Refining Linseed Oil:
A Guide for Working Painters

Background

Linseed oil has a reputation for creating a strong paint film, but it also has a reputation for yellowing over time. This was especially true earlier in the 20 Century, when painters had to contend with several less than ideal varieties of commercially processed oil. Academic writers such as Laurie, Mayer, Taubes, and Wehlte agree that cold-pressed linseed oil is best. But none of them offers a complete discussion of how it might be processed, possibly because simply obtaining it at the time was difficult enough. (This gives some idea of the depths from which the craft is now slowly ascending). And while cold-pressed alkali-refined linseed oil may yellow less than a hot-pressed oil, it still yellows noticeably. This situation has always left many currently working painters wondering how older painters, most notably the Dutch and Flemish painters of the 17th century, created a quick-drying, non-yellowing linseed oil. This has been especially true since the publication of Rembrandt: Art in the Making, by the National Gallery (New Edition 2006). The included technical essay on Rembrandt's paint medium by Raymond White makes it clear that, when examined at the molecular level, Rembrandt's medium consisted of chalk and linseed oil, nothing else. While these researchers do find resins, they are found less often than one might suppose, and tend to be small additions of a soft pine resin such as larch balsam. There are at this point thirty volumes of yearly Technical Bulletins published by the National Gallery. These are a helpful balance to the maze of historical documents – often not written by working painters – in providing a genuinely empirical baseline about the materials found in older paintings. In viewing older painting practice as both a developed craft and a living upon which reliability of the product depended, it is logical that painters would have only become inventive within traditions that were conservative.

So, if the major medium component of painters such as Rembrandt and Velázquez is linseed oil, the quality of the oil and it's processing procedure are of considerable importance.

Oil 101

All plant derived drying oils used in painting are composed of long strings of complex, water-soluble fatty acids attached to triglycerides. The triglyceride component is a constant, the proportion of the fatty acids in each oil is responsible for their different behaviors. For example, the proportions of linoleic acid (Omega 6) and linolenic acid (Omega 3) in linseed and walnut oils are different. Having significantly more linoleic acid, linseed oil has a tendency to dry faster, and also more of a tendency to yellow. Because these oils are grown in a specific location, and processed – or not – in a specific way, they have individual, and somewhat amorphous, identities. As such, two things may be labeled "linseed oil" which are profoundly different in composition and working character. For much of the 20th century, a quality cold-pressed linseed oil was simply not available in many locations. It is important to take this into account when reading the more recent academic writers, as well as any modern research into the behavior of the oil. What was the starting point? Conservators, for example, have a tendency to use the Kremer Swedish oil as a conveniently available constant. But this oil is not organic, has not been refined, and therefore, naturally, it yellows.

Science

Because of it's historical and continued commercial importance, a long history of scientific research into the behavior of linseed oil exists. Science has many long words to use here, and is always quite confident of the validity of its results. For this reason, painters -- reeling from the labyrinth of half truths in the catalogues? -- will often look to the findings of the laboratory for more reliable information.

In theory this is a great idea. But in practice this proves much more complex, especially with regard to the many scientific papers available now through the internet about linseed oil. While science is always highly subtle in its analysis, it is not necessarily as perceptive in its fundamental conception of the situation. The 17th Century scientific attitude -- the De Mayerne manuscript offers a legendary example -- was result or goal oriented. Materials were investigated with a specific practical end in mind, and De Mayerne provides a virtual encyclopedia of the 17th Century techniques of working painters for refining raw linseed oil. The current

scientific attitude is grounded in the ability of the modern laboratory to look deeply into the way materials are constructed, and how they interact. For this reason, it is easy for modern science to have no practical purpose, or to simply miss the point. As a primary example, I have not been able to find a single scientific analysis of the behavior of linseed oil which begins with a cold-pressed, unrefined oil, and then refines it before further investigation. In a way this is logical, the refining process introduces a profound experimental variable. But it is known that all older painters began with cold-pressed, unrefined oil. So, what we have here is an unfortunate, “scientific” attempt to create an empirical constant where none exists historically. If we grant that certain older paintings are in much better shape than they should be -- Rembrandt is the usual example because of his later manner, but there are many others as well -- the conclusions of science with regard to its abstract version of "linseed oil" are unfortunately moot. Does a cold-pressed, unrefined oil behave the same way as the alkali-refined linseed oil of commerce? Not at all. From the perspective of the painter looking for high quality, traditional materials, the reams of available analysis are therefore about the wrong thing. This is by no means an isolated example of the way in which specific oversimplifications unfortunately make the scientific approach to painting materials suspect, if not dysfunctional, for working painters. But it is a somewhat fundamental one.

