Graphite Track Treatment

Rather than derail the NoOx thread and in response to Bill's request, I'm starting a new topic on using graphite for contact enhancement on track. I'm sure someone has mentioned it here before, but I couldn't locate a specific thread on the topic.

We heard about graphite first, or at least secondhand, from another member after he visited Trevor Marshall and operated on his S scale CN branchline layout. Trevor mentioned to him that he uses artists' graphite sticks to improve operation on his layout. The sticks are square bars of graphite like used in pencil leads. We use 4Bs mostly, which are fairly soft. The stick consists of graphite and a clay binder, and the graphite is extremely conductive; if you put it across the tracks with power on, it will short the rails.

We just use the end of the stick to rub some onto the railhead here and there. The engines will transfer it around the layout to some extent. We just let the locos carry it into the hidden track areas.

After removing NoOx from the track in normal track cleaning operations, we started applying the graphite. We didn't have a carefully planned regemine or anything, we just took the sticks and rubbed them along the tracks in convenient locations, and if we had a spot where pickup was a problem, we would clean it and then run the stick over the cleaned rails. Nothing was done to the engines, other than cleaning the wheels on a dry paper towel as we used to do with NoOx. We simply stopped cleaning them on engines not showing pickup problems, and stopped cleaning the track with abrasives unless there was evidence of dirt in a particular spot.

The experiment is only a few months old, but the layout has never run better, other than one time after we spent the entire summer cleaning all the wheels on every piece of rolling stock and every inch of track. That was way too much work and only lasted about 3 sessions before we had all the old contact problems again. The graphite is closest we have come to the magic bullet for smooth ops, and we have tried everything for over 15 years.

Easy enough to understand why the graphite is working for you. Graphite, as you note, is a good conductor of electricity. Your graphite treatment is essentially placing a conductive layer on top of your metal rail conductors. Since the graphite doesn't oxidize the conduction remains in place. Even if you were to put the graphite on oxidized track it would probably still work as the graphite could pickup current from the spots on the track that do not have oxidation and conduct it throughout the graphite layer.

The one possible issue that may arise is the fact that the graphite is not mechanically or chemically bound to the rails. It is analogous to a powdered donut. The powder stays

put until a force acts upon it. Since wheels roll instead of scrape or slide then one would think the graphite has a reasonable chance of hanging around for a while. Still, it would be nice if the graphite were anchored to the rails so as to maintain a contiguous conductor.

The clay used as a binder in the graphite stick also makes it want to cling to surfaces, so it will stay put better than you might think. That's another reason to use the softer grades, since they have more clay in them. Reapplication is simplicity itself anyway; you just grab the stick and drag it along the railhead again--it takes seconds.

Quite the contrary, since we got rid of NoOx and started using graphite instead, our traction has improved on our helices. There has been no downside to the graphite at all so far.

Agreed, almost any conductive material exhibits resistance-over-distance at room temp (25deg C).

However, when you consider that a (exceedingly thin) layer of graphite on top of a freshly-cleaned railhead has but-microns of "insulated distance" between "surface contact points", the distance rail <> railhead <> graphite layer <> wheel tread at any randomly-selected point on a layout is soo miniscule as to present an almost unreadable resistance value (certainly less than 1ohm, and well under what my 3 and-a-half digit DMM readout can display...).

Think of the distance between railhead<>graphite-layer contact points as being analogous to the distance between track feeders
(the rail is the track buss,
the graphite layer is the rail,
the contact points between rail surface and graphite layer are the feeders).

If however, we are talking about the situation where a modeller mixes graphite powder with metholated spirits or mineral turpentine, and then slathers the resulting "paste" on every possible railhead surface,

then yes, certainly the *excessively accumulated graphite* can present a "low, yet measurable, resistance joint",
to the point where drawing significant current accross the graphite joint/link/bridge can cause it to heat and glow.

Believe this post covered the situation?
http://model-railroad-hobbyist.com/node/16814#comment-134033

I have to admit I've never looked at nickel-silver rail oxidisation at a microscopic level like some of our members here onlist, (shout out to LK&O Alan :-)). I guess I feel like a

science student at the start of an exercise. We have observable reproducible symtoms, which have been "in the field" tested over decades. We also have a number of hypothesis which could explain the symtoms and effects.

Without the actual microscopic images to confirm/deny the theory, my personal suspicion is:

- As a dry treatment, graphite is unlikely to be able to form a perfectly-continuous air-tight oxygen barrier
(I can't blow air-bubbles thru a stream/sheet of graphite powder,
nor can I get a vacuum-seal on a sheet of glass which has a load of graphite dust covering it's surface)

- However, we can prove (thru naked-eye observation of both operation, wheelsets, and rail surface) that graphite applied with a single swipe from a 2B "woodless pencil" on one section of track can easily be transmitted to the wheelset treads, and spread around/across the layout via train movement.
(Bonus points: a graphite-coated rail looks less "gleaming yellowish" and more "dull grey silver", which tends to be less visually intrusive and more in-keeping with weathered rail aesthetic).

