Case Hardening Compounds
The Wonder Powders

John Bates

Case-hardening materials like Kasenit, Hard-N-Tough, Hardite and other are good but the case they leave can be thin. Time at temperature makes a difference as does frequent refreshing of the salt coat and heating in a muffle.

Small items are case-hardened by repeated heating with a torch and quenching in a carbon rich medium, such as the commercial products "Kasenit" and "Cherry Red". Older formulations may contain toxic Cyanide compounds; more recent types do not.

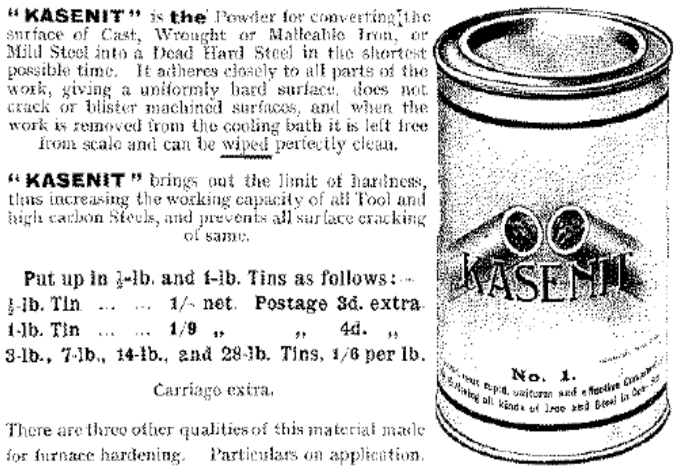
I found a recipe for case hardening compound, but I'm not sure about finding the ingredients:

- *Pulverize equal weights of Saltpetre, Prussiate of Potash, and Sal Ammoniac and mix together.*
- *Prepare a dipping solution by adding to each quart of cold water 1 ounce of Prussiate of Potash and half ounce of Sal-Ammoniac.*
- *Heat steel to red hot, roll in the powder, then plunge into the liquid.*

KASENIT

Left: Kasenit advertisement November 1922

Below: advertisement 1932 George Adams catalogue (London)



Below: Kasenit advertisement November1926

*Left: A b*rass 'Kasenit' furnace plaque from 1930s to 1950s

Above: Kasenit advertisement November1934

Below: Kasenit advertisement 1936

KASENIT INSTRUCTIONS

For mild steel

1. Heat part uniformly to a bright red (approximately 1650 degrees F)
2. Dip or roll in compound to form a fused shell around area to be hardened. Re-heat to bright red
3. Quench immediately in cold water using a scrubbing action to ensure maximum cooling rate
4. To increase depth, repeat Step 2 before quenching. To insure maximum of hardness reheat and repeat Step 3.

For tool steel

Heat part to a light-yellow glow. Deposit in compound and leave until it is at the right tempering heat then plunge into clean cold water or oil. This will bring out the utmost limit in hardness and also prevent scratching.

For deeper cases on mild steel

Immerse part in compound using an open, shallow receptacle. Subject to heat of 1650 degrees F for a period of from 15 to 60 minutes, depending upon depth of case required. Use dry tong to remove part from molten compounds. Quench part only in clean, cold water.

Kasen it compounds are highly refined, non-poisonous, non-flammable, and non-explosive.

Above: Kasenit advertisement1951

SOME 'KASENIT' HISTORY

1951: Manufacturers of case-hardening compounds, heat treatment salts etc. of 7 Holyrood Street, Bermondsey, London SE1

1924: Address was: 8 and 9 Ludgate-square. They took over the world's rights and sole manufacture of "Anti-cementite".

1925: They changed their address from 8 and 9, Ludgate-Square EC4 to Henry-street, Bermondsey-Street, London, SE1.

1937: Case hardening compounds and heat treatment appliances. "Anti-Cementite" Anti-Carburiser. "Durapid" Liquid Carburiser. "Kasenit" Case Hardening.

1940: *Kasenit Case Hardening Compounds and Heat Treatment Appliances*. Kasenit Ltd, London.

CHERRY RED

Cherry Red "instant hardening compound" can be bought online in Australia for around $35-45.

Cherry Red is a powder which enables you to surface harden mild steel quickly and easily; you can use it in the workshop or out in the field.

