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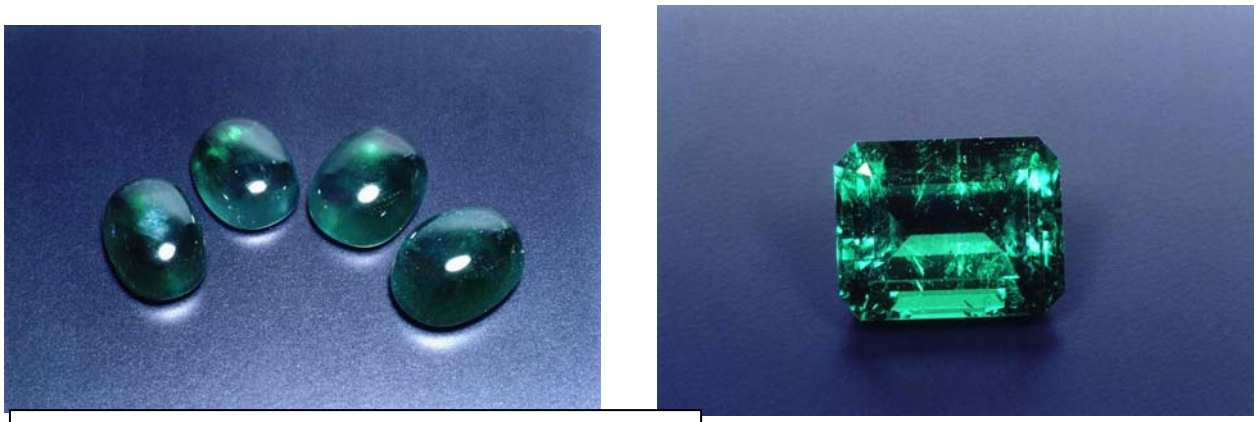
Emerald Oiling (In-Fill) Process

by Ted Themelis

Natural gemstone creation, as a rule, is a brutally wrenching process, often as wounding as it is wondrous. Even so, few gems take the amount of abuse that emerald does during its genesis. These emeralds tend to have numerous cracks, imperfections and birth scars. For this reason, many emeralds need their looks improved to become presentable and saleable.

Improvement has long consisted of the so-called "oiling process", which hides their cracks and fractures, in much the same way a beauty parlor mudpack hides skin wrinkles. *[Author's note: in this report, the term "oiling" is considered as an external description only, since in most cases, other than true oils are used in the filling process].* This camouflage process is so pervasive that it is safe to say that every emerald destined for jewelry is filled with oil, or with some other filling substance(s). While that's an overstatement, it is hardly an exaggeration to say that this process is attempted on just about every emerald as a final step toward market readiness.

And no wonder. All an emerald needs is a surface-breaking crack that will accept the filler media. With nothing to lose and everything to gain, it would almost be foolish not to subject the emeralds to this process. That's why this treatment is standard procedure in the world's main emerald mining and processing centers: Colombia, Zambia, Brazil, Israel, India, Hong-Kong, and elsewhere.



Emeralds after the “oiling” process.

There's just one drawback to emerald "oiling." The beauty it brings is nearly always transitory. Every known emerald filler (oil, oleoresin, epoxy and plastic) will eventually decompose in time. This means that the constituent elements of the filler start to separate and that the substance as a whole, begins to lose its bonding strength with the host emerald. Chemists call this breakdown "dissociation."

Once dissociation sets in, the camouflaged emeralds revert to their original unsightly appearance. Since the loss of their filler in emeralds is gradual under normal conditions, consumers may not notice what has happened, or ignore it when it occurs - especially when they have not been told that their emeralds were subjected to "oiling." Granted, disclosure is a rather delicate duty with a treatment as impermanent as "oiling." Yet, it is a duty, which must be done, especially since the filling media loss can be speeded up from the gradual to instantaneous when uninformed owners bath emeralds in ultrasonic cleaners.

The pity of non-disclosure is that most dried-out emeralds can be restored to their beauty by "re-oiling" them. Members of the jewelry industry must take a positive approach to disclosure - first explaining the benefits of "oiling," then encouraging customers to bring in their emeralds for periodic inspection and, if needed, reconditioning.

To be blunt, most "oiled" emeralds sooner or later would require a lube job. Nevertheless, revealing this fact of life doesn't have to be an unpleasant chore. Instead, disclosure can be used as a potent sales tool to keep customers coming back, if only to have their emeralds checked. This is where an understanding and appreciation of "oiling" is important. Contrary to the popular impression, successful "oiling" is a sophisticated process that cannot be done simply by plunking dried-out emeralds in trays of, say Mazola oil. Rather, this

treatment should be left to professionals versed in its intricacies. This means that the emeralds must be sent to special labs where residual oil (or other fillers) can be removed and new filler applied.

