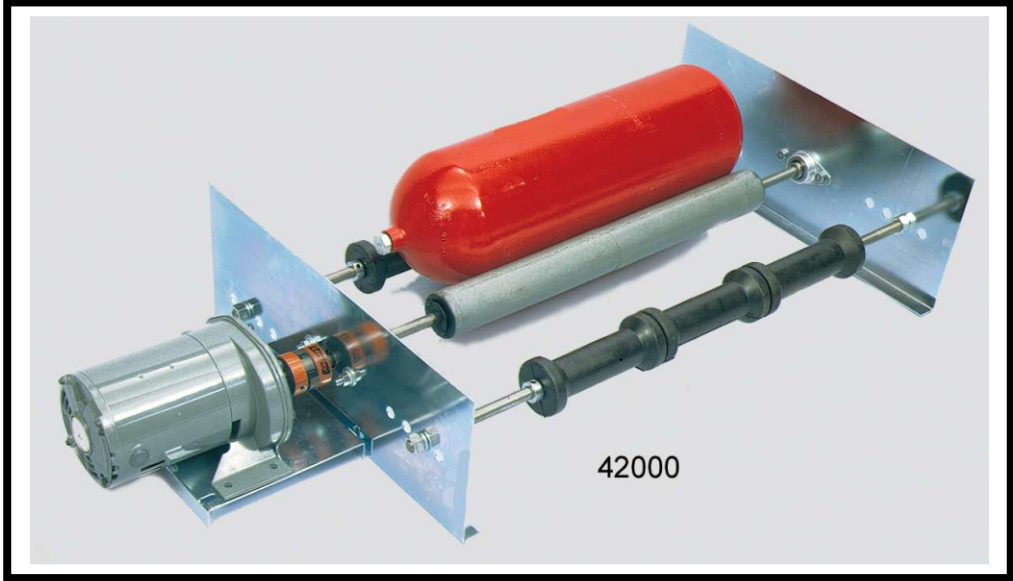


TANK CLEANING & TUMBLING TIPS ©



by
Dr. Dick Boyd, Greg Kent and Dave Anderson (GMC)
Fourth Edition / January, 2006

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OVERVIEW

SCUBA tanks can become contaminated with a variety of undesirable substances including rust, oil, water, filter chemical residue, silicone grease, crystalline aluminum oxide powder (Bayerite), epoxy liner chips, and foul odors! While removing some of these is simple, the elimination of most contaminants requires putting abrasive pellets with a solvent into the tank and then rolling it in a horizontal position for some period of time. This procedure involves certain specialized equipment, materials, and some generally obscure knowledge of tumbling operations. Therefore, the purpose of this bulletin is to provide fundamental information on tank cleaning techniques and equipment.

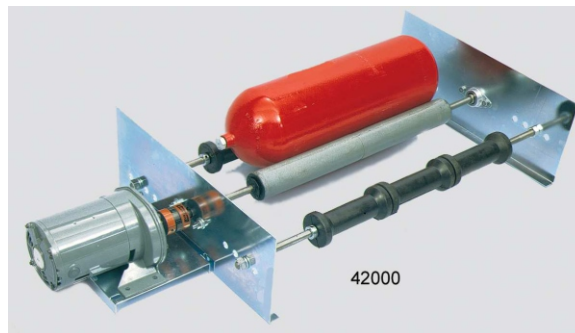
Considering the variety of cylinders that have been marketed over the past 50 years, it is not possible to cover every situation which the repairman might encounter. Nonetheless, this bulletin should provide enough basic information to allow one to develop workable procedures for most situations. Notably, the aluminum tank presently dominates the market, but steel has made a significant comeback. The majority of the operations described below are for the common 72 cu. ft. steel and 80 cu. ft. aluminum cylinders since these are respectively considered to be past and present industry standards. Of course, many other sizes have been manufactured, but the following PROCEDURES will generally work on any SIZE tank; the repairman need only adjust the quantities of materials to compensate for different tank capacities.

TANK TUMBLING IS AN INHERENTLY NOISY AND DIRTY BUSINESS. WHEN SETTING UP YOUR REPAIR SHOP, TAKE THIS INTO CONSIDERATION AND DO NOT ESTABLISH TUMBLING OPERATIONS WHERE CLEAN AND QUIET CONDITIONS ARE REQUIRED.

