M14 Rifle Preservation and Soft Lubrication

By

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Foreword: The following information is for educational purposes. No guarantee is implied or given. The reader should exercise caution to not "read between the lines." This article is presented in order to remove some of the mystery surrounding lubricant performance. If you have a favorite lubricant, stick with it. No particular brand is endorsed herein. The following is an excerpt from the 03/24/07 draft of *M14 Rifle History and Development* Third Edition.

M14 Rifle Preservation

Corrosion – In layman's terms, corrosion is the wasting away of a material. This is not desirable but the M14 type rifle must be expected to perform in harsh environments. Thus, corrosion is an issue of concern in its design and application. Corrosion of metal parts can occur from contact from various sources such as chemicals, water immersion, humid air, human body sweat, salt water spray or microbes. Fine grain dust that is high in salts and carbonates, such as that found in Iraq, can corrode metal parts. Alloy aluminum, carbon steel and alloy steel surfaces will oxidize (rust) in moist air but at varying rates. Carbon and low alloy steels have similar poor corrosion resistance in aerated neutral pH water and sea water. Rubber and plastic materials are not immune from corrosion either. Corrosion of rubber and plastic can cause cracking or softening of rifle parts.

Stainless steels have good resistance in mild environments but are susceptible to localized chloride pitting corrosion from sources like salt water or body sweat. This susceptibility to chloride pitting corrosion is at its greatest when stainless steel is heated to a temperature around 195 degrees Fahrenheit, e.g., the M14 gas cylinder after firing. Martensitic stainless steels are used to manufacture some M14 type rifle parts (see USGI Part Materials). Martensitic stainless steels have the least corrosion resistance of the five types of stainless steels (see General Information on AISI 416 Stainless Steel). In sea water or in water near neutral pH, AISI 416 stainless steel will suffer general surface corrosion at a faster rate than carbon steel or low alloy steel. Martensitic stainless steels are also susceptible to hydrogen embrittlement cracking corrosion but this is not an issue when in service as a M14 type rifle part.

Preservation – Carbon and alloy steels can be preserved with coating or plating. Most M14 type rifle parts are made from alloy steels. Alloy steel parts are almost always coated with manganese phosphate or zinc phosphate coating for corrosion protection. Both methods of phosphate coating have been in use for decades.

Thomas Coslett developed and patented iron phosphate coating in 1907. Six years later, Frank Richards of the United Kingdom patented the process of manganese phosphate coating. In 1915, Clark Parker obtained the rights to both patents and formed the Parker Rust-Proof Phosphating Company of America. Zinc phosphate coating was developed by the Parker Rust Proof Company as an inexpensive alternative to manganese phosphate coating. The U. S. Patent for the zinc phosphate coating method was issued in 1942 to Van M. Darsey, an employee of the Parker Rust Proof Company.

Phosphate coatings can and do wear off of M14 rifle parts from normal use and handling. Many gunsmiths are equipped to refresh or replace the phosphate coating on parts with a worn finish. The color of phosphate coating on USGI M14 parts varies from light gray to green-gray to charcoal gray. Manganese phosphate produces darker shades of gray color finish. Zinc phosphate coats the parts with lighter shades of gray. M14 parts were phosphate coated in batches and by many companies for the U. S. government. As an example, the finish on the butt plate assembly was allowed to vary among shades from gray (FED-STD-595 color 36118) to black (FED-STD-595 color 37038). Consequently, the M14 enthusiast should not expect new-in-wrap or used USGI M14 parts to match in color when assembling a M14 type rifle.

The USGI rack grade barrel bore, gas piston, spindle valve, gas cylinder plug, operating rod front end, gas cylinder bore and commercial stainless steel barrels are not phosphate coated. The bolt roller was not coated at the factory but left bare. Some bolt rollers on stripped bolts were phosphate coated during arsenal or depot inspection, recoating and rewrap. Some alloy steel barrels are blued, such as the commercial barrels and the early 1980s military barrels made by Gene Barnett (see USGI M14 National Match barrels). Gun bluing and phosphate coatings will not adhere to stainless steel. Consequently, USGI M14 gas cylinders, spindle valves and gas cylinder plugs were blackened with molten sodium dichromate oxide coating. Commercial reproduction gas cylinders are protected with paint that will adhere to stainless steel. Alternately, the gas cylinder, spindle valve, front band and gas cylinder plug exterior surfaces can be preserved with a ceramic coating as is done by Jeffrey Shapiro (NY) as part of his National Match modification.

