

# **Oils and Pigments**

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Jan Esmann  
Model on chair 1 (Rune)  
Oil on canvas, 2011  
130 x 100 cm

## **Sad facts about commercial tube colours**

### **1. You can not trust the name on the tube**

Colour manufacturers tend to sell pigments under fancy names or even sell fancy mixtures under irrelevant, but regular, names. Thus for example, you will find that a tube labeled manganese violet or ultramarine violet really contains a mixture of dioxazineviolet and lithopone. This, unfortunately, goes for even good and respectable companies. So until you are skilled enough to recognize any pigment instantly, you should only trust a colour manufacturer that states what's in the tube by pigment number – either on the tubes label or in their catalogue. Always demand to see the catalogue, if nothing is stated on the tube. If you don't get any wiser from that, then go for some other brand at once. Anyway: get skilled enough to recognize any pigment and its mixures more or less instantly. Now, the situation is not as simple as this, because sometimes it is okay to replace an original pigment with an emulation. Sadly most colour companies make ridiculous alternatives, like selling dioxazine as ultramarine violet, or manganese violet as cobolt violet. Not to mention all the mixtures sold as naples yellow that bear no resemblance with the real pigment at all (real naples yellow is toxic and not generally available).

In the pigment list you will find recipes for the best emulations of expensive or unavailable pigments. You can safely replace expensive colours with these mixtures and no eye will ever be able to see any difference.

### **2. You can not trust the stiffness of the tube colour**

Today we have a number of plasticizers that can be added to the paint in order to make it stiff. This means that a tube of a pigment like cobolt blue, which requires about 125% oil (a lot), can actually contain 250% oil (relative to the amount of pigment, so that's more than twice the amount of pigment). Such a colour with excess of oil will naturally yellow with time and be more liable to crack. You will find in books about the impressionist painters, that they would place the colours from the tube on blotting paper in order to remove the excess oil. You can't use that method today if the colour has been made stiff with modern plasticizers, because in this case, there is, technically speaking, no excess oil.

The most common plasticizers today are aluminium stearate and aluminium hydroxide. If used wisely both are blessings, because some colours are practically impossible to grind without such additions (like ultramarine), but both – especially aluminium stearate - can be abused to cut expensive colours into virtual uselessness for any artist who makes immortal works. If on the other hand you only want to make decorative works that are meant to last less than a lifetime, then no reason to bother. In older works on technique, such as Max Doerners Malmaterial, you will find a 2% addition of wax mentioned as a plasticizer. Know that aluminium hydroxide and aluminium stearate are infinitely better in all respects.

Aluminiumstearate is a modern synthetic wax-like substance. Aluminiumhydroxide is an inert (colourless) pigment that makes the colour more buttery but does not make the oil itself thick like wax or aluminiumstearate melted into the oil does. Remember wax is a soft substance and that introducing it into your paint introduces a non-hardening substance, that will soften the paint layer or destabilize the paint film, or even melt in hot climate or when your immortal work of art needs treatment by restorers, who regularly subject paintings to heat up to 60°C. Aluminium stearate is difficult to use. You can't just add it to the colours, but have to either a) coat the pigment particles with it under heat, which is impossible to do at home, or b) heat your linseed oil high enough melt aluminium stearate into the hot oil. Then, when the oil cools to normal temperature, it should be slightly jelly-like or slimy. Grinding

colours in this slimy oil will of course produce more stable tubecolours, but they will also have a larger oil content. Rheologically, there is no advantage to this while painting. Perhaps on the contrary.

One way to judge if a tube contains a regular amount of pigment is to have some idea about the weight of the pigment. Know that organic pigments are generally lightweight and nonorganic pigments are generally heavyweight (ultramarine and lamp black being exceptions). So if your tube of cobolt blue or ceruleum blue does not feel distinctly heavy in your hand, compared to for example quinacridone, reject it promptly. This is difficult with the small 38 ml tubes, but easier with large tubes.

These pigment classes are heavy: cobolt, cadmium, zinc, iron (mars), manganese – and of course the obsolete lead colours. Earth pigments are medium weight and thus difficult to judge, but since earth costs about the same as oil, there is no need to worry too much about earth colours. Even more so that the earth colours have much the same hue as darkened oil, especially burnt sienna. Anyone who has compared the weight of a homemade zinc white with a commercial zinc white will be shocked by the weight and pigment density of the real thing. This is also because a zinc white must be ground several times, each time adding more pigment. Commercial manufacturers do not have the patience to do that, so they grind it once or twice and add a plasticizer.

Artist! Grind your own zinc white! Grind zinc white in alkyd or poppy or walnut oil, all with siccativ. Don't grind your lead, cadmium or cobolt colours, because they are poisonous. If you insist on doing so, wear a mask over your mouth and nose.

### **3. You can not trust that the oil used is the best oil for the pigment**

Most colours should be ground in linseed oil. However the whites and blues could be ground in either alkyd, stand, walnut or poppy oil, because these oils yellow less or, rather, at least more slowly. These oils dry slowly, so they need an addition of siccativ to accelerate the drying rate. Some respected companies market a zinc white ground in safflower oil, which is nice considering that it yellows more slowly, but because they do not add siccativ, the colour needs about a month to dry, hence it is useless. Also safflower oil is not recommended since it has a tendency to turn soft and sticky with age. In fact I would say: shun safflower oil like the plague.

## **The elements of paint**

### **Siccativ**

It is a myth that siccatives (drying agents) should be avoided. The siccatives cobolt naphthenate or cobolt linoleate are okay to use. Old siccatives based on lead or manganese are bad because they keep on working on the paint in undiminished strength, even after the paint has dried. You only want the siccativ to work on the paint while the paint is wet. Otherwise it will cause all the bad effects of ageing to come too soon (yellowing, cracking, etc.). Cobolt siccatives tend to work while the paint is wet and will diminish in effect as the oil dries. Intuitively you will try to avoid cobolt siccatives because of the dark violet hue. Lead and manganese siccatives are brown. Cobolt naphthenate siccatives can be recognized by their smell of naphthalene, their thin liquid diluents and their more neutral violet-brown colour. Cobolt-oleate siccatives can be recognized by their thick oil-like fluidity and their strong blue-violet hue. Oleates are the best from the point of view of rheology: they only slightly alter the consistency of the paint they are added to and may even tend to make it more short and buttery. But if you want to mix oil and siccativ and store it, fx as a medium, then cobolt oleate is a bad choice because somehow it congeals into odd lumps. I have not experienced

problems when cobalt oleate is ground into colours along with the pigment and oil. Probably because the mixture with dispersed pigment and the fine mixing in the rollers keep the oleate dispersed and suspended enough. There is a third cobalt siccative, cobalt carboxylate, which can be distinguished from the two other cobalt siccatives by not being violet but blackish brown. Its use and behavior is similar to cobalt naphthenate because it is diluted in mineral spirits or similar solvent. It does not have an odor like cobalt naphthenate. Don't be concerned about the violet hue because it will fade away within a week or so, even from blanc fix.

Siccatives are sold diluted and the concentration is usually adjusted so that normal linseed oil paint will dry within a day if you add about 2-5% of the amount of paint (2% cobalt naphthenate, 5% cobalt oleate). However you can't trust the label on the bottle in this respect. I wasted my money on a flask of cobalt carboxylate siccative from Rubens that claimed 1% was enough, however a zinc white required 10% to dry as rapidly as with 2% of a cobalt naphthenate from Roberson, which claimed 2% was appropriate. Don't trust a cobalt siccative that is not dark and non-transparent – you will need too much of it in your paint so that its diluents will become a nuisance by thinning your paint to a useless amount. Some colours require much more depending on the pigment and oil. In average linseed oil colours, add a few drops for an amount of paint equal to a lump of sugar (about a cubic centimetre). Slow drying pigments, like zinc white or ultramarine, ground in walnut oil will need four times as much, that is about 10-20%. If you add aluminium hydrate to the paint, it will need more siccative because aluminium hydroxide retards drying.

When you use siccative, be aware that the paint is apt to skin dry, that is, develop a deceptive fully dried surface film while still wet underneath. If overpainted such will be liable to crack. If this is the case with a work you destine for immortality, either wait till it's dry throughout or scrape off the dry film and wait for the exposed wet paint to dry. If really too much siccative is used, the paint film will remain sticky. Adequate siccative will accelerate the drying of the surface to make it barely tacky while the body paint below also dries and it will not form a fully dried surface film before the body paint has set, if not dried hard (this depends on the oil used, though). Such a break point is difficult to match and depends on the kind of oil used, so you can't trust a given pigment always requires the same amount of siccative, because one tube colour manufacturer may grind it in safflower oil, while another grinds it in linseed oil. Just be alert for wet paint under a dry surface and wait with overpainting till it's dried through.

## **Oil content**

In the list of pigments are given approximate amounts of oil needed to grind 100 parts of pigment (by volume). These amounts change if the oil changes. The thicker the oil, the more oil you need. So poppy oil makes leaner colours than linseed oil. Stand oil gives very fat and fluid colours. The amounts given are for linseed oil. Also the amount of oil needed changes with the amount of water imbedded in the pigment. Pigments like ochre are hygroscopic because they often contain some clay. This water is no problem, but it explains why measures are only approximate. You can get rid of the moisture by heating the pigment and this will change the oil absorption. However, it will also change the hue of the pigment if you heat too much.