"If you do general fitting and turning or maintenance, you need a tub of Cherry Red in your cupboard (it has an almost indefinite shelf life, but keep the lid on tight as it is hygroscopic) for when you need to surface harden something in a hurry."

The only equipment needed is something to heat the work piece, such as a torch, forge, or furnace and a bucket of water. Cherry Red is fast-acting. The case hardening takes only minutes and produces good results on cheap mild steel flats and rounds.

How does it work?

The red hot mild steel, when heated with carbon readily absorbs carbon into its surface, and when that steel is quickly chilled from red heat by quenching in cold water or sometimes oil, the surface is harder than it was originally.

Now, people have been case hardening for generations by packing the steel in a carbon filled metal box and heating the whole lot in a forge or furnace.

Cherry Red works in a similar but more convenient way, the powder melts and congeals around the part and the powder's carbon is absorbed into the red-hot steel.

If you have an oxy torch or a good LPG torch you can quickly case harden mild steel parts in the workshop or out in the field. Larger parts can be heated in a forge.

Cherry Red can be used for simple items such as drawbar pins, drifts, bushings, sliding parts, wear plates, thrust washers, through to more complex parts such as D-bits, punches and broaches.

Hardness from 50 to 60 Rockwell C from 1018/1020 mild steels.

Step 1. Thoroughly heat the required section of the item to a cherry red colour

Step 2. Coat the heated part in Cherry Red, the compound will blister and harden

Step 3. Reheat the part to a cherry red colour for 5 minutes or more as needed

Step 4. While the part is still red-hot quench in water or oil

Step 5. Lightly wire brush to remove residue

Quenching

Because there are so many different items that people want to case harden it is difficult to give hard and fast rules on whether to quench in water or oil.

Quenching in water produces the quickest chill and hence the hardest surface. Mild steel 3mm (1/8") thicker and above, generally quench with water. Something thin like a knife blade may be too brittle when quenched in water and may be better being either oil quenched or quenched in water and then tempered.

The **Cherry Red** formulation has been the same for the last forty years, and is made in Hartford, Connecticut, USA. It does not contain any of the Cyanide compounds some case hardening powders contain.

The original **Kasenit** was by all accounts a pretty heady mix of substances. 'KASENIT No. 1' contains Potassium Cyanide and Sodium Cyanide as well as Carbon, which might mean that it's banned from sale in the many countries.

Does anyone know of a source of 'genuine' KASENIT No. 1 case hardening powder?

I've "Googled" and found some in the USA plus the odd alleged "look-alike" products such as Shirley Aldred & Co Ltd "Case Hardening Powder" (sold in the UK by Chronos). Trouble is that some of these products appear to be pure Carbon and, therefore may not work as well as the original KASENIT.

I may be wrong (.... let's hope not) but I don't think Kasenit contains any Cyanide.

My tin of Kasenit does not state that it contains Cyanide, but it does contain Potassium Ferri-Cyanide which is about a 1000-times less poisonous!

HARD-N-TOUGH

HARD-N-TOUGH is manufactured by American Chemical & Flux Products, City of Industry, California USA. Hard-N-Tuff is a steel hardening compound.

HARD-N-TUFF USER GUIDE:

Mild Steel - *Heat uniformly to a bright red (1650-degrees F). Coat area to be hardened with hardening compound. Reheat to a bright red. Quench in cold water. Agitate until cool to touch. To increase depth, repeat heating and coating.*

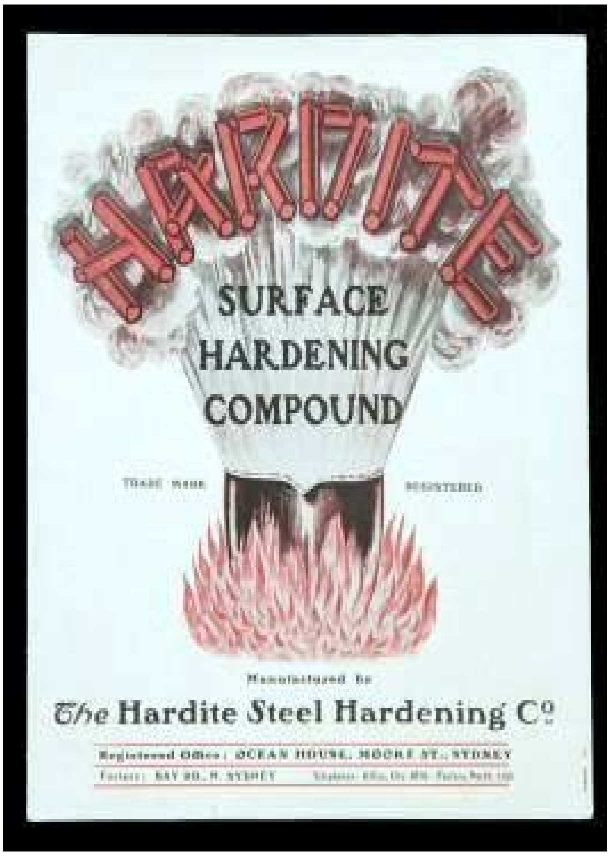
Tool Steel - *Heat part to a light yellow. Deposit in compound. Remove after right tempering heat is reached. Quench into cold water.*