The M14 rack grade barrel bore is chromium plated for corrosion protection among other benefits (see USGI M14 Rack Grade Barrels). The process of chromium plating a rifle barrel was patented in 1932 by John M. Olin and Alfons G. Schuricht. John M. Olin was a chemical engineer at Western Cartridge Company when he and Mr. Schuricht developed the plating process. The two gentlemen developed the process as a means to minimize corrosion and erosion in gun barrels caused by the use of ammunition. Mr. Olin went on to become President of Olin Industries in 1944. In 1954, he was elected Chairman of the Board at the newly formed Olin Mathieson Chemical Corporation. Mr. Olin retired in 1957. He was awarded, solely or jointly, twenty-four patents for items related to firearms and ammunition. He passed away in 1982. Between 1953 and 2005, the John M. Olin

Foundation distributed more than $370,000,000 to politically conservative academic institutions.

Parts such as scope mounts and gas cylinder lock wrenches made from aluminum are typically anodized to prevent oxidation. All of these metal surface finishes serve to preserve M14 type rifle parts and accessories from the harmful effects of corrosion.

Wood Stock Preservation - Linseed oil, tung oil and a number of commercial wood finishes have been used with great success to bring out the natural beauty of M14 rifle stocks. Well-preserved wood M14 stocks command a collector premium.

There are four categories of surface finishes for preservation of wood gun stocks: 1) raw or pure oils 2) boiled oils 3) polymerized or bodied oils and 4) varnishes. When applied to a wood surface, these liquids harden into a solid film to form a protective seal. Oil and varnish finishes are susceptible to deterioration from mildew and fungus and generally do not offer ultraviolet light protection.

The first three categories, pure, boiled and polymerized oils, are known as drying oil finishes. Drying oils cure over time by forming a network of long chain molecules (polymerization) while reacting to the presence of oxygen (oxidation). Drying oils offer good, affordable moisture resistance and are easy to apply. Drying oil finishes soak into the wood thereby enhancing the natural appearance of the grain.

Raw or pure oils are obtained from plants. Raw oils that have been used at one time or another include linseed, tung, walnut, poppyseed, perilla and walnut oil. Raw oils take weeks to fully cure when applied to wood. All environmental factors and the applied oil film thicknesses being equal, tung oil will dry faster than linseed oil because it absorbs less oxygen. Among raw oils, linseed and tung oils are the universal choices for gun stock preservation. Linseed oil is an extract of the seed of the flax plant (*Linum usitatissimum*). Tung oil is made from tung tree nuts (*Aleurites fordii*). Tung oil is also known as chinawood oil. With age, linseed oil will turn yellow on a wood surface but tung oil is very resistant to yellowing.

Until 1942, the U. S. Army used raw linseed oil to preserve wood gun stocks. From M1 rifle production in 1942 until at least 1963 when the last M14 rifles were assembled with wood stocks, tung oil was the preservative used in the factory. Tung oil gives a more durable finish than linseed oil. For maintenance purposes, raw linseed oil was the preservative specified in U. S. Army M14 rifle technical manuals. U. S. Army manual FM 23-8 cautions against getting linseed oil on the metal parts. The reason for this is that a sticky gum can form on the metal parts from dried linseed oil.

Long curing time for wood finishes is not always desirable. Boiled oils have additives known as siccatives. A siccative is an oil soluble organic acid metal salt. Adding siccatives to raw drying oil reduces the cure time from weeks to less than two days. The presence of drying additives, siccatives, is what classifies it as boiled oil. Siccatives may contribute to yellowing of an oil finish but do not affect the water moisture content of the wood. Boiled linseed oil is a popular choice among civilian collectors. It gives the wood stock a military appearance without the long cure time.

There are two common polymerized or bodied oils, linseed and tung. Bodied oils are made by heating raw oil sufficiently in an oxygen-free atmosphere to complete polymerization. Thus, oil viscosity, or resistance to flow, of the polymerized or bodied oil is significantly increased. Bodied oil then only has to react with oxygen to fully cure. This results in a much faster cure time and a more durable film as compared to the raw oil. Bodied oils generally "set" after a day. Polymerized tung oil produces a smooth gloss appearance as compared to the matte finish of pure tung oil.