## **Oils**

The following oils can be used to grind colours, though they are not equally good: Alkyd (oil modified, not urethane used for varnish, it yellows), stand oil, linseed oil, walnut oil, safflower oil, poppy oil, sunflower oil, hempseed oil, candlenut oil (lumbang oil), tallowseed oil (stilinga oil). The most usual are linseed, walnut, poppy and safflower. In Russia they

traditionally grind in sunflower oil. However, I do not approve of sunflower or safflower oil because they remain very tacky for a very long time after drying causing dust and dirt to stick to your masterpieces. Safflower oil becomes sticky again after some months or a year after it has dried to satisfaction. During the 16<sup>th</sup> and 17<sup>th</sup> century walnut was often used alongside linseed. You can either buy the mentioned oils from a professional craftsman's shop or buy them, at least safflower and walnut, at your local supermarket as cooking oils. The problem buying them as cooking oils is that cooking oils may have added antioxidants in order to ensure the oils do not jelly in the bottle. Antioxidants retard or counteract the drying and cause your painting to remain sticky for years. So if you purchase your oil as cooking oils check if it's free from antioxidants. If it does not say so on the label, then purchase your oil in a biologically grown brand you trust shuns additives. You should always use cold pressed and purified oil in order to avoid contamination with yellowing and non-drying pollutants (organic residues). You can buy linseed oil raw and as varnish in many shops, but you should not be tempted to use these very yellow oils unless driven by immediate need since it is neither cold pressed nor purified. No matter what oil you purchase and from what brand, you should always initially check the drying of the oil by placing a small pool, about a few square centimetres and half a millimetre or so deep, on a piece of cellophane. Observe how long it takes for it to dry compared to linseed oil. Make experiments with adding siccatives in small amounts to a duplicate set of test samples. Do not be lazy and avoid doing this! Only this way can you get to know the drying rate and drying phases of various oils and various brands. This will reveal if the oil contains antioxidants and it will teach you things about the drying and yellowing of oils you can not learn in any other way. For example, here you will directly see the difference in how various oils wrinkle (this is proportionate to how it will make paint films crack).

For those of you who are too busy making masterpieces to do these tests, I can help you by saying, that you will find that all oils in thick layers without pigment will form heavy wrinkles upon drying, less so stand oil and alkyd. In other words: all oils, least so stand oil and alkyd, may cause your work to develop cracks of some kind over a century or more – and I assume you intend to make immortal works, if not, then there is no reason to read all this anyway! So whenever you can replace some of the colours oil content or your mediums oil content with stand oil or good alkyd, then do so! Now that we are praising alkyd and standoil, you will also find, when you study your samples after 20 years, that good alkyd and standoil practically have not yellowed, while linseed oil has turned as dark as burnt sienna. Walnut oil turned orange like red ochre or mars orange and poppy turned yellow like yellow ochre or mars yellow. Safflower and sunflower should yellow even less. Stand oil and thick alkyds hardly change. In fact some thick alkyds may be, for all practical purposes, considered non-yellowing, like the siccatived AH-oil sold by Kremer. Kremer also sells a siccatived oil called Aussenlack, which defies logic and yellows very little (Kremer does not divulge its exact nature). These two oils also do not wrinkle. As a consequence, I have begun using AH as a medium. Here is a list of how much oils yellow in relation to each other:

Alkyd (thick oilmodified, yellowing varies)

Stand

Sunflower (try to avoid because of its bad drying)

Safflower (try to avoid because of its bad drying)

Poppy

Walnut

Linseed

Boiled linseed oil

The next thing you will observe from your tests is that all oils except sunflower and safflower set when dry, that is, they are dry to the touch, whereas sunflower and safflower oil remains sticky for a long time after drying – and with the term dry I mean after the period when the oil has first expanded, then contracted to form the characteristic solid wrinkles (which stand oil and good alkyd do not form, wherefore we love them). This residual stickiness, what so ever causes it, you certainly don't want, because it will cause your painting to catch any dust that might settle on it, and even worse, your glazes will show a cobweb of cracks with a few years.

In short: shun sunflower oil and safflower oil. Stick to alkyd and standoil when you need thick oils. Grind in linseed as much as possible. All three dry slowly, so add cobalt siccative. You can make very durable colours by adding 20% standoil (or non-diluted thick alkyd, if you can find it anymore, it seems to be no longer available, once there were such oils called GG and MM, but they are gone) when grinding the colours. If that is too thick, grind in a mixture of walnut oil with 20% stand oil and 5% siccative. The reason for adding stand oil is that thin oils tend to make more brittle films in time, and it is my belief, that adding a bit of stand oil can counteract this. Paint ground in stand oil makes the most durable and tough of all paintfilms but it is only to be used for very special applications since it is extremely thick and impossible to brush. Alternatively add stand oil, or thick alkyd, in your painting medium.

One way you can identify which oil has been used in a commercial tube is smell and also the colour of any free oil that may have settled at the top. You can do this test in the shop before buying. The colour can be seen in tubes of titanium white or zincwhite, or if the tube has a white cap. Sunflower and safflower oil often have a slight pinkish colour. Sunflower oil more so. Sunflower oil is quite odorless, while safflower oil has a nutty odor. Other oils are colourless. Linseed oil has a somewhat stinky smell, while poppy oil is odorless. With these parameters you can identify the four most common oils. The smell of linseed oil is very characteristic. This is valuable to know if you want to make sure your zincwhite is ground in a relatively nonyellowing oil and you want to have a hunch about how much siccative may be required. But the again, you never know if siccative has been added. So...

Always test the drying rate of an untested tube of a new colour by placing a blot of it on a nonabsorbant surface – like the top of the tube itself. Making the test here will also help you know what really comes out of the tube, because printed labels are usually far out.

Oils can be preprocessed in order to make them more viscous or make them dry faster. Normaly this is a matter of oxidizing or boiling with or without added driers. If you boil an oil without access to oxygen, you get modern stand oil which is superior in every respect except that it dries slowly. Boil an oil with access to oxygen (boiled oil), and you get an oil that dries rapidly, yet yellows faster.

The following common oils can not be used: olive oil, castor oil, corn oil, because they are nondrying. The industry uses other oils that the artist can not use: tung oil, perilla oil, cottonseed oil, fish oil. Don't grind your colours in any of these colours, even though the paintindustry uses them, because they need expert preprocessing in order to dry properly and because they will darken. Boiled castor oil is available and it dries very slowly and yellows slowly, though in the end just as much as walnut oil. Also don't use any kind of commercial varnish because they most likely yellow or become brittle. Some use pure castor oil as a plasticizer because it never dries and is nonyellowing, but this practice is dubious since any added nondrying oil will wander through the paintlayers and cause unpredictable results. You can make a vaselinelike drying oil by boiling linseed oil with castor oil, but its use is not recommended because it will only hold a small amount of pigment due to its high viscosity and will therefore yield a colour that yellows badly. If you have an electric roller mill for grinding colours, you might use these vaselinelike oils as additives or other special purposes,

but they are impossible to handgrind to anything of practical use. However, they are not recommended because they enhance yellowing.

Stick to Thick alkyd, stand oil and linseed oil. Of the thin oils, use walnut oil.

### **Grinding colours**

Actually you don't need to "grind" your colours today, since virtually all pigments are manufactured to very minute particle sizes. You merely need to disperse the pigment in the oil. However, we still call it to grind colours. Proper dispersion does require some mechanical squeezing of the oil/pigment between tight surfaces in motion, which can only be properly done with either a muller or with electric rollers. Merely mixing with a spatula will rarely lead to a satisfactory result: the colour will quickly appear okay, but will separate or harden later upon storage with due cracking.

Plasticizers, such as aluminium hydrate or clay, make the final paint more short, butter-like. If you prefer this from the raw paint is largely a matter of personal preference. Different pigments produce very different paints and they can be somewhat homogenized with aluminium hydroxide. A short/buttery paint will retain the brushmarks, whereas more fluid paint tends to soften out. Adding aluminium hydrate prolongs drying.

No matter what your preference is, the proper way to grind colours is as follows:

1. Mix the pigment and oil with a large spatula on a large, thick glass plate.
2. Grind the mixture thoroughly as you can with the means you have. Be it either with a spatula, a muller or with electric rollers (preferable because it is much, much faster). Do not add plasticizers yet. You can add siccative to the oil in step 1 if you have experience with the oil/pigment combination you are grinding. Otherwise follow the advice to do drying tests.
3. Cover the mixture with cellophane so it won't dry, but place a brushstroke of the paint on some nonabsorbent surface with access to air. Leave it a day.
4. Next day (or two, depending on the desired drying time) see if your brushstroke is dry. If not you know you have to add siccative to the paint. Also check if the large lump of paint has become either more fluid or more stiff.
5. If the lump of pigment has changed to an undesirable consistency, either add more oil or add more pigment. Instead of pigment you might want to add aluminium hydrate or bentonite. If you choose to add pigment, you might have to go on ad infinitum, whereas adding aluminium hydrate or bentonite once and for all settles the matter of consistency. However you want to proceed, you must once more cover the paint with cellophane and leave it a day. Remember to take notes on each pigment!
6. Once the lump of paint has the right consistency even after a day or two, it is time to consider the amount of siccative. Check the brushstroke exposed to air and see if it is sufficiently dried after the time you allow. Most people want their paint to dry from one day to the next. If it is not dry, add about 2% siccative to the lump, make a fresh brushstroke on a nonabsorbent surface and cover the lump with cellophane. Leave it a day.
7. Check if the stroke of paint is adequately dry. Adequate is a matter of taste, but be especially careful not to be fooled by a skin dry paint. Thin paint might be dried through, but

thicker layers may only be dried on the surface while wet underneath. This is a very tricky situation. Should one add more siccativator or not? This is again a matter of taste. On the one hand you can add more siccativator to make it dry through faster, on the other hand you might decide you have added too much already, since the paint has surface dried and not dried through while the only thing lacking was your patience. Slow drying oils tend to skin dry no matter what, that is: poppy oil, safflower oil, sunflower oil and to some degree walnut oil. Polymerized oils tend to dry through, even though they may actually be slow driers, that is: stand oil and alkyd oils. Linseed oils normally dry through unless one has added too much siccativator or unless the case is that exceptional one where the pigment is a retarder (like zinc white) and one has added sufficient siccativator.

8. The general rule is: first grind the pigment and the oil. Then wait a day and decide if you need plasticizers and/or siccativators. Also: make notes! Grinding colours is an individual matter and while one grinds colours to a very stiff paste another might like them more fluid, so no set formulas can be given about hand making of colours – except that, if made with diligence, they surpass any commercial colour, because you get exactly what you want.

9. Some colours tend to be very poor in commercial tubes, so they ought to be made by oneself, especially: zinc white, ultramarine violet, ultramarine blue (they should all be ground in alkyd, walnut or poppy oil, perhaps with an addition of 10-20% stand oil for strength). In addition one might want to grind a small number of titanium whites with distinctly different consistency so as to be able to control the texture of the brushstroke. I will return to this elsewhere.

