HOFFMANN MINERAL
Unternehmensgruppe Hoffmann

ABRASIVES

Essential components of polishing and cleaning agents

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VM-9/0500/06.2019

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Summary

The present brochure will discuss the effects and interactions of the various raw materials as used in polishing and cleaning agents.

The efficiency of individual components in polishes and cleaners, alone and combined, will be interpreted on the base of their morphological structure and chemical composition. The focus of the discussion will aim at selected Neuburg Siliceous Earth grades which have found wide acceptance as abrasives or grinding agents in such products.

Based on the physical structure of the abrasives, a theory has been developed for the function of the Siliceous Earth grades SILLITIN and SILLIKOKOLLOID in such formulations. Intentionally, a purely empirical approach has been chosen to interpret the existing relationships between the raw materials, rather than trying to develop mathematical or physical models. The report should be understood as a guideline for practical work, and not so much as a theoretical dissertation.

A multitude of guide formulations for different applications of polishing and cleaning agents is included, with the intent to indicate ways to solve various polishing and cleaning problems by specifying optimum abrasives or their combinations.

The Appendix lists the suppliers of the raw materials used in the guide formulations, as well as their chemical composition. This will offer useful information to the formulator for developing proprietary products, or modifying and optimizing the guide formulations given.

Contents

1 Introduction

Many articles and objects in daily life tend to gradually lose their original appearance when exposed to light, humidity, oxygen or dirt of various origin. Their surface turns to become dull, rugged and unattractive.

In addition, numerous products made from metal, but also from glass or from plastics, exhibit a more or less pronounced surface roughness after the molding or shaping process, and are partly covered with an oxide layer. This requires a post-treatment step for technical and esthetical reasons.

Surface treatment processes concern both the regeneration of old surfaces and the upgrading or generation of new surfaces. Both objectives are the result of human inventiveness, and create ever new challenges.

Surface treatment generally means the refinement of surfaces via selected chemical-physical methods, such as chrome-plating or painting, or by mechanical operations such as polishing or cleaning.

2 Cleaning and Polishing

Abrasives (grinding agents) of different grain size and in varying amounts are used, according to requirements, to wear off ultrafine surface layers and create surfaces of high quality finish. The conditioning agents included in the product formulations then form a protective film on the surface and even out small irregularities.

Optimum efficiency and quality is obtained with a suitable balance between abrasive, conditioning, surface active and dirt removing ingredients. Polishes based on such combinations have for many years proved their value in industrial and household applications, in car maintenance and in the processing of noble metals.

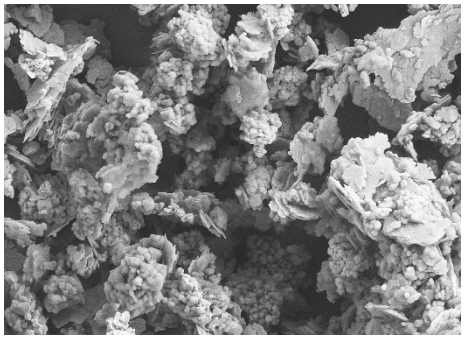
The Neuburg Siliceous Earth grades SILLITIN and SILLIKOLLOID from HOFFMANN MINERAL have been successfully used as efficient abrasive agents in high performance polish formulations since the beginning of the 20th century.

3 Major ingredients of polishing and cleaning agents

3.1 Abrasives

- **Neuburg Siliceous Earth**

As already mentioned, Neuburg Siliceous Earth grades are included as abrasives in manifold polish formulations. The following considerations about the processes that take place during polishing operations, should help to appreciate the interactions which characterize the underlying mechanisms. It is not intended to explore the deeper mathematical and physical interrelations which govern the extremely complex individual process steps, but to offer an approach to help optimize practical product formulations.



Neuburg Siliceous Earth, extracted in the surrounding of Neuburg (Danube), is a natural combination of corpuscular Neuburg silica silica and lamellar kaolinite: a loose mixture impossible to separate by physical methods. The silica portion exhibits a round grain shape. Therefore, the silica portion does not present any sharp-edged structures, and the low grit content (sieve residue) allows a gentle polishing of surfaces.