A varnish is typically a combination of drying oil, resin and a solvent. A varnish will form a hard surface on the wood stock as the solvent evaporates. Turpentine and turpentine substitutes, e.g., mineral spirits, are used as varnish solvents. Varnishes are sold in glossy, semi-gloss or satin finish. Varnishes have little or no color. There are several types of varnishes: acrylic, alkyd, drying oil, epoxy, lacquer, marine, polyurethane, resin, shellac, and violin. Polymerized linseed oil varnish is commonly sold as Danish oil. Varnishes dry faster and harder than drying oils and provide excellent water resistance but often lack aesthetic appeal. Some varnishes have additives for ultraviolet light protection.

Normal Climate Care – FM 23-8 requires a daily inspection of the M14 rifle to check for any corrosion when in use. For preservation, the same manual requires a light film of lubricating oil to be applied on all metal parts except the inside of the gas cylinder, the gas piston and the gas cylinder plug. Note: **The barrel bore and chamber should be cleaned, dried and checked clear of obstructions before firing.** Lubricant or bore cleaner left in the barrel can affect rifle accuracy. More significantly, foreign material may adversely increase chamber pressure.

Cold Climate Care - For temperatures below freezing, all moisture and excess lubricant must be removed to keep the rifle working properly. The U. S. Navy prescribes a light coat of the synthetic blend, Cleaner Lubricant Preservative (CLP), in subzero temperature. The Mk 14 Mod 0 operator manual states CLP will provide adequate lubrication between 0 and - 35 degrees Fahrenheit in areas where grease is normally applied with the exception of the bolt roller. Regardless, it is best to keep the rifle outside in the cold air in such conditions. Without risking loss of life or limb, cover the rifle with cover (poncho, blanket, tarp, etc.) to protect it from snow or ice. If the rifle is brought into a heated space, do not clean it until the rifle has reached room temperature.

Hot and Humid or Ocean Climate Care – Wipe metal surfaces dry and lightly coat with CLP or other preservative oil. This maintenance will help protect the rifle from the effects of perspiration or saltwater. If the rifle is submerged in saltwater, clean all metal surfaces with fresh water as soon as possible before drying and lubricating. Frequently apply raw or boiled linseed oil to the wood stock to keep it from swelling.

Desert Climate Care – Clean the rifle daily or more often to keep sand and dust from accumulating in the bore and on the moving parts. Keep the rifle dry and the muzzle and receiver covered when dust or sand is in the air. It is better to keep the rifle dry of soft lubricants in sandy areas. If not, oil or grease will collect dust and sand. The debris-laden lubricant then becomes abrasive when the rifle is employed. The U. S. Army has determined that moving vehicles in the desert, and firearms. This lesson also has application for ranchers and outdoorsmen who stow firearms in their vehicles. In sandy, dusty areas, the M14 rifle should be periodically wiped down with a clean soft cloth to keep down the dust build up. The M14 wood stock should be hand rubbed with raw or boiled linseed oil to keep it from drying out.

Muddy Area Climate Care - Clean, thoroughly dry and then lubricate the rifle as soon as possible.

M14 Rifle Lubrication

A comprehensive discourse of tribology is beyond the scope of this work. The reader is referred to U. S. Army manual EM 1110-2-1424 *Lubricants and Hydraulic Fluids* for an excellent introduction to the subject. The following information is intended to familiarize the reader with the topic of lubrication for the M14 type rifle. The M14 rifle needs lubrication under normal climate conditions to operate as designed while minimizing wear of the parts in sliding contact. The engineering materials used as lubricants in the M14 rifle can be divided into two categories, soft and hard.

Soft Lubricants – Oils, greases and sprays are used to lubricate moving parts within a firearm to facilitate proper function and minimize parts wear. Soft lubricants also provide modest protection against corrosion where applied. They are economical and readily available. Soft lubricants do not perform well in cold weather and do break down over time and with rifle use. Greases do not dissipate heat well and small quantities not easily dispensed. As a rule of thumb, more is not better for soft lubricants. The minimum amount of lubricant should be applied to the M14 rifle in its care.

Some ingredients and properties of grease are defined as follows:

Anti-wear (AW) additive - Solid lubricant particles are dispersed in grease to prevent metal-to-metal contact of lubricated surfaces. These solid particles are known as anti-wear additives. Phosphorous and zinc compounds and suspended polytetrafluoroethylene (PTFE) are common AW additives. Anti-wear additives are useful up to about 465 to 480 degrees Fahrenheit. Above that temperature range, the compounds begin to break down. Anti-wear additives will reduce the oxidation resistance of grease. Consequently, grease containing anti-wear additives will need to be reapplied much more often than grease without AW or oxidation inhibitor additives.