It is noteworthy that when you grind your own colours they will dry up matt. Commercial tube colours usually dry up glossy or semi-glossy. So commercial colours contain too much oil. What is interesting about this observation that home ground colours dry up matt is that you can use ample painting media – far more than with commercial tube colours – before there is danger of an alarming excess of oil. This sheds some interesting light on old master's technique, because we know that the paintings of Rembrandt dried up glossy, yet he of course ground his own colours so they should have dried up matt. In other words he used much medium and a medium of a glossy oil-rich kind.

### **The secret of pastose brush strokes**

What I reveal here is a very, very, very big secret and it has probably been undiscovered since Rembrandt. The biggest secret is that of creating a paint that will be easily brushable while retaining the brushstrokes even in impasto layers, as if making the stroke was nothing special. Rembrandt used it mainly in his whites and he is the father of the magical brushstroke. A fluid oil, that will retain the brushstrokes and look like Rembrandt's strokes, can be made only by grinding the colours fresh before use. The secret is to first grind the colour in a mixture of thick oil and thin oil (stand oil and linseed oil will do; Rembrandt probably used a mixture of heavily oxidized linseed oil and fresh linseed oil, which would also ensure his impastos would dry through quickly), then when you are ready to use it, add a drop of egg (yolk or white, results differ and it is a matter of taste) and pure magic will happen!

## Pigments

### Historic use of pigments

When you look at old paintings and wonder what pigments they used, it is good to have some knowledge of the most important pigments and when they were in use.

Up to about 1800 a special green was used: copperresinate. According to some recipes it was made by boiling verdigris into a balsam like venetian turpentine. Other recipes mention grinding verdigris in balsam and allowing it to dry, then scraping the dry mixture off and grinding that in oil. It is highly transparent and only used as a glaze. It got replaced by mixtures with prussian blue etc.

In the following pigments are ordered according to in how many paintings they were found out of a specific corpus (1). This survey did not include copperresinate.

#### **Up to 1500**

- Black: Charcoal, ivory black.
- Blue: Azurite, natural ultramarine, indigo (rarely).
- Green: Verdigris, azurite + lead-tin yellow, green earth, malachite, azurite + yellow ochre.
- Red: Vermillion, organic reds, red ochre, minium (rarely).
- White: Lead white.
- Yellow: Ochre, lead-tin yellow. Auripigment (rarely).

#### **1500 - 1600**

- Black: Charcoal, ivory black.
- Blue: Azurite, natural ultramarine, smalt (rarely), indigo (rarely).
- Green: Verdigris, azurite + lead-tin yellow, green earth, malachite (rarely), azurite + yellow ochre.
- Red: Vermillion, organic reds, red ochre, minium (rarely).
- White: Lead white.
- Yellow: Lead-tin yellow, ochre. Auripigment (rarely).

#### **1600 - 1700**

- Black: Charcoal, ivory black.
- Blue: Natural ultramarine, azurite (use fades out from 1650-1700), smalt (rarely), indigo (rarely).
- Green: Verdigris (use fades out during the century), azurite + yellow ochre, azurite and lead-tin yellow (use fades out during the century), green earth (comes in vogue around 1675 and is the most used green at 1700).
- Red: Vermillion, organic reds, red ochre, minium (rarely).
- White: Lead white.
- Yellow: Lead-tin yellow, ochre. Auripigment (rarely).
- Brown: Earth browns.

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<sup>1</sup> Kühn, H.: Terminal Dates for Paintings Derived from Pigment Analysis, Museum of Fine Arts, Boston Massachusetts, 1973. Pp 199-205.

## 1700 - 1800

- Black: Charcoal, ivory black.  
Blue: Prussian blue (from 1725, quickly becomes dominant blue). Use of ultramarine fades out. Smalt (rarely), indigo (rarely).  
Green: Green earth, prussian blue + naplesyellow, prussian blue + ochre, malachite (rarely).  
Red: Vermillion, organic reds, red ochre, minium (rarely).  
White: Lead white.  
Yellow: Ochre, naples yellow, (use of lead-tin yellow fades out).  
Brown: Bistre. Earth browns.

## 1800 - 1900

- Black: Ivory black, charcoal.  
Blue: Prussian blue, cobolt blue (from 1825 equal in use to prussian blue), artificial ultramarine, natural ultramarine (very rarely).  
Green: Prussian blue + chrome yellow (from about 1850), prussian blue + naples yellow, prussian blue + ochre, chromium oxide, viridian (from about 1850), emerald green (from about 1850), green earth fades out.  
Red: Vermillion, organic reds, red ochre, minium (rarely).  
White: Lead white, zinkwhite, barium sulphate.  
Yellow: Ochre, naples yellow, chrome yellow, cadmium yellow.  
Brown: Bistre, asphaltum. Earth browns.

## The impressionist palette

The impressionists favoured a palette that came as close to spectral hues as possible. They quickly incorporated the new pigments, so their use of colour warrants special attention. An impressionist palette could typically consist of: Zink white, lead white. Chrome yellow deep and light, (strontium yellow), true naples yellow, cadmium yellow deep, yellow ochre. Chrome orange. Vermillion, red ochre, natural madder. Emerald green, viridian, prussian blue + chrome yellow. Cobolt blue, artificial ultramarine blue, cerulean blue. Ivory black.

## List of pigments

In the following list pigments are classified as good, acceptable and bad. This partly follows ASTM standards I, II and III. The reason for not quite following it is that ASTM concerns the pigment alone and we are specifically interested in oil ground pigments. ASTM I is permanent and lightfast in all techniques and even in fine tints. ASTM II is acceptable, but faint tints may fade. ASTM III is the permanence of Alizarin, which actually is not adequately lightfast to be used in works destined for immortality. Even though a pigment in itself may be ASTM I, it may be classified as acceptable, not good, if it tends to darken in oil, like Prussian blue does, or if it contains so much oil it is prone to wrinkle upon drying and make overpaints crack, like carbon black.

## Blue Good

- PB 15 Phthalocyanine (copper). Phtalo blue. Cyan. Heliogen blue. Monestial blue. Monestral blue. Thalo blue. Requires 30-50% oil. semi-slow drier. High tinting strength. Transparent.

In commercial tubes it is often cut with considerable amounts of transparent fillers, which will make the colour turn greenish on age because of the yellowing of the excess oil, so avoid too cheap products, like student colours. It's tempting to buy cheap products because the cut colour is more manageable than the incredibly intense full strength product. This colour is so intense, it is practically never used pure. It is lighter than paris blue but resembles it if mixed with black and ultramarine (PB 27). Most other blues can be mixed with phtalocyanine blue as a base, but pure phtalocyanine can not be emulated by other colours. Hence it can be considered a primary colour even though it is rarely of any use if laid out pure on the palette because of its intense colour. In use since about 1935.

- PB 15:4 Phthalocyanine – cyan. See PB 15.
- PB 15:6 Phthalocyanine – blueish. See PB 15.
- PB 16 Phthalocyanine (metal free) – greenish. See PB 15.
- PB 22 Indanthrone. See PB 60.
- PB 28 Coboltblue. Oxides of cobolt and aluminium. Expensive. 120-150% oil. Weak tinting strength. Semi-transparent. Fast dryer.

There are several varieties of cobolt blue, so don't expect to get the same blue from different brands.

It can be replaced by a cheap mixture of ultramarine, phtaloblue and titanium white. This mixture also emulates the relative transparency of coboltblue and can be manipulated to any of the many shades coboltblue comes in. In addition it contains less oil (30-50%) and can be safely used for underpainting.

Since cobolt blue requires so much oil it is wise to dispense with it, because it will turn greenish upon ageing and if used pure in underpaints, may cause overpaints with leaner colours, like ultramarine, to crack. For underpainting it ought to only be used 1:1 with white or other lean colours.

You might lament so many of Manets or Krøyers masterpieces are made with cobolt blue in the shadows. It would be if they had used ample oily painting medias, but as far as I know they did not and even – before introducing this colour to the battlefield of the palette - placed the cobolt blue straight from the tube on a piece of blotting paper to ensure all excess oil got drained out. Now, you might comment, that the cobolt blue you have is so stiff already and does not have excess oil like the tubecolours did at the end of the 19<sup>th</sup> century. Well, not so! Today we have a plasticizer, they did not have then: aluminiumstearate. This devil in disguise can be used to make any colour appear stiff and apparently without any excess oil, even though in reality it contains as much as twice the needed amount of oil. So be warned: if you turn niggardly and purchase a cheap cobolt blue in good faith because of its stiffness in the tube, then know that it probably (due to its cheapness) contains not 150% oil, but 300% oil with large amounts of aluminiumstearate to disguise it. So, paradoxical as it may sound: you must never deviate from the maxim that expensive colours must be purchased in the most expensive and trustworthy brand, while cheap pigments, like earthcolours, may often be purchased as the cheapest studentcolours. This last fact is because oil and aluminium stearate are more expensive than earth, so even studentcolours of ochre are likely to contain only ochre.

PB 29 Ultramarine. Cheap. Most difficult to handgrind and requires plasticizers like 2% wax, 2% aluminiumstearate or aluminium hydroxide (varying amounts depending on the stiffness you want). Requires 30-50% oil. High tinting strength. Semi-slow dryer.

When grinding your own ultramarine, a nice trick is to add 20-50% poppy oil to the linseed oil in order to counteract the threadyness of a pure linseed oil ultramarine. You will in any case need some siccative too. The problem is that the paint will either harden in the tube or become very fluid within a days time. To counteract this, leave the grinded paint on the slab overnight and then grind it again. It is difficult to reach the exact break point when handgrinding with a muller. Electric three-cylinder rollermills are much better, but expensive. In any case you have to grind, wait a day, grind again, etc. for a couple of days.

Ultramarine is one of our most useful colours and in combination with phtaloblue it can emulate most other blues.

In oil, ultramarine can (rarely) develop what is known as ultramarine disease: a chalky grey hue. Its cause is not quite understood, though older books claim to explain it. If you believe your works are destined for immortality and you fear any disease that may strike your child, stick to cobolt blue, phtalocyanine and ceruleum.

You can emulate ultramarine with a mixture of phtaloblue and dioxazine violet. This mixture will be deeper than ultramarine, and not have its chalkiness, and probably serve you better in the shadows since you can manipulate it to be more or less violet. If you desire the faint chalkiness of light ultramarine add a small amount of zink white to the mixture.