HARDITE

HARDITE is a surface hardening compound manufactured by The Hardite Steel Hardening Co of Sydney.

The stunning logo (at top right) was registered at the Australia Patent Office by the Steel Improvement (NSW) Pty Ltd.

HARDITE was sold widely in Australia at least up to 1991.



Below: an ad from ***The Evening Post*** (Auckland, NZ) 5 February 1919

TO ENGINEERS

THE connecting link between Case Hardening and Efficiency is "HARDITE."

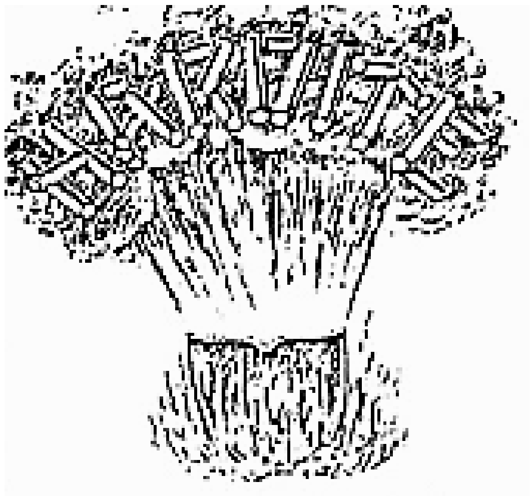
"HARDITE" CASE-HARDENING CRYSTALS.

For use with Mufflers. Prices and particulars on application.

"HARDITE" SURFACE-HARDENING COMPOUND. For use with open hearth.

2lb tins, 7 shillings each; postage 8d. Full particulars and pamphlet on "Case- J Hardening" from Sole Agents:

RAE CULPAN AND CO.
Importers of Engineers' Requisites, Fanshawe Street, Auckland.



HARDITE contained 20% Barium Chloride the rest was presumably Potassium Ferro-Cyanide.

Guano-plus-charcoal would make a good case hardener for today's mild steels - guano contains Nitrogen, charcoal contains Carbon. Nothing more is needed - the case hardening process involves the dissolving of Carbon and Nitrogen into low carbon steel.

The extra Carbon and Nitrogen make the outside layer of the steel harder (but more brittle and/or harder to machine - which is why steel isn't sold that way in the first place).

But the problem is that Carbon and Nitrogen form into Cyanide when they are in contact at high range temperatures.

That still happens, but if you don't use Cyanide itself as a starting material, and take some simple precautions, there isn't really all that much danger.

Please note that if you do it recklessly, and without knowing what you are doing, you may die.

HARDITE was banned because of this potential danger.

Case hardening was once the best way to stretch a limited steel budget. Today, it provides a hard surface with a tough inner structure.

Article by Chip Todd, **American Gunsmith Library**, Tools & Techniques

Many of us have seen the term "case hardened," but know only that a tool so marked is hard. The case-hardened item may have a subdued colouring reminiscent of an "old-fashioned" tool.

This notion is not far off the mark, as case hardening was often used in the past when the selection of steels was considerably more limited. In times past, it was more economical to harden only the surface of a relatively soft steel than to pay for a much more-costly steel which could be hardened throughout. This fairly easy process was done in early times with fire and various powders—mainly bone. The bone supplied carbon and calcium which both hardened and coloured the surface.

While case hardening is no longer used as much for economy, it makes sense in terms of obtaining a hard surface with a tough inner-structure. Conventional through-hardened steels must be used for parts which must undergo hammering or repeated impacts.

