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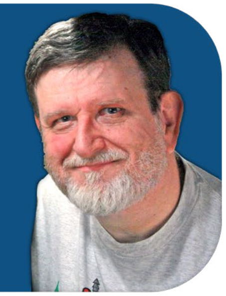



## Joe Fugate: Keeping your track and wheels clean longer – a look at polar vs non-polar solvents

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**As part of my "Run like a dream" writing** project we've been discussing here in my recent editorials, I've been pursuing an in-depth knowledge of better track cleaning. One of my goals has been to learn what causes the black gunk we get on our track and wheels, and also *how to inhibit its formation.*

If we can slow down the process that's getting our wheels and track dirty, all the better!

One story that caught my attention came from the La Mesa club in San Diego. This famous club has a fantastic layout modeling the Tehachapi Loop line of the Southern Pacific. They run trains for a good 8-12 hours daily, so if anyone is "stress testing" model railroading methods, it's this club!

According to members of this club, they were using isopropyl alcohol (i.e., rubbing alcohol, or IPA) to clean their track and wheels. Much to their dismay, they found the harder they cleaned things, the more quickly they got black gunk buildup again.

After some experimentation, they discovered cleaning the track and wheels with mineral spirits resulted in things staying clean longer.

This story reminded me of the "Wahl clipper oil" claims that surfaced in the hobby several decades ago. The claim was cleaning the track and wheels with Wahl clipper oil actually reduced the frequency of the cleaning.

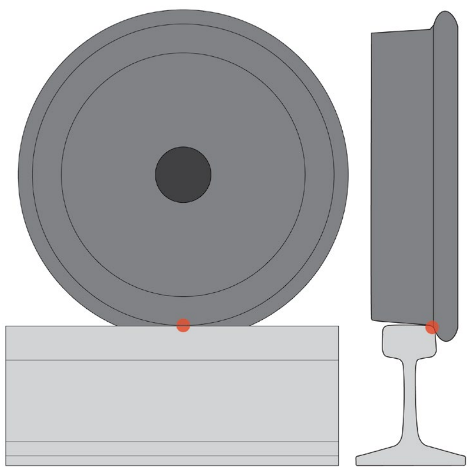
Something seems to be definitely afoot here and it cried for more in-depth investigation.

## What causes the "black gunk" on wheels and rails?

Several years back, a model railroader submitted dirty track for an in-depth chemical analysis of this "black gunk" and reported the results on the MRH forum [mrhmag.com/node/3229].

Bottom line, this black gunk is mostly metal oxides formed from microarcing between the wheels and the rail. This contact point is quite small, as you can see in [1]. Esssentially, the electricity flowing at this tiny contact point triggers a chemical reaction in the wheels and rails.

The electrical current in effect "explodes off" metal alloy molecules from the wheels and rails. It oxidizes these metal molecules, forming a fine dark gray powder. So the key to slowing down the buildup of metal oxide is to *inhibit the microarcing.*



1. The electrical contact between wheels & rail is on the inside rail head and quite small.

If you know something about the history of electric motors, you know they first tried copper motor brushes, but they arced badly and burnt out quickly. The solution was to use graphite because it inhibits arcing at the contact point! Interesting ...

Further discussion with a chemist who also understood electrical contact cleaning such as in relays and switches, put me on to the concept of polar versus non-polar solvents.

Once I delved into polar vs non-polar solvents, something very interesting emerged.

## Polar vs non-polar

Molecularly speaking, you can use what's called the substance's dielectric constant to derive its molecular polarity.

The chemist told me that non-polar solvents work best to both clean electrical contacts and to protect them by inhibiting microarcing. Apparently, polar solvent molecules get trapped in

