



REFORMULATING TO COMPLY WITH RULE 1144

The Good, The Bad, and the *Oh My!*

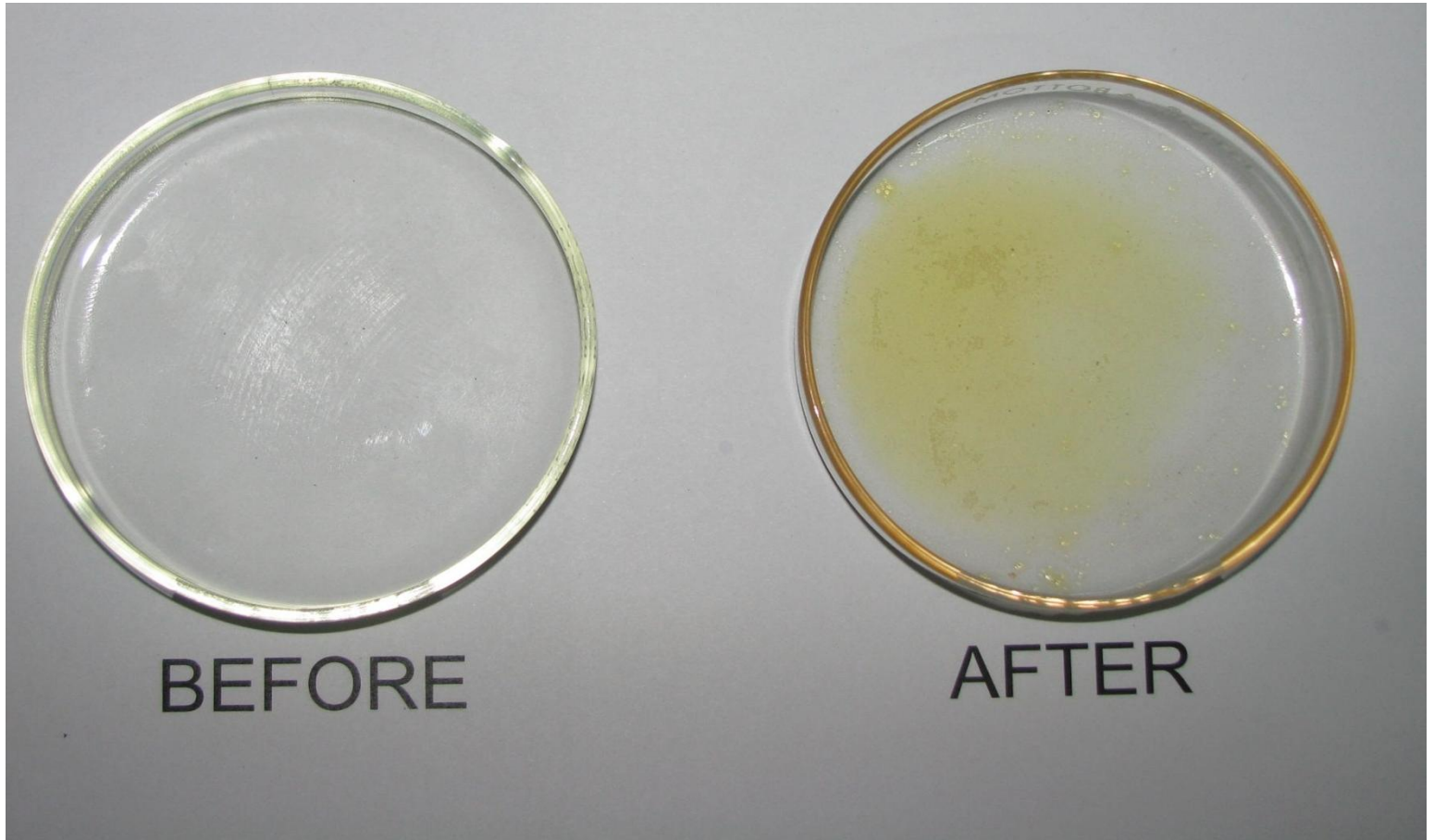
Mike Pearce
W.S. Dodge Oil Co.
March 8, 2012

Why did we reformulate?

- Many fluids use viscous (thick) components
- Our industry sometimes uses low viscosity base oils, and even solvents, to balance the final viscosity of a finished fluid
- Testing showed oils we thought to be stable were “semi-volatile”
 - Naphthenic Oil 40 793g/l VOC
 - Naphthenic Oil 60 103g/l VOC
 - Naphthenic Oil 100 46g/l VOC

Naphthenic Oil 40

6 month evaporation study



Why did we reformulate?

- Many finished fluids need a very low viscosity
 - Honing Oils
 - Aluminum Tapping Oils
 - Aluminum Cutting and Grinding Oils
 - Oils that are sprayed
 - Gundrilling and Trepanning Oils

Why did we reformulate?