Apparent viscosity - Viscosity is the resistance of a fluid to flow. Oil has a consistent viscosity for a given temperature. The viscosity of grease decreases as the shear rate (speed of metal surfaces sliding against each other) increases. Thus, the apparent viscosity of a grease is its resistance to flow for a given shear rate at a given temperature.

Bleeding - Bleeding is the separation of the lubricant from the thickening agent in a grease.

Boiling point - The temperature at which the grease will begin to vaporize at atmospheric pressure.

Consistency - The hardness of grease. It is a primary factor in selecting suitable grease for a given application, e.g., lubrication of the M14 rifle.

Corrosion inhibitor – A corrosion inhibitor protects the lubricated metal surfaces from corrosion attack by moisture or other foreign contaminants.

Dropping Point – Dropping point is the temperature at which grease will drop from a standard test orifice.

Evaporation - The loss of the lubricant component of grease as it is heated.

Extreme pressure (EP) additive - An EP additive in grease prevents seizing of sliding metal surfaces under very high pressure. Graphite and molybdenum disulfide are common EP additives and may also be used for service above 600 degrees Fahrenheit.

Flash point - The vapor from the grease may ignite from an open flame above this temperature.

NLGI (National Lubricating Grease Institute) Number - A comparative scale number to indicate the hardness of grease as tested at 77 degrees Fahrenheit. The higher the NLGI number, the harder the grease. NLGI number 000 is the lowest rating (semi-fluid) and 6 is the highest (solid). The NLGI number for commercial and military rifle grease is usually 2 or 2.5.

Oxidation inhibitor – This is an additive that minimizes oxygen attack of the grease. Oxygen attack, or oxidation, will increase apparent viscosity. An oxidation inhibitor, or anti-oxidant, will extend the useful life of a soft lubricant. Oxidation inhibitors are consumed over time as the grease is exposed to the open air. Oxidation of grease also increases as its temperature increases. The higher the service temperature the sooner the grease will need replacement.

Penetration - A test for measuring the hardness or consistency of grease.

Pour point - The lowest temperature at which a grease or oil will flow under standardized test conditions.

Shear rate - The relative rate of sliding between molecules of the grease as it flows.

Water resistance – Water resistance is the ability to lubricate in the presence of water.

Most firearms lubricants today are petroleum based oils and greases. As of 2007, over 98 % of lubricating oils and greases were made with petroleum (mineral) oil. Lithium complex grease containing mineral oil is generally considered true multipurpose grease. Due to its versatility, lithium-based soap grease accounted for 72 % of the commercial market in 2007. Lithium-based soap greases have been available since 1942.

Although oils and greases will both lubricate metal surfaces in sliding contact, MIL-L-46003 compliant rifle grease is the specified military lubricant for the M14 rifle under "normal" climate conditions. Aside from military specification grease, there are a number of commercially formulated greases that provide adequate lubrication for the M14 type rifle in all but the most severe service conditions.

As a general rule, different greases should not be mixed together or applied one over another. If a new type of grease is to be used, the M14 type rifle should first be disassembled and thoroughly cleaned of all grease. Combining greases may result in a mixture that is too hard or too soft or the maximum useful temperature may be lowered too far or the enhanced performance of the additives may be diminished. As an example, a grease manufacturer, Henkel KGaA, notes on its specification sheet that Plastilube will lose its heat resistance if mixed with a grease containing a soap thickening agent.

SAE 10 engine oil or automatic transmission fluid can be used in a combat or other life threatening situation to lubricate a M14 rifle. Automobile engine oil *may* have corrosion inhibitor and anti-wear additives and/or *may* contain benzene. Some automobile engine oils do, some do not. Automobile engine oil should be used as a last-ditch option for lubricating the M14. A better choice for an expedient lubricant is automatic transmission fluid. Automatic transmission fluid does contain corrosion and oxidation inhibitors and will not break down until about 220 degrees Fahrenheit.

Grease is an emulsion of a fluid lubricant and a thickening agent. It may have additives for enhanced performance. *Typically*, the fluid lubricant is oil and the thickener is soap. The oil can be made from petroleum or a vegetable or a man-made synthetic composition. Aluminum-, calcium-, lithium- and sodium-based soaps are common thickening agents in greases. Complex grease will have a second thickening agent. The second thickener is added to increase the useful service temperature of the grease. All three parts, lubricant, thickener and additives, influence the properties and performance of grease. The lubricant portion of the grease can be from 50 % to 95 % by weight. The thickening agent(s) are generally 5 % to 20 % of the grease recipe and additives can be 0 % to 15 % of the composition by weight. Cost and the intended application (customer or end user requirements or specifications) for a grease influence what ingredients and how much of each make up a manufacturer’s "recipe."