The Recent Organic Oils

Painters are very fortunate now to have a quality of linseed oil available that is exceptional, without precedent. Organic, cold-pressed, unrefined linseed oil is now widely available for perhaps the first time ever because of it's potential role in human nutrition. No commercial oil, regardless of the supposed quality or price, has comparable working qualities as artist-refined cold-pressed linseed oil. When I used the first batch of oil I'd refined for the first time, it was a revelation in terms of it's charismatic working qualities. Commercial oils cannot have this quality because of the lower quality oil that they begin with, and the extent of the subsequent processing. This oil is typically available in a health food store, but can almost always be had more cheaply ordering online in bulk. It is always called Flax Oil, not linseed oil, and is beginning to come in a complex variety of flavours and variations. For painting purposes, you want the plain variety, not “high lignin”, “lemon”, or “strawberry shake”. The purity of the oil and the care with which it is extracted are completely unprecedented, some varieties are even packed under nitrogen.

The quality of oil being marketed for painting has generally improved from the Taubes/Mayer era, but it is still nowhere near that of a cold-pressed organic oil. If more painters understood the foundational role of quality oil in the long term life of their painting, this might change, as the industry is consumer driven. For the time being, the quality raw oil exists. The question is, how to refine it?

Sources

There are two major sources of historical procedures in English, the first is the first volume of Eastlake's "Methods and Materials" published in 1847, the second is the English translation of the De Mayerne Manuscript (Sloane 2052) published in "Lost Secrets of Flemish Painting" by Donald Fels. Both of these remain well worth reading as they demonstrate the level of both ingenuity and concern which older painters brought to the subject of refining the oil.
Both these books also make numerous mention of procedures involving traditional varieties of lead: lead carbonate, lead oxide (litharge), and basic lead metal. While it is true that a small amount of a lead compound can help the oil to dry, and also appears to produce a photo-sensitivity in the oil, most painters are anxious to avoid lead. Using the faster drying linseed oil, as opposed to walnut, poppy, or safflower oil, this can be done, especially if a form of calcium carbonate is incorporated into the paint. If the introduction of lead is of interest, the safest procedure is to use the metal, with no heat, after the oil has been refined.

Eastlake focuses on a particular recipe given to De Mayerne by the German painter Sorg, which involves washing the oil repeatedly by shaking it with a mixture of rainwater and salt, then allowing the cleaner oil to separate. The procedure is then amplified via several other traditional procedures to include sand. In the excellent but less well known "Medieval and Renaissance Treatises on the Art of Painting", Merrifield concurs with the usefulness of the procedure outlined by Eastlake, and comments that it proceeds more quickly if the oil is exposed to moderate heat, such as that of a low oven. This procedure, by a combination of physical – the sand -- and mild chemical action – the salt being a base, the water being polar – separates the oil from its water soluble fatty acids. The predominant one of these in linseed oil is linolenic acid, Omega 3. This component has also been proven to be a major potential cause of yellowing. Oil made by the procedure below exhibits none of the negative characteristics associated with commercial linseed oil. It does not skin or wrinkle, it dries hard without any gumminess, and, if used with a chalk or other calcium carbonate, or aged in the light, it does not yellow perceptibly.

Traditional Procedure

This is how I reconstructed the directions in Eastlake and Merrifield: A quart of oil was placed in gallon jugs or jars, along with 6 tablespoons of sea salt, 1 cup of fine sand, and 2 quarts of hot, water, non-chlorinated if possible. The sand must be washed first to remove any dirt it may contain. If you can get mason's sand, or river sand, it will work better than standard hardware store sand. The jar is capped, then shaken vigorously, letting the pressure off by releasing the cap slightly. The jar is then placed on a low source of heat. I used several lab hotplates on their lowest setting, one for each jar. Other people have reported using a food warming tray with good results. Merrifield recommends putting the whole jar into a low oven, but I found this didn't work as well for removing the break as having the water warm, the oil cool. If you use a low oven, be careful to loosen the cap of the jar beforehand.

