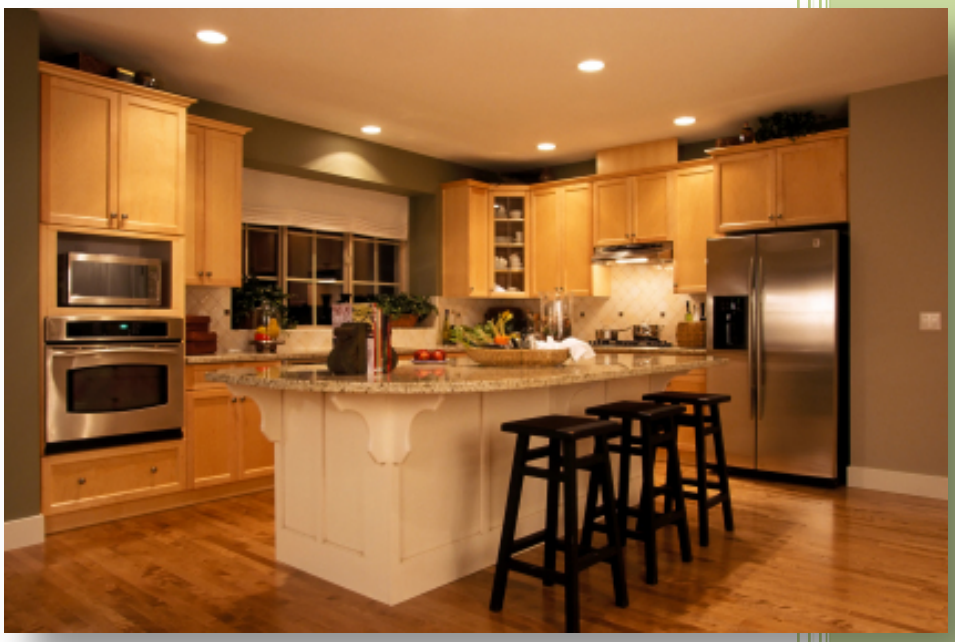
International Institute for Bau-biologie® & Ecology

IBE 205.5

IBE 205.5 Natural Finishes



BRINGING TOGETHER TECHNOLOGY AND DESIGN METHODS TO PROVIDE THE INFORMATION NEEDED TO CREATE HEALTHY HOMES AND WORKPLACES

Natural Finishes – IBE 205.5

Welcome

Thank you for choosing IBE for your educational needs. Current environmental realities demand a new approach to ensuring that our homes, schools and office buildings support the health and wellness of all who dwell there. We strive to provide the latest information and cutting edge methodology on the vital, complex relationship between the natural and the built environments. May you find your educational experiences enlightening, and take this knowledge out into your community for the benefit of all. **Michael Conn**, *Executive Director*, Institute for Bau-Biologie & Ecology.

Course Navigation

You will find that it is very easy to navigate through this course.

- Progress through the lessons using intuitive navigation tools. When you study, make sure to be aware of and use all supporting materials, such as pdf files, video and audio clips, links to other websites or relevant articles or papers, as well as the online forum.
- The last lesson will give you the option of downloading an electronic version (PDF) of the course. Please be aware that this information is copyright protected.
- When finished, you will be ready for the test. These tests are "open book" and are designed to help you evaluate your understanding of the subject.
- When you have finished the entire Course Pack, a Certificate of Completion is available on-line.

By using the Forum feature, students can share information and solve problems. We would like to see truly interactive discussions take place.

Please be advised that links to third party information may not reflect or support the Building Biology viewpoint. However, it might be of some interest to see how other people, groups, institutions, etc. argue the same subject.

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Lesson 1 – Introduction to Finishes

Building Biology Assessment of Finishes Introduction

Surface finishes have always been at the heart of the building biology movement. Natural building materials such as wood, clay or lime have a very positive impact on indoor air quality (i.e. breath ability, hygroscopicity, non-toxicity), and are highly recommended by building biology. But even those materials can easily lose their beneficial properties when coated with the wrong products. Today, many finishing products are toxic to the environment as well as to human health. It is most unfortunate when healthy building materials are then turned into a toxic product by the application of toxic finishes. Also refer to the course packs Living Climate and Wood Preservatives, Pests and Fungi (future course packs).