Property	Unit	Method	SILLITIN V 85	SILLITIN N 85 PURISS	SILLITIN Z 86 PURISS	SILLIKOLLOID P 87 PURISS
Particle Size d_{50} d_{97}	 µm µm	acc. to ISO 13320	 4.0 18	 3.0 16	 1.9 9	 1.5 6
Residue > 40 µm > 200 µm	 mg/kg mg/kg	acc. to DIN ISO 787, part 18	 25 5	 8 1	 8 1	 8 1
Oil absorption	g/100 g	acc. to DIN ISO 787, part 5	45	45	55	55
Mineralogical Composition: - Neuburg silica - Kaolinite - Amorphous mineral phases - Other minerals	 % % %	based on X-ray diffraction pattern analysis combined with Rietveld	 70 17 8 5	 65 20 10 5	 60 25 10 5	 55 30 10 5

The PURISS grades of Neuburg Siliceous Earth are far superior to the classic SILLITIN in terms of grain quality. The grit portion (sieve residue) of these products – which is already very low – is further reduced in comparison with standard SILLITIN. Dispersal behavior in low-viscosity systems is considerably improved. These effects are achieved through a final process after actual production.

As an abrasive, Neuburg Siliceous Earth offers particular application benefits:

* Siliceous Earth can be as readily incorporated into straight aqueous systems as into solvent/water mixtures.

* As a result of its low tendency towards sedimentation, Siliceous Earth efficiently contributes to the stability of such dispersions.

* Neuburg Siliceous Earth, in particular the very fine-particle SILLIKOLLOID 87 PURISS, helps to adjust the desired thixotropy and structural viscosity in polishing and cleaning agents. The further addition of costly rheology additives can, therefore, be minimized or even completely eliminated.

* In polishing operations, the relatively loose clusters of Siliceous Earth are destroyed under the action of the shearing forces. The flat kaolinite platelets cover the surface to be polished, and prevent a direct contact of the silica particles; this way, the development of grooves in soft surfaces is prevented. On the other hand, certain asperities which stand out from the surface, are quickly leveled away, because they cannot be covered by the small amount of kaolinite present.

* Neuburg Siliceous Earth is available in 4 different particle size distributions, in order to offer optimum abrasivity for different polishing requirements. The proper choice of the Siliceous Earth grade greatly depends on the state of the surface to be treated. For sensitive surfaces, or limited fouling, the finer products such as SILLIKOLLOID 87 PURISS or SILLITIN Z 86 PURISS are preferred. Grossly fouled or less delicate surfaces can safely be polished with SILLITIN N 85 / SILLITIN N 85 PURISS or SILLITIN V 85.

- **Aluminum oxide**

Contrary to Siliceous Earth, aluminum oxide (Al_2O_3) is characterized by a structure which will be divided up into ever smaller segments during polishing operations. Particularly on delicate parts, this finally gives rise to a highly glossy, scratch-free surface.

Aluminum oxide (also called alumina), in suitable combinations with Siliceous Earth opens up further application areas which would be difficult to attack with the individual abrasives alone. Polishing grade alumina counts among the hardest minerals in nature.

- **Siliceous Earth/alumina blends**

Combinations of Siliceous Earth and alumina are outstandingly suited for upgrading heavily fouled, but sensitive surfaces.

The coarse, very hard alumina particles serve to erode all the rough surface asperities. The action of the polishing forces also causes a deagglomeration of the Siliceous Earth particles. The kaolinite then covers the surface, and the released fine silica grains break up the alumina crystals which likewise disintegrate into lamella-type fragments. Jointly with the kaolinite, they build up a rooftile-like protective layer on the surface, which is already smooth and free from loose particles.

The final result, after removing the residues of the polishing agents and abraded particles with polishing cloth or polishing wool, is an extremely smooth and highly glossy surface.

3.2 Other ingredients

In response to environmental considerations and to growing customer preference for physiologically non-hazardous products, aqueous formulations based on native raw materials are gaining ever more in importance.

The general makeup of a formulation also plays a vital role. It is of high importance whether a formulation is based on solvents, on oil/water or water/oil emulsions, because mineral particles show a strong tendency towards flocculation in non-polar (organic) systems.

- **Waxes for surface protection**

Surface conditioning agents generally contain hard waxes, which produce a decorative surface sealing that is heat resistant and protects against moisture and dirt.

Usual hard waxes in polishing formulations are the following.

Carnauba wax

- a natural wax obtained from the Brazilian fan palm
- is predominantly used in water-based, environmentally friendly polishes

Montan waxes

- are C_{26}-C_{32} waxes extracted from bituminous lignite
- are readily soluble in white spirit and thus are uniformly and homogeneously distributed throughout the polishing system

Typical representatives of this class are:
- acid waxes
- ester waxes
- partly saponified ester waxes

Fischer-Tropsch waxes

- fully synthetic products from the hydrogenation of coal, are characterized by a high portion of non-branched (linear) carbon chains. They are often used after partial saponification.