The jar is shaken every day, several times a day, with the pressure being let off each time. At the end of the first week a large portion of the break will have appeared between the oil and the water. The oil is poured off, the break and water are discarded. To save as much of the oil as possible, put the last bit into a tall, narrow container and let it sit until the oil has again come to the surface, then return it to the jar. The process is repeated a total of five or six times, all but the last time containing sand and salt. The last wash is simply water and oil. In the end, the volume of the oil decreases by about 35 to 40 percent.

This oil is lighter but slightly cloudy when it is finished due to residual water in the oil. There are several traditional ways to clear it, including the addition of a small amount of lime, the addition of wood chips such as those used for pet bedding, breadcrumbs, or simply leaving it in a warm windowsill for a time. I've used two teaspoons of dried, ground lime per half gallon of oil, and have also found that a small addition of lead carbonate clears it quickly, 2 tablespoons per half gallon. It is also possible to clear the oil by heating it slowly and carefully, with rapid stirring, to just above the boiling point of water. At this point I use 1 tablespoon natural chalk and ¼ teaspoon dried powdered lime per cup of oil. The oil is stored in a windowsill in relatively full glass jars. Be careful of making these too full as the oil expands in summer in the heat. It dries in two days, more quickly in summer or when used with chalk. It yellows relatively little in tests, less after being aged in the light, less when used with chalk. If it is planned to age the oil a long time, a small amount of a mild alkaline material such as lime, calcium carbonate, or a mixture, should be added to neutralize the acidity which inevitably

still develops over time. This is less of a potential issue when using a chalk-based medium.

Later note: A much quicker version of the above procedure can be done using finer sand such as Mason's sand or River sand. This becomes nearly as fast as the procedure below. Finer sands are available from Kremer Pigments: a combination such as 58630 (.04 – .15mm), 58650 (.25 – .4mm) with a little added 58678 (.5 – 1 mm) might be tried. A fine sand is also available at hardware stores as the aggregate used in paint to make stair treads less slippery.

Traditional Procedure, Modern Method

While the above procedure works well, it did take six week or slightly more to complete and contains a decent amount of fiddling around. More recently I've done the washing using a small amount of sand mixed with the mixture of cristobalite and calcined diatomaceous earth used to filter swimming pools, available at hardware stores during the summer. These are both fine forms of silica, used to remove impurities from water, and they shorten the process considerably. Alternatively, diatomaceous earth can be purchased separately, and mixed with fine sand such as mason's sand or river sand. However, this diatomaceous earth needs to be the calcined variety, not “raw”, or food grade, this will produce an impossible sludge. It may be simplest to look for the pool filter mix online, a box lasts a long time. (Fine silica should always be handled with care using a respirator). The fineness of the diatomaceous earth means that it binds to the fatty acids much more tenaciously. For a half gallon jar, the proportions are: 2 cups oil, 3 cups water, ½ cup pool filter mix, 2 T any clean sand, 1T salt for the firast washing. Oil which is new, unopened, and packed under nitrogen will process quickly and cleanly using this procedure. The oil will separate naturally in a few days during the summer, sunny windowsill helps, but separation must be done using a low oven in cooler weather. Only two washings are needed, of two or three days each. A final water rinse can be done as well. In summer, the jars can simply be shaken at will for two or three days and allowed to separate naturally. In winter, after being shaken several times, the jar is placed into a low oven to facilitate separation. Then it is removed, allowed to cool somewhat, and shaken again. When shaking jars that are hot to the touch, always vent them after shaking by loosening the cap or lid slightly to release pressure. The clearing and storing procedures are the same.

Oils Used

There are several different brands of cold-pressed, organic oil available, and these vary from country to country. Just make sure from the label that the bottle *only* contains flax oil, nothing else to make it more palatable or nutritious. In America I've used Flora, an oil from British Columbia, Azure Farms, from Oregon, Jarrow, an oil from the northwest or British Columbia, and the Allbäck oil from Sweden. I'm sure that similar oils, such as the Barlean's oil, are fine. The Flora oil is packed under nitrogen and is easy to process, as is Jarrow. The Azure oil is similar, not packed under nitrogen but much cheaper by the gallon. The Allbäck oil is also reasonable, but is marketed for making paint, not nutrition. It is aged, more acid to begin with, gets an addition of chalk or lime on being processed.
Allbäck also markets an organic, cold-pressed "boiled" oil which has been refined and heated. I put boiled in quotes because the boiled oil of commerce is usually quite dark, relatively thick, and contains significant amounts of driers. This oil is lighter than unrefined oil, still relatively thin, and contains a small amount of a manganese drier, .00135 %. Placing a liter of this in glass in a windowsill results in lightening to a pale yellow brown over time. Adding a teaspoon of dried, powdered lime quickly results in the release of more break. This oil is not absolutely perfect, does yellow a bit over time, but not enough to discolor even lead white.