"We can build the most beautiful homes, use the best materials available, and take great care and skill to craft and install them. Yet, as soon as we cover everything with dead synthetics, all our efforts will be in vain." Carlo Vagnières

However, finishes may also be used to help reduce negative impacts from certain building materials. A thin layer of clay plaster over concrete or gypsum board (drywall), for example, can improve indoor air quality tremendously due to the clay's amazing moisture-buffering capacity. In order to reduce toxic emissions from treated wood (preservatives) or particle board (formaldehyde), shellac-based sealers are another option.

Until recently, paint manufacturers were almost exclusively concerned with competitive pricing, long shelf life and ease of application. After victims hurt by toxic wood preservatives took their cases to court, the detrimental health effects of products containing PCP, lindane, arsenic and such became better known. Unfortunately, the above listed substances have not yet been banned in North America. The public demand for less toxic, environmentally friendly and healthy alternatives has grown ever since. Natural paint manufacturers have come a long way and offer competitive products, often with superior properties.

The list of symptoms caused by toxins added to finishes, especially pesticides and fungicides, is long. Acute symptoms such as irritation of the eyes and mucous membranes, headaches or vomiting can be easily related to a specific product and hopefully will subside after exposure is eliminated. However, it is rather complicated and challenging to track down chronic poisoning, which is caused by low-level exposure over a long period of time. Often it is only after a long time of suffering and investing in highly expensive and specific tests that the culprit(s) of chronic poisoning are discovered. The organs most often damaged include the central nervous system, where fat soluble toxins accumulate in higher concentrations, the inner organs, especially the detoxifying organs such as the liver and kidneys, or the immune system, developing allergic eczema or allergic asthma. Acquired allergies for particular substances (e.g. formaldehyde, PCP) can lead to disabilities for an entire lifetime. For such individuals there is no safe threshold. On the contrary, affected people tend to become more and more sensitive.

If you thought that natural paints would pose no health or environmental risk whatsoever, you are in for a bad surprise. Unfortunately, not all natural finishes are as safe as they claim to be. Essential oils, for example, are sometimes added in very high concentrations. As with many other natural substances such as salt, sugar, coffee or black tea, they become poisonous at higher dosages. The risk associated with natural finishes is often a question of concentration, amount and frequency of usage. Compared to conventional finishes, however, natural finishes are usually a better choice. But as with everything else, you must compare products from different manufacturers and educate yourself about the health risks from various ingredients. In addition, follow the precautions listed throughout the following chapters.

Lesson 2 – Basic Ingredients

Basic Ingredients of Natural Finishes

Today we are faced with a dazzling array of finishing products. It is a daunting task to make a choice, especially when considering how little information is revealed on their labels and how much knowledge is required to decipher them. The quality of any given finish is determined by its chemical-physical properties as well as the origin of its ingredients.

Finishing products usually consist of four major ingredients: **binders, solvents, coloring agents and additives.** Let us closely examine each one of them.

Binders and Mediums

Binders, also referred to as mediums, are a type of adhesive, which binds the pigments together and attaches them to a surface. They not only have an impact on the visual appearance of the finish (e.g. flat or non-flat) but on the area of application as well (e.g. washable or waterproof).

Natural binders may include plant oils, resins, waxes, size and casein. In contrast, **artificial binders** (synthetic resin emulsions) are made from either chemically modified natural materials (e.g. alkyd resin emulsions) or petroleum (e.g. acrylates). During the manufacture of those synthetic resin emulsions, toxic emissions and harmful waste products are created. In addition, the synthetic monomers released during application and drying can also be damaging to our health.

Solvents and Thinners

Solvents, also referred to as thinners, "thin" the mixture of binders and color pigments, improve its workability, and sometimes also increase its penetration depth. The simplest and most natural solvent is water, though it is only suitable for water-soluble binders. Finishes based exclusively on water have an extremely short shelf life, which is why those paints were traditionally prepared at the time of application. Ready-mixed paints, however, usually require some kind of preservative added to prevent spoilage.

