Carb Chemistry 101

Cleaning Zinc Alloy Fuel Bodies By Bruce Smith

Since the invention of the carburetor in the late nineteenth and early twentieth centuries (when Zenith, Pallas, Pierburg, and SOLEX* were pioneering designs), there has been a need to clean the residues and reactants that accumulate during use. The crud that forms in and on carburetors and fuel pumps generally falls into two categories: organic (from petroleum residues, grease, and oil) and inorganic (from metal reactants, minerals, and salts). Most of these contaminants can plug jets, nozzles, and pathways, preventing proper mechanical operation. Some can also corrode and degrade the integrity of internal components. When a car is used on a regular basis, cycling fresh gas through the fuel system, most buildup will be associated with organic compounds. Reactions with gasoline, oil, varnish, grease, and atmospheric contaminants result in hydrocarbon residues of various mysterious forms. The exact composition of this gum isn't really important as long combative weapons are available. Early cleaners and degreasers were based on chlorinated hydrocarbons like carbon tetrachloride, used since about 1900 as a highly effective solvent. Methylene chloride (aka dichloromethane) was introduced around 1940 and has been the key ingredient in carburetor cleaners until recently. These chlorinated solvents pose serious health and environmental risks and have been phased out of consumer products over the past 30 years. Carb cleaners now contain less effective but safer solvents like acetone, toluene, and alcohol. Methylene chloride is still available and can be found if looked for. But people die every year from its improper handling. Using a safer alternative is probably a good idea.

Inorganic Residue in Old Fuel Bodies

Solvent-type cleaners do little or nothing regarding the inorganic stuff found in a carburetor or fuel pump. Although less of a concern in daily drivers, these residues are quite common in older cars that have been idle for some period of time. Many of these cars' carburetors and fuel pumps can have scale, flakes, crust, or powder in the float or fuel bowl. Knowing the composition of this inorganic contamination is more important in order to understand its origin and find an effective way to eradicate it.

The composition of much of the inorganic residues that accumulate in a fuel body is unique to pot metal. The main component of our carburetors and fuel pumps is zinc, alloyed with aluminum, magnesium, and copper. The acronym ZAMAK is a trade name for the alloy, substituting the German kupfer for copper. There are various standard formulations and European casting ZAMAK has a zinc content of about 95% with 4% aluminum and 1% copper. Most inorganic reactions are based on this zinc content, which can form deposits and lead to corrosion damage. Extreme examples result in internal corrosion sufficient enough to damage a casting beyond repair.

A bit of chemistry background is useful to understand the processes that occur. Zinc is resistant to corrosion if kept reasonably dry. A thin layer of zinc oxide naturally forms on the metal surface and will protect it from further corrosion. In wet conditions, a white porous residue of zinc carbonate, zinc hydroxide, and zinc oxide will form, consuming the zinc and leading to volume expansion of the residue by a up to 100X. But zinc corrosion may be less an issue on the outside of a carburetor than on the inside. The question is how these reactions can take place within a closed fuel system. Under ideal conditions, refined petroleum will not attack zinc. If fuel contains sufficient amounts of water or acidic compounds, reactions will occur to form corrosive byproducts. This can be accelerated with other contaminants like sulfates and chlorides.

Water Effects

Water content in gasoline is always a hot topic. With the introduction of oxygenated fuels and ethanol blended gasoline, concerns of water in fuel have increased. Since alcohol and water readily dissolve in each other, the ethanol added to gasoline will carry water along with it. An ethanol fuel mixture can have up to 0.5% water before phase separation (at 70°F) compared to 0.02% for pure gasoline. But even the water in pure gasoline can pose problems when the fuel is left open to the atmosphere for long periods of time. For instance, at a temperature of 100 °F, pure gasoline will reach water saturation in 200 days. In the float bowl of an open ZAMAK carburetor left filled with gasoline, this assures a constant supply of water (albeit it at low level) for chemical reactions with zinc to take place. Since the gasoline and water starve the reaction of free oxygen, a protective zinc oxide layer is prevented and corrosive compounds will form. The situation will be worse when ethanol is involved. Contaminants in the fuel and the atmosphere will also accelerate the problem. Fuel left for a long period in a gas tank will go through the same process, ensuring ideal conditions for corrosion in zinc fuel pump bodies as well. The worst case scenario for a carburetor is to replenish the gasoline in the float bowl after it evaporates, ensuring a good supply of water saturated fuel. Carried out over several years, this sets up the ideal conditions to maximize zinc reactions. The preventative solutions are to ensure that only fresh gas is in the fuel system and that the carburetor and fuel pump are run dry before storing.