The M14 rifle, like other firearms, is usually subject to short periods of use bracketed by long periods of inactivity. The M14 rifle has sliding contact of parts under an applied force, e.g., bolt-to-receiver, operating rod-to-receiver, hammer-to-bolt, etc. Lubricating oil will run or migrate from where it is needed with time so it is not well-suited for the M14. If a grease with too hard a consistency is applied to sliding surfaces, it may not flow to parts surfaces where needed during operation. The ideal M14 lubricant will be a type of multipurpose grease instead of oil.

The ideal M14 rifle grease should have: 1) the consistency of paste 2) good or better temperature resistance with minimal bleeding 2) good or better water resistance and 3) contain anti-wear, corrosion and oxidation inhibitors. Such properties are desirable because the M14 rifle is likely to perform in intemperate weather. Military specification MIL-PRF-63460 prohibits the use of graphite as an ingredient for Cleaner, Lubricant and Preservative. Since CLP is authorized for use in the Mk 14 Mod 0, and other military weapons subject to combat use, lubricant with graphite additive is not recommended.

Operating temperature has a significant effect on the performance of grease. As the operating temperature decreases, the apparent viscosity of grease increases to the point that it can cause the M14 to malfunction in its operating cycle. Generally, the low temperature operating limit for grease is its pour point. As operating temperature increases, softening and then bleeding will occur. As the temperature is further increased the lubricant in the grease will evaporate. The higher the operating temperature of the lubricated surface, the more frequent the grease will need to be reapplied. At even higher temperatures, the thickening agent and any additives will boil and break down chemically forming harmful solid deposits and off-gases. An industry rule of thumb is the service life of grease is halved for every 59 degrees Fahrenheit over 158 degrees Fahrenheit.

Over the years, Lubriplate and Plastilube grease have been issued to U. S. military troops for lubrication of the M14 rifle. Both greases serve well as lubricants for the M14 type rifle. Both contain mineral oil but the major difference is in the thickening agent. Lubriplate 130-A uses calcium-based soap and Plastilube is made with an inorganic clay thickener. The trademark, LUBRIPLATE, was registered to the Lubriplate Corporation (New York, NY) on October 06, 1931. The name LUBRIPLATE was later registered by Fiske Brothers Refining Co. (Newark, NJ) on October 19, 1948. The trademark registration has since expired. Lubriplate 130-A grease was developed for the M1 Garand rifle during World War II. It is pale yellow in color. Lubriplate 130-A is water resistant and contains anti-wear, oxidation, and corrosion additives. Lubriplate 130-A has a kinematic viscosity of 135 centiStokes at 104 degrees Fahrenheit. Greases with a base oil viscosity over 100 centiStokes at 104 degrees Fahrenheit are classified as high viscosity greases. The viscosity of the base lubricant is designed to meet the intended application. The sliding surfaces in the M14 rifle are not heavily loaded but do move at a fast *cyclic rate* of 750 times per minute. A high viscosity grease approximating the kinematic viscosity of Lubriplate 130-A and with consistency of children's paste, is then appropriate for the M14.

Plastilube grease was developed in January 1950 by Warren Refining & Chemical Company Corporation (Cleveland, OH). The name, PLASTILUBE, was registered to Warren Refining & Chemical on February 20, 1951. The trademark registration has expired. Plastilube is reddish-brown in color. It is thicker in consistency than Lubriplate.

The Military Qualified Products List for military specification rifle grease was last updated on March 02, 1992. The sole entry on the latest list is Lubriplate RG-62-A (equivalent to Lubriplate 130-A) made by Fiske Brothers Refining Company.

U. S. Army FM 23-8 specifies rifle grease should be applied at a number of contact points on the M14 as a part of normal maintenance: bolt locking recesses, the bolt camming lug on the hammer, operating rod camming surfaces, and the lip of the receiver that contacts the rear top edge of the bolt. As part of normal maintenance, M14 gunsmiths may also recommend a light film of rifle grease in: 1) the operating rod channel 2) the operating rod saddle that contacts the barrel 3) the bolt roller 4) the receiver bolt raceway 5) between the top of the lip of the front band and the bottom of the stock ferrule 6) the inside of the cylindrical portion of the operating rod 7) the inside diameter of the operating rod guide 8) the operating rod spring guide 9) the bottom of the rear sight base and 10) sides of the rear sight aperture. Grease should be removed and reapplied yearly to prevent solidification. Grease stored in containers deteriorates over a long period of time. The lubricant will typically separate from the thickener. In this condition, the grease may or may not still meet its design specifications. Tests for penetration, dropping point and oil separation are needed to determine if the grease is still usable.

