins cher, ce qui fait qu'on l'emploie volontiers quand on peint de grands tableaux qui exigent une grande quantité de couleur, dans les fonds et autres grandes parties, où la beauté du blanc n'est pas d'une absolue nécessité, et surtout pour les ébauches'

preparatory layers. He furthermore adds that sometimes it is mixed with large amounts of chalk.¹³⁰

Unfortunately Bouvier and others do not specify exactly which preparation or processing stages receive less attention in lower quality lead whites. However, when we look outside of the body of recipes describing ground preparation and focus on recipes that deal with lead white production and processing, as was done in this chapter, it becomes clear that quality differences may have a number of causes and that quality differences are introduced from the moment the ingredients for lead white production are selected until the last stage, when the artist further processes or mixes the lead white inside his own studio.

The assumption that washing may be one of the stages that is neglected in the preparation of low quality lead white is very plausible. The *Excellency of the pen and pencil* (1668) recommends to save the finest particles of thoroughly washed lead white 'as the choicest and purest of all', and advises that the remainder, 'which is not altogether so pure, may be serviceable for some uses, though not for all'.¹³¹ Also Dossie (1758), states: 'There is no previous preparation necessary, in the case of white lead, to its use; except washing over where it is intended for more delicate purposes'.¹³²

Chapter 14 investigates the effects that a number of washing methods advised in historical recipes have, both on the chemical composition of lead white and on its visual characteristics. It also describes reconstruction experiments involving particle size selection methods and discusses the effect particle size selection has on pigment composition.

¹³⁰ Mérimée 1830: 223: 'La céruse est surtout celle de Hollande, réputée pendent long-temps la meilleure de l'espèce, est d'un blanc sale, et, par cette raison, n'est employée que dans la peinture en batimens et dans l'impression des fonds sur lesquels on exécute les tableaux. Elle est aussi très souvent mélangée de craie. Les céruses d'Allemagne, par exemple, contiennent une grande proportion de sulfate de baryte; mais la céruse de Hollande de première qualité est sans un aucun mélange'. (1).

(1) Ces céruses contiennent aussi de l'ammoniaque, de acetate de plomb et du plomb métallique.'

¹³¹ *Excellency of the pen and pencil* 1668: 71-72.

¹³² Dossie 1758: 123.