Case hardening is a selective process of hardening which raises the hardness of the surface of the part without hardening it all the way through. There are many steels which won't harden and are also much less costly than tool steels or other high-carbon steels.

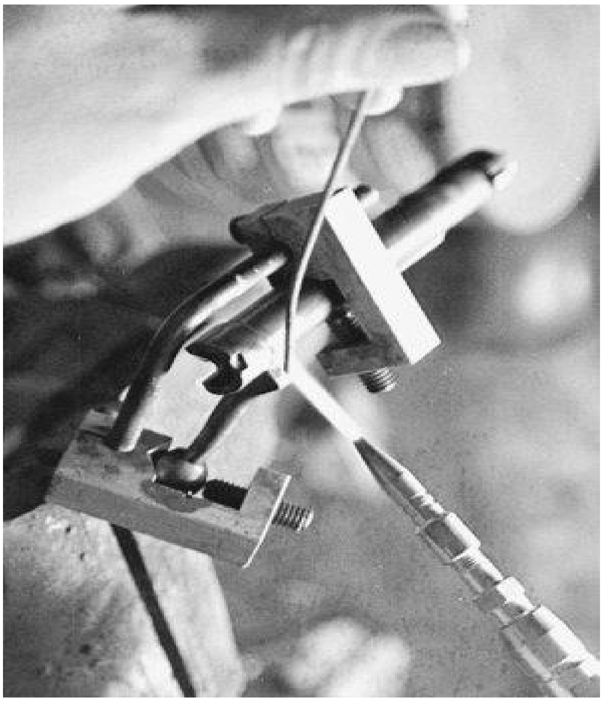
One of the main ingredients of steel which makes the part capable of being hardened all the way through is carbon. Low-carbon steels tend to be softer and more malleable, while stronger and less malleable steels are higher in carbon content. Low-carbon steels have a lower propensity to align the charges on the molecules—a necessary property to harden steel, and exhibit a low degree of hardening.

Case hardening causes a hard skin by combining the hot metal surface with another metal (or the salt of another) to form a layer consisting of an entirely different composition or alloy. This skin can vary in depth depending upon the different processes and the extent of the heat and time involved.

The beauty of case-hardened metal isn't just skin deep. An important benefit of case hardening is that the material toward the centre of the piece is still in a more forgiving condition and is tough, not brittle.

This often is used to an advantage, as the main part is slightly flexible and less apt to break, though it has a good, hard, and long-wearing surface.

Steel is hardened by heating the metal to a cherry red and quenching it by quickly dipping the red-hot piece in either water, saltwater (brine), or oil. The particular quenching liquid necessary depends on the type of steel. This information is supplied along with new steel or, if you know the steel type, you can look it up in a tempering book or Machinery's Handbook. When I don't know the type of steel I am dealing with, I always try hardening the piece in an oil-quench bath first. If this doesn't harden the metal sufficiently, I use water. A water quench is much more violent than an oil quench and can make steels which should be quenched in oil very brittle and glass-like. It is often necessary to identify the approximate type of steel before deciding whether it would be best to harden the surface or harden it throughout.



The tools necessary to case-harden metal with Kasenit

These include a handling tool and a torch Also needed are a lighter, water bath, hardening powder, and face shield.

The relative amount of carbon in a piece of steel can be recognized fairly reliably by anyone with a grinding wheel or disk. By observing the shape of the sparks thrown when grinding, you can determine whether the steel will take complete hardening or will require a form of case hardening.

The best way for someone who isn't conversant with steel alloys to identify the approximate type of steel is to get samples of known types of steel and compare the spark patterns thrown off when holding the pieces of steel against a grinding wheel. There will be quite a difference between the sparks of a tool steel and that of a low-carbon steel. One will throw mostly straight sparks which streak out in straight trajectories with slowly decaying paths, while others will send sparks out which resemble fireworks sparklers.

Once seen, these star-burst patterns are easy to recognize. Spark patterns of steel which are like dying flares, and don't have definite star-burst sparkles, will most likely be a mild steel and will not take regular, deep hardening. For these steels, a good case hardening can often increase the life of the part.

There are some types of tool steel which are air hardening, a quality which I find most frustrating when needing to anneal (soften) it. Heating the metal to a cherry red and cooling it slowly softens most metals, but I have never been able to cool an air-hardening steel slowly enough to consistently anneal it properly.