Throughout history ultramarine has been used as an addition to shadows, even in the 15<sup>th</sup> century <sup>(2)</sup> (then, of course, one used the expensive semi gemstone, lapis lazuli). You will probably also want to use ultramarine to deepen your shadows, and for that you might want to premix it with black. In the middle ages, they sometimes underpainted ultramarine with black for the same reason. This will remove the somewhat chalky appearance pure ultramarine can have in tempera, especially when set against other darks like umber and black, and which the light variety of ultramarine may also display. If you grind your own ultramarine, you will have less of the chalkiness, since ultramarine is very sensitive to the fillers and plasticizers colour manufacturers put in this difficult colour to force it to some unnecessary standard plasticity. I say unnecessary because once you grind all your colours yourself, you will realize that the different plasticity of ultramarine compared to ceruleum blue or umber, for example, will force you to use different brushstrokes and manners of handling, which again will present itself as great variety in your brushwork..

PB 33 Manganese blue. Barium manganate. No longer manufactured but still available as a tube colour. Toxic. 30% oil. Transparent. fast dryer.

It is no tragedy that this beautiful colour is no longer manufactured, because it can be very exactly emulated by phtalocyanine blue and large amounts of blanc fix (PW 21). The mixture will truthfully copy the real things transparency and will not be more prone to yellowing, since the mixtures oil content is lower. Alternatively you can emulate manganese blue with a mixture of phtalocyanine

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<sup>2</sup> Technical Bulletin of the National gallery, London, vol 18, 1997, pp 6ff.

blue and cerulean blue, though it will be a bit darker and will have a higher oil content, about 60%, so it will probably be more likely to yellow. This latter mixture will also be more expensive.

- PB 35 Ceruleum, Bleu Celeste. Oxides of cobalt and tin. Very expensive. Weak tinting strength. Medium dryer. 120-140% oil. Because of the high oil content it should only be ground in low-yellowing oils like alkyd, poppy or walnut. This is a strikingly beautiful blue, hard to emulate. It can be replaced by a mixture of ultramarine, phtaloblue and some zink white (titanium white will make it more opaque than the original product). This mixture also emulates the relative transparency of ceruleum and can be manipulated to any of the many shades ceruleum comes in. Since ceruleum blue requires so much oil it is wise to dispense with it or only use it in overpaintings. The suggested mixture will only contain about 40% oil and is much cheaper, so it is a wiser choice. Mix it and fill a tube with it. If you really need the nice skylike hue and texture of ceruleum, then so be it, but grind it yourself in a low-yellowing oil. Remember that for any blue to contribute to the immortality of your work, it should have a low oilcontent, because otherwise it may turn greenish upon ageing. Certainly don't use it with oil rich painting mediums like gelmediums. If you grind it yourself, know that some sources claim it will harden after a few days, so first grind it, then leave it covered to see what happens and add more oil accordingly. Doerner for this reason recommends 2% wax in the oil. Personally I have only experienced a separation in the tube so the oil would flow out when you remove the cap from the tube. Large amounts of aluminiumhydroxide might counteract this, but 2% aluminiumstearate would probably be wiser. The best, of course, is not to care about the excess oil and simply allow it to flow out on an old newspaper without further ado. If the colour itself is too soft, leave it on the newspaper awhile to remove some of the oil.
- PB 36 Cobalt turquoise. Ceruleum (Chrome). Oxides of cobalt and chromium and aluminium. Expensive. See PB 28 and PB 35. It can be emulated with phtaloblue, ptagreen and zinkwhite.
- PB 60 Indanthrone, Anthraquinone, Paliogen. Good tinting strength. Transparent. Its hue is indigo, somewhat like prussian blue but not so intense.
- PB 74 Ceruleum. Dark oxides of cobalt zinc silicate. See notes for PB 35, PB 28.

### **Acceptable**

PB 17:1 Phtalocyanine blue lake.

PB 27 Prussian Blue, Berlin Blue, Paris Blue, Milori Blue. Ferri ammonium ferrocyanine. High tinting strength. Transparent. Fast dryer.

It may be emulated by a mixture of phtaloblue, ultramarine and black or phtaloblue, dioxazine and black. Since it requires up to 120% oil, it is prudent to replace it with this mixture when used pure or for underpainting. If not for any other reason, replace it because its permanence is dubious, though authorities seem to differ in this respect. Its tendency to become dull may be because of its high oil content.

## **Bad**

PB 1 Victoria pure blue.

PB 24 Fugitive peacock blue.

PB 66 Indigo blue.

## **Miscellaneous blues**

Academy Blue: Ultramarine + viridian.

Cyan: Cobaltblue + prussian blue.

Pure blue: Cobaltblue + manganese blue.

## **Traditional blues**

PB 29 Natural ultramarine. Lapis lazuli. Extremely expensive.

PB 30 Azurite. Blue malachite. Basic copper carbonate. A natural mineral. The most common blue in European painting up to about 1650. From about 1650 the expensive azurite becomes replaced with smalt and indigo.

PB 31 Egyptian blue. Copper silicate derived from quartz. It is a highly transparent colour prone to turn green due to the yellowing of the oil.

PB 32 Smalt. Saxon blue. Royal blue. Ground blue glass.

--- Indigo. Fugitive.

## **Black**

### **Good**

PBk 8 Charcoal. Vine black. Blue black. Semi transparent. Cold and slightly grayish. Very slow drier. 50-120% oil.

PBk 9 Ivory black. Burnt animal bone. 50% oil. Inexpensive. Slow drier. If used as an underpaint it will cause overpainted layers to crack badly. Do not use as an underpaint unless mixed 1:1 with pigments or fillers of low oil content - or mix 1:1 with manganese black or mars black. Can be used as a glaze, though the pigment is strictly speaking not transparent.

PBk 10 Graphite gray.

PBk 11 Mars black. Ferro-ferric oxide. Cheap. Very opaque black. Good for underpainting. 40-50% oil. Medium drier. Good tinting strength. If one requires black in either the ground or underpainting, then manganese or mars black are the best choices.

PBk 14 Manganese black. This pigment number also refers to manganese brown. Manganese oxide. Manganese black is actually not absolutely black, but a very dark grey no darker than a dark umber. It has a brownish tone in glazes. Requires 30% oil and dries fast. If one requires black in either the ground or underpainting, then manganese or mars black are the best choices. It is not readily available in tubes so one will have to grind it oneself. Toxic. Patented 1871.

PBk 19 Gray hydrated aluminium silicate.

PBk 26 Spinel black. Manganese ferrite. Truly transparent black. Expensive. Good tinting strength. You can with some skill mix your own transparent blacks from the dark, transparent organic pigments, so this pigment is really not needed unless you require an absolutely black glaze – but then again: why use an absolutely black glaze? In use since about 2000.

### **Acceptable**

PBk 6 Lamp black, blue black, carbon black. Requires a huge amount of oil – from 100-800% depending on the particle size - so though it is a permanent colour, its use in oil is unwise. It practically never dries and tends to wrinkle. If used as an underpaint, layers above it will crack badly. It is best to mix it 1:1 or 1:3 with manganese black or mars black, but then again, why not simply stick with marsblack? There is really no need for lamp black unless you want deep black glazes since it is the blackest of all the blacks. In use since about 1885.

PBk 7 Carbon black. See PBk 6.

PBk 19 Slate grey, Davy's grey. Powdered slate. Medium to dark gray colour.

### **Bad**

PBk 1 Aniline black.

### **Miscellaneous blacks.**

Payne's grey: Ultramarine + lamp black + slate + iron oxide red.

Davy's grey: Powdered slate.

### **Here are some of my own favourite mixtures:**

Opaque grey: Chromium oxide + caput mortuum/mars violet. This grey is for when you either need to cover an underpaint with a grey or when you need a grey in your opaque lights and really need to preserve opacity.

Transparent grey: 8 parts azomethine yellow, 4 quinacridone, 1 phtalocyanine. Proportions vary depending on the brand used and upon what hue you need. This grey you should adore and dream about at night. It will serve your shadows like nothing else.

Neutral grey: 3 ultramarine + 1 umber (burnt or raw). This is my standard grey. It is cheap, semitransparent and also dark, yet bright, enough to serve as a black in most cases.

### **Brown**

PBr 6 Mars brown. Very opaque dull brown. 50-60% oil.

Mars brown resembles manganese brown but is warmer in mixtures with white. It can be emulated by a mixture of light red and black. If you use any of the other red earths it will not match. It can also be somewhat emulated by burnt sienna and phtalo blue if you want the hue but desire it in a transparent version.

Reynolds recommended a mixture of indian red and black for the underpainting, but here mars brown might do equally well (or vice versa) if you want to emulate this old English master's technique.

You could substitute mars brown with burnt iron oxide black if you possess the iron oxide black pigment and desire to do the roasting yourself. Roasting pigments can be done by placing the pigment in a thin layer on a metal plate, like a cleaned lid from an empty can of paint, and then heating it above a flame or on a stove. You can get very beautiful roasted ochres this way, but strong heating can not be done on an electric stove because you need the greater heat of a direct flame. Remember to stir the powder so you don't just roast the bottom layer and leave the top unchanged. On the other hand such mixtures can be truly beautiful, though hard to reproduce next time you do the roasting.

PBr 23 Gubbio red. Semi transparent earthlike brown. Expensive.

PBr 24 Chrome titanate. The colour can be emulated by a mixture of dark cadmium yellow (or cadmium orange and cadmium yellow light), raw umber and white. The mixture will not be as warm in mixtures with white as the original, but this can be leveled with less umber. Since making this emulation is rather complex – involving four colours – you might want to use the real thing. Adding chrome titanate to raw sienna will make it look like yellow ochre, though more beautiful. So if you want chrome titanate and raw sienna on the battlefield of your palette, you don't need to crowd it with yellow ochre too.

PBr 25 Benzimidazolone

### **Other browns**

PY 42 Mars yellow. See below.

PY 43 Ochre. See below.

PBk 14 Manganese brown. 30% oil. Opaque. Good drier. It resembles mars brown but is slightly colder when mixed with white. It has somewhat the mass colour of a pale burnt sienna, though not sienna's glow when glazed. It's difficult to glaze with manganese brown. It is also cold when mixed with white, where burnt sienna is warm. Use this intense pigment when you need brown in your underpainting or cold brown greys. You will have to grind it yourself since it is not readily available in tubes. See manganese black. Harmful, so don't breathe dust.