- “Super Compliant”
 - 50g/l or less VOC
 - Exempts end user from recordkeeping
- Lower VOC content reduces total plant emissions
 - Title V limit is 4 tons/year overall emissions from facility (over 4 TPY requires permitting)
 - Typically, Metalworking Fluids (MWF) not previously inventoried due to lack of data

Three Largest Challenges

- Metal Protecting Fluids (“Rust Protectant” or “RP”)
- Low Viscosity Fluids
 - Honing
- Vanishing Films (“VF”)

Metal Protecting Fluid

- Functions

- Remove water from part surface
- Completely coat part
 - Crack and crevices, blind holes, etc.
- Leave a uniform film
- When solvent evaporates, the remaining semi-dry film is resistant to casual wiping, fingerprints, etc.

Metal Protecting Fluid

- Classic Formula:
 - 10% Additive
 - Chemical rust inhibitor plus waxes/petrolatums/wool grease (residual films)
 - 20% Naphthenic Oil
 - Carrier for additive package
 - Modifies final film
 - 70% Solvent
 - VOC was 465g/l
 - Unfortunately, limit is 50g/l

Metal Protecting Fluid

- Special Challenge-Rule 219
 - 219 lists VOC emitting equipment NOT requiring a permit
 - In order to meet 219 a RP must meet:
 - Rule 219 (l)(6)
 - 3 pounds/day VOC or 66 pounds per calendar month
 - Rule 219 (t):
 - Adequate recordkeeping per Rule 109
 - Daily log of usage
 - System for accurately measuring usage
 - $465\text{g/l} = 3.9 \text{ \#VOC per gal.} = 0.75 \text{ gallons per day usage limit per application station}$
 - $50\text{g/l} = .42\text{\#VOC per gal.} = 7.1 \text{ gallons per day limit}$

Alternative Technologies

- Vegetable Oil
- Water Based
- Straight Oil

RP-Vegetable Oil

- Low VOC
 - Most C18 oils around 1 g/l VOC
- “Veggies will be Veggies”
 - Double Carbon bonds makes them prone to gum/varnish formation
 - Reports of hard to clean films
 - One early user had to build a wire brush machine to remove hardened films
- Fully formulated fluids higher cost than petroleum

Water Based

- Ultra low VOC
- Comparable protection from current state of art compared to classic
- Problem: Water
 - When solvent evaporates, no chance it can subsequently rust parts
 - Longer drying time
 - Use heat?
 - Avoid closing parts containers until water is gone

Straight Petroleum Oil

- Challenges
 - Remove solvent
 - Lose demulsibility (water removing and separating)
 - Replace Naphthenic with Paraffinic oil
 - Paraffinic averages 80% less VOC for same viscosity grade
 - All old additive technology designed for Naphthenic
 - Without solvent evaporating, cannot form old-style films

Straight Oil

- New additives have been developed
- Field tested for 9 months
- Lab and Field Trial Results
 - Outperforming the “classic”
- Raw material costs roughly comparable

Metal Protecting Fluid Case Study

- Large Tube Mill in So. Calif.
 - Makes welded steel tubing
 - Rounds, 1 1/2" to 5" diameters, squares and rectangles up to 4" x 4"
 - Uses about 250 gallons per month of RP
 - Needs indoor storage up to 1 year
 - Copious amounts of coolant trapped in bundles of squares and rectangles



Field Trial Setup and Results

- Three field trials
 - Tested on 3" rounds, 1" x 2" rectangles, and 1 1/2" squares
- One bundle of each run and set aside
- Bundles opened t 2, 3 and 4 months post manufacturing
- In all cases, 60 to 90% reduction in rust/staining inside bundles
- No rust observed on exteriors
- Now in daily use on 5 mills

Metal Protecting Fluid Summary: “The Good”

- All three technologies are working
- Many options for end users
- Little cost of conversion
 - Only major costs are associated with heating water based
- All three commercially available in market today
- Water based and straight oil same or lower price

Low Viscosity Straight Oils

- Honing Oil

Honing

- Process involves using grinding blocks or “stones” in cylinders
 - Brake pistons
 - Engine cylinders
 - Hydraulic cylinders
- Goal is to create extremely uniform finish with excellent concentricity

Honing Tool

- This tool is inserted into a cylinder and then rotated



Honing Oil

- Classically made with Naphthenic Oil 40 or solvent, low viscosity esters or fats, and/or sulfurized fats
- Typical viscosity range is 4.3 to 10.3 cSt (40 to 60 SUS)
 - Allows for good flushing of “swarf” (broken down grinding stone and removed metal)
 - At these viscosities, Naphthenic Oils yield VOC over 75g/l
- No commercially practical Paraffinic Oils in marketplace in that range
 - Lowest common paraffinic is 13.1 cSt (70 SUS)

Honing Oil

- Possible solutions
 - Use more low viscosity (4.6 cSt) esters
 - Adds cost, too much reduces performance
 - Use synthetic basestocks
 - Extremely high cost

