

INTRODUCTION

We have contracted Henry Pearce to record and compile this information from his own personal experience, (and that of his father) in the Blacksmithing industry.

It is essential that all normal safety precautions be used in accordance with modern day requirements, ie. all chemicals should be handled with care and locked away when not in use. All heating of steel and heating and mixing of chemicals be performed in a well ventilated area well clear of inflammable materials.

In keeping with our policy of providing practical useful information we have included address's and phone numbers of suppliers of the required chemicals so that if you are not able to buy them locally, you will still be able to acquire them without undue effort.

These case hardening procedures and methods are very effective, and give a high quality finish while still being safe and easy to use in the backyard work area. The old formulas and procedures have all been highly successful, and widely used in the early 1900's when steam power was in full force, and there was a heavy reliance on brute force and the durability and reliability of properly treated steel.

Case hardening is one of the most over-rated and mysterious procedures of the metal working industry. The general impression is that it is some highly specialised and complex procedure. The usual experience is that it is extremely difficult to bend, it cannot be filed sawn or drilled and is generally thrown away as some unrepairable, unworkable useless piece of steel.

However case hardened items can be softened, re-tempered, cut, drilled, welded or re-made with mild steel additions, then case hardened again.

THE IMPORTANT POINT IS THAT YOU CAN DO ALL YOUR OWN CASE HARDENING IN YOUR OWN BACKYARD WITHOUT PRIOR EXPERIENCE, AND AT A VERY LOW COST.

The beauty of it all is that you can fashion your own tools or devices from ordinary easily worked mild steel, then case harden the whole lot, ie. cutting edges, gears, pins, bolts, bolt holes, curves, welds all in one go. Alternatively

you can build the whole thing, and then case harden certain specific spots such as wear points, bolt holes shafts etc.

Mild steel or low carbon steel is ideal for case hardening as it is able to absorb the the case hardening solution into its outer grain, yet still retain its tough resilience. It is then hard and tough where required without becoming brittle.

CHARCOAL / CABONATE MIX.

An old time case hardening mix which has proven its worth over many years is as follows :

- 13 Parts of hardwood charcoal.
3 parts of Barium Carbonate. (Barium Chloride can be substituted).
2 parts of Sodium Carbonate. (Commonly known as Washing Soda)
1 part of Whiting powder.

This mixture works on the principle of "carburization" of the mild steel surface. The carbon content in the charcoal mixed with the other ingredients penetrates the steel surface, and changes it to a carbon-steel or tool- steel texture. This can then be hardened by heating and quenching in water or oil in the normal manner.

The above ingredients are easy enough to obtain. The hardwood charcoal is normal charcoal from burnt hardwood. It is often sold as barbecue charcoal, and can be bought in small bags from shops and service stations..

The Barium Carbonate is a bit difficult to buy in some areas. Contact your local chemical wholesaler and ask for the "Technical Grade". This is one of the less purer grades and is cheaper to buy. If you are able to buy a coarser less refined grade than "Technical Grade", it will be cheaper again, and it works just as well as the pure grades. Barium Chloride can be substituted for the Barium Carbonate if you are able to get it easier, or at a cheaper rate. (Both are used in industrial and agricultural products. **They are both poisonous and must be handled strictly in accordance with the safety directions on the packaging.**).

It is best to buy from either a manufacturer or wholesaler. ~~xxxxxx~~ **Chemicals** ~~xxxx~~

~~Xerox 8050SP, plus copy, CDSK x 211 x R m (02) p 618 x 122 x charge xxxxxxxx \$15.00 x fax~~
Spectrum Distributors, Unit 3, Cnr Frank & Walter St. ~~\$72.00 - 09~~

Wetherill Park NSW 2164, stock this product and can arrange transport. Ph. (02) 725-5222, and ask for Craig Goodman.

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25Kg bag of the "technical grade". It costs about the same price to buy one Kg from chemical distributors who package and re-sell..

The Sodium Carbonate is ordinary household washing soda, and can be easily purchased from any grocery store for a couple of dollars. Whiting is easily bought in small bags for a few dollars from any hardware or paint shop.

The case hardening procedure is as follows ;

Grind up the charcoal and all the other ingredients mixing them thoroughly together. A convenient way of doing this is to put them into a 4 litre paint tin, together with a few stones about the size of golf balls, and holding the tin with one hand over the lid shake it vigorously. Now sift it through an ordinary kitchen flour sifter. It is important that the charcoal is fine and dusty.