PG 23 Burnt green earth. 80% oil. Resembles a mixture of burnt umber and burnt sienna. Can with advantage replace burnt sienna in many cases, because it contains less oil and darkens less.

### **Acceptable**

PBr 7 Burnt and raw umber and burnt and raw sienna. Good driers. Semi-transparent.

The umbers and the sienas darken with age (even within a relatively short time, that is 10-20 years) because of their large oil content. It is therefore advisable to grind ones own using good alkyd (most alkyd is thicker than linseed oil), poppy or walnut oil. Some umbers need an addition of a plasticizer in order not to settle or jelly in the tube, but I have observed that one brand of raw umber

did not change, while an other brand stiffened in a few weeks and had to receive additional oil. Probably this difference stems not from the umbers, but from the presence of clay or chalk. Traditionally one recommends 2% wax or aluminiumstearate melted into the oil. Kurt Wehlte recommends substituting umbers with mixtures based on burnt siena in order to reduce the oil content (and avoid subsequent darkening), but this seems ill advised since burnt siena requires even more oil than the umbers. Replace them with mixtures based on manganese brown or mars brown. Burnt siena can often be replaced with burnt green earth.

## **Sienas**

Burnt siena requires up to 200% oil which means it will darken with age as the oil turns brown. Raw siena requires up to 120%, so it will also darken somewhat. Do not use pure siena for underpainting since it will cause overpaints to crack. If you need pure burnt siena as a heavy glaze or as an underpaint, you can emulate the colour with a mixture of azomethine yellow (PY 153), quinacridone and black, though this is more expensive. For underpainting you can replace it with mars brown or manganese brown, for glazes add azomethine yellow to the mars/manganese brown.

If you run out of raw siena and have an immediate need, you can make an ochre (or mars yellow) look like raw siena by adding burnt siena (or mars brown) and adjusting with a bit of green or blue. Since raw siena darkens a lot, it is wiser to use this substitute which will have half the oil content. If you grind your own colours, mix a raw siena substitute from mars colours and chromium oxide green.

## **Umbers**

You strictly speaking don't need both raw and burnt umber of the type commonly available on tube by various manufacturers. Common (warm) raw umber can be made to look like burnt umber by adding either benzimidazolone red (PR 175) or nickel azomethine red (PO 65) or alizarin. You can make burnt umber look like raw umber by adding a bit of chromium oxide green (phtalo green will not do) and adjusting with ochre.

What you want is a major difference between your raw and burnt umber. I have come to the conclusion that the ideal combination of umbers is to choose a green raw umber and a violet burnt umber. The burnt umber should become cold when mixed with white but remain warm when used pure as a glaze. Raw umber should become grey when mixed with white, and when used pure as a glaze it should have a cool brown-grey effect so beautiful in shadows. This difference between burnt and raw is unfortunately seldom encountered in ready made tubes. So, artist, grind your own umbers! Make a violet burnt umber and a greenish raw umber and you will be well on your way to becoming a colourist and clair-obscur master all at once.

The umbers are often recommended for underpainting, but are actually not a technically good choice if used pure and solid because they contain about 100% oil – or more. One can overcome this by mixing the umbers 1:1 with zink white or blanc fix (PW 21), which may reduce the general oilcontent to about 60%. Using blanc fix will hardly change the colour of umber but will make it more transparent, which can be desirable in the underpainting, though this has other drawbacks. Adding too much black fix is problematic because the pigment is transparent in oil and though it reduces the average oil/pigment ratio, it raises the

amount of oil that the actual pigment (the umber) has to hide, thus enforcing yellowing. This might not be a problem when underpainting, but certainly when overpainting. So what to do?

Perhaps the best is to grind umbers (and sienas) in walnutoil and add 20% stand oil – this oil mixture needs 10% coboltlinoleate siccative, even with umbers. This mixture, I believe, will counteract the deficiencies of the various oils (stand oil counteracts the tendency to become brittle with age, that the other oils show), and this mixture certainly will yellow less, or at least much slower, than linseed oil. Probably it is the best mixture to grind all colours with. More research on the subject is required. Please consult the sections on grinding colours and on oils for more technical details.

## **Bad**

NBr 8 Van Dyke brown. Genuine Van Dyke brown is rarely sold in tubes today – and thank God for that since the colour is not lightfast. They usually contain a mixture based on umber. Some insist on using the true pigment for underpainting – following the so called 19<sup>th</sup> century "brown sauce" of traditional academy painting used for laying in shadows. This is a bad idea because Van Dyke brown contains 250% oil and will cause the overpaint to crack. If used for glazes, the painting will darken much upon age. Avoid it. The "brown sauce" of the "academicians" of the 19<sup>th</sup> century was a red-brown colour easily mixed by several colours (try burnt umber and earth red for one).

PBr 8 Manganese brown. Reputed to fade rapidly. See PBk14 (manganese black).

## **Traditional outdated**

NBr 9 Sepia. Not usefull in oil. It was used for brown semitransparent inks. Under this name is sold a number of browns mixed from umber and other earth colours. The original colour fades in all mediums.

--- Asphaltum. Bitumen. Asphalt must be dissolved in turpentine and oil. It is in itself a nondrying oil and will cause the paint layer itself, as well as overpaintings, to crack and darken. It began to be used as an underpaint in the middle of the 18<sup>th</sup> century and was highly valued in 19<sup>th</sup> century English painting because of its warm tone in glazes as well as deep black when thick. Don't use it. If you need a warm black to deepen warm shadows with a glaze, use instead a mixture of ivory black, azomethine yellow and dioxazine violet. This mixture needs siccative.

--- Bister. Yellowish greybrown soot with some woodtar. Today various permanent brown mixtures based on umber is sold under this name.

## **Green**

### **Good**

PG 7 Phthalocyanine green. Monastrial green, phtalo green. Very high tinting strength. Very transparent. 30-45% oil. Medium to slow dryer. Can be used to emulate the more expensive viridian (PG 18). Available since about 1940.

- PG 10 Nickel-azo, Green Gold. Quindo green gold. 35-40% oil. (see PY 150). Very slow drier. Extremely transparent and strong colour. Irritates nickel allergy. Medium to slow drier.
- PG 17 Chromium oxide. 30% oil. Very opaque. Good tinting strength. A peculiar dull green, that is neither yellowish nor blueish. Inexpensive. Medium dryer. This is one of the most opaque colours we have and as such it can not be emulated. The hue of chromium oxide green can be emulated with a mixture of phtalgreen, raw umber and titanium white. It is more transparent than the real thing. You can also emulate chromium oxide green with phtalgreen, mars yellow, mars black (or manganese black) and titanium white. The choice of pigments in this mixture reflects an urge to use the most opaque substitutes. You could use raw siena, ivory black and zink white instead if you want a semitransparent version. Because these emulations are more transparent than the real thing, you can make some nice scumbles on flesh with them. Discovered 1797. In use since about 1865.

- PG 18 Viridian. Guignets green. Vert Emeraude (not emerald green). Hydrated chromium oxide. 50-100% oil. Good tinting strength. Very transparent.

The pure hue of viridian can be emulated by a mixture of phtalo green and zink oxide, however, if you mix this with white, it will be far too saturated with the typical phtalocyanine green hue. In comparison a mixture of viridian and white will seem greyish. A mixture of phtalgreen, blanc fix (or zinkwhite) and black will yield a similar hue as viridian when mixed with white, but will appear darker in the pure. It is, however, an altogether fine substitute, because you will rarely use viridian pure anyway. Similarly it's even less likely that you will ever use pure phtalocyanine, so it is not unwise to replace, on the palette, both phtalocyanine and viridian with this latter mixture – which also contains less oil. Anyway, viridian is inexpensive and you could probably squeeze in a place for it on the palette, since many of the mixtures using phtalocyanine can also be made with viridian. In mixtures viridian and phtalocyanine behave similarly although you need more viridian and it can't make the same darks as phtalgreen since it is inherently paler.

But remember this important fact: any colourist knows that green pigments are often redundant, since you will fare much better by mixing the greens you need from the blues and yellows already used in the picture. Available since about 1860.

When grinding it will become fluid after a day or so. You can then add the same amount of pigment. Doerner recommends 2% wax in the oil.

- PG 19 Cobolt green, Rinmans green. Oxides of cobolt and zinc. 70% oil. Expensive. Weak tinting strength. Semi opaque.

Cobolt green can be emulated with a mixture of phtalgreen, siena and zink white. Depending on the particular shade of cobolt green you want, you can use either raw or burnt siena. You can also emulate it with ultramarine, viridian and black.

Because of cobolt greens high oil content and high price, you will probably want to use a substitute and will, in case you fancy it, benefit from having it premixed in a tube. Remember, though, that it is often better to do without greens altogether, since it's better to mix greens from the blues and yellows used in the picture if greens are needed. Flesh can appear to have green tints which might

require a premixed green; here cobolt green substitutes in the tube come in handy and there is no need for the real stuff. For foliage try to manage with greens mixed from blues and yellows. If you have a man made green object in your picture, like a painted cupboard, please try to manage by not trying to reproduce its true colour, but instead approximate it with a mixture of the blue-greens and yellows you already have on your palette. Available since about 1835.

When grinding, know that it may harden in the tube, so leave it a few days and then add more oil. Doerner recommends 2% wax in the oil.

- PG 23 Green earth. Natural earth. 80-100% oil. Low tinctorial power. Normal dryer. Cheap. There are several types of green earth. Bohemian and Tirolean are warm and transparent, Veronese is cold and a bit more opaque. The coldes varieties can be icy green. They were much used in medeival Italian anconas as an underpaint for flesh. Doerner notes that Böcklin and Marées used it that way too as well as for the shadow and middle tones of flesh. Because of its large oil content and transparent nature it will darken. It can be replaced with a mixture of ochre, chromiumoxide green, black and white. This mixture is less prone to darkening since it has less oil and is more opaque, but it will not be so good for glazes. If you heat green earth you get a brown semitransparent colour, burnt green earth, which is quite nice and somewhat resembles burnt siena, though it is not as fiery.
- PG 24 Ultramarine green. Polysulphide of sodium alumino silicate 77013.
- PG 26 Cobolt green. Oxides of cobolt and chrome. Medium tinting strength. Fast dryer. 70% oil. See PG 19. Expensive. Can be emulated with Phtalgreen, siena (raw or burnt depending on the shade you want) and zinc oxide.
- PG 36 Phthalocyanine green. Monastralgreen, thalogreen. (se PG 7).
- PG 50 Cobolt green dark. Oxides of nickel, cobolt and titanium. Medium tinting strength. Fast dryer. 70% oil. See PG 29.

