

# Black Magic: The Science Behind the Magic

Hubbard-Hall's Black Magic is a hot alkaline nitrate black oxidizing solution containing self-rectifying compounds and high temperature stable wetting agents. Black Magic is operated at a boiling point of 285°F, which corresponds to a salt concentration of approximately 6 lbs. per gallon.

The hot black finish developed is a true conversion coating, converting iron to the naturally occurring black iron oxide compound called magnetite (Fe<sub>3</sub>O<sub>4</sub>). This conversion coating has a tight, adherent, highly durable composition, which does not easily scratch and does not chip, flake or peel. The coating produces an attractive black finish that enhances the salability of the article blackened, imparts moderate corrosion resistance, and yields a finish that when properly sealed, resists galling and enhances lubricity. Black Magic is a top performer that will last indefinitely as long as proper care and maintenance are performed.

The main constituents of Black Magic are: sodium hydroxide, sodium nitrate, sodium nitrite, rectifier and special wetting agents. These quality ingredients formulated together will produce a high quality, cost effective, uniform black finish which yields little to no dimensional change. The rectifier incorporated into our formula plays a very important role in our blackening process. This role is simple yet essential to the development of a high quality black oxide layer. The rectifier complexes the impurities that are introduced into the bath. The contaminant introduction is done by either drag-in or chemical reaction. This chemical reaction is divided into two parts:

1. Carbon dioxide in the atmosphere reacts with the sodium hydroxide in the solution to form soda ash (Na<sub>2</sub>CO<sub>3</sub>) which is sparingly soluble in an alkaline solution.
2. Sodium nitrate and sodium nitrite reacts with the iron of the parts. The nitrite and nitrate oxidizes the iron to produce a black oxide layer. However, this reaction also forms red iron oxide (Fe<sub>2</sub>O<sub>3</sub>); which is not soluble in solution.

When the rectifier has complexed the contaminants, it will float them to the surface where they can be easily skimmed or carried off on the work to later be removed in the rinse water. Rectification that floats contaminants to the surface is a significant factor in bath operation in that it eliminates need to decant the bath to remove the sludge and it eliminates the settling of



precipitated contaminants to the bottom of the tank where they build up as a sludge which will reduce the efficiency of heating the solution. The rectifier will also help prevent any copper contamination from plating out onto the work. Therefore, you can see that the rectifier is essential in removing the red oxide and other metal contaminants (i.e. copper, ferric hydroxide and ferrous hydroxide) produced or introduced into solution. Another important constituent of our hot black oxide formula is the introduction of special wetting agents. These wetting agents lower the surface tension to produce a less viscous solution, which reduces drag-out of solution and hence, reduces operating costs. In addition, the wetting agents help the solution produce a more uniform black finish. Having made the chemical formulation of the hot black and its characteristics clearer, we can now look at processing, operating, maintenance and safety.

#### **GENERAL PROCESSING PROCEDURE:**

1. Mi-Clean, alkaline soak cleaner, 8 oz/gallon, 5 minutes, 160-180°F.
2. Cold water rinse
3. Hot black oxide, 15 minutes at boiling, 285°F.
4. Cold water rinse
5. MetalGuard, rust preventive

#### **OPERATING:**

1. A glass mercury thermometer should be kept on hand to check the accuracy of the automatic temperature controller
2. The solution must be boiling to achieve the proper blackening.
3. Operate the bath at a boiling point between 280-290°F. As the boiling point approaches 300+°F., a greater buildup of red iron oxide ( $Fe_2O_3$ ) will occur that can impart a reddish color to the surface of the blackened part.
4. Transfer time from the hot black oxide tank to the rinse water should be minimized. A red oxide or red tint to the black which cannot be wiped off can be developed. This red is due to removing heavy parts from the rinse water following blackening, before they have cooled completely or due to too long of a transfer time between the hot black oxide tank and the rinse water.
5. Ensure a water break-free surface after the cold water rinse following the Mi-Clean bath and prior to the hot black oxide bath. This will show that the work is clean and free of oil, soil and sediment.



## **MAINTENANCE:**

This is the key to long black oxide bath life. As long as the following is observed, a hot black oxide bath need never be dumped.

1. Ensure work is clean prior to introduction into bath.
2. Desludge tank regularly. Add salts while bath is boiling. The rectifier in the hot black oxide will float the sludge and other contaminants to the surface where it can then be removed by skimming. This should be done on a regular basis.
3. Maintain the boiling point of the bath at 285°F. The boiling point is critically important to the functioning of the hot black bath. The boiling point is a function of the salt concentration and is maintained by the automatic addition of water to replace that which is continuously boiled away. As the water in solution is boiled off, the boiling point will increase and must be lowered by the addition of water. If the volume is to be maintained at a constant level, black oxide salts must be added.

An automatic temperature controller will automatically feed water to the tank to maintain the boiling point thus relieving the operator of this responsibility and allowing him to concentrate on production. Also, an automatic controller will prevent the bath from reaching a boiling point of greater than 300°F, which could cause discolored finishes.

## **SAFETY:**

The hot black oxide does not present an extremely hazardous environment. The main danger is alkali burns or irritation from the high operating temperatures.

1. Ensure adequate ventilation to remove the alkaline aerosol that is given off.
2. Wear protective clothing: rubber gloves, apron, safety glasses, face shield, and alkaline resistant boots when making up the bath, adding chemicals, or processing work.
3. A safety shower and eyewash should be in the immediate vicinity of the processing line. If hot black salt or solution should come in contact with body tissues or eyes, immediately flush effected area for at least 15 minutes with a gentle stream of fresh, cool, clean water. In case of eye contact, get medical attention immediately.

The information and recommendations presented should enable you to maintain and operate a hot black oxide process that will produce consistent quality black oxide finishes.



**Our people. Your problem solvers.**



For questions or comments on this information please call us at

1-800-648-3412

or [techservice@hubbardhall.com](mailto:techservice@hubbardhall.com)