The U. S. Navy cleaning regimen for the Mk 14 Mod 0 rifle is as follows: every 250 rounds - clean the bore and chamber; every 500 rounds - clean the gas piston and gas cylinder;

every 1000 rounds - 1) clean the rifle including the bolt, operating rod and connector 2) apply rifle grease to bolt lugs, receiver bolt raceways and recesses, bolt roller, receiver operating rod channel and operating rod camming surfaces and 3) clean and preserve other metal parts.

U. S. Army armorers applied MIL-G-10924 specification grease to M14 NM rifles. The official name of this grease is "Grease, automotive and artillery" and is commonly referred to as "GAA."

Cleaner, Lubricant, Preservative - The all-purpose weapons liquid Cleaner, Lubricant and Preservative (CLP) was adopted by the U. S. Department of Defense some time before July 1979 with promulgation of military specification MIL-L-63460. CLP replaced several different small and large caliber weapons cleaners, lubricants and preservatives in the U. S. military supply system. Where allowed by the operations and maintenance manual, e.g., Mk 14 Mod 0, CLP is authorized for use in lieu of rifle bore cleaner (MIL-PRF-372), medium preservative and lubricating oil (MIl-PRF-3150), low temperature weapons lubricant (MIL-PRF-14107), automatic weapons lubricant (MIL-L-46000) and rifle grease (MIL-G-46003).

Because MIL-L-63460 (now MIL-PRF-63460) was a performance specification and not a required list of recipe ingredients, the CLP formula composition was left to the USGI contractor to develop. CLP does tend to dry out after about one month after application on the rifle. If the particular brand of CLP has PTFE additive, the container should be shaken immediately prior to application as the PTFE tends to settle within minutes inside its container. Additionally, CLP with PTFE additive left in the bore will cause erratic accuracy for as many as twenty shots out of the rifle until blown out of the muzzle.

As of early 2007, military approved vendors and associated product designations for CLP included Sentinel Canada (SENT-CLP and CLP 22), Anderol, Inc. (ROYCO-634), Arpol Petroleum Co. (ARPOLUBE 63460), Shell International (Aeroshell Fluid 634), and LHB Industries (Pro CLP). In the commercial market, the CLP formula made by Royal Lubricants (marketed by Remington Arms) does not contain PTFE additive. The CLP liquid supplied by Armor Holdings contains PTFE additive.

Operating Temperature - The U. S. military has tested the M14 and M16 type rifles to determine the temperatures at which various parts are subject to during heavy use. Cookoff is a condition where ammunition is heated sufficiently from its surrounding environment to explode. Automatic rifles and machine guns are susceptible to this condition during heavy use. If the weapon is air cooled, has a thin contour barrel and is fired from a closed bolt, e.g., M14, the rate of fire needed for cookoff is substantially lowered. The rate of cooling of the M14 barrel limits its sustained rate of fire. The ambient temperature, length and contour of the barrel, the styles of hand guard and stock, and the attachment of a sound suppressor all affect the rate at which the barrel cools off. As the M14 rifle is fired, the temperature along the barrel will vary substantially. The chamber area will heat up the least. The barrel forward of the chamber up to the gas port will be the hottest section. As some of the gas flows into the gas cylinder, the barrel muzzle will not be quite so hot. Regardless, the temperature in each portion of the barrel will increase with the number of rounds and/or the rate of fire.

Most lubricants and cleaners left inside the bore will boil off as the barrel heats up before cookoff occurs. Each lubricant or cleaner will have its own boiling point. The commercial and military firearms lubricants researched all had boiling points in excess of 400 degrees Fahrenheit. For general comparison, butter in a heated frying pan will smoke at about 395 degrees Fahrenheit. As previously mentioned the bore should be swabbed clean and dry before firing to avoid loss of accuracy or any ill effects to the operator. Sliding surfaces of the M14 rifle will be less than 400 degrees Fahrenheit. Thus, firearms lubricants applied to sliding surfaces of the M14 should not boil off.

While not an evaluation of the M14, the following summary illustrates the approximate range of temperatures extant in a centerfire rifle barrel at cookoff. The U. S. Army conducted substantial testing of the M16A1 and M16A1E1 (later adopted as the M16A2) in 1982. Part of this testing included a thorough evaluation of the barrel temperatures under cookoff and sustained firing conditions. The profile of the M16A2 barrel approximates that of the M14 standard contour barrel.

