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Mid Iowa Tools, Inc.
Metro Tool & Abrasives
McNeal Tool Company

Everything You Need to Know About Dielectric Fluids

INSIDE THIS ISSUE:

SUMMARY

High oxidation stability:
>600 minutes AST D877

Low viscosity:
32 to 36 (SUS @100°F)

High dielectric strength:
> 50Kv ASTM D877

Odor: Nil

Narrow distillation range:
IBP >470°F (243°C)

Low specific gravity/density:
typically <6.5 Lb/Gal

Low aromatic content: <0.1%

For sinking EDM machine users, the following is invaluable information about the key performance characteristics of dielectric fluids. It will help you better understand this product and make more informed buying decisions. We are deeply indebted to the author, Fred Herdman, President of Commonwealth Oil Corp., and we appreciate Fred's contribution to our industry.

Appropriate ASTM tests are referenced, where applicable. ASTM is the American Society of Testing Materials, and is the recognized body for establishing proper test methodology and procedures.

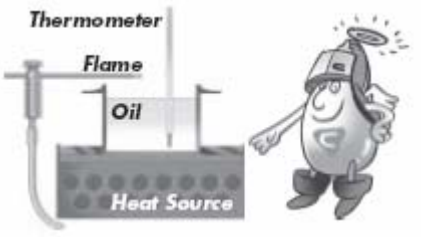
Petroleum Hydrocarbons

Natural petroleum hydrocarbons are an organic compound consisting exclusively of the elements carbon and hydrogen. They are derived principally from petroleum, coal tar and plant sources and are generally grouped into three types – aromatic, naphthenic and paraffinic. For environmental and health reasons, Commonwealth Oil uses paraffinic hydrocarbons wherever possible.

Most synthetic fluids are manufactured from chemical constituents or by polymerization of hydrocarbons (olefins), rather than by conventional refining processes. When compared to conventional oils, synthetics are more expensive, but have better oxidation stability, higher flash points, higher auto-ignition temperatures, lower volatility, and are less corrosive and toxic.

Flash Point

ASTM D92-52 (Cleveland Open Cup)



When a liquid petroleum product is exposed to air, some of it evaporates, causing a certain vapor/air concentration. As the temperature of the liquid product is raised, more and more evaporates, and the vapor/air ratio increases.

Eventually, a temperature is reached at which the vapor/air ratio is high enough to support momentary combustion, only if a source of ignition is present; an important differentiation from auto-ignition. This temperature is the Flash Point of the product.

Auto-Ignition Temperature

ASTM 659-78

If no ignition source is present, as heat increases above the product's flash point a temperature is reached at which the product will ignite spontaneously, without an external source of ignition. This is called the auto-ignition temperature of the fluid.

Product	Flash Point (°F)	Auto-Ignition Point (°F)
EDM Fluid (Oil)	259	410
Synthetic EDM	266	428
Mineral Seal Oil	260	455
Unleaded Gas	–40	752
Diesel Fuel	100	482
K-1 Kerosene	100	485
Propane	–108	878
Octane Booster	40	1,000

Comparing Typical Flash Points and Auto-Ignition Temperatures of Various Products.

Viscosity

ASTM D445-82

Viscosity is a measure of a liquid's resistance to flow. It arises from internal friction, which occurs when one layer of molecules of a solvent moves past an adjoining layer in that liquid. A higher viscosity value indicates the fluid is more "viscous", and flows more slowly than a lower viscosity fluid.

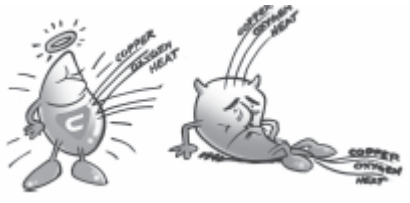
Viscosity is most commonly measured in Centistokes (cSt) @ 40°C or in Saybolt Universal Seconds (SUS) @ 100°F. It varies inversely with temperature; i.e., the warmer the fluid becomes, the thinner, or lower viscosity.

Viscosity is an important factor when considering an EDM fluid, since the lower the viscosity, the easier the fluid is to pump and the better its flushing characteristics.

Oxidation Stability

ASTM D2272

Oxidation is a form of deterioration; a chemical reaction that occurs between portions of the oil and whatever oxygen may be present. The oxidation of oils is accelerated by high temperature catalysts, such as copper. The rate of oxidation increases with time and temperature, and oxidation tends to raise the viscosity of an oil.



Oxidation stability is an important factor in the prediction of an oil's performance. The higher the operating temperature, the greater the need for oxidation stability, especially if water, catalytic metals or dirt are present.

Oxidation Stability is a very important consideration when selecting an EDM fluid. Lower quality, low cost fluids will oxidize much more quickly and shorten the life of the fluid by as much as 5–7 years.