Water-based acrylic latex paints, for example, usually contain up to 10% glycol ethers as a solvent. Since glycol ethers are semi-volatile, in other words they are rather slowly released, the out gassing can take several months. Just because their odor is not as noticeable as highly volatile organic solvents does not mean that they are harmless. Ethylene glycol, for example, can cause headaches, nausea and damage the liver and/or kidneys. In paints, ethylene glycol is now most often substituted by the less toxic, yet still irritating, propylene glycol.

Artificial solvents[1] (benzene, xylene, naphthalene, toluene) contain aromatic hydrocarbons, which can damage the central nervous system and promote cancer. Increasingly, glycol ethers are being used as a substitute.

As **natural solvents**, turpentines are most often used. The two most common choices are balsam pine turpentine and citrus or orange peel oils. As their names imply, the first is distilled from pine resins, which are a by-product of the paper and pulp industry, and the latter is distilled from the peels of citrus fruit, which is a by-product of juice making. These solvents are extracted directly from plants and can be safely returned back into the natural cycle. In general, they show no specific toxicity and are tolerated quite well by many people. However, people suffering from chemical sensitivities and a weak immune system are usually not able to tolerate even natural solvents, which irritate their eyes, skin and mucous membranes. Allergic reactions may include eczema or contact dermatitis, which is triggered by delta-3-carene in turpentines.

Whether finishes with artificial or natural solvents are being used, appropriate ventilation is always of utmost importance during application. It is recommended not to move immediately into newly painted rooms in which finishes containing solvent have been used, but rather to wait for at least four weeks. You certainly would not want to sleep in such a room for the first two weeks. During that time the space should be thoroughly heated and ventilated.

Natural paint manufacturers have begun to develop alternatives for sensitive people.

- Use of high-quality South American turpentine with **low levels of aromatics**.
- Substitution of so-called **isoaliphatics** for turpentines.
- To date, isoaliphatics can only be derived from non-renewable petroleum or natural gas. In contrast to other petrochemical solvents (e.g. methylated spirits), however, they have the advantage of containing very little or no aromatic hydrocarbons. Because of their rather low toxicity, they are even being used in cosmetic products and pharmaceutical drugs.
- **High Solid Products:** These professional coatings designed for commercial applications contain higher amounts of solids and remarkably lower levels of organic solvents (usually no more than 5 - 15%). As a result, they are also very economical. This can be achieved by adding solvents made from natural sources such as lactic acid and pure bioalcohol.
- **Solvent-free or Zero-VOC Finishes:** New technologies make it possible to successfully emulsify pure water and natural oils without the use of organic solvents (e.g. Aquasol by Aglaia, Aqua by Auro). (Synthetic finishes are also available without organic solvents. However, they are based on acrylates and often contain fungicides and preservatives.)

Ideally, choose natural finishes without solvents. If, however, a solvent-containing finish is given preference, choose finishes with the lowest amount of aromatics-free solvents possible and keep those applications to a minimum.

Coloring Agents

Pigments lend color and opacity to a finish. In exterior applications, the pigment particles also protect wood from UV radiation by reflecting solar rays. In the past, inorganic pigments such as lead white and zinc oxide were used that are now banned because of their heavy metal content. The common white pigment, titanium oxide, does not pose any health risk, but its production can be highly problematic if acid recycling is not practiced.

Artificial organic pigments were originally manufactured from black coal tar (tar colors). Today, they are most often synthesized from petrochemical products such as aniline, anthracene and azo dyes, some of which are suspected in causing cancer.

The following natural pigments are in use:

	Made from
Purple Imperial	Crushed sea snails
Carmine	Dried cochineal insects
Indian Yellow	Urine of cows fed mango leaves
Sepia Blue	Secretion of the ink sac of the cuttlefish
Dragon's Blood	Ruby red resin of a certain palm species
Indigo	Fermented leaves of the woad plant
Crimson or Madder Red	Roots of the madder plant

- **Natural Earth Pigments:** Colored (e.g. iron oxides) or white (e.g. chalk) earth pigments are first mined in open pits. Then they are sorted and ground into a fine powder. They are alkali-proof, lightfast and easy to use.
  Raw Umber
  Yellow Ocher
  Manganese Black

Veronese Green
Dolomite
Terra di Sienna
Spanish red
Graphite

Unfortunately, natural earth pigments are not available in all colors. And some of them can actually be quite toxic, such as malachite or azurite.