In the cookoff test, the U. S. Army determined that the M16A1 could be fired at a rate of 85 rounds per minute for 150 rounds without cookoff. The maximum barrel temperature measured was 849 degrees Fahrenheit at a point 12.9 " from the breech end. Likewise, the M16A1E1 was able to fire 170 rounds per minute at the same rate without experiencing cookoff. The maximum barrel temperature for the M16A1E1 was 903 degrees Fahrenheit at a point 12.8 " from the breech face. In the testing of the two rifles, the lowest recorded temperatures at which cookoff occurred was 847 degrees Fahrenheit on the barrel surface at 12.9 " from the breech end and 338 degrees Fahrenheit on the chamber, both on the M16A1E1. Cookoff occurred at much higher chamber and mid-barrel surface temperatures in the sustained rate of fire test. It occurred at 564 degrees Fahrenheit and above at the chamber and 1,018 degrees Fahrenheit and above in the middle portion of the barrel. Cookoff occurred as soon as fifteen minutes of firing at 30 rounds per minute in the thinner barrel M16A1.

During development of the Mk 14 Mod 0, the Naval Surface Warfare Center (Crane, IN) found that cookoff could occur in as little as 150 rounds of continuous semi-automatic fire with a wood stock M14 on a hot sunny day. NSWC, in later testing, obtained the following temperature readings on a Mk 14 rifle fitted with a Smith Enterprise, Inc. M14DC sound suppressor and a third generation Sage International, Ltd. M14 EBR stock:

Mk 14 rifle fired in semi-automatic mode for 160 rounds at a rate of one per second then allowed to cool -

chamber temperature - 178 degrees Fahrenheit

gas cylinder temperature - 496 degrees Fahrenheit

sound suppressor temperature - 734 degrees Fahrenheit

cookoff - no cookoff after ten minutes

Mk 14 rifle fired in automatic mode for 200 rounds in twenty round bursts -

chamber temperature - 250 degrees Fahrenheit

gas cylinder temperature - 525 degrees Fahrenheit sound suppressor temperature - 1,107 degrees Fahrenheit

cookoff - cookoff occurred at sixty seconds

PTFE Additive in Firearms Lubricants under High Temperature - The following is not meant to be a comprehensive treatise on polytetrafluoroethylene (PTFE), its use and its limitations. However, the use of PTFE as an additive for firearms lubricants is a matter of some curiosity. It is beyond the scope of this work to fully address this issue but some facts are presented here as the basis for further inquiry on the part of the reader.

PTFE was discovered on April 06, 1938 by Dr. Roy J. Plunkett, a chemist at the Jackson Laboratory of E. I. du Pont de Nemours and Company, Inc. while working on a new air conditioning refrigerant. Kinetic Chemicals, Inc. (DuPont) patented PTFE in 1941. DuPont is the sole supplier of PTFE in the United States.

At room temperature, PTFE is a white wax-like substance. PTFE has very low friction resistance, excellent dielectric strength and high heat resistance. The first PTFE resin coated cooking pan was created in 1954 by Marc Gregoire (France). PTFE resin is a common coating for non-stick cookware. PTFE is used as an insulator in electrical cables, an ingredient in printed circuit boards and as a stain repellant on fabrics.

Due to its very low coefficient of friction, PTFE is used for applications where sliding action of parts is needed such as bearings, bushings, gears, slide plates and firearms. For these applications, PTFE particles are mixed with mineral oil as an anti-wear additive.

PTFE is chemically inert below 464 degrees Fahrenheit. If left unattended on a hot stove burner, PTFE resin cookware can reach temperatures high enough to release toxic byproducts into the immediate atmosphere. These toxic byproducts can be lethal to birds and can cause temporary flu-like symptoms in human beings. In a 1973 study of PTFE resin coated cookware, pet birds were found to die from the toxic fumes of PTFE when the PTFE resin coated cookware reached 536 degrees Fahrenheit.

