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Operating Instruction for Du-Lites' Steelkote Black Oxide Salts
For Blackening of Cold Rolled Steel, Plain Carbon and Low Alloy Steels.
STEELKOTE MEETS SPEC MIL-DTL-13924D, CLASS 1

1. Cleaning Tank: To remove oil, grease or buffing compounds from steel and ferrous alloys we recommend Du-Lite's #45 Cleaner, mixed at 12 oz./gal, heated to 150°-160°F, with a cleaning time of 5-15 minutes.

2. Warm Water Rinse Tank: Water should be heated to 150°F and **overflowing slightly** to keep rinse tank **clean**. Rinse parts for 30-45 seconds. Warm water does an excellent job of removing all cleaner residues from your work and preheats parts before next process. If this rinse is **too hot**, parts being removed will dry and cleaner residue in the rinse water will cause a cloudy stain to appear in the finish of your black oxided parts. **Cold water rinse is not recommended because it can cause white specks to form on your parts which will appear in the final finish.**

3. Black Oxide Tank: Steelkote operates at a temperature of 280°-285°F. Processing time is 15 to 30 minutes. Concentration of blackening salts is 7-7½ lbs. per gl. which is required to obtain the proper bath boiling temperature. **Run new solution 2-4î lower than recommended operating temperature for one week to stabilize bath, after this break-in time, increase operating temperature to 280-285îF.**
If the solution is boiling at the correct operating temperature, the chemicals required per gallon to produce the best results is correct.

<u>Warning:</u> Steelkote solution, heated to the correct operating temperature, but not boiling will not blacken your parts (solution must be boiling at the correct operating temperature to blacken your parts).

4. Cold Water Rinse Tank: Work is immersed in a cold water overflowing rinse to remove any remaining processing salts. Work should be transferred quickly from the black oxide bath into this rinse to prevent salts from drying on the surface of parts. Run your water supply line to the bottom of this rinse tank for better circulation and rinsing.

5. Final Protective Coating: Kwikseal, Kwikseal A or Kwikseal D are recommended to seal the black oxide finish and enhance its corrosion resistance. Rinsed parts do not have to be dried off before entering the oil tank, water is displaced and forced to the bottom of the tank where it is easily drained off through a petcock valve the next day.

WARNING - Some firearm receivers and trigger guards are made of aluminum and are black anodized. Steelkote contains sodium hydroxide (caustic soda) which will destroy parts made of aluminum and will pollute the black oxide solution. Aluminum parts that have been dissolved in the black oxide tank will coat the inside tank walls with aluminum; you must sandblast this tank before using again. Discard and replace the solution - **it cannot be saved.**

Water - Water used to make up the blackening solution or cleaners can be regular city water or well water. There is no need to use distilled or spring water. The only water that can pose a problem is water that contains high amounts of copper.

Tank Construction - Tanks can be constructed of stainless steel or plain steel. Soak cleaners and black oxide solutions are formulated from alkaline material (caustic soda) which will not harm equipment made these materials.

Heat Sources - There are three main heat sources for use with black oxide solutions. The heat source recommended by Du-Lite is LP (or Natural) Gas, with burners placed beneath the processing tank. Tanks heated with gas burners can be kept clean by using Du-Lite's solution clarifiers. Electric heating elements can be used, but the heat distribution will not be as even and the solution movement will not be as vigorous. The third type is steam heating - plate coils can be used. **Never use immersion gas pipe heaters in a black oxide tank. Chemicals will settle on these pipes and will harden.**

Gas Controls - Small installations generally do not require special controls for gas burners. Larger installations incorporate pilot burners with Baso safety valves and automatic throttling gas controls for added safety.