Consumers and members of the gems and jewelry industry should realize that treatment is a combination of art and science; the processing techniques vary from lab to lab, ranging from primitive to highly sophisticated. Nevertheless, this report covers the current mainstream and avant-garde techniques of emerald "oiling," as practiced by the author Ted Themelis, at his laboratory. It divulges some secrets of the treater's art known up to this point only by a few trade insiders, in the hope that demystifying the subject of "oiling" will promote disclosure of this increasingly pervasive and essential trade practice.

Ends and Means. Emeralds are "oiled" to reduce the visibility of cracks and internal imperfections, thus improving their overall appearance. Flawed or poor-quality emeralds which have cracks, crevices or fissures that break the surface are candidates for this process, since these openings provide the only entry point for the filling media. Although some treaters restrict themselves to one or two filler substances, most high-tech treaters choose from a wide selection of fillers, depending on the size, configuration of the cracks, their knowledge, available equipment and other parameters. The success of the "oiling" process in emerald, depends on the ability of the chosen filler to be induced into the surface-breaking cracks of the emerald and remain there, as long as possible. Rough, pre-formed, faceted and cabochon emeralds are suitable for the "oiling" process, as long as these emeralds have crack(s) reaching the surface.

Fillers (In-Fill Media)

Today, emeralds are commonly "oiled" using the common filler substances:

1. Organic and synthetic oils (usually Cedarwood oil)
2. Oleoresins (most commonly Canada balsam)
3. Synthetic epoxy resins (Opticon)
4. Other fillers ("Jobin," etc.)

Oils (organic and synthetic). In the past, just about every conceivable organic oil (including castor, coconut, cottonwood, mineral, palm, peanut, olive, whale's oil and other oils) or a combination of these oils, has been used as filler in emeralds. Unfortunately, most of these oils have two strikes against them discourage use by professional treaters. First, their refractive indices are under 1.50; second, their viscosity is too low. While the former has some bearing on the treatment's effectiveness, the latter influences both its stability and longevity. If viscosity is too low, the filler will tend to be thin and loose, likely to dry-out quickly and exit from the emerald's substance. Treaters prefer high-viscosity fluid fillers that, at room temperature, are thick, syrupy and sticky in their natural state, but which lend them to thinning during induction into the emerald's substance. Of the scores of natural organic oils that can used as emerald fillers, Cedarwood oil has merged as favorite, although the quality and physical properties vary, as received from the suppliers.

Cedarwood oil is transparent, colorless to slightly yellow, volatile (readily vaporized), somewhat viscous, insoluble in water, but soluble in ether and pure alcohol (which make the latter two ideal solvents to clean out Cedarwood oil residues before re-oiling), sensitive to other than normal room temperature and prone to chemical alteration from light exposure. Cedarwood oil has a refractive index of 1.495-1.510 and its specific gravity is about 0.94-0.95 gr/cm^3.

Oleoresins. Canada balsam is another favorite filler among treaters. Canada balsam is not exactly an oil, but rather an oleoresin - a solution of resin in essential oil extracted from the North American balsam fir tree. Canada balsam is transparent, yellowish to slightly greenish, viscous, slightly fluorescent, sensitive to both light and temperature, insoluble in water, completely soluble in ether or oil turpentine and only 90% so in alcohol (making all three good cleaning agents for stones filled with this oleoresin). Specific gravity is about 0.980-0.994 gr/cm^3 and its refractive index ranges from 1.52 to 1.54.

Epoxy/resin fillers. In recent years, epoxy resins (polymers used as adhesives) have begun to vie with traditional oils and oleoresins as standard in-fill mediums. The most popular of them is synthetic polyester epoxy resin, marketed by the trade-name "Opticon", famous as a fracture sealer that has endeared itself to treaters because is more stable than oil. Opticon is transparent, light amber in color, slightly fluorescent and comparable in viscosity to that of Canada balsam. It has refractive index of about 1.545.

Despite its virtues, Opticon is still non-permanent filler. Treaters can extend its life by adding in its companion hardener in any desired ratio. Few do so, however, because removal of hardened Opticon is very difficult should it become necessary as a result of chemical breakdown of the filler. Ethyl-based ketones have been used as cleaning agents, in chemical condenser apparatus, but only with limited success.

Plasticizers/hardeners

Various agents, such as Plasticizers and hardeners, may be mixed with the fillers that contribute to emerald's life expectancy.

Because oil and epoxy resin fillers prove unstable over time and exit partially from the emeralds, treaters are experimenting with additives known as plasticizers that act both as filler-stabilizers and sealants. These additives mixed with fillers, increase their viscosity and resistance to breakdown. When they are applied as a surface coating over the filler, they form a closure that reduces greatly and in sometimes stops seepage.