As PTFE is heated above food cooking temperature, it begins to emit ultra fine particulate matter at 464 degrees Fahrenheit. It melts at 621 degrees Fahrenheit. Further heating of PTFE to very high temperatures results in the release of several toxic gases:

At 680 degrees Fahrenheit - difluoroacetic acid (DFA), hexafluoropropene (HFP), monofluoroacetic acid (MFA), perfluorooctanoic acid (PFOA), tetrafluoroethylene (TFE) and trifluoroacetic acid (TFA), ,

At 878 degrees Fahrenheit - silicon tetrafluoride (SiF_4)

At 887 degrees Fahrenheit - perfluoroisobutene (PFIB)

At 932 degrees Fahrenheit - carbonyl fluoride (CFO_2) and hydrofluoric acid (HF)

At 1,112 degrees Fahrenheit - octafluorocyclobutane (OFCB), perfluorobutane (PFB) and trifluoroacetic acid fluoride (CF_3COF),

At 1,202 degrees Fahrenheit - carbon tetrafluoride (CF_4)

Firearms cleaner, lubricant or preservative oil or grease containing PTFE additive applied to sliding surfaces of the M14 rifle will not reach a temperature of 464 degrees Fahrenheit or higher with the possible exception of the cylindrical portion of the operating rod and the operating rod guide. Thus, firearms cleaner, lubricant or preservative with PTFE additive will remain chemically inert when applied to the saddle portion of the operating rod and areas to the rear. Application of any cleaner, lubricant or preservative oil or grease containing PTFE additive forward of the chamber may result in deterioration of the PTFE additive.

Experience of the U. S. Marine Corps found that when CLP containing PTFE additive was left in the bore of a M14 rifle it would shoot erratically until the CLP had been blown out after the first fifteen to twenty rounds of fire. The accuracy would return indicating the washing out of the CLP with its PTFE additive. Even with automatic fire, it's unlikely any portion of the barrel surface would reach 464 degrees Fahrenheit or higher in no more than twenty rounds. If the M14 rifle was fitted with a sound suppressor, the propellant gases and any residual bore cleaner or preservative will blow back into the shooter's face each time the rifle is fired. If the bore cleaner or preservative contained PTFE additive then it is conceivable that some PTFE high temperature particulate or off-gas could be blown on to the shooter.

For civilian use, what cleaner, lubricant or preservative should be used for the M14 type rifle? No one product will perform all three functions in a superior manner. The M14 enthusiast should choose a different product for each need.

Each chemical product on the market should have a Material Safety Data Sheet (MSDS) available. If the MSDS cannot be found through an online search, the manufacturer or distributor should be contacted to obtain one. The MSDS is very helpful because it will give the reader the product physical data, any handling precautions to be aware of and it will usually disclose some, if not all, the product ingredients. Undoubtedly, the amount and type of ingredients in a firearms care product will vary from manufacturer to manufacturer for a similar product.

Disclaimer: The user of any firearms care product is responsible for following all manufacturer instructions and precautions. Follow all product instructions and warnings on the container. Some products should be used in well ventilated areas and/or may require skin protection. Never use these products in a manner other than what is intended by the product manufacturer.

Cleaner - Commercial brand bore cleaner that is suitable for removing gun powder residue and copper fouling.

Lubricant - Commercial NLGI # 2 grease made of mineral oil, a calcium complex or lithium complex soap, and additives. Both types of thickeners possess good to excellent water resistance. Sodium-based greases have poor water resistance. Grease containing synthetic oil serves just as well as those with mineral oil as a firearms lubricant but typically at additional retail cost.

For NLGI # 2 greases, lithium-based soap grease will remain fluid to a point between - 20 and 0 degrees Fahrenheit depending on the formulation. In comparison, a calcium-based soap grease with a NLGI # 2 rating is typically useable to a temperature between 0 and + 10 degrees Fahrenheit depending on its recipe. Calcium-based greases are usually more affordable than lithium-based greases.

The following list is a few of the common grease additives and their uses:

Antimony dialkyldithiocarbamate - antioxidant, anti-scuff, anti-wear, corrosion inhibitor, extreme pressure additive, friction reducer

Methylene-bis-dibutyldithiocarbamate - antioxidant and anti-wear

Potassium triborate - antioxidant and anti-wear

Zinc dialkyldithiocarbamate - anti-wear, corrosion inhibitor, and oxidation inhibitor

Zinc dialkyldithiophosphate - anti-wear, corrosion inhibitor

Zinc oxide - corrosion inhibitor

The civilian M14 type rifle owner will not likely need the high temperature or extreme pressure protection afforded by solid anti-wear additives such as graphite, molybdenum disulfide or PTFE. Grease with a service temperature up to 350 degrees Fahrenheit should suffice for civilian use.

Preservative - Commercial brand of Cleaner, Lubricant and Preservative (CLP) without PTFE additive due to concern over possible release of off-gases from elevated barrel temperature.