I've used this oil for several years now in a chalk medium with no discernible yellowing, although it has been aged in the light first for several months. This is the only commercially available oil I know of which is cold-pressed, organic, and minimally refined. If you're interested in exploring what you'll have access to by refining the oil yourself, this product is closer than anything else on the market.

Final Color

The unrefined oil starts out orange, the final color of the oil after processing is light yellow with the original process, mid-yellow with the modern method. In either case the color bleaches slowly but surely when aged in the light. It is possible, by leaving the processed oil in a thin layer on a bed of water – such as in a Pyrex baking dish, to create an oil which is very nearly colorless. This takes a few weeks, depending on the thickness of the layer. However, this oil is not necessarily

better. Wehlte points out that the color of the oil is not nearly as important as the color after it dries. Mayer wonders if the oil should be used with a certain amount of color, so that it bleaches to it's maximum on drying, rather than risk having it revert back on drying. This is an area where only time and experience can supply adequate answers. Using this oil and various stone dusts as a medium, and observing the procedures detailed in the section on yellowing below, I've experienced no issues with yellowing, or lowering in tone over time. When aged in the light for a year, this oil does not yellow at all after eight months in a plain oil test on gesso.

Process

With an involved procedure there's always a temptation to dive in and make a lot, get it over with and forget about it. But any procedure like this is going to have local and personal variables. So I'd suggest that, if you can stand it, you do the opposite: go slowly, feel your way with how the oil you choose responds. The behavior of oil is subtle, it's easy not to notice things. If, for example, you process even one quart of oil a month in two half gallon jars, this gives you, at the end of a year, about two gallons of oil at a cost of about 25.00 per month. You will know a lot more about your procedure by the end of a few months, and it will be integrated into your routine. If you work large or want to make your own paint, you might double this amount after a few rounds of the procedure.

Yellowing: Standard Causes and Prevention

There are several different potential causes of yellowing in a painting. While lower quality linseed oil in commercial paint is on the wane, this has been a major cause of darkening in 20th Century paintings, and it is unfortunately possible to see this readily in major museums.
Another standard but more culprit is turpentine which has been oxidized by exposure to light and air, the residue of this can yellow badly and affect everything it was a part of. If used, turpentine should always be the highest quality, and protected from both light and air by being stored in small size amber glass bottles.
A thin application of a given oil may dry without yellowing, while a thick application of the same oil will darken. Oil which has been pre-heated slightly or aged in the light has less of a tendency to yellow than the same oil, new and raw.
Humidity is another factor often overlooked: an oil which dries without

darkening in low humidity may dry with significant darkening in high humidity. In some climates, a dehumidifier is a studio necessity during the summer. The oil itself benefits from the addition of substances such as chalk and lime which attract water.

The use of a form of powdered calcium carbonate in the medium may well help minimize yellowing by creating a more basic environment for the oil to age in over time, as well as providing a physical inhibitor for progressive crosslinking of the oil molecules as they polymerize.

Setting paintings to dry in moderate sunlight is a traditional remedy for short-term darkening, north or east windows work well for this: simple but effective. Paintings will darken naturally if not exposed to enough sunlight, this is especially true of work made with linseed oil. However, subsequent exposure to light will brighten the work once again. The darkening associated with resins is longer term. It is wise not to use a hard resin such as amber or copal in any but the most minimal amount, never as a final varnish. It is wise to keep all resin use to an absolute minimum: these materials are so strong that between 2-4% of a hard resin varnish in a paint layer will make a significant rheological and optical difference. More may well be inviting trouble down the line.

Oil paintings made with permanent pigments do not ever get lighter or brighter over time. Painting on a white ground is therefore a good idea, as is painting the midtone values "up" somewhat, especially when working in layers. Painters are often attracted to the expediency of a toned ground, but it is virtually impossible to keep this from affecting the painting over time. This is especially true of the midtones: there are many older paintings whose contrast has been heightened significantly by lowered midtones. An absorbent ground offers a similar possibility of building the paint quickly, but the oil it absorbs will turn it instantly gray. A high key initial underpainting can minimize this issue.