Water Feed Systems - On small installations, water is added to the black oxide tank to replace water driven off as steam. If this is not done, the black oxide solution will overheat. Add small amounts of **COLD OR ROOM TEMPERATURE** water slowly and carefully while wearing gloves, protective clothing, goggles and face protection. As water is added to the hot bath it will spatter. For larger tanks, Du-Lite recommends an automatic Partlow Controller which will automatically add the proper amount of water required. **NEVER ADD HOT WATER TO A HOT BLACK OXIDE TANK - IT WILL ERUPT VIOLENTLY.**

Hoist System - In small operations, parts being processed can be moved quickly and easily from one tank to another by hand. In large operations, where workloads are heavy, Du-Lite recommends an overhead monorail and air operated hoist system for easy transportation from one tank to another.

Exhaust Equipment - Exhaust hoods should be installed over cleaning and blackening tanks to remove fumes from the surface of these solutions. Hoods, piping and blower fans should be made of steel (not aluminum). The solution contains caustic soda which will destroy items not made of steel or plastic.

Bluing/Black Oxide - U.S. gun manufacturers all use black oxide to finish the outside of their firearms. A black oxide finish is also referred to as bluing.

MIXING INSTRUCTIONS:

If a new **PLAIN STEEL** tank is being used, no special preparation is required. If an old tank is being used, it must be cleaned and rinsed well to remove any possible contaminants. When mixing a new solution, first determine the number of gallons your tank holds; then you can determine the amount of Steelkote required to make the solution. Measure the processing tank, using the inside dimensions. The solution should be three to six inches below the top of the tank to allow for expansion and boiling action. For square or rectangular tanks use the following formula:

Figure in Inches: Width x (Solution) Depth x Length ÷ 231 = Gallons
Example: For a tank measuring 6" x 9" x 40" with the solution down 3", calculate as follows: 6" x 6" x 40" = 1,440" ÷ 231 = 6.23 gallons

Once the tank capacity in gallons has been calculated, multiply that number by 7.5. (To obtain the proper boiling temperature of a black oxide solution, 7.5 lbs. of Steelkote is required for each gallon.) After

determining the quantity of Steelkote required, you are ready to mix the new solution.

MIXING SOLUTIONS: IMPORTANT! - When mixing a new solution, never start with HOT WATER (use cold or room temperature water only). When adding Steelkote or any other chemical to water, add small amounts and stir constantly. Steelkote can generate heat as it is being mixed with water. If this solution becomes too hot, it can erupt violently or cause a tank boil over! Steelkote must be added slowly and mixed well to insure that it is completely dissolved into the solution.

To mix the new solution, fill the black oxide tank about one-third full with room temperature water. Slowly add a small amount of Steelkote to the tank while stirring constantly. The size of your tank will determine the increments of chemicals to be added at one time, i.e. a small gunsmith tank - 6x9x40" - with a capacity of 6 gallons requires 45 lbs. of Steelkote. This should be added to the tank in 4 lbs. increments while mixing constantly. For large industrial tanks, with a capacity of 100 gals or more, requiring 750 lbs. or more of salts; add in 10 to 15 lbs. increments while mixing constantly.

After adding half of the amount of Steelkote required, a sufficient amount of cold or room temperature water should be slowly added and mixed into the solution to bring the level in the tank up to about half the operating level. At this time turn on gas burners or electric heaters. Now you can alternately add water and Steelkote slowly and carefully, mixing constantly until the desired operating level and required quantity of Steelkote has been added. This procedure is not difficult and should be followed to avoid a boil over and to ensure the new solution is mixed properly.

BATH MAINTENANCE:

The Steelkote solution is maintained simply by making periodic additions of fresh salts and water to replace any material lost by "drag out".

The bath must be boiling before adding fresh **SALTS OR WATER** to it. **NEVER ADD CHEMICALS OR WATER TO A BLACK OXIDE BATH THAT IS NOT BOILING.** The best time to add salts is at the end of the day. If you add chemicals while work is in the processing tank during the day, the chemicals can settle on your work creating spots. **Solution Life** - Small black oxide tanks can only tolerate so many impurities. New solutions should be made up every nine to twelve months.