Annealing steel is the process of wiping the blackboard clean, so to speak, by returning the metal to its dead-soft stage. In most cases, this is done by heating the metal to red hot and cooling it slowly. The slow cooling allows the molecules to relax their alignment back to a random arrangement, resulting in a soft condition—the opposite of arresting the lined-up molecules to produce a hard condition. The usual ways to slow the cooling of the heated metal are to bury it in sand or cover it with asbestos. The slower the cooling, the more nearly dead soft the metal will be.

I often use mild steel found around my shop to make some minor parts, and depend upon a hardening of the surface to save the part from wearing excessively or rusting easily. Mild (low-cost) steel can be made fairly rust-free by a quick, cheap method, utilizing the used oil drained from your car. (This is also a good excuse not to be in a rush to take the drained oil to the recycling place until you're good and ready.) The dirtier the oil, the better, as this is a rich source of carbon.

I heat the part to a cherry red and quench it in the carbon-blessed oil,

This surface is reasonably hard, but more importantly, holds up under the 96 percent average humidity found in the Southeast Gulf Coast of Texas.

It simply won't rust.

Colour case hardening

Another type of case hardening is usually referred to as "colour case hardening" or "case colouring."

One way to do this is by using ground bone as the material to be combined with the surface metal.

The colour case hardening process gives beautiful, swirled colour variations to the hardened surface and is a science unto itself.

Colour case hardening usually is not as hard a surface as the dull-grey look of real hardening.

Cyanide

There is also a very good procedure which utilizes Cyanide, with easily recognizable results. But its obvious dangers require it to be a well-controlled process done under factory conditions only.

This method results in a maroon colour on the surface, and is usually found on firearms where appearance is not the primary concern.

There are many types and brands of hardening powders on the market, but the one I use most and will describe here is Kasenit, a brand Brownells supplies and endorses.

I have been using Kasenit for more than 12 years and have had no occasions where it has let me down.

I'm sure that there are many good powders available. The procedures outlined here should be similar enough to enable you to understand slight differences in instructions.

The Kasenit powder is a dull, grey, grainy powder which tends to lump up in the can over time. This doesn't seem to hurt its functioning; I just break the lumps down as deep as I think I will need before I use the stuff. Unless the piece to be hardened is too big to fit into the 4-inch opening, I don't even take the powder out of the can.

Kasenit is non-poisonous, non-flammable, and nonexplosive, according to the manufacturer.

My experience confirms these statements.

I use case hardening to increase the life of the cutting edges of drill bits and other cutters to prolong their edges without making them as brittle as hardening the entire drill bit would.

Tools for hardening

You will need to have some tools with which to harden parts, a work area big enough to use a torch and set the can of Kasenit, and a water bath large enough to accept your workpiece.

It is nice to have an acetylene torch available, but you can get by with any source of heat sufficient to make the metal reach an even cherry-red colour throughout.

I have found most propane torches unequal to this task, if the workpiece is other than a small part. Since most of the parts which require case hardening are small anyway, the acetylene torch might qualify as a luxury, at that.

Safety

Your work area needs to be ventilated properly, be relatively fireproof, and in an area where dropping some hot particles on the floor will not incur the wrath of the housekeeper.

To utilize the heat more efficiently, I also like to have a firebrick or asbestos block upon which to reflect the heat from the torch.

Asbestos

Yes, I still use asbestos, but only in a compressed block, as I am afraid of the fibres and dust from it.

Your decision

Make up your own mind and accept the risk as one you have decided for yourself. When I think of it, I find and use a firebrick and feel that it works as well.

I begin by setting out the things I will need: the Kasenit, a container with enough water to be able to completely immerse the workpiece easily, some tongs or other suitable handling tool, and the heat source.

Rosebud tip

When using acetylene and oxygen, I employ a tip which will produce a large flame without having to use a high velocity in the gas stream. A suitable rosebud tip—a heating tip with multiple flame orifices—is preferable to using a single flame with too much heat concentrated in a small area.

The tongs used should be expendable, as the heating and quenching operations will most likely ruin the temper as well as the looks of the instrument. I use the ones that are my favourites for extracting the steel clips out of molten tire weights when casting.