### **Bad**

- PG 1 Brilliant green
- PG 2 Permanent green.
- PG 7 ...
- PG 8 Hookers green. Nitroso. Traditionally Hookers green was an impermanent mixture of prussian blue and gamboge. Replace it with prussian blue (or phtaloblue) and azomethine yellow (PY 153). You may somewhat emulate it with a mixture of raw umber and phtalogreen.
- PG 12 Green.

### **Miscellaneous greens**

Cadmium green. Mixture of cadmium yellow and phtalogreen. It used to be cadmium yellow and either ultramarine or viridian. Slow drier.

Emerald green, vert emeraude, schweinfurt green. Traditionally this was copper acetoarsenite, which is toxic and impermanent. Under this name is now sold a variety of intense, light, cold greens. You can mix your own emerald green from phtalogreen, azomethine yellow (PY 153) and titanium white.

Chrome green, vert anglais. In the 19<sup>th</sup> century this was chrome yellow + prussian blue, not chromium oxide as today. Chrome yellow is impermanent. Some odd mixtures exist today, but most of them are too saturated and pure hued because they are based on the cheap phtalocyanine green and hansa yellow. You can easily emulate the beautiful earthly hue of the original chrome greens. Chrome green light can be emulated with cadmium yellow light (not lemon) and chromium oxide green (not viridian nor phtalogreen). Chrome green dark can only be emulated by prussian blue and cadmium yellow light (or dark, depending on the hue).

Zink green, Zink yellow + prussian blue. Obsolete.

Verdigris, Copperacetate. Toxic. Obsolete.

Malachite. A natural green. Never much used. Long obsolete.

## **Orange** **Good**

- PO 20 Cadmium orange = 99,9% Cadmium sulpho-selenide. Available since about 1840. 40-60% oil.
- PO 20:1 Cadmium-barium lithopone orange.
- PO 23 Cadmium vermilion orange, .
- PO 23:1 Cadmium-barium vermilion orange, .
- PO 36 Benzimidazalone orange HL.
- PO 43 Perinone, anthraquinone.
- PO 48 Quinacridone gold. Yellow orange, similar to burnt siena, but with higher tinting strength. Semi-slow drier.
- PO 49 Quinacridone deep gold, quinacridone red gold. Red-orange, similar to burnt siena, but with higher tinting power. Semi-slow drier. Transparent.
- PO 59 Paliotol orange. Bright red-orange. Medium drier. Semi transparent.
- PO 60 Benzimidazalone orange HGL. Hostaperm orange. Warm orange. Slow drier. Transparent.
- PO 61 Isoindoline orange. Warm dark orange. Slow drier. Transparent.

- PO 62 Benzimidazolone orange HSG.
- PO 65 Methin nickel complex.
- PO 67 Pyrazolochinazolon.
- PO 69 Isoindolin.
- PO 71 Irgazine orange. Diketopyrrolopyrrole 561200.
- PO 73 Irgazine orange. Diketopyrrolopyrrole 561170. Slow drier. Hue resembles vermilion or cadmium red light. Semi opaque.

### **Acceptable**

- PO 5 Permanent orange RN 2G. Dinitraniline orange.

### **Bad**

- PO 1 Hansa orange.
- PO 12 Chrome orange.
- PO 13 Permanent orange G. Pyrazolone orange.
- PO 34 Diarlylide orange.
- PO 105 Red lead, minium. Toxic. Turns brown. Replaced by cadmiums or irgazine orange (PO 73).

### **Miscellaneous oranges**

Academy Orange: English red + cadmium yellow.

Titanium orange. See PBr 24.

### **Red**

#### **Good**

- PR 20 Quinacridone brown. Can be somewhat emulated with a mixture of azomethine, quinacridone red and dioxazine violet. In my opinion the mixture is preferable since it has better tinting strength.
- PR 88 Thioindigoid red violet. A very intense violet that it is difficult to match.
- PR 101 Synthetic iron oxide in many shades. In order from warm to cold they are: light red, english red, indian red, venetian red, mars red, mars violet (synthetic caput mortum). 30-70% oil. Cheap. When grinding colours like english red, know that they tend to become fluid after a week or two, then you have to add more pigment or aluminium hydrate.  
Mars violet can be emulated by a mixture of dark cadmium red and raw umber (perhaps with a bit of black, depending on the umber), though it won't be quite as

cold when mixed with white. The mixture is of course more expensive than mars violet.

Light red is identical to pozzuoli red.

- PR 102 Burnt ochre, Light red, Antwerp red, Bolus. Calcined natural ochre. See PR 101.
- PR 108 Cadmium red light/medium/deep/purple, 99,9% cadmium seleno sulphide. Expensive, Toxic. Slow drier. Opaque. 40% oil. Available since about 1915. Purple cadmiums can be somewhat emulated with a mixture of indian red and quinacridone.
- PR 108:1 Cadmium-barium red. Expensive, Toxic. Slow drier. Opaque.
- PR 113 Cadmium-vermillion red. Expensive, Toxic. Slow drier. Opaque.
- PR 113:1 Cadmium-vermillion red. Lithopone red. Expensive, Toxic. Slow drier. Opaque.
- PR 119 Naphtol FG. This is the only naphtol, that is lightfast even in pale tints.
- PR 122 Quinacridone magenta Y. Slow drier. Very transparent. High tinting strength.
- PR 123 Perylene vermillion. Medium drier. Transparent.
- PR 144 ...
- PR 149 Perylene red BL. Anthraquinone red. Medium drier. Transparent. High tinting strength.
- PR 166 Cromophtal scarlet R (CGY).
- PR 175 Benzimidazolone hft & maroon.
- PR 176 Benzimidazolone.
- PR 178 Perylene red.
- PR 179 Perylene maroon. Paliogen maroon. Indanthrene red. Transparent. Slow drier. Good tinting strength. Somewhat similar to Madder deep. Norma Madder Deep 342.
- PR 181 Thioindigoid magenta.
- PR 190 Perylene scarlet.
- PR 192 Quinacridone scarlet. Slow drier. Very transparent.
- PR 194 Perinone red, perylene red deep. Slow drier. Transparent.
- PR 202 ...

- PR 207 Quinacridone scarlet. Slow drier. Very transparent.
- PR 209 Quinacridone scarlet. Slow drier. Very transparent.
- PR 214 Condensed azo.
- PR 216 Pyranthrone red.
- PR 254 Diketopyrrolopyrrole 56110. Similar to cadmium red but transparent.
- PR 255 Diketopyrrolopyrrole 561050. Similar to cadmium red but transparent.
- PR 260 Isoindolin.
- PR 264 Diketopyrrolopyrrole 561300. Somewhat similar to alizarin crimson. Rembrandt Permanent Madder Deep, 342. Norma Madder Ruby 320.

### **Acceptable**

- PR 5 Naphtol red ITR. Slow drier. Transparent. Pale tints may fade.
- PR 7 Naphtol red F4HR, naphtol red AS-TR. Slow drier. Transparent. Pale tints may fade.
- PR 9 Naphtol red AS-OL, permanent red FRL. Slow drier. Transparent. Pale tints may fade.
- PR 14 Naphtol AS-OL, permanent bordeaux FGR.
- PR 106 Vermillion. Cinnabar. Toxic. Opaque. Good tinting strength. Very slow drier. 25% oil.
- PR 168 Anthraquinone red, anthanthrone red, Rowney red. Dibromanthanthrone, brominated anthraquinone. Transparent. Semi slow drier. High tinting strength. Similar hue as vermilion, but with a very synthetic intensity.
- PR 187 Naphtol red HF4B.
- PR 188 Naphthol AS & HF3S.

### **Bad**

- NR 9 Natural madder lake, garance.
- PR 3 Studio red. Hansa red. Slow drier. Transparent. Pale tints may fade.
- PR 4 Monoazo (Naphthol) 12085.

- PR 8 ...
- PR 12 Naphtol AS-D.
- PR 17 Naphtol AS-D.
- PR 23 Naphtol AS-BS.
- PR 31 Naphtol AS-BS.
- PR 48:1/2/3 Permanent red.
- PR 49:1 Lithol red.
- PR 52:2 Lithol red.
- PR 53:1 Red lake C.
- PR 57 Lithol rubine.
- PR 57:1 Lithol brilliant carmine 6BN .
- PR 60 Scarlet lake.
- PR 60:1 Pigment scarlet 3B
- PR 81 Rhodamine.
- PR 83 Alizarin Crimson, rose madder alizarin. Slow drier. Transparent. 60-75 oil. Alizarin can be closely emulated by a mixture of dark quinacridone and azomethine yellow (PY 153). Quinacridone and umber can sometimes do. According to Pip Seymour (<sup>3</sup>) it may be emulated by quinacridone (PV 19), perylene red (PR 149) and ultramarine blue. I disagree. However, an almost perfect emulation can be made with dark quinacridone magenta, azomethine orange and burnt umber (first mix equal parts of quinacridone and azomethine, then mix 12 parts of the mixture with one part of good dark burnt umber). This mixture needs siccatives. Alizarin can be somewhat replaced by paliogen maroon (PR 179); it is perfectly replaced by PR 177.
- PR 87 Eosine lake.
- PR 90 Phloxine red.
- PR 105 Red lead.
- PR 104 Chrome red/orange. Molybdenum red. Toxic. Turns dark in oil. 40% oil.
- PR 112 Permanent red FGR = Naphtol red AS-D.

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<sup>3</sup> Seymour, Pip: The Artists Handbook, Arcturus Publishing 2003, p. 82.