- **Natural Animal and Plant Pigments:** Those pigments are seldom found in wall finishes because they are usually neither alkali-proof nor lightfast. Furthermore, they can be rather expensive. Plant pigments, however, are perfectly suited for glazing techniques because only small amounts of pigments are needed.

- **Synthetic Mineral Pigments:** These are pigments manufactured by subjecting natural minerals to chemical reactions, including oxidation, high temperatures and such. As a result, new and more vibrant colors can be created, which otherwise could not be extracted from pure mineral pigments.

- Some of those mineral pigments, such as iron oxides, are completely non-toxic and environmentally friendly. Others pose no health risk to humans, but their manufacture can be more or less harmful to the environment (e.g. titanium oxide, ultramarine blue). Pigments containing heavy metals such as lead white or chromium yellow are limited to highly specialized applications, such as authentic restoration work. The softer hues of natural earth pigments are particularly welcome in our home environment.

- **Other Additives:** Various compounds are added to improve the application properties of a given finish. One such group of additives includes so-called driers that are made from heavy metals. As their name implies, they speed up the drying process. Though natural paint manufacturers usually stay away from lead, they do use manganese, cobalt or zirconium octates, which are also suspected of being carcinogenic. Fortunately, natural paint manufacturers usually use less than 1% driers, which do not outgas during application. Yet they can be found in the dust. The highest risk of inhaling those substances occurs during renovations when the wood is sanded or during heavy use and/or weathering. Therefore, it is recommended that you provide respiratory safety anytime you sand finished wood, using sufficient ventilation, respiratory mask and vacuum controls.

  In addition to driers, synthetic finishes often contain a host of other hazardous additives in the form of biocides (arsenic disulfide, phenol, copper, formaldehyde), fungicides, flame-retardants or plasticizers.

Footnotes

[1] MFL Occupation Health Center, Inc.: Organic Solvents

Lesson 3 – Biological & Ecological

Building Biology Recommendations for Natural Finishes

The following recommendations are meant to offer guidance for the selection of healthy interior and exterior surface coatings:

Paint as Little as Possible

Just because you can does not mean you should paint everything. Be mindful of resources. Allow each material speak its own unique language. Those characteristics specific to each material can often be enhanced by simple, transparent or only slightly tinted finishes.

Surface Finish	S_d Value
Two-component Silicate Finish Size Paint Lime Wash Casein Paint Natural Oil Glaze Wax	< 0.1
Boiled Linseed Oil Natural Oil Varnish	0.1 – 0.5
One-component Silicate Finish (5% acrylic emulsion)	> 2.0
Synthetic Emulsion Paints (Varies according to specific formula)	0.1 – 2.0
Oil Paints Based on Natural Resins	> 2.0
Acrylic, Acrylic Resin and Acrylate Varnishes	0.5 – 2.0
Varnishes Made from Natural Resins, Alkyds, DD, PUR, Polyurethane and Polyester	> 2 – 3
Epoxy Varnish	7.5
Varnishes Made from PVC, Melamine Resin, Phenol-Urea-Melamine Mixtures	10

S_d Value = Approximate value for surface finishes of 0.2 mm thickness
WVP = Water Vapor Permeance for coatings

S_d Value	Vapor Permeability	WVP Value
s < 0.5 m	Water vapor permeable	> 10 perms
s = 0.5 – 2.0 m	Water vapor semi-permeable (vapor retarder)	< 10 perms and > 1 perm
s > 2 m	Water vapor impermeable (vapor barrier)	< 1 or 0.1 perm

Source: *Baustoffe unter ökologischen Gesichtspunkten* ed. by Landesinstitut für Bauwesen und angewandte Bauschadensforschung LBB Aachen, 1993.

Water Vapor Permeability of Surface Coatings

Prefer Natural Finishes

Either buy finishes from a natural paint company, which fully declares all ingredients, or mix your own finishes.

Choose Non-toxic Finishes

All finishes, including their solvents and binders, should not emit any vapors detrimental to human health. Look for solvent-free or zero-VOC finishes without toxic biocides, fungicides or preservatives.