It is becoming more common for painters to pay attention to conservators, and this is by and large a good development. But sometimes conservators become focused on, not to say obsessed by, yellowing. In oil painting, there is a profound difference between normal, visually comfortable mellowing and an overall darkening which is fact disfigures the work. It is important to keep in mind that the dire warning of the conservator about a material "yellowing over time" might be a little overstated: some conservators simply like to terrorize painters. If a painter wants a medium which is guaranteed not to yellow, the answer is egg tempera. Conversely, it's possible to see before and after photos of paintings where old varnish was removed which show that the painting clearly benefited from the warming effect of the varnish layer: as

perhaps the painter intended. So, the issue is to know one's materials. A lower chroma earth color palette, such as used by Rembrandt or Velasquez, can be used safely with quality linseed oil, as was in fact the case for both painters. Raphael's higher chroma palette may well have benefited from his use of walnut oil. The more the color depends on a cool, neutral light, the more the color is focused on dazzling pure color in the midtones, the more the painter needs to be concerned with yellowing in the choice of the oil. However, following the transparent to opaque method of most older painting from dark to light values, it is possible to paint in such a way that the relative warm-cool dimensional distance of the colors in the painting remains constant or in fact increases as the painting ages. A simple but reliable way to get a feeling for how materials operate over time is to do yellowing tests. For oils these should be done on the ground used for painting and kept in the light. About three months will show where a given oil is headed. A yellowing test will show you the worst possible scenario, the dried oil film without any pigment involved.

Conclusion

A paint film is vulnerable to the effects of atmospheric oxygen: the same material which causes the oil to polymerize ultimately desiccates it. Raw oil tube paint does not create a strong enough paint film to resist oxygen for very long, the paint must be further modified or protected in some way: the look of many modern paintings after only fifty years proves this conclusively. The vulnerability of tube paint has resulted, since the beginning of the tube paint era, in a great variety of mediums designed to alter the behavior of the paint and increase its longevity. If tube paint is a given, it is very easy for a technical Tower of Babel to be the end result. The sincere research of the 19th century was waylaid into an interest in hard resin varnishes because these varnishes protected the paint film so well from atmospheric oxygen. Yet, modern research finds almost no amber, copal, or sandarac used as a medium in the paint. It is logical to conclude, therefore, that ways of processing and subsequently modifying the oil exist which protect the paint effectively over time. An oil like this would have been especially important to Dutch and Flemish painters working in a relatively cold and damp climate.
There are many factors potentially in play here that may contribute to the creation of a superior paint film consisting simply of linseed oil. First is the acknowledged greater film strength of linseed oil compared to the other drying oils. Second is the greater film strength over time of paint containing white lead. Third is the potential for linseed oil from which the water-soluble fatty acids have been removed to be more resilient long term by being inherently less reactive to atmospheric oxygen. Fourth is the way this oil thickens naturally over time in a

container that is not full, giving the painter a “raw” oil which is thicker for use in a medium. Fifth are the many historical ways in which lead was introduced into the oil, often acting as a subtle thickener as in the case with litharge, but also introducing an element of photo-sensitivity to the oil which many older recipes refer to, but which, to my knowledge, has not yet been studied in our time. And finally, in the case of Rembrandt, the potential of an addition of chalk to the paint to neutralize the long term acidification of the oil, physically stabilize the paint film, and inhibit long term cross-linking.

My experience beginning with cold-pressed organic linseed oil processed by the washing methods above and used in conjunction with a natural chalk has been very positive. This method enables a straightforward, solvent-free method of painting which allows for concentration on the work. Brushes are kept on their sides in oil, washed in soap and water occasionally. It is simple, using traditional methods such as preheating or exposure to the sun, to create a linseed oil paint film which dries quickly, hard, and with significant depth and gloss. Using a chalk medium with a high quality oil, such as was apparently the case with Rembrandt, a great deal of paint can be used without the risk of subsequent cracking. The more the paint can be enriched in the end using oil which has been slightly thickened, the more the paint film will resist oxygen over the course of time. While it would probably be ideal to use painter-refined organic linseed oil exclusively, for both the paint and the medium, it is also possible, using a chalk putty made with this oil, to convert modern tube paint into paint which is much stronger. The tenacity of this paint once dry is quite surprising. So, while processing one's own linseed oil represents an investment in terms of time, effort, and capital, it is really the only thing a painter needs to make to have access to a much more versatile, attractive, and stable way of painting. For more on the chalk putty medium, see the techniques section of the website.

Buon lavoro.

Tad Spurgeon.