The piece to be case hardened is thoroughly cleaned by either an abrasive disc, wire brush or by sand blasting. (**Note : Do not use chemical cleaning compounds to clean the steel because they can sometimes inhibit the full penetration of the case hardening chemicals**).

It is now packed into a steel or cast iron container, ensuring that the mixture is in close contact with the item being hardened. The mixture should completely surround the item so that it is not in contact with the walls of the container at any point.

The container is then placed in a very hot fire, or a moderate heat of a forge and is heated until the container is a bright orange colour. (**Note; The colour should be viewed in a dim light. If it is bright orange in sunlight, then it is far too hot and can damage the grain and texture of the steel being case hardened, if this heat was maintained long enough to reach the item inside. About 10-15 minutes would be too long**)..

The fire should be adjusted to maintain the heat for as long as is required to reach the desired depth of case hardening.

As a guideline, 2½ hours at a bright orange will give a case hardening depth of 1/64". 5 hours will take it to 1/32", and a maximum penetration of 1/8" is reached after 14 hours.

The piece is then taken out and given a vigorous dunking in cold water. Do not allow it to remain still in the cold water as the steam will create a vapour

barrier in certain parts , thereby reducing the full quenching effect and creating soft areas in the case hardening.

Allow the container to cool, then tip the mixture out and seal in air-tight glass jars. It can then be re-used again several times before needing to be replaced.

One of the easiest to make, and most frequently used container for case hardening is made from a short length of old cast iron gas mains pipe with a cap on each end. Drill a 1/8" hole through both caps for the escape of any build up in pressure. Another 1/8" hole is drilled midway along the pipe. This hole must be facing upwards when the container is laid in the fire.

Similiar containers can be made using short off-cuts from heavy industrial pipes, or the inner steel casing of an old hotwater system.

The lid, ie. one end of the container should have an easy to release latch or taper pin so that it can be hit open with a hammer, and the piece quickly removed using a hooked rod or pair of tongs.

CHARCOAL AND SALT CASE HARDENING.

This method is suitable for an emergency job where facilities are limited, and only a thin film of case hardening is required.

A mixture of 3 parts of charcoal and 1 part of ordinary salt is crushed and mixed together. The previous heating procedure can be followed, or a blow torch can be used for small jobs.

If using a blow torch for emergency repairs, the part is embedded in the mixture and heated to a bright red and kept at that temperature for $\frac{1}{2}$ hour, then turned over, again ensuring that it is still well covered. The bright red heat is maintained for another $\frac{1}{2}$ hour, then quenched in cold water.

This mixture does not enable the carbon penetration to be as deep and effective as the previous mixture. However it is included because of its

emergency value. Charcoal and salt are readily available, and any heat source can be used eg. an open fire, a blow torch, oxy torch etc

Note; When using whatever case hardening procedure you choose, it is always a good idea to include small pieces of steel in with the item you are case hardening. Attach a small piece of wire to each one, and you can withdraw them at intervals to check if the case hardening has reached the required depth. This is particularly useful when the heat has not been maintained at a constant level., and the rate of absorbtion has varied to an unknown degree.

PROTECTION FROM CASE HARDENING.

It is generally best to avoid including screw and bolt threads in the case hardening process. The hardening process makes the fine thread metal brittle, and therefore an increased tendency for them to break. There are exceptions such as set screws where the hardness and overall toughness is more important than the tension obtained by the thread strength.

To protect a critical part from the case hardening effect, the following methods can be used.:

1. Special Protective Cement.

This dough like cement is packed into the inside of holes either already have a thread, or which will later have a thread cut in them.

The cement is made by mixing 2 parts of Fire Clay, 1 part of Sodium Silicate, 1 part of fine sand. Add water as required to make a pliable dough like cement.

This cement is also useful for a protective covering over areas which need to remain soft., eg. where drilling, filing or hacksawing is required.

Sodium Silicate is commonly known as "Water Glass", and was used extensively in most homes up to the 1960s and later. It is water soluable, and dries to a glassy finish. It was used for preserving eggs, coating wood, stone and cement.

It is still used today in the manufacture of soap and putty, and is relatively cheap and easy to get.