Honing Oils

“The Bad”

- Practical result of reformulation:
 - Largest manufacturer of Honing Oils and Honing Machines had 12 products commercially available in Los Angeles in 2010
 - Now has one as of December 2011
- Higher cost due to use of Paraffinnic
- Lower overall performance
 - One customer reports 2x reject rate due to poor swarf removal (leaves marks on finished product)

Vanishing Films

- Primarily used in Drawing and Stamping (“D&S”)
- Used on thin gauge (.035” thick or less) steels and aluminum
- Goal is to simultaneously extend die life and leave behind an imperceptible product residue
 - Parts can be welded, painted or plated with little or no cleaning

Vanishing Films

- Classic Formulation
 - $\geq 90\%$ Mineral Spirits or Odorless Mineral Sprits
 - Up to 10% additives
 - Low viscosity esters for lubricity
 - Low viscosity Extreme Pressure additive (typically phosphorous or chlorine) for heavier duty die protection
 - VOC 600 to 700g/l

Vanishing Films

- Challenges
 - Classic Solvents dry quickly
 - Solvent has zero potential for rust
 - Many times parts “nest” or stack together allowing for little or no evaporation
 - Cannot use oils, as they all leave too much residue

POSSIBLE SOLUTIONS

- Minimum Quantity Lubrication (“MQL”)
- Pre lubricated metal
- Water Based fluids
- Use VOC Exempt solvents

Vanishing Films-MQL

- Requires expensive equipment to apply
- Does not work on many parts
- If not adjusted properly leaves too much residue

MQL Applicator

- For stamping, they are typically custom manufactured to fit the size and needs of a given punch press



Image Copyright © 2010 ITW ROCOL North America

Vanishing Film-Pre-Lubricated Metal

- Not readily available on West Coast
- Too much residue

Vanishing Film-Water Extended Fluids

- Much less expensive than conventional when diluted with water
- Water equals ever present danger of rust
- Steep learning curve
 - Operators have to learn how to carefully control concentration
 - Too little-poor die life, rust
 - Too much-unacceptable residue
 - Parts cannot be packaged “wet”
- Very limited compatibility with “E-Galv” (electrodeposited zinc)

Vanishing Film-Exempt Solvents

- PCTBF
 - 5x the cost of conventional solvents
 - Strong “mothball” odor
 - Risk of central nervous system depression and long term damage
- Acetone
 - Flash point around 0°F-NFPA Fire rating is “4”, the highest level
 - May evaporate too quickly

Vanishing Film-Field Experience with Water Extended

- Customer #1
 - Large stamper in So. Calif.
 - Makes parts sold in home improvement stores
 - Parts have to be 100% rust and residue free
 - Tried multiple water-extended products from multiple suppliers
 - Selected a semi-synthetic with low residue and moderate die performance
 - Used for 1 year

Part Example

- Note the “nesting”



Vanishing Film-Field Experience with Water Extended (cont'd)

- To date have rusted 2 40' truckloads of parts
 - \$50,000.00 lost in ruined parts, sorting bad from good, and emergency production of replacements
- Root cause: lack of sufficient drying time on humid days results in parts shipping with excess water contamination
- Solution: Converted 2 days ago to exempt solvent formulation
 - Cost went from \$3.00/gallon to \$35.00/gallon
 - Purchased 4 new fans for odor removal
 - Employees are NOT happy about odor

Vanishing Film-Field Experience with Water Extended

- Customer #2
 - Makes lighting fixtures for high-tech architectural lighting
 - Parts nest together
 - Parts are “Just in Time”, ordered today and shipped tomorrow
 - Customer wants to paint fixtures without washing
 - Some parts are E-Galv
 - Customer’s marketing campaign prominently features “Made in USA” and 10 days from order to arrival at job site

Vanishing Film-Field Experience with Water Extended

- Tried 3 fluids reputedly “safe” on E-Galv
 - Two stained immediately
 - Third candidate left too much residue for customer
- Health and Safety officer rejected exempt solvent
 - Punch press cannot be adequately ventilated as it is in the center of the shop
- Solution: Customer will be working with SCAQMD towards a possible variance

Vanishing Film Summary

“Oh My!”

- No ethical company is entirely comfortable with substituting exempt solvents
 - They have ridiculously high costs, increased health risks, and poor operator acceptance
- Water extended has to walk a very fine line between rust and excess residue
 - Failure is exorbitantly costly
- MQL has high (\$2,000 to \$10,000) upfront capital costs and very mixed results
- Pre-lubes not practical on West Coast

CONCLUSION

- Metal Protecting
 - Good options are working and available
- Honing Oil
 - The jury is still out
- Vanishing Films
 - Much more work is needed
 - At this point, many replacements are not meeting customer's needs



THANKS FOR YOUR
ATTENTION!

QUESTIONS???

Mike Pearce
W.S. Dodge Oil Co.
March 8, 2012