The Kasenit can should be opened and placed in a convenient place so that it will be ready when the metal is heated.

Hazards

It should go without saying that any time you work with heated chemicals you should be wearing a face shield, but I repeat the warning.

I do need to caution you that heating Kasenit will produce a flame which will greatly affect your vision, if not damage it.

Eye protection

Kasenit doesn't mention eye protection, but I know from experience that I couldn't see well enough to finish the job the one time

I tried to reheat Kasenit and metal without a gas-welding lens. I now combine eye and physical protection in a tinted face shield, since welding glasses don't allow me to use the necessary portion of my trifocals.

Next, I prepare the metal so that I know I won't be introducing an unwanted chemical into the process. This means that I clean the metal as if I were going to either plate it or blue it.

Clean metal

The metal to be hardened must be absolutely clean and free of rust. I usually do this by grinding, by buffing with a Scotch-Brite wheel, or I chemically etch it and rinse it thoroughly.

Equally effective would be sanding, sand or glass beading, or any other method which insures fresh metal being exposed throughout the cleaning process.

Rapid even heating

Heating the metal should be done as rapidly as possible without causing any one spot to become excessively hotter than the other regions of the part.

I also use a slightly rich (high fuel) mixture to ensure that no oxygen is introduced into the metal during the heating process. When the metal has reached an even cherry red throughout (approximately 1,650 degrees Fahrenheit), keep it at that temperature for several seconds, if possible, by moving the flame so that the flame covers a wider area.

Dip the workpiece into the Kasenit can, working the part under the surface of the powder until it is entirely covered. Hold it there for about 10 or 20 seconds and pull it out. The Kasenit powder should stick on the part in a mighty clump. If it isn't clumped over the part completely, I quickly dip it into the powder again and leave it for another count of 20.

Reheat the entire mass until it glows a bright red again and immerse it in the cold, clear water bath without wasting any time.

Hot Tongs

It is most important that the method of holding the part being hardened involves a tool which can be heated with the workpiece, as the tool cannot be allowed to draw heat from the area it contacts.

Hot tongs would result in a spot which wouldn't be hardened as much as the surrounding area. The forceps I use has long fingers, placing the box joint far from the heating area. This heavier portion — the joint — would not last long under the heating I give the tips.

The quenching operation should include an action which insures that the workpiece is moving in the water in order to be surrounded by cool water at all times until the piece itself is cool. Holding it in one place would allow it to be masked from the cool water by bubbling and by natural convection of heat in the water; keep it moving.

Note:

If you would feel better wearing gloves, do so, for the sizzling and popping will be quite violent when the hot mixture hits the water.

In fact, it will sound unlike anything you have ever heard. You must have your face protected by the goggles and face shield I discussed earlier.

If I know I am working with a very soft alloy, I just repeat the dipping into Kasenit, reheating, and quenching. This might be necessary to reach the maximum hardness.

However, you might not want to make the surface as hard as glass, so once more might meet your needs. I often use an old file from my junk drawer to check the hardness of the quenched metal.

If the metal has taken a sufficient hardness, it will not file, and will sound like you are dragging the file over the edge of a piece of glass — not steel.

That sound tells me more of what I want to know about case-hardening than a Brinell test, as the softness of the subsurface usually causes a false reading by allowing the "skin" to flex, thereby reading softer than the actual surface really is.

There is no mistaking the sound of an ineffective file once you have heard it. It is a very treble sound which metal, other than dead-hard, cannot coax from a file.

Tool Steel

If you desire to harden tool steel, you use this same procedure except for the amount of heat.

Tool steel should be heated until it reaches a light yellow (hotter than straw colour) and then deposited into the compound. Leave it in the compound "until it reaches the tempering temperature," and then quench. This quote is from Kasenit.

I don't know how you can see the temperature under the opaque compound. I have found that holding it under the compound for about five or six seconds and then quenching gives me satisfactory results. This will bring out the utmost hardness of tool steel without getting a part which will be brittle.

Using an oven

Another method is possible, but requires more Kasenit than I usually keep on har The Kasenit instructions say to immerse the part in a shallow pan of the compour heat it to 1,650 degrees Fahrenheit for 50 to 60 minutes, lift out of compound wit dry tongs, and quench in clean water.

One would obviously need quite an oven-a tempering oven to be exact-to perform degree of hardening.