2. EXCESS METAL METHOD.

When making up special parts, tools, gears or fittings from mild steel, it is sometimes easier to leave excess metal in the area where the case hardening is not required. After the case hardening process is complete, the excess metal is removed using an angle grinder or abrasive disc, thereby removing the case hardened surface, and leaving the soft mild steel.

3. THE COPPER PLATING METHOD.

This method is suitable when only a small portion of the job is to be case hardened, and a large area of complex shape is to be protected.

A copper plating solution is made by dissolving 10oz of Copper Sulphate in $\frac{1}{2}$ gallon of water. Slowly add 1 oz of Sulphuric Acid.

The steel has to be thoroughly cleaned, then scrubbed with hot water and detergent. Dry thoroughly. The solution is then painted on the areas requiring protection.. On occasions it is quicker and easier to dip the entire piece into the solution. In this case you must paint the parts to be hardened with melted paraffin, beeswax or shellac.

This puts a coating over the steel, thereby eliminating the copper platings effectiveness. The wax-like coating will quickly burn off with the heat of the fire thereby enabling the case hardening to take effect. This type of wax coating will not in any way interfere with the case hardening process. The remaining copper plated areas will not be hardened at all.

This solution should be stored in strong plastic or glass bottles. Old empty acid containers are ideal.

Copper Sulphate is commonly known as Blue Stone, and was until recent years a well known household product. It is a bit difficult to buy these days in the form of "blue stone" , but can be quite easily purchased from hardware stores or garden products suppliers. It is used extensively for horticultural and garden treatment.

READY MIXED COMPOUNDS.

Up until recent years most commercial case hardening was done using cyanide based chemicals. This is of course a very dangerous deadly substance, and special safety equipment and specific safety procedures had to be followed.

However it is now possible to buy relatively safe ready mixed compounds which give quite good results.

Check with your local engineering / industrial suppliers describing what you require. We have had difficulty in locating this type of product in Sydney, and were only able to find one such product. It is sold under the trade name "Hardite", and is manufactured by Steel Improvements Pty.Ltd. 37 Day St. Lidcombe, NSW 2141. Ph. (02) 748-2344.

They will not supply direct, but ask them for a distributor nearest to you. It comes in 2 kg tins at a cost of around \$18-00 including sales tax.

The procedure for using it is as follows; (As per the directions on the can).

"A. SUPERFICIAL HARDENING : The object to be given a hard skin is heated to a bright orange in a forge or furnace, then covered with "HARDITE" and the compound allowed to boil. This process is repeated two or three times, and the steel is then quenched in water.

B. CASE HARDENING IN LIQUIFIED HARDITE. Hardite surface hardening compound is melted in a STEEL POT on a forge (or some other heating device) and heated to a bright red colour - about 850°C. The articles to be case hardened are then suspended in the molten bath by means of wire or steel baskets and left at this temperature for a period of time, dependent on the depth of case required. One hours immersion will give approximately .025" case. To determine the length of time required, small steel test pieces should be added, and periodically taken out, broken and the depth of case noted for that particular length of time. When the case depth is found to be satisfactory, the articles are taken from the bath and quenched in water. It is then advisable to wash them well with water and smear with oil to protect the object from rust".

HELPFUL HINTS.

In actual practice the "Superficial Hardening" can be done using an oxy torch or larger objects can be heated with the Diesel / Air torch torch designed by

Allowyn. (Trendline manual No.DT54). The object can be heated to a bright orange with the torch, then dipped into the Hardite powder. The powder will stick to the hot surface.

The protective process detailed earlier can also be used successfully with this compound.

With regard to the liquified procedures, a cast iron pot can be used instead of a steel pot. We have found that the aluminium furnace and cast iron saucepan set-up (Trendline manual ^{MF55} ~~A53~~) is the ideal set-up for maintaining the correct heat for long periods. The insulated design of the small aluminium melting furnace retains the heat and a bright red molten temperature can be maintained for several hours at a very low fuel cost.

PUBLISHERS NOTE :

The information in this manual is designed to convey practical and useful information without the reader having to get bogged down in fancy words and glossy pages.

The suppliers address' and phone numbers are included purely for the convenience of the reader. We do not have any commission or business arrangement with them.

It is a costly time consuming process ferretting out suppliers of relatively rare products or ingredients such as used for this process.

For the interstate or country dweller, the cost of long distance calls phoning around, waiting on while calls are transferred etc. would inhibit or destroy the intense satisfaction one gets from "doing things yourself, and making your own gadgets and inventions."