- **Silicone oils**

Silicone oils mostly are linear polydialkylsiloxanes of different molecular weights. In view of their extraordinarily low surface tension, they are capable of near-perfectly wetting all sorts of surfaces.

The resulting lubricating action helps to reduce the forces required for polishing, and to enhance the gloss. The chemical stability of polysiloxanes over a wide range of temperatures ensures long-lasting glossiness. The pronounced hydrophobic nature of these substances is responsible for the desired water repellent effect.

- **Water**

An environmentally friendly solvent, water today represents an essential constituent of many polish formulations. As a disadvantage, water requires longer polishing times and higher energy input. With its high specific heat capacity, water in particular plays an important role in automated polishing operations, where it acts as a cooling medium and thus minimizes thermal damage to temperature sensitive surfaces such as paints and plastics.

- **Solvents**

For certain applications, solvents still today cannot be eliminated. In such cases, it is recommended to use highly purified white spirit (free from hazardous substances), by itself or in combination with water. White spirit has a low specific heat capacity and low heat of evaporation, which implies less effective cooling, but easier evaporation.

- **Surfactants**

Surfactants is the generic term for all sorts of surface or interface active substances. Frequently, surfactants are merely understood as detergents which decrease the surface tension of water, and thus impart to the cleaner a high dirt removal and cleaning potential.

In view of the widespread use of cleaning agents, their formulations resp. the surfactants included are expected to meet stringent requirements with respect to environmental properties. As a result, current-day development projects very much aim at using surfactants which are obtained from renewable resources (fats and oils).

Surfactants also include other substances which are often treated separately in the literature. As the following discussion will show, the same chemical substances can often be used for very different purposes.

Emulsifiers

Emulsifying agents or detergents decrease the interfacial tension between two immiscible liquids, and form a coherent layer between their interfaces.

White spirit and water cannot normally be mixed. The addition of an emulsifier in polishes based on white spirit/water mixtures as solvents, however, makes it possible to obtain stable emulsions. Suitable emulsifiers here are ethoxylated fatty alcohol and similar products.

Dispersing agents

Dispersing agents facilitate, or indeed allow to obtain a dispersion of solid materials in a liquid. They reduce the surface tension of the particles to be dispersed to the point to achieve good wetting, followed in the process by fine dispersion of the solid particles in the liquid phase. Dispersing agents are particularly useful in polishes with very high abrasive content. Suitable products, among others, are fatty alcohols and their polyglycol ethers.

- **Preserving agents (microbiocides)**

In environmentally friendly, water-based polishes, microbiological attack can lead to spoilage, similar as found in food products. The formulations, therefore, include microbiocides which act to prevent growth and spreading of microorganisms.

- **Thickeners and thixotropic agents**

Thickeners are used to increase the viscosity of liquid systems, and thus allow to deliberately adjust the working viscosity of cleaners and polishes. Partly, they also contribute to thixotropic properties which are particularly appreciated when working with polishes on inclined or even vertical surfaces: run-off and drip-off are minimized. Equally, thixotropy and structural viscosity as brought about by many thickeners, play an important role for storage stability. They minimize or completely prevent a sedimentation of the heavier abrasive particles, and thus counteract de-mixing. At the same time, these physical features allow an easy redispersion of deposits in the cleaning or polishing agent by simple stirring or shaking.

Suitable thickeners are organic aluminum compounds (e.g. Bentonite) and/or fumed silica, and to a certain extent the abrasives themselves. Especially the very fine particle SILLIKOLLOID is used in many formulations, besides its mild polishing action, for viscosity adjustment.

4 Guide formulations for polishes

Manifold are the materials used to produce technical and consumer goods, and as manifold are the application areas for **polishing agents**.

Their product range extends from coarse polishes for kitchen stoves via paint and varnish conditioners to polishes for optical glassware and plastics goods.

The selection on our hompage contains basic formulations for very different requirements, which can of course be modified and optimized to adjust for desired end properties or special problem areas.

In view of the complex way of action as typical for polish formulations, there will often be a need for individual adjustments and optimization in order to respond to particular requirements. The expertise our Technical Service specialists and the various test facilities of our laboratories are available to assist our customers.

The basic formulations can be found on our homepage at:

https://www.hoffmann-mineral.com/guide-formulations/polishing-cleaning-agents