New Solution Temperature - When making up a new solution, run the bath **2 to 4îF degrees lower** than the recommended operating temperature. This lower temperature is necessary for the first week because the bath is so strong it requires time to stabilize. After one week, run the bath at the normal operating temperature. If this is not done, work may develop a reddish haze after being removed from the cold water rinse. If this reddish haze wipes off with a rag, it indicates that the operating temperature is too high.

Black Oxide Temperature - Since water boils at 212°F at sea level and the operating temperature of Steelkote is 280-285°F, black oxide salts must be added to the bath to raise its boiling temperature. To understand how the amount of salts in a solution affects the boiling point, you must understand that adding salts to the solution makes it stronger and denser. Denser liquids have higher boiling points. Adding water to the solution lowers the density and, therefore, lowers the solution boiling point.
When the boiling point is correct, the solution concentration is correct.

Steelkote has a recommended operating temperature of 280-285°F. The black oxide operating temperature is not controlled solely by the heat source, it is controlled by the combination of the heat source and the concentration of chemicals in the solution. Never try to obtain the proper operating temperature of a black oxide bath by adjusting the tank's heating system up or down. The heat source should be set for the day at a gentle rolling boil - then you can maintain the proper **operating temperature**

with the additions of **salts or water**.

For example, if your solution is boiling at 275°F, you must add black oxide salts to your tank which will result in a denser solution and raise the boiling point. If your solution is boiling at 290°F, you must add room temperature water to the tank to create a thinner solution which will lower the boiling point.

Boiling Point - The boiling point of a black oxide bath is indicated by a slight eruption in one corner or along the sidewall of the tank. This slight eruption along with the **proper operating temperature** indicates that blacken- ing is occurring. A black oxide tank can be heated to the proper **operating temperature** but without this **boiling action** - **blackening** will not occur.

STARTING A COLD BLACK OXIDE TANK - Before turning on the heat source, always mix the solution thoroughly to insure that there aren't any hardened or crusted-over salts in the tank. Check your temperature probes to make sure that crystallized salts have not built up around them. Once the salts have been thoroughly mixed back into solution, turn the heat source on, and mix every ten to 15 minutes while heating to operating temperature. If the bath does not boil at the proper temperature: add water (if solution boils above recommended operating temperature) or salts (if solution boils below recommended operating temperature). **Failure to thoroughly mix crusted salts will result in an eruption and boil over!**

BLACKENING HARDENED STEEL (which most gun parts are made of) If the basic five step Du-Lite process fails, we recommend one of the three methods mentioned below:

The first method is a single black oxide tank heated to a temperature of 287°- 289°F. Parts should remain in the tank at least 30 minutes. Quite often this temperature will successfully blacken difficult hardened steel parts. If not, then use one of the two methods mentioned below.

The second method is a dual temperature process which uses two separate black oxide baths. The first blackening bath is mixed to obtain a boiling point of 283°- 285°F and the second blackening bath is mixed to obtain a boiling point of 300°- 305°F. Bath control is accomplished in the same manner as with a single temperature process. This process has been proven to provide superior results, even on plain carbon steel, and can reduce processing time of all work by over 50%. A five to ten minute immersion in each bath of a two-temperature process will produce results superior to those obtained by a 20-40 minute immersion in a single temperature bath. The two temperature process penetrates the metal deeper and leaves a more durable finish.

The third method is a dual temperature process which uses a single black oxide tank. Place parts in the black oxide tank at a temperature of 285°F allowing the parts to remain in the blackening tank until enough water has evaporated to raise the boiling temperature of the solution to 301°F. After reaching the higher temperature, parts should remain in the tank for approximately 10 minutes.

Cast metal parts, such as rifle and shotgun receivers, slides, frames, triggers and hammers which turn red in one to 14 days after black oxiding contain too much silicone in the casting metal itself. The silicone is added at the foundry (.5% or less) to aid in the pouring of the casting metal. Parts manufactured with too high a silicone count (that turn red) are successfully blackened by using Du-Lite's 3-0 Process for cast iron and stainless steel. 3-0 Process instructions available upon request.