**2. Polar, semi-polar, and non-polar solvents.**

| Solvent | Dielectric constant |
|---|---|
| Kerosene | 1.8 |
| WD-40 contact cleaner | 1.9 |
| CRC contact cleaner & protectant | 2.0 |
| DeoxIT D5 | 2.0 |
| Gasoline | 2.0 |
| Neverstall | 2.0 |
| Diesel | 2.1 |
| Mineral spirits | 2.1 |
| Wahl clipper oil | 2.1 |
| Turpentine | 2.2 |
| Carbon tetrachloride | 2.2 |
| WD-40 (regular) | 2.4 |
| Graphite (microscopic thin layer) | 1.8-3.0 |
| CRC 2-26 | 4.6 |
| Automatic transmission fluid | 4.8 |
| Rail-zip | 4.8 |
| Bachmann track cleaner | 4.8 |
| Butyl acetate | 5.1 |
| Butyl cellosolve | 5.3 |
| Ethyl acetate | 6.0 |
| Graphite (thick layer) | 10.0-15.0 |
| Isopropyl alcohol (IPA) | 18.0 |
| Methyl Ethyl Ketone (MEK) | 18.9 |
| CRC QD contact cleaner | 20.0 |
| Lucas contact cleaner | 20.0 |
| Acetone | 20.7 |
| Vinegar | 24.0 |
| Ethyl alcohol (e.g. vodka, wine) | 25.0 |
| Ammonia solution | 31.6 |
| Propylene glycol | 32.0 |
| Lacquer thinner | 33.6 |
| Glycerine | 47.0 |
| Hydrogen peroxide | 60.0 |
| Water | 80.4 |

Non-polar

Semi-polar

Polar

micropits of the metal surface, leaving an "electron charged" microscopic residue. This electron-charged polar residue encourages micro-arcing in the presence of an electrical current, quickly forming new metal oxides on the metal surfaces in electrical contact.

But non-polar solvents do the reverse. They actually "protect" the metal surfaces from forming new oxides because they *inhibit* microarcing.

In the chart [2], I list the dielectric constant for a number of solvents, contact cleaners, track cleaners, and the like. To make this chart, I assume a dielectric constant of 3.0 or less constitutes a non-polar solvent for our purposes. I assume a dielectric constant of 10.0 or more means the solvent is polar. Anything in between is semi-polar.

The best solvents for track cleaning are the non-polar ones. The worst ones for track cleaning are the polar solvents! How many of us have used IPA, lacquer thinner, or acetone for track cleaning? Bad, bad!

Also notice the "wonder cures" for dirty track are all non-polar! *Ah-hah!*

The other thing I notice is not all electrical contact cleaners are created the same. CRC Contact Cleaner and *Protectorant* (do their chemists know something here? – sure sounds like it) is CRC's lowest dielectric constant non-polar product!

While CRC 2-26 is often recommended on modeling forums for cleaning, it's actually semi-polar. It's far better than IPA or the like, but the CRC Contact Cleaner and Protectorant is better still. Notice, CRC QD Contact Cleaner is actually *worse* than IPA.

Notice some model railroad track cleaners have lower dielectric constants as well. They're on the right track, no pun intended!

From this list you can see kerosene, WD-40 Contact Cleaner, CRC Contact Cleaner and Protectorant, Deoxit D5, Neverstall, and mineral spirits are all excellent solvents to use for cleaning track and wheels.

Solvents to avoid include: isopropyl alcohol, MEK, acetone, and lacquer thinner.

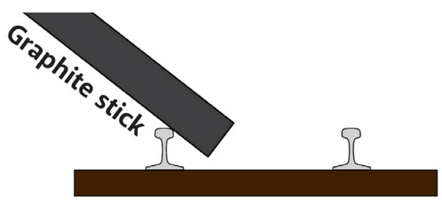
## What about graphite?

Per the polar/non-polar chart, graphite is a very interesting substance.

Microscopically thin layers of graphite are actually very non-polar and greatly inhibit microarcing.

But thicker layers of graphite get increasingly polar. The "layers don't bond" nature of graphite is what makes it work so well to counter friction. The layers of graphite freely slide right over each other.

But these extra natural layers also dramatically increase graphite's dielectric constant.




3. Applying graphite to the inner railhead.

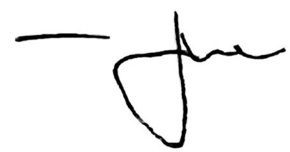



When applying graphite to your track to help keep the rails from microarcing, *more graphite is not better!*

In fact, what I tell people is one quick swipe on the inside railhead is all you need [3]. You don't want to see it. If you can see the graphite, then you have applied way too much! Just one quick swipe with moderate pressure is plenty.

At this point, I think these non-polar versus polar solvents findings suggest a clear direction for better track and wheel cleaning, and how to reduce the amount of re-cleaning needed by inhibiting the build-up of fresh black gunk on the wheels and railhead.

It appears you want to clean your track (and wheels) with a non-polar solvent and then treat the inside railhead with graphite to further reduce your frequency of cleanings. That's about as good as it gets! ☑



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