KC WOODTURNERS CLUB – 10 OCTOBER, 2016 PRESENTATION

I. Introduction / Background – original requested topic was for turning alternate materials. Turning alternate materials is not high on my list, but I turn them because the price is right ***free!***

I worked for over 40 years as a chemist at was once COOK PAINT AND VARNISH. The subject I am most comfortable with is finishes. Objective is to cover basic chemistry, leading to finishes and tying this into alternate materials.

II. Chemistry – For simplicity I will deal only with the number of carbon atoms.

For illustration purposes I will use paperclips to show the number of carbon atoms. One paper clip represents one carbon atom which is methane gas, commonly known as natural gas.

Progressing up the line, propane is three carbon atoms. Butane has four carbon atoms. So far all three examples are gasses but under a little pressure butane becomes a liquid. Eight carbon atoms is octane, as in gasoline and another liquid. At about twenty carbon atoms there is another physical change from liquid to solid what you know as paraffin wax.
String thousands of carbon atoms together and you have polyethylene. Tens of thousands yields ultrahigh molecular weight polyethylene (UHMWPE).

The point of this is more carbon atoms result in physical changes from gas to liquid to solid and solids that are stronger. All examples are with chain like structures but in reality they can be branched making things more complicated.

So far I have dealt only with carbon. Bonded to carbon are hydrogen atoms. Here is where it gets complicated. Other atoms can be part of the molecule and those change physical and chemical properties.

Carbon to carbon double bonds introduces other properties. For one thing they are more likely to be a liquid even with many carbon atoms in the chain. Anyone remember in the 50's when talked about hydrogenating oils to make margarine. Double bonds can be reactive sites and is how drying oils and finishes like polyurethanes are able to increase the number of carbon atoms as they dry.

III. Polymers / finishes- Poly means many so polymers are made up of many similar units.

There are two categories of polymers. Thermoplastics are those that can be melted and reused. Some can be dissolved in a solvent, but not all. Milk bottles and pop bottles can be

Recycled by melting but there is no solvent that will dissolve them. Lacquer can be melted and can be dissolved in a solvent. These are examples of thermoplastics.

Thermosets require a chemical reaction to take place which increases the number of carbon atoms. Once this reaction has taken place, or ***set***, it can not be melted or recycled. Examples of this include: CA glue; epoxies; polyurethanes; and drying oils.

Epoxies require two different components, mixed together to start the chemical reaction. Part “A” is the epoxy and epoxy refers to a particular chemical structure. There are numerous part “A’s” in order to achieve various cured properties. Fast curing epoxies use a mercaptan for part “B” which smells skunky as there is sulfur in the molecule. Slower curing epoxies use amines for part “B”, and they have an ammonia type odor.

Drying oils, varnishes, polyurethanes and Danish oils all contain at least one carbon to carbon double bond. Oxygen reacts at the double bond, to link separate polymers together. If the starting polymer has one double bond and twenty carbon atoms the new polymer will now result in multiples of twenty carbon atoms, such as forty, sixty, etc. A polymer with forty carbon atoms will likely be soft and gummy.

Drying oils can contain up to three double bonds so once reacted the new polymer can contain any number of multiples. Generally more carbon atoms results in a more durable finish.

Varnishes and polyurethanes contain many more carbon atoms than drying oils so they will yield harder finishes.

Danish oils are a blend of polyurethane and drying oils.

Wipe on “poly” consists of polyurethane, thinned with more solvent. Each application results in less film build. Advantages include faster drying times and less film thickness.

Polymers that require oxygen to dry react faster if each application is thinner.

Driers will shorten dry time.

Raw linseed oil does not contain any “driers”. Boiled linseed refers to the fact that “driers” have been added to speed up dry times.

Additional dryer can be added for faster dry times of any of these polymers.

Driers available to buy are called “Japan Drier”. They are made by dissolving various metals in an organic acid and then cut with solvent to yield specific concentrations. Common metals can include: cobalt; calcium; iron; manganese; zinc; and others. They act as a catalyst

and shorten dry time. Concentrations less than 500 parts per million of the metals are low enough that they are not considered toxic.

Not all oils will contain driers; walnut oil and Tung oil are two examples.

Tung oil is another because it is so reactive that shelf life is a problem. Tung oil contains as many as three double bonds, yielding dense crosslinking. This crosslinking results in a harder surface and better moisture resistance.

Lacquer dries quickly, can be “feathered”, and repaired easily. Water resistance is limited as can be adhesion. Because it dries so fast it is best sprayed and that results in more solvent in the air. Lacquer thinners are a blend of solvent, some are very flammable and others can have strong odors.

Waterborne finishes start with a high molecular weight resin (more carbon atoms), which uses non-toxic solvents and water. They raise the grain, dry quickly so application is tricky. Additional coats are limited because unlike lacquer it does not bite into the previous coat. Low color is one of its strong points.

Epoxies can be both an adhesive and a finish. When used as a finish it is slow drying. It has good adhesion and good water resistance. They have very poor exterior durability.

Oil finishes yield limited gloss and should have several applications for best durability. In general they have fewer carbon atoms so the films tend to be softer. Gradually, over time they yellow developing a patina that can be appealing.