- PR 114 .
- PR 146 Naphtol red, naphtol carmine fbb, permanent pink fbb.
- PR 149 Perylene red BL.
- PR 170 Naphtol crimson, naphtol red F5RK, permanent red F5RK. Slow drier. Transparent. Pale tints may fade.
- PR 171 Naphtol AS.
- PR 173 Rhodamine.
- PR 177 Anthraquinone. Replacement for Alizarin. Impermanent. I had a medium glaze of this placed in the window for a year, and it had completely faded to invisibility. I also had a pale mixture with titanium white and it had faded quite markedly. Unfortunately PR 177 is a gorgeous colour and many manufacturers use it in mixtures. Even worse, many manufacturers list it, or its mixtures, as permanent.
- PR 259 ...

### **Miscellaneous reds**

Scarlet red. A mixture of alizarin crimson and vermilion much used in portraits in the 18<sup>th</sup> and 19<sup>th</sup> century. Resembles cadmium dark.

### **Untested reds**

- PR 13 Toluidine Red.
- PR 242 Sandorin scarlet.
- PR 251 Pyrazoloquinazolone 12925.

### **Violet**

#### **Good**

- PV 14 Cobolt violet dark, cobolt phosphate. Very expensive. Weak tinting strength. 100% oil. Semi transparent.  
Cobolt violet can be emulated by a mixture of manganese violet and zink white. Alternatively use ultramarine violet, quinacridone and zink white if you want greater control of its hue. Since the substitutes will only have about 20-30% oil, it is wise to use them instead of cobolt violet. If you really want cobolt violets hue, reserve it for overpainting and glazes. Available since about 1860.
- PV 15 Ultramarine violet/red. Synthetic ultramarine V1S. 30-50% oil. Medium tinting strength. Transparent. Slow to medium drier. It is highly recommended to grind this colour in a low yellowing oil like alkyd, poppy or walnut because in linseed oil it tends to turn muddy as the oil turns brown. If ground in a slow drying oil, it

requires three to four times as much siccative as normal colours do -- 10-20% siccative depending on the concentration of your siccative. Ultramarine violet can be emulated with a mixture of ultramarine blue, dioxazine violet and some blanc fix or zink white.

- PV 16 Manganese violet, manganese ammonium pyrophosphate. Semi transparent. 20-30% oil. Fast dryer. Available since about 1870. Manganese violet can be emulated by ultramarine violet and some quinacridone. When grinding this colour know that it will become fluid after a few days.
- PV 19 Quinacridone violet. Slow drier. Very transparent.
- PV 23 Dioxazine. Carbazole violet reddish. Permanent violet RL, RS. (BS, bluish shade, is not as permanent, but acceptable). High tinting strength. Slow to medium drier.
- PV 23:1 Dioxazine.
- PV 31 Isoviolanthrone.
- PV 46 Graphtol violet CI-4RL.
- PV 47 Cobolt violet light. Cobolt ammonium phosphate. Toxic. See PV 14.
- PV 49 Cobolt violet brilliant. Cobolt ammonium phosphate. See PV 14.

### **Acceptable**

- PV 14 Cobolt violet light. Cobolt Phosphate.

### **Bad**

- PV 1 Rhodamine B (Triarylcarbonium) 45170:2.
- PV 3 Triphenylmethane (Triarylcarbonium) 42535:2. Rhodamine lake.
- PV 4 Magenta.
- PV 5:1 Alizarin maroon.
- PV 39 Crystal violet lake.

### **Untested violets**

### **White**

### **Good**

- PW 6 Titanium dioxide (rutile). Our most opaque white. Slow dryer. Inexpensive. 15-20% oil. In use since about 1920.

## Acceptable

- PW 1 Lead white, Ceruse, Cremnitz white, Flake white. Lead carbonate. Toxic. Fast dryer. 20% oil. Very toxic. Do not grind yourself. If you desire its semitransparency, replace it with a mixture of titanium white and zinc white (1:2) or titanium white and black fix (1:3). Turns more transparent with age.
- PW 4 Zinc white. Should be ground in alkyd, poppy or walnut to prevent (or delay) yellowing. Slow drier. It requires siccative – especially in these oils. Semi opaque. 15-25% oil. Available since about 1835 as watercolour, but not much used as oil colour before 20<sup>th</sup> century. If ground in slow drying oil, like poppy oil, it requires about 10-20% siccative depending on the concentration of the siccative. Zinc white is one of the most difficult pigments to make good colours of, because even though ground to a stiff paste, the next day it will be thin again – and this seems to be going on day after day – and again after a few weeks. For this reason manufacturers add much plasticizer like aluminiumstearate to put an end to this. If you grind your own zinc white, grind it again and again over three days, then use more zinc white, or perhaps aluminiumhydroxide, to make it stiff, wait a day and finally add some more zinc white or aluminiumhydroxide and put it in tubes. It will still become more fluid later, but not so much. And it will be a dense pigment, which still has the semitransparent nature of zinc white. It is much advised to grind zinc white in good alkyd because alkyds are more flexible and zinc white in oil produces a brittle film. It is not advisable simply to mix your pigment with oil, because the resultant film will be weak and tend to crack in a few days. Doerner recommends grinding zinc white with a mixture of oil and resin in order to make it dry faster, but that would be bad. I disagree because this will only make the film even more brittle and will not impart any good qualities such as less yellowing. It is generally advised not to use zinc white in the underpainting because of its slow drying. I believe there is no problem if you add cobalt siccative in sufficient amounts and keep your underpaint relatively thin. Zinc white becomes more transparent with age, just like lead white does, due to saponification. For this reason it is often mixed 1:1 with titanium white, which is a good practice also because the film will be stronger and titanium tends to be too opaque anyhow. Zinc whites transparency can be emulated with a mixture of titanium white and blanc fix (1:10) or titanium white and aluminiumhydroxide 1:5. The latter yellows less. Zinc white has fallen in disrepute lately amongst restorers, because its film always cracks and for various other serious reasons I do not readily remember.
- PW 5 Lithopone. Coprecipitate of zinc sulphide and barium sulphate. Semi-transparent white. Very slow drier. 10-20% oil.
- PW 7 Zinc sulphide.

## Bad

- PW 2 Lead sulphate.
- PW 17 Bismuth white.

### **Miscellaneous whites.**

PW 15 Mica, iridescent, pearl lustre pigment.

PW 18 Chalk.

PW 20 Mica, iridescent, pearl lustre pigment.

PW 22 Baryte.

PW 26 Mica, iridescent, pearl lustre pigment.

PW 27 Silica.

--- Mixed white. A useful mixture of equal parts of titanium and zinc white. In older books it's flake white and zinc white.

### **Fillers, extenders and plasticizers**

PW 21 Blanc fixe. Barium sulfate. Less transparent than aluminium hydroxide. Can be used to manipulate transparency and oil content. 10-20 % oil. Should be ground in alkyd, poppy or walnut oil.

PW 24 Aluminium hydroxide, aluminium hydrate. Transparent filler used to control consistency of oilpaint. 5-10% is acceptable and improves the stability of the ground paint while stored in tubes or jars. More than 15% tends to increase yellowing because it is a transparent pigment. More transparent than PW 21 and also has a stronger effect on the consistency and rheology (brushing quality) of the paint. Very slow drier. Adding it to paint prolongs drying time.

Clay As dry powder. Clay of various types can be used as an additive to control the rheology (brushstroke and flow) of oilpaint. Most clay contains iron, hence its typical colour which can be a nuisance even though it is permanent. Kaolin, or China clay, is the most colourless (white) of the clays. Bentonite is a wonderful plasticizer, but it has the usual claycolour and will tone your colours cream. Some recipes recommend using clay in large quantities in the ground, but this is a bad practice since clay is hygroscopic and can hold the water for a long time with the effect, that subsequent layers of oilpaint may eventually peel off. The use of kaolin in the ground of van Dyck's "Great Peace" was as early as 1676 thought to be responsible for the paint peeling off.

Chalk 20% oil.

Gypsum 10-20% oil.

Talcum 20 % oil.

### **Yellow Good**

- PY 31 Barium Yellow Lemon. Barium chromate. Toxic. Medium dryer. 15-20% oil. Even more milky than nickel titanate (PY 53).
- PY 32 Strontium Yellow. Strontium chromate. Toxic.
- PY 35 Cadmium lemon, cadmium-zink yellow, 99.9% cadmium zinc sulphide. All cadmiums require 40-60% oil. All cadmiums are slow driers, semi opaque and generally of good tinting strength. Expensive. Invented 1818. Available since about 1840.
- PY 35:1 Cadmium-barium yellow light, lemon yellow, barium yellow.
- PY 37 Cadmium yellow (medium & dark). 99.9% cadmium sulphide. See PY 35.
- PY 37:1 Cadmium-barium yellow (medium & dark). See PY 35.
- PY 41 Naples yellow. Antimony yellow. Lead antimonate. Toxic. 20-40% oil. No longer available unless purchased from chemists. Under this name is sold a variety of mixtures based on titanium white and/or zink white with any other pigments the manufacturer fancies. True naples yellow light can be emulated by a mixture of one part cadmium yellow and two parts titanium white. This will also emulate its low transparency. If you want a warm, creamcoloured, milky yellow you could mix nickel-titanium yellow (PY53) with a little yellow ochre. In use since the 17<sup>th</sup> century. If you get hold of the real pigment and want to grind it yourself, then know that it tends to harden after a week and will then need more oil. Also it tends to harden in the tube in a years time or so, even if you add 2% wax (as Doerner recommends).
- PY 42 Mars yellow & orange. Synthetic iron oxide. 65-70% oil. See PY 43. More opaque than natural earths. There are specially manufactured highly transparent ironoxides available, but they are comparably quite expensive. Grinding mars yellow is tiresome. You can run it through the mill several times. You can add up to 100% aliminiumhydrate (which is far too much for any pigment) and still run it through the mill and see it become extremely fluid upon grinding, though stiff to begin with. What to do? Replace your plasticizer with bentonite. Bentonite is a clay with aproximately the same colour as ochre and it will for some reason serve you better than aliminiumhydroxide or aluminiumstearate. Personally I mix a stiff paste of oil and ochre (mars yellow) and run it through the mill, then run ochre (mars yellow) and oil through the mill an extra time, adding more ochre (mars yellow) and bentonite (1:1) each time. On the third run I add enough pure bentonite to make the paste very stiff, then run the stiff paste through the mill and do with the result.
- PY 43 Natural ochre, chamois, yellow/brown ochre. 50-60% oil. Semi-opaque. Semi-slow drier. About grinding see PY 42. If you run out of yellow ochre and have an immediate need, you can mix it from raw siena and cadmium yellow or chrome titanate (PBr 24), this is a waste of money. Likewise, you can make an ochre look like raw siena by adding burnt siena and adjusting with a bit of green or blue. Regarding grinding, see PY 42. Use ochres instead of raw siena when ever possible.