- If we accept that electricity can track accross a layer of graphite, then the idea that the graphite is acting as a "conductive surface" accross the top of (miniscule, esp immediately after a decent PECO trackblock cleaning?) sections of oxidisation, and creating conductive-layer "jumpers" between (varying size) areas of non-oxidised conductive surface seems viable, and gels with observed behaviour.

- Whether (2B?) graphite is more or less physically/mechanically hard-wearing than surface-based oxygen contamination/oxidisation on Nickel-Sliver rail is unknown to me at this time.

However, we do know that graphite on rail surfaces can coat passing wheel treads, and said coated wheeltreads can transfer/deposit graphite on rail.

Whether that means that the oft-stated "run trains more often = less oxidisation issues" is due to the oxidiation being polished-away with the passing friction of the wheels while the graphite remains,
(IE graphite is harder than NS-surface-borne oxide),

or whether the effective "continual re-distribution/re-application of graphite by passing graphite-coated wheels", simply masks/over-coats any developing oxidisation occurances with more "layer of conductive material" in realtime
(compounding/related issue as above, does graphite exclude contact between Oxygen

and Nickel-Silver?
If not, does oxide which forms *on top of* a graphite layer "harder-wearing" than oxide that forms directly on a clean NS surface?

Oh dear, why do I feel like we've taken the Red Pill???
http://www.youtube.com/watch?v=A9vGMMPM5Lg)

is again also up-for-analysis...

Whatever the case, at the risk of sounding like a cracked record, it's been proven for my situation and layouts, and the layouts of many modellers I know of accross Australia (from Sydney in the East to Perth in the West, and from Brisbane in the north to Tasmania in the South, so no lack of varying temperatures/humidities/proximity-to-sea/saltwater/average-airborne-dust/layout-construction conditions under test) for some decades now.

As such, personally, I'm not actually greatly concerned about the microscopic "how it works",
although if someone wants to visit Sydney Aust to do the analysis,
I'd be more than happy to provide verifiably "clean rail" and "graphite-treated" test subjects... ;-)

We just had another operating session yesterday. We did *no* track cleaning beforehand and only cleaned the wheels on a handful of locomotives out of a fleet of 70 or more. Electrical pickup was only a problem on a few light switchers and a Budd car with brass wheels, and only on dead frog turnouts.

I talked to one yard operator and he mentioned having trouble on two turnouts with dead frogs on the yard lead. I carefully applied graphite to the powered parts of those turnouts and he later said there was no problem on them anymore. He did complain of a lot of trouble switching the freight shed, though. When I checked the shed trackage, I discovered a couple broken feeders on point rails--no amount of graphite will save you when *no* power gets to the locomotive.

We run 40 car freights up several helices with grades of between 1.6 and 2 percent. We run 3 or 4 diesels on them; they had no traction problems. We used to have spinning wheels with No-Ox at times on the same trains. Even locomotives which used to be considered problem children ran flawlessly. I can't say there were no problems, but electrial pickup was *not* one of them. It was a pleasure to run the layout, and with a fraction of the pre-session maintenance.

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I can see where someone with a smaller layout and easily accessible track and a nice clean layout room could follow the magic No-Ox procedure to the letter and get good results. Our layout is in a converted barn/quanset hut and it took weeks of occasional effort to get to all the track with No-Ox. Applying it was difficult and frustrating and it was hard to keep track of where it had been applied and where it had been wiped off, etc. It was too complicated and in the end, ineffective.

The problem we had with No-Ox was on mulitple levels. First, our layout is pretty big, and mostly handlaid track. Trying to apply No-Ox to the railhead was laborious, and the cloths we used snagged on the spike heads all the time. It was hard to get into deeper areas of the layout and some of the hidden track was inaccessible to this sort of effort.

We also made the mistake of doing a major cleanup after we applied the No-Ox which kicked up quite a bit of dust. The dust seemed to get stuck on the rails afterwards and made operation worse than before we applied the No-Ox. We did try cleaning all the track, but it didn't seem to help. The layout simply didn't run any better after all that effort, and in some cases units which ran well before started giving us problems.

We did all sorts of work on them to fix them and couldn't solve the issues. In some cases they were brand new locos with only a few sessions on them. It was frustrating.

Now that the No-Ox is no longer being applied, and in most areas has been removed by track cleaning work, and graphite is being more or less randomly applied, these same units work flawlessly--with no other work done on them. It's almost eerie, how well everything runs. When you get used to sound units cutting out constantly for no good reason, it's strange to have them run perfectly now.