Any coating that requires oxygen to cure, such as oils and polyurethanes have limited shelf life once opened. Bloxygen is an inert gas that can be used to reduce oxygen content once the container has been opened, but my experience with it has had limited success. Any inert gas will work: nitrogen; carbon dioxide; even welding gases void of oxygen. In my experience they just reduce how much is thrown out before it gels.

My own experience started with “salad bowl” finishes. Once the can was half used, they gelled on me. Same thing happened with polyurethanes. I did not like using aerosol cans because of cost and limited spray control. Oil finishes took time to dry and required multiple coats and that did not fit what I wanted in the way of a finish. I did not have much success with water born finishes as they were harder to apply, raised the grain and in general did not provide a satisfactory coating.

Lacquers are what I finally settled on. They are easy to clean up, repair and in general to work with. I apply them with an air brush. With up to 50% by volume lacquer thinner I can spray a “wet” film that flows nicely and smoothly. First coat is Mylands cellulose sanding

Sealer. Second and third coats are Mohawk vinyl sealer. Final coats are Mohawk catalyzed lacquer. In between coats I sand with 320 and 400. After the final coat I sand down to 1500 and then use a polishing compound. Last thing I do is apply one coat of Gel Gloss. Gel Gloss has a cleaner, mild abrasive and wax that gives the final feel to my turnings.

Waxes are another way to protect the wood. It adds a small film that actually reduces surface friction and therefore a pleasing feel.

Solvents – General rule of thumb “like dissolves like”. What does this mean? There are “polar” solvents such as water and “non-polar” solvents (think of oil) and some that are in between (think many shades of gray).

Acetone is a good organic solvent. It cuts viscosity faster than most. Is fast evaporating and has low toxicity. With a flashpoint of twenty degrees Fahrenheit it is best to work with small amounts in confined areas. Water can be mixed with it in any proportion. Likewise it can cut many oils. I like it to use cleaning up CA glue as well as other finishes, particularly lacquer. First coats of many finishes will dry faster if cut with acetone, these can be epoxies, oil finishes and polyurethanes.

Denatured alcohol is a good substitute solvent for aniline dyes. I like it when using epoxies as a finish. It has some “polarity” to it.

Mineral spirits is at the other end, being “non-polar”. Consider it best for cleaning polyurethanes and oil finishes. V&P Naphtha is a purer and more expensive alternative to mineral spirits. These solvents have flash points above one hundred degrees Fahrenheit

Xylene, commonly labeled “xylol” is faster drying than naphtha so it is a good candidate for making wipe on poly from polyurethane.

Lacquer thinner is a mixture of fast and slow solvents. Some are “partially polar” like acetone, MEK, alcohols or ethyl acetate. Remainders are “non-polar” such as toluene, xylene and naphtha.

IV. Viscosity – The unit measurement is “Poise”. The standard is water, at one Poise, but is more often expressed as 100 cps (for centipoise).

Thin CA glue ranges from a single digit to about 25 cps. This gives you a number that shows it to be thinner than water.

Medium CA glue is 200-300 cps, or several times thicker than water.

Thick CA glue ranges between 1,100 – 1,500 cps which you could compare to honey.

Gel CA glue starts out in the medium range but has a chemical that gives it a false body so it will not drip or run. This chemical can separate with time so it should be shaken before use and possibly discarding the first drop or two.

V. Thermodynamics – A model for simple thermodynamics is that for every 10 degrees Celsius change the rate of reaction will change by a factor of two.

I will use epoxy as a good way to explain this. At 25 degrees C (77 degrees F) the epoxy will “gel” in 20 minutes. If the temperature goes up 10 degrees C (18 degrees F) it will now “gel” in 10 minutes. Take it up another 10 degrees and the “gel” time is again cut in half, or 5 minutes. Going down 10 degrees C, to 15 C, will double the gel time to 40 minutes. This will help explain the roll temperature has on cure time.

Using the same epoxy, there is another factor to be considered. That 20 minute “gel” time is for a 100 gram mixture in a cup. As soon as “A” and “B” are mixed the reaction starts and the clock is ticking. Heat starts to generate and in a concentrated mass the temperature can be close to boiling! This is mass sensitivity. Put that same 100 grams on two pieces of wood and there is no detectable change in temperature so it can stay liquid for hours.

VI. Alternate turning materials – Years ago, at work, someone that supplied Penn State with their polyester pen blanks called looking for another source of resin. I mentioned being a wood, and pen turner. He sent me several polyester pen blanks. Have since made some of my own.

I also had access to solid surface materials. So once again, ***free material***, I made paper towel holders and one bowl.

I use a lot of epoxy to fill cracks and color is added to them. These are mixed in used medicine bottles resulting in unusual coloring. These I turn to make Christmas ornaments. And again ***free material.***

Alternate turning materials are usually some form of plastic. Generally they have similar turning characteristics. I prefer scrapers over other tools and they must be sharp so carbide tools are best. Thermoplastics tend to machine better because heat from friction softens it so they cut easier. Thermosets tend to be harder and are easier to chip or crack. Chipping can be fixed with CA glue or with sanding.