Although plasticizers extend the life of impregnation treatment, they don't make them permanent. In time, these stabilizers/sealants lose their initial strength and dry-out, creating dust-like whitish particles within voids. Painstaking cleaning is then required, before the emeralds can be "re-oiled".

Dyes

Multitudes of pale low-grade beryl can be converted to "emerald" by adding green organic dyes to conventional filler substances. In general, "greening" emerald by means of artificial coloring is condemned by many gem dealers and consumers as unethical, although widely employed in India, Brazil and elsewhere. Defenders of this practice argue that it is arbitrary to approve of "oiling," but not of dyeing when each serves the same purpose of improved looks. Yet there is a rationale for censuring this treatment. Organic dyes speed up the breakdown of the fillers to which they've been added jeopardizing the beauty they help create.

Choosing fillers

Although the range of these in-fill media vary widely, treaters narrow their choices according to certain criteria, such as: 1) Refractive index (which should be as close to that of emerald as possible) 2) Viscosity (flow characteristics) 3) Solubility 4) Fluorescence 5) Environmental sensitivity (light and temperature).

In choosing fillers, treaters determine the following:

1) Single or multiple fillers (type and ratio)
2) Hardener to be used in the in-fill process
3) Dye to be used in the in-fill process

Cedarwood oil and Canada balsam are sometimes mixed at approximately a 3:1 ratio for use as emerald in-fill. What's more, Canada balsam has been mixed with other oils as an in-fill for other gems. An untold number of mixing combinations and ratios involving oils, oleoresins, epoxies have been applied to produce the final filling media. The results after the treatment vary significantly and depend on many parameters.

Identification of the Filled Emeralds

Generally, an experienced gemologist can identify whether or not the emerald in question is "oiled'. This is achieved by observing its inclusions residing at or near the cracks, crevices and fractures, using any microscope equipped with a dark-field illumination and a fiber optic unit. Some dry-out filler media in emerald's cavities stand prominent as minute, white dots, or specks, having characteristic appearance and configuration. Other fillers appear as "rusty", "burnt", especially when heating was incorporated during the "oiling" process.

Immersion microscopy techniques may be used to identify "oiled" emeralds. The emerald to be examined is embedded in a glass transparent crucible with flat walls containing an immersion liquid whose refractive index is very close to that of the emerald. A suitable liquid would be bromoform whose nD=1.56 is very close to that of emerald, which is around 1.57. Once an emerald is observed embedded in bromoform, all that will be visible are those areas that contain lower refractive index filler. As for the emerald whose fillers have green dyes with lower refractive indices mixed into them, these dyes will give themselves away as small, localized patches of color confined to the small areas of cracks into which the dye was forced.

Fluorescence is also used to determine the fillers in the emerald substance. Some treaters mix purposely the selected filler with fluorescent dyes, such as "fluoresin", to aid the identification.

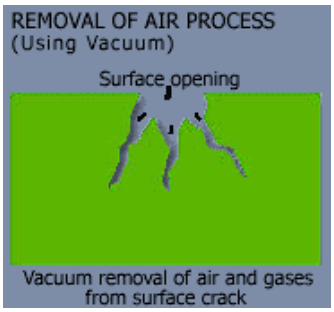
In many cases, the use of the hot-point instrument is very helpful. The hot-point is applied at the emerald's surface cracks; the thermal reaction causes the oil to "bead-up" producing characteristic inclusions.

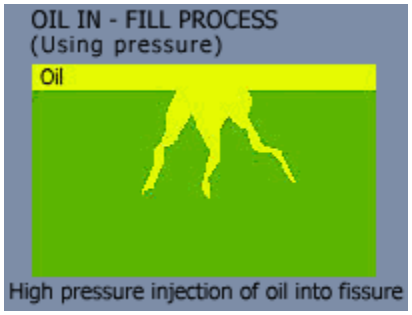
When one of more fillers were mixed together with or without added hardener to compose the final filler media, the precise determination of these filler ingredients residing in the emerald's substances is extremely difficult and cannot be achieved using conventional gemological instruments. Furthermore, it is impossible to determine when the filler media was induced into the emerald's substance. The determination of these fillers, may be achieved with using various spectrophotometer techniques, employing sophisticated instruments, distant to average gemologists.

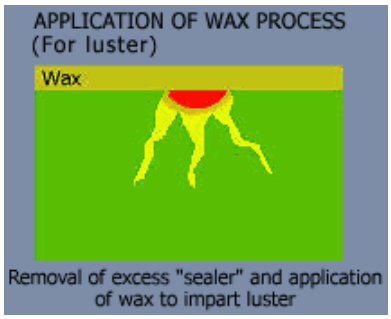
The "Oiling" Process

Before the typical crack-infested emerald is "oiled," it looks a lot like an ice-skating rink in need of surfacing. Stones show feathers running in every direction and configuration. The goal of "oiling" is to conceal or minimize all of the emerald's surface-breaking fissures and also hide inclusions trapped within them.