OPERATING TIPS:

Racking Parts - Never lay parts in the bottom of the black oxide tank. This will cause stains in the finished work. Parts must be suspended in the middle of the solution by small wire baskets, racks or steel mechanics wire threaded through the gun barrels and fastened off in a circle to be used as your handle.

This will enable you to transfer the parts from one tank to another without touching the parts with your gloves.

Thermometer - One of the most important pieces of equipment needed to run black oxide properly is an accurate thermometer. You should verify the accuracy of your thermometer every three months. Place the stem of the thermometer in boiling water and note the reading. At sea level the boiling temperature of water is 212°F. To calibrate a Du-Lite thermometer, place a wrench on the nut that is located under the face of the thermometer and turn the thermometer to 212°F. If your thermometer cannot be adjusted in this manner, note the difference in the reading and adjust for the difference when taking the temperature of your bath.

High Altitude Temperature - Du-Lite's operating temperature is based on water boiling at 212°F at sea level. At higher elevations where water can boil at 209°F or lower, you must adjust your temperature accordingly. This 3 degree temperature difference must be taken off the operating temperature, i.e. at sea level 280-285°F at a higher elevation 277-282°F.

Immersion Time - Normal blackening time is 15-30 minutes. Work cannot be harmed by extended immersion time in the blackening bath because black oxide is a staining process into the metal and not a surface coating buildup.

Competitor's Chemicals - Do not add Steelkote to our competitor's black oxide solution, especially Brownell or Unibath. Their formulas are so different from Du-Lite's that they will not work together. Use up the last of their chemicals, discard the bath and thoroughly rinse the tank before making up your new solution with Steelkote.

Rust, Scale and Heat Discoloration on Welded Areas - Parts must be cleaned before applying black oxide over these areas. Glass bead blasting is an excellent method to clean these parts. Hydrochloric acid can also be used but for only a short time - 1-2½ minutes - because hardened parts cleaned with an acid can become hydrogen embrittled. Parts with hydrogen embrittlement can break easily and lose their heat treating temper.

Stripping Black Oxide - To strip old black oxide finishes from parts, use 50% hydrochloric acid 20°Be and 50% water at room temperature for ten seconds. If your parts are immersed in the acid mixture too long they will etch and your new black oxide finish will look dull.

OPERATING PROBLEMS:

DOUBLE BARRELED SHOTGUNS - The Du-Lite Process is not recommended for use when refinishing soft soldered assemblies such as **older double barrel shotguns**. Some of these firearms are extremely valuable and we cannot guarantee that soft solder will not be harmed or destroyed by the highly alkaline nature of the bath. We do not feel this risk should be taken.

Barreled Receivers - can pose a problem for black oxiding. Sometimes manufacturers install stainless steel gun barrels to regular steel receivers. When black oxiding these parts only the receiver will take the black oxide finish while the stainless steel barrel will not blacken at all. The stainless steel barrel must be blackened using Du-Lite's 3-0 Process designed for stainless steel and cast iron.

Sludge - A slight buildup of iron sludge in the bottom of the tank is normal when the bath has been in operation for a length of time. Remove the sludge at the end of the day - shut off the heat source, after the boiling action stops, the sludge will settle to the bottom. You can now remove it with a hoe or similar

implement or scoop. Du-Lite sells solution clarifiers which are designed to capture and contain this sludge for easy removal.

Scum - It is a normal condition to have brown scum form and float on top of your boiling black oxide solution. This material is purged out of the metal being processed. You should scoop this scum from the bath a couple of times a day and discard it. When placing parts in the black oxide bath or removing them, do not let your parts come into contact with the scum at the top of the tank, as it can stain your finished work. Small amounts of scum can be pushed to one side with a piece of steel (while wearing gloves).

Bath Contamination - Racks, baskets, wire, etc. used in handling work during processing should be steel or stainless steel. NEVER USE COPPER OR BRASS wire. Processing baskets should not be assembled by brazing, because the copper content in the brazed areas will cause contamination of the black oxide solution. Water supply lines near the top of the black oxide tank should be made of iron - NEVER COPPER - corroding copper pipe flakes can pollute the bath. Other metals that can contaminate the bath are: aluminum gun receivers, tin, cadmium, zinc or galvanized steels.