Cleaning Organic & Inorganic Contaminants

So cleaning an old Zenith or SOLEX carburetor or a Pierburg fuel pump involves removing both organic deposits and inorganic byproducts. Methods can be mechanical or chemical and need to do as little harm as possible. Mechanical cleaning sufficient to reach all surfaces might suggest abrasive blasting. This however is a very bad idea not only from the standpoint of physical damage but, more importantly, from the media left behind that will eventually damage more that just the fuel system. Soda blasting may be more viable since sodium bicarbonate is water soluble and can be washed away, but special equipment is needed and the cleaning of cavities and passages can be difficult. Spray and ultrasonic cleaning are other forms of mechanical cleaning. Spray cleaning is common in large parts cleaning operations, which use dedicated equipment and an immersion tank. Spray pressures from 20 up to several hundred psi are used, often assisted with heat. Heated ultrasonic cleaning at is also an effective mechanical approach and can clean difficult to remove insoluble contaminants. Small parts ultrasonic cleaners are available for occasional home use but heavy use or large parts require industrial grade equipment. Mechanical soda blasting, spray cleaning, and ultrasonic cleaning are all available for small parts operation but aren't really necessary to achieve thorough cleaning of most ZAMAK fuel parts.

For chemical cleaning to be successful it needs to remove all contaminants without harming to the part being cleaned. Chemicals should also be safe to handle and easily disposed of. Chemical cleaning using hydrocarbon solvents may work for organic contaminants, but new formulations are lacking the necessary strength to do an adequate job. An alternative approach is the use of less hazardous degreasers, detergents, surfactants, and acidic or alkaline based chemicals to attack organic and inorganic buildup separately. The challenge is to find the right chemicals and an approach that will lead to acceptable results.

Cleaning a Zenith 32NDIX Carburetor

This Zenith 32NDIX carburetor exhibits a heavy buildup of varnish, deposits, and staining, and has probably been inoperable for a long while. Signs of corrosion are evident inside, with possible damage to internal cavities of the zinc body. Although a chlorinated solvent would probably clean the outside of ZAMAK surfaces, it would leave much of the internal residue behind. A safer solvent carburetor cleaner would probably give disappointing results all around.

A Multi-Step Cleaning Approach

Formulations for water soluble cleaners and degreasers are abundant. Many secret recipes and patents exist for industrial and household chemicals with various claims. A problem with these cleaners and degreasers is that their usefulness for any particular type of cleaning is uncertain until tested, and they not created equal. The usefulness of any one cleaner for ZAMAK can be predicted to some extent by looking at its composition and pH. Acids and bases are measured on a 0-14 pH scale, with higher values indicating basic (or alkaline) solutions and lower values corresponding to acids. Water has a neutral pH that falls near 7. Alkaline cleaners are generally effective at degreasing. Acidic cleaners can remove inorganic compounds including oxides, hydroxides, and chlorides but can attack metal as well. Zinc is readily etched in strong mineral acids like hydrochloric, acetic, and nitric acids, leading to the erosion of metal and the creation of metal compound byproducts. Zinc is more mildly etched in organic acids, the extent depending on specific chemical makeup. So the choice of cleaners and degreasers for ZAMAK needs to be made with special consideration.

Alkali and Acid Degreasers / Cleaners

Many cleaners and degreasers are commercially available. Among these are trademarked products like Simple Green, Greased Lightning, and Pine Sol. Chemically, there is little in common between these cleaners, as their formulas and pH values show:

Simple Green pH = 9.5
2-butoxyethonal (a solvent)
Ethoxylated alcohol (a surfactant)
Trisodium phosphate (TSP, a degreaser)
Sodium citrate (an acidity regulator)

Greased Lightning pH = 12.8
dipropylene glycol monomethyl ether (solvent)
dodecyclobenzene sulphonic acid (a surfactant)
sodium hydroxide (a base)
2,2-aminodiethanol (a foaming agent)

Pine Sol pH = 2
alkylalcohol ethoxylate (a surfactant)
glycolic acid (improves flow)
sodium petroleum sulfonate (an emulsifier)
isopropyl alcohol (a solvent)
Pine oil (a solvent)

Subjecting ZAMAK to these cleaners at high strengths will lead to varying results. Soaking for several hours in full strength alkaline degreasers (like Simple Green or Greased Lightning) will attack organic residue but won't adequately remove inorganic contaminants. Using a full strength acidic cleaner (like Pine Sol) for a long period can remove both organic and inorganic residue, leaving a thin zinc oxide layer on the surface than can be polished bright. But the low pH can lead to dangerous amounts of zinc erosion with prolonged soaking. Cleaning should therefore be separated into two phases – a long alkaline degreaser soak followed by a shorter acid cleaner soak. This can then be followed by a brush polishing step.