Basically, "oiling" is a three-step process involving 1) removal of air and gases from the cavities of the emerald 2) application and induction of the filler using high-pressure and 3) final cleaning and waxing.







1. Removal of air/gases	2. Induction of oil	3. Waxing and cleaning

Emerald oiling experts are well aware that among treatable emeralds some are far more enhancement-friendly than others. Acceptance of the filler substances depends on the dimensions of permeable openings. What's more, residues from decomposed or incomplete previously treatments frequently obstruct penetration of new filler. Furthermore, if stabilizers are used, "oiling" becomes a five-step process that begins with a thorough cleaning of the emerald:

Cleaning. This step is necessary only for previously "oiled" stones. No matter what the filler, it almost always leaves sediments behind when it decomposes. So, before previously filled emeralds can be re-treated, they must be thoroughly cleaned. Removal of plain oil residues is a relatively easy task; cleaning emeralds of leftover oleoresins and epoxy resins are much harder jobs. But the hardest cleaning job, by far, is the elimination of filler remnants to which hardening agents (stabilizers and plasticizers) were added.

Cleaning emeralds involves presoaking them in the appropriate solvent solution. Heating the solution to a low temperature, say 150 to 250 F, helps the solvent interact better with the remaining filler and quickens cleaning. Selection of the solvent is determined by the nature of the filler being removed. The author has found best results using the chemical condenser incorporated with automatic control heating apparatus, utilizing ketone-based cleaning agents, methylene chloride, super-saturated xylene and lacquer thinner. Because a single immersion in a solvent usually does not rid stones of all foreign matter, the cleaning process must often be repeated several times. The entire process can take from hours to days. There is no specific rule, method or pattern to follow.

1. *Removal of air process.* Once a previously "oiled" emerald is cleaned of lingering filler, it is placed in a vacuum chamber where air and gases are removed. It is important that no air remain in fissures meant to receive filler because the presence of air will create bubbles in the substance. Only powerful and efficient vacuum pumps will ensure air-and gas-free fissures.

2. *Filler application process*. Immediately following the suction of air and gases from cracks, the emerald is embedded into the filler substance for induction. Pressures of up to 3,000 pounds per square inch are used. To reduce its viscosity (resistance to flow) and boost its penetration power, the filler is thinned by heating to anywhere from 150 to 250 F, while is pressurized. After being forced into the emerald, the filler is allowed to cool and its viscosity level rise high enough to prevent seepage. Although the filler process follows the same outline in most labs, the actual procedures may be performed slightly differently, depending on the treater's skill and technical know-how. For instance, in some cases the author uses a radio-frequency thermal wave transmitter of his own design to heat the filler and reduce its viscosity during induction. A custom-made hydraulic pressure apparatus ensures the maximum impregnation of the filler into the emerald (see photo of emerald enhanced apparatus, appearing in my web page).

3. *Stabilization process*. In some cases and under suitable conditions, various stabilizers are applied in emerald. The selected "add-on filler-plasticizer" is actually a cured sealant that is usually applied after the filler is induced into the emerald substance and under suitable conditions.

4. *Application of wax process*. After induction of the filler, the emerald is cleaned thoroughly, externally. Either wax or Vaseline is applied to its surface with a chamois cloth to give the stone its final finish and luster.

Electromechanical apparatus designed and fabricated by Ted Themelis for "oiling" emeralds. High-vacuum pump is used to remove the air from the cracks-crevices of the emerald being treated, while a hydraulic piston "push" the filler into the emerald's substance at 3,000 psig in designed time/rate controlled by different controllers. The design allows automatic "switch-over" from pressure to vacuum without induction of air in the piping.

Proper handling

Since the majority of emeralds are "oiled", caution should be exercised when they are handled loose or mounted. Stone setters should be instructed to assume emeralds are all "oiled" - unless told otherwise - so as not to damage these emeralds whose cracks have been successfully concealed. Bench men should also be warned that undue heat applied to "oiled" emeralds during jewelry repair or fabrication can char stones, causing serious and irreversible damage.

Cleaning treated emeralds even with simple solvents such as benzene or ether-based compounds is to be avoided, especially in an ultrasonic cleaner. This process may remove the filler and leave stones in their original unsightly condition.

When storing treated emeralds in stone papers, do not wrap them in cotton. Cotton absorbs oil (as well as dye) over a period of time. Also, keeping oiled emeralds in hermetically sealed plastic bags is not recommended; these tend to build up moisture that weakens and draws out the oil. Since most of fillers are light-sensitive, it is best not to display "oiled" emeralds under flood light or any other strong heat-producing lighting conditions, such as tungsten lamps. Strong lights produce excessive heat that dry out the oil very quickly and in time turn the emeralds dull and opaquish.