Red Bath - A newly made up black oxide solution is clear in color. As the solution is used, it can pick up a deep red rusty color. This is due to the iron that is drawn out of the parts and tank walls and should not be a cause for alarm as long as your parts are blackening properly.

White Specks - You may notice white specks on your work - these are caused by using a cold water rinse after the hot soak cleaner. The cold water will not rinse all of the cleaner from your parts resulting in white specks on your finished work. To eliminate this problem, use a warm water rinse of 150°F.

Red or Green Work - The TEMPERATURE of the black oxide bath is the most important detail an operator should be concerned with. If a black oxide bath is operating at too high a temperature it can produce work that has a color range from a slight reddish or green haze to a dark heavy red rust. Lower the boiling temperature of the bath by 1-5 degrees by adding water.

Brown Foaming - A black oxide tank with a chocolate milk shake appearance on the surface is an indication that your heat source is too high. Foaming can appear all over the top of the tank or crawling up the side walls and overflowing - turn down your heat source to correct this problem.

Blotchy Finish - A blotchy finish can be caused by poor cleaning, uneven buffing, old black oxide finish remaining, or if two or more different metals have been used to make up the part.

Pollution - Du-Lite's processes are highly alkaline and corrosive in nature. If the solution must be disposed of, or rinse water waste treated, request Du-Lite's Neutralization and Disposal Information.

Safety Equipment Required - When operating Du-Lite's black oxide solution the operator must wear a long sleeve cotton shirt, rubber gloves, boots, long pants, apron, goggles or face shield. Black oxide is an industrial process, do not use it around children. After processing work, lock up the work area.

Burns from Solution - Black oxide solutions are highly alkaline and can cause severe burns to unprotected skin. Wash affected areas thoroughly with water and neutralize the alkaline chemicals on your skin with white vinegar.

Redness Caused by Silicone - Cast metal parts, such as, rifle and shotgun receivers, slides, frames, triggers and hammers which turn red in one to 14 days after black oxiding contain too much silicone in the

casting metal itself. The silicone content should not exceed 0.5%. Silicone is added to the casting metal at the foundry for easier pouring and to produce parts with greater detail. Parts with this condition are successfully processed by using Du-Lite's 3-0 Process formulated for stainless steel, cast or malleable iron and nickel alloys.

Nickel Steel

Nickel steel is sometimes used in the manufacturing of gun barrels and receivers. They can be blackened by the following process. Clean thoroughly with #45 Cleaner, warm water rinse, black oxide with Steelkote, two tanks, two temperature process. The first tank should be heated to 285-290° F for 20 minutes, remove parts from this processing tank and transfer quickly to the second black oxide tank heated to 310-315°F for 20 minutes. A small amount of Du-Lite's Black Bath Purifier should be added to the blackening tanks before processing for best results. Cold water rinse, warm water rinse 150°F for one minute. Kwikseal or Kwikseal A rust preventative oil completes the process.

HOT WATER BOIL OUT TANK - DU-LITE RECOMMENDS NEVER TO USE THIS PROCESS

The hot water boil out tank is used by some gunsmiths to remove occluded salts from barreled actions, sintered metal, MIM metal and parts prone to bleed out. After black oxiding and cold water rinsing, parts are immersed in hot boiling water. This process should not be used for the following reasons: Parts placed in this tank deposit chemicals that did not get rinsed off completely or released from trapped areas. These trace chemicals pollute the hot water, staining all parts processed. Leaving parts in this tank for long periods of time will not get rid of this problem. REFER TO DU-LITE'S OPERATING INSTRUCTIONS FOR SD COMPOUND AND NECCO #2.

IMPORTANT! Material Safety Data Sheets are available for all Du-Lite products. All operating personnel should read and understand these sheets.

THE PRODUCTS MENTIONED IN THESE INSTRUCTIONS ARE FOR INDUSTRIAL USE ONLY

03/13/2019