Three Simple Steps

Three simple steps to ZAMAK cleaning can be done at home using readily available cleaners and no special equipment other than a few buckets, a toothbrush, and some small brass wire brushes. The steps are as follows:

Step 1 – Alkali degreaser. The formulation for Greased Lightning is quite effective at removing organic buildup, used at 50% strength at room temperature (above 65°F) and soaking for 12 hours or more. Halfway through the process and again at the end, a light brushing with an old toothbrush will assist in the removal of the most stubborn dirt and deposits. Soaking beyond 12 hours may yield little additional removal but will do no harm to ZAMAK bodies. Rinsing is important and a 20 minute warm water rinse will remove the residual degreaser.

Step 2 – Acid cleaner. The acidic nature of Pine Sol works in two ways. It will dissolve the inorganic residue and produce a lightly adhered zinc oxide surface layer. A full strength Pine Sol soak for 2 hours at room temperature is sufficient and safe. A slow foaming will occur during soaking as hydrogen is released from the dissolving of inorganic residue. Soft brushing with a tooth brush mid-cycle will help and a final brushing at the end will remove reactants from the surface prior to rinsing. A 20 minute rinse should be followed by thorough drying of the parts and passages with compressed air.

Following these steps, a Zenith carburetor body will look as shown below. A uniform zinc oxide coating will cover all surfaces, which can be removed using a brass wire brush.

Step 3 – Zinc polishing. Polishing with a small brass wire brush is sufficient to remove the light surface oxide without scratching the zinc alloy, exposing bright zinc metal. These disposable brushes are cheap and one brush probably won't last longer than a single carburetor and top. Brushing the inside and outside of the ZAMAK body leads to results like those on the next page. The exterior of the carburetor is clean as are the inside cavities and passageways. The original internal corrosion in this carburetor left no appreciable damage behind. Threads can be chased, mating surfaces flattened, hardware plated, brass cleaned, jets sized, and the carburetor can be assembled and tested.

Continued

Above: After brushing with a brass wire brush, a successfully cleaned Zenith carburetor body - inside and out. Left: Too long in less than optimum conditions.

How Bad Can it Get?

Left too long neglected, ZAMAK casting will corrode beyond repair. The amount of damage in the poor Zenith body below is a result of unknown exposure to the elements not from the outside (which is in fairly good shape) but from within. After alkali degreasing and a long acid cleaning, the removal of corrosion revealed the extent of pitting inside this pot metal body (right). This carburetor had been out of commission for many years so the damage probably occurred without the help of ethanol in the fuel. There is a wide range of fuel additives that claim to allow fuel to remain in your car for prolonged periods. These are various petroleum distillates and organic solvents that may help prevent the breakdown of fuel that leads to gum formation.

But there is no miracle elixir that can prevent damage to zinc castings. Many additives contain alcohol, which will increase the capacity of gasoline for water and make matters worse. The best remedy is fresh gasoline or no gasoline - and eliminating ethanol if possible.

A Note about Safety

Although the chemicals used here are common household cleaners, it should be clear from their ingredient lists that they can contain some nasty stuff. Household cleaning products are responsible for about 10% of reported toxic exposures in the U.S. Ingredients should be considered poisonous and can be harmful to the skin, lungs, and eyes. Adequate ventilation is necessary, as are safety glasses, gloves, and common sense.

Membership Renewal / Join Form

Membership questions? email Membership@Porsche356Registry.org or call **651-342-1524**

Go to www.Porsche356Registry.org for fast and easy membership changes!

NO INTERNET ACCESS? PHOTOCOPY this page and mail to 356 Registry, PO Box 356, Stillwater, MN 55082

This is a (choose one)**:** _____ **New Membership.** _____ **Renewal. You may join or renew for up to 3 years.** _____ **Gift.** Please call 651-342-1524

Name _____

Address _____

City _____ State / Province _____ Zip / Postal code _____

Your EMAIL address _____ **BEST** way for us to stay in touch

We do **NOT** sell or rent our email list to anyone!

USA via Periodical mail	@$45 / year.	_____ years = $ _____	
USA via First Class mail	@$60 / year.	_____ years = $ _____	Country _____
Canada / Mexico	@$55 / year.	_____ years = $ _____	
International	@$65 / year.	_____ years = $ _____	

Check/Money Order enclosed _____ Charge credit card the total amount above: VISA ____ MASTERCARD ____ DISCOVER ____

Card number ____ ____ ____ ____ - ____ ____ ____ ____ - ____ ____ ____ ____ - ____ ____ ____ ____ Exp. date ____ / ____

Signature for credit card _____ Date _____