- PY 46 Lead-Tin Yellow. Lead stannate. Toxic. Fast drier. 30% oil. Low tinting power. This is probably the Giallorino of the Italian renaissance. It was the most common yellow up until the 17<sup>th</sup> century then from about 1650-1750 it became replaced by Naples yellow and ultimately forgotten, only to be rediscovered by restorers at the middle of the 20<sup>th</sup> century. It is not needed anymore because we have the safer nickel titanate yellow (PY 53), which, if you add equal amounts of titanium white, very much resembles the cold pale variety of lead-tin yellow (type I). The warm darker variety (type II) can be emulated by nickel titanate yellow, ochre and white. The dark variety is what Rembrandt used to imitate gold. The pale yellow light in his pictures stems from pale lead-tin yellow. PY 46, strangely, also refers to massicot (litharge, lead mono oxide), which undoubtedly is what some Italian renaissance writers call giallorino.
- PY 53 Nickel titanate. Nickel/antimony/titanium oxides. 15-20% oil. Not considered toxic, but irritates nickel allergy. Slow drier. Very opaque. Available since about 1960. This is a milky pure yellow. It is difficult to emulate, but you can approach it with titanium white, light cadmium yellow and a small amount of phthalocyan.
- PY 65 Arylide yellow, Hansa yellow RN, permanent yellow RN. 50% oil. All Hansa yellows are semi-transparent and very slow driers. They come in a variety of shades. Available since about 1915.
- PY 73 Arylide yellow, Hansa yellow GX, monoazo yellow, permanent Yellow GX. 50% oil.
- PY 74 Arylide yellow, Hansa yellow 5GX, monoazo yellow, permanent Yellow 5GX. 50% oil.
- PY 83 Diarylide yellow, permanent yellow HR70.
- PY 97 Arylide FGL. 50% oil.
- PY 98 Arylide yellow, Hansa yellow. 50% oil.
- PY 108 Anthrapyrimidine yellow, pyramid yellow. Medium drier. Good tinting strength.
- PY 109 Isoindolinone G. Tetrachloroisoindolinone.
- PY 110 Isoindolinone R, irgazine yellow. Tetrachloroisoindolinone. Slow drier. High tinting strength. Opaque.
- PY 112 Flavanthrone. An orange-yellow.
- PY 119 Spinel brown. Zinc iron oxide. Opaque. fast dryer.
- PY 120 Benzimidazolone yellow.
- PY 128 ... Transparent bright yellow.

- PY 129 Azomethine. Methine copper complex.
- PY 138 Quinophtalone.
- PY 139 Isoindolinone, paliotol yellow. Tetrachloroisindolinone. Slow drier. Semi transparent. Similar hue to cadmium yellow deep.
- PY 150 Nickel-azo yellow 4G (se PG 10).
- PY 151 Benzimidazolone yellow H4G.
- PY 153 Dioxine nickel complex. 40% oil.
- PY 154 Benzimidazolone yellow H3G. 60-70% oil.
- PY 156 Benzimidazolone yellow HLR. 60-70% oil.
- PY 157 Priderite yellow. Nickel barium titanium primrose. Slow drier. Opaque with medium tinting strength.
- PY 175 Benzimidazolone yellow H6G. 60-70% oil.
- PY 184 Bristol yellow, sicopal yellow. Bismuth vanadate. Opaque. Good tinting strength. Full range from light yellow to reddish hues. Available since the 1980's.
- PY 216 Orange brown hue.

### **Acceptable**

- PY 3 Arylide yellow, hansa yellow 10G, monoazo, permanent yellow 10G. 50% oil.

### **Bad**

- PY 1 Arylide yellow, hansa yellow G, monoazo yellow, permanent yellow G. 50% oil.
- PY 12 Diarylide yellow AAA. Benzidine Yellow G.
- PY 13 Diarylide yellow AAMX. Permanent Yellow GR.
- PY 14 Diarylide yellow OT. Permanent Yellow G.
- PY 17 Diarylide yellow AO. Permanent Yellow GG.
- PY 20 Benzidine yellow B.
- PY 34 Chrome yellow 5GH. Lead chromate. Turns dark and greenish. 30-60% oil. Lemon to orange shades. Opaque. Fast drying. Invented 1797, in use since about 1940.
- PY 36 Zink chrome yellow. Toxic. No longer in use. 40% oil.

PY 40 Aureolin, cobalt yellow. Cobalt potassium nitrite. Expensive. Slow drier. 30-40% oil. Semi transparent. Available since about 1850. You don't need this colour, because you can exactly duplicate its hue and transparency with a mixture of azomethine yellow (PY 153), a small amount of chromium oxide green (not viridian or phtalogreen) and some zink white. If you don't have chromium oxide green, you can approximate aureolin by substituting chromium oxide green with ultramarine blue or ultramarine violet, though it won't be an exact match.

PY 55 Diarlylide yellow PT.

PY 100 Tartrazine yellow.

PY 182 ...

### **Untested yellows**

PY 73 Arylide yellow, Hansa Yellow.

PY 75 Permanent Yellow RX.

PY 81 Benzidine Yellow 10G & 10GX.

### **Traditional yellows**

PY 39 Orpiment. Expensive and highly toxic.

PY 46 Massicot, litharge. Lead oxide. Toxic.

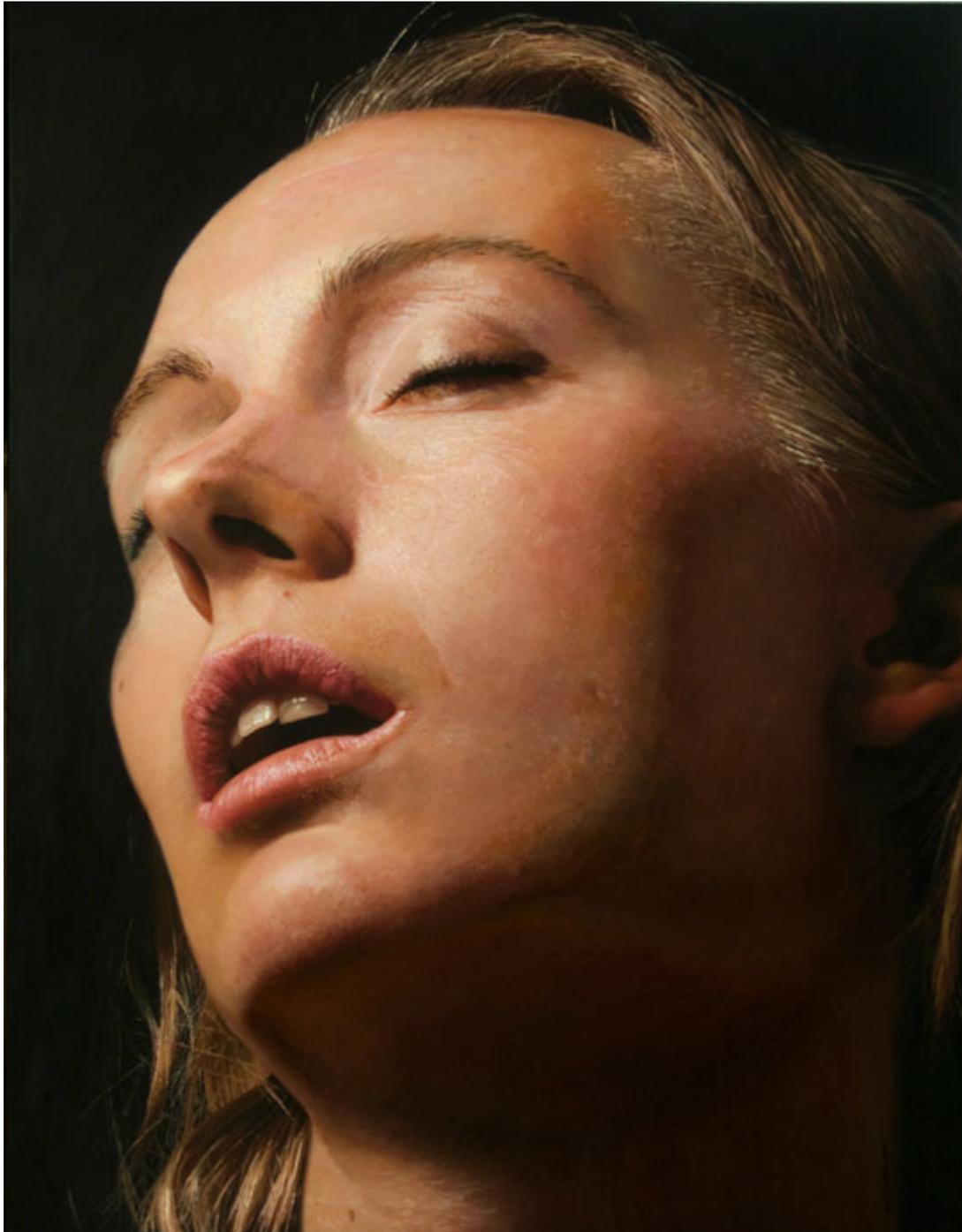
NY 24 Gamboge. Toxic. Replaced by aureolin (PY 40) or PY 10.

--- Indian yellow. Illegal since 1920's. Made from the urine of cows on a painful diet of mango leaves. Can be replaced by nickel azo green-gold (PG 10). Some replace it with aureolin (PY 40).

--- Stil de grain, yellow lake. Dark brown-yellow glaze. Fugitive.



Jan Esmann  
Open face (Johanne)  
Oil on canvas, 2011  
130 x 100 cm



Jan Esmann  
Open face (Julie)  
Oil on canvas, 2010  
130 x 100 cm



Jan Esmann  
Open face (Kirstine, I)  
Oil on canvas, 2010  
130 x 100 cm