Acid Number

ASTM D-974

This test indicates an EDM fluid's life expectancy. A specific quantity of KOH (potassium hydroxide) is required to counter-balance the acid characteristics.

How high an acid number can be tolerated depends on the oil and service conditions. An acid number in excess of 0.5 indicates a fluid at the end of its life expectancy.

Acid number is a measure of oxidation stability; the lower the number, the higher the stability; and higher stability results in longer fluid life and greater predictability in your costs.

> The real voyage of discovery consists not in seeing new landscapes, but in having new eyes.
>
> Marcel Proust

Evaporation Rate

ASTM D3539-76

Petroleum solvents are volatile materials, and evaporation rate can be an important factor in some applications, including EDM. Typically, evaporation rate is never constant for a mixture of compounds, but varies throughout the entire process.

Evaporation rate is important in EDM; it should be as slow as possible, to the point of almost being nil. Reduced evaporation means fewer top-ups of new fluid, and operators do not unnecessarily expose their respiratory systems to EDM fumes.

Aniline Point

ASTM D611-82

Aniline point is a measure of the solvency of a petroleum product; the lower the solvency, the higher the aniline point. Aromatic hydrocarbons have the greatest solvency and the lowest aniline points (usually well below room temperature), while naphthenic materials are intermediate between the paraffins and the aromatics.

If the Aniline Point is too low, it can cause excessive softening and "mushiness" of rubber components, tending to dissolve seals,hoses and gaskets. Low aniline point EDM fluids will also age very quickly.

Conductivity/Dielectric Constant

ASTM D877

Dielectric Strength/Breakdown Voltage is the minimum voltage required to produce an electric arc through the fluid. This value is the measure of the insulating (arc preventive) properties of an EDM fluid. A low dielectric-strength value may indicate contamination from dirt, and especially water, which is usually introduced to a system by compressed air.

Distillation Range

Distillation of any hydrocarbon product takes place over a range of temperatures. Initial boiling point (IBP) is the temperature at which the liquid begins to boil, and final boiling point (FBP) is the last measurable temperature prior to complete evaporation.

The narrower the distillation range, the fewer varieties of chemicals and hydrocarbons are present; thus a purer fluid. A narrow range also means a more uniform rate of evaporation for the whole fluid, with a resultant consistency in viscosity and flushing characteristics.

Avoid fluids with an IBP of less than 470°F.

Specific Gravity (Density)

ASTM D287

Comparative Weights/Gallon

Product	Density (Lbs/Gal)
EDM Fluid (Oil)	6.42
Synthetic EDM Fluid	6.49
Mineral Seal Oil	6.89
10W-30 Motor Oil	7.30
Water	8.34
Tapping Fluid	11.05

Density is the weight of a given product per unit volume (i.e. pounds per gallon), and is usually given as specific gravity. This is important to the EDM operator because the higher the density of a given fluid (the more it weighs per gallon), the longer any electrode material or metal particulate will stay in suspension.

A fluid which is too dense is undesirable, particularly with older machines, since too much micro-fine particulate matter in suspension can lead to uncontrolled DC arcing.

Sulfur Content

The more highly refined EDM fluids require extremely low sulfur levels. These products must be non-reactive and non-corrosive, and free of the odors caused by sulfur.

EDM fluids should not be considered for use with sulfur above 3 ppm.

Odor

High quality EDM fluid should be virtually odorless. The presence of a fuel or solvent type odor will always be a first indicator of a poor quality EDM fluid.

Color

Buy an EDM fluid listed as 30+ Saybolt, which means the color is “water white” (clear and colorless). Any fluid proposed for EDM applications which is not “water white” should be viewed with suspicion. Non-dyed EDM fluids with a faint, yellowish/off-white color are manufactured using lower quality raw materials. Off-color fluids often were intended for an application other than EDM, and may contain hazardous components. They also exhibit low oxidation stability, discolor very quickly, create foul odors, and cause both fluid and filters to fail prematurely. Some fluids use a coloring dye, which adds no value, but may mask or accelerate the oxidation process. Buying “water white” Commonwealth EDM fluids is your assurance of quality.

Aromatic Hydrocarbons

Any product with an aromatic content greater than 0.05% should be considered too dangerous. Aromatics are carcinogenic!

Examples are:

Toluene–CAS: 108-88-3 The 27th highest volume chemical produced in the U.S. (1985). Used in gasoline, adhesives, airplane glue, saccharin, and perfumes. Benzene–CAS: 71-43-2 The 16th highest volume chemical produced in the U.S. (1985). Used in detergents, solvents, chemical inter-mediaries, and in the manufacture of Maleic Anhydride (permanent press resins for textiles, and pesticides).

Low quality EDM fluids almost always contain high levels of free aromatic hydrocarbons; occasionally in excess of 17%!

Please contact your

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Sales Engineer for more

information or quotations.

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