The contrast between having to clean the wheels on every locomotive during our staging sessions, as well as run track cleaning trains up and down all the mainline and hand cleaning the track with abrasives (wrecking trackside detail as we go, naturally) to now doing none of these things and getting better operation than we did with all the effort is remarkable. I was skeptical at first, too, but I am definitely a believer now.

Try it, it doesn't cost much and is easy to do. It doesn't get any better than that.

In order of appearance:

- No, you do not n*eed* to use soft artists pencils. However, I find that the "woodless pencils" are some of the most consistent, easy to handle, and cheapest ways to get a reliable source. FWIW, I use and rely on "Progresso" brand 2B "woodless pencils", available online or from your nearest art-supply store...

(which, if you're in any way doing weathering or scenery work,
or use X-acto #11 blades at the rate I do,
is already one of your "go to" materials source stores, ... or should be...)

http://www.eckersleys.com.au/products/Koh-I-Noor-Progresso-Woodless-Grap...

https://www.google.com.au/search?q=progresso+woodless+graphite+pencils&e...

- Directly applying graphite to brass wheels can help. However, to ensure an even *not-excessive* coating, I much prefer to graphite the rails and then run the trains (with freshly cleaned wheels) over the graphite'd rails.

As already mentioned above, and linked to previously, there is a world of difference between
* a swipe along the railhead with a graphite stick
and
* slathering a rediculously-thick graphite paste all over everything

- Graphite AFAIK does not embed itself into the metals. As such, it is one of the few treatments which is 100% reversible with not much more than a decent pass with a

PECO track rubber. That said, it is slippery, and a single pass with a finger will not remove the coating "after just one pass". (Finger will come up with a grey graphite "stripe", but graphite will still be present on the railhead).

RE Automation

Honestly, I wouldn't bother. Part of the appeal of graphite is that with the graphite "sticks"/woodless pencils, it's literally "a swipe along the rails" anytime you think a hesitation occured. Applying any more than that is ***too much***, and does not gain you any more benefit. (Indeed, once you have a basic graphite coating on wheel treads and rail, any excess can only become "traction sapping").

Equally, the action of the wheels running over the treated mainline naturally spreads, distributes, and coats the wheel treads nicely, evenly, and not-excessively. Why try to emulate what physics and the nature of graphite does appropriately, automatically, "for free"???
(NB that dead-end spurs and sections with lower traffic thruput may benefit from the odd occasional additional graphite swipe... ;-)).

Happy Modelling,
Aim to Improve,
Prof Klyzlr

PS as mentioned by PeterRossNZ, 2B stoicks tend to get a "notch" in the tip/end of the stick after only a few applications, This is beneficial, as it allows the graphite stick to "wrap around" the head and inside face of the rail, and allows confident "follow the track" swiping at speed (minimises the risk of "coming off the rail" and leaving a black graphite stripe up the ballast... ;-)).

I did a couple of tests on this when it first came up-- not on a layout, as mine is currently ripped up for tortoise installation, but with an ohmmeter. I couldn't really measure any consistent resistance change, but I did notice that it was easier to get a reading with my needle point meter probes. I tried both old and new track, and found that before application I would either have to fish around for a magic spot or apply extra pressure to see anything but open circuit. After applying graphite my one touch success rate was better. This was not freshly cleaned rail. On polished rail, the graphite had no effect, as I could always get a reading.

When you think about it, the improvement in conduction provided by graphite makes sense. In the best case, the surface area of contact between wheel and rail is a vanishingly narrow line. More likely it's a point or tiny oval because the wheel camber

does not match the profile of the rail. Now picture the rail and wheel as Alan described, microscopically cratered like the moon with spots of oxidation. The chances of a crater on the rail or wheel matching up with the magic spot increase with the number of craters. When you apply graphite, it lies on the rail in flakes and clumps, held somewhat by the remains of the binder. The flakes are big enough to bridge the craters, providing a conductive path. If there is enough graphite, it can fill the angle between the wheel and rail, providing even more conductive surface.

But wait, there's more. Graphite has more resistance than brass. Not a significant amount in the thickness we are talking about, but some. Furthermore, the resistance of loosely packed graphite will vary according to the pressure applied. That old fashioned telephone we have in our garage has a packed graphite microphone. So, as a loco wheel rolls though a pile of graphite the resistance starts on the high side (the carbon microphone is 600 ohms) and goes down as the wheel applies pressure. This reduces the arcing that makes the oxide craters in the first place. Why? The arc will jump the closest distance from conductive spot to conductive spot. Since the graphite is on top of the rail, the slightly higher resistance will reduce the arc intensity.

I'm going to go put some down as soon as I get my rail painted.