An additional resource that should be mentioned is Luxfer's manual, "Guide to Scuba Cylinder Inspection," a fine reference on aluminum tank maintenance (www.luxfercylinders.com).

CAUTION: CLEANING DIVE TANKS REQUIRES THE HANDLING OF VARIOUS ABRASIVE MATERIALS, LIQUID CLEANERS, GAS-FORMING CHEMICALS, AND HIGH-SPEED BRUSHING DEVICES. THE PRUDENT TECHNICIAN SHOULD EXERCISE CONTINUOUS CARE DURING THESE OPERATIONS AND WEAR PROTECTIVE GLOVES, CLOTHING AND GLASSES OR FACE SHIELD AS PERSONAL SAFETY MAY DICTATE.

TUMBLER MACHINES: Tank tumblers such as the GMC # 42000 are basically sets of horizontal rubber rollers powered by a ¼ HP gearmotor. The spacing of the rollers is usually adjustable so that the machine can handle tanks of various diameters. Tumblers must rotate scuba tanks at about 25-50 rpm (dependent on tank size/diameter) for proper cleaning to occur. Slower speeds work but greatly increase the cleaning time. Faster speeds, above 75 rpm, usually interfere with effective cleaning by causing the tumbling media to ricochet around inside the tank. The GMC tumbler will handle two scuba tanks at a time, but will not accommodate commercial size industrial cylinders.



TANK TUMBLING MEDIA: Cylinders to be cleaned must be partially filled with an abrasive substance nicknamed "Tumbling Chips". There are two popular types: aluminum oxide (GMC #42040) or ceramic pellets (GMC #2050). Aluminum oxide, similar to the Carborundum or Emery used on grinding wheels, is a very hard, pea-sized, random-shaped granule. It has excellent cleaning action and will last for years even under heavy use. Historically, it has been used for over 50 years for successful scuba tank cleaning.

Preformed ceramic pellets are a more recent innovation which were developed for industrial cutting and deburring processes. They are cast resins of a designed shape that contain abrasives such as quartz, aluminum oxide, or silicon carbide. Because of their specific shape, these pellets have a more predictable cutting activity over a given time span than does aluminum oxide. However, ceramic chips are more costly.



GMC also offers a Tumbling Expeditor (GMC #42055) that, when used in conjunction with aluminum oxide ceramic media, augments their cleaning action. A fine, abrasive grit, it speeds the cleaning activity in particularly dirty steel tanks, and often produces a high sheen finish in most cylinders. GMC now recommends it for all tumbling operations where especially dirty or pitted units are encountered. At this time, it is not recommended for use in aluminum tanks.

Over the years, many unorthodox materials have been employed as tumbling media by experimenting technicians. These have ranged from pea gravel to metal filings. While such aberrant substances may give successful results, these methods have little or no industry documentation to back them up if something goes wrong! The prudent repair service should stick with what has been time-tested and proven to work satisfactorily and safely!

ADDITIVE CLEANERS: Dive tanks can be tumbled either "wet" or "dry." In the "wet method," a liquid cleaning solution is added to the tumbling media; in the "dry procedure" only the chips are used. GMC believes that the "wet technique" clearly gives superior results with less chance for problems since dry tumbling causes rapid wear of media and produces excessive internal dust that often adheres electrostatically to the inside of the tank. This dust vigorously resists complete removal, which often results in a sub-standard job.

To prevent unwanted dust formation, most tumbling procedures utilize some liquid adjunct with the media. The simplest additives could be water containing a mild alkaline detergent such as a dish-washing soap. Patented cleaning agents such as Crystal Simple Green, Fantastic, 409, Blue Gold, etc. are also suitable. GMC recommends our Social Cleaner (#42100), a non-toxic, biodegradable, alkaline degreaser. It thoroughly suspends the debris being cut from the tank walls and enhances thorough rinsing of the interior after the tumbling process. A built-in anti-oxidant also retards new rust formation during final stages of the cleaning process.

In steel tanks only, the tumbling process can be hastened by using an acidic cleaning agent with the media. GMC Acidic Tank Cleaner (#42070), a mild form of phosphoric acid containing certain additives, can decrease tumbling times from the usual 12-24 hours to a mere 2-4 hours. While this can expedite rush repair jobs, greater care must be exercised to control the length of the procedure. Also, only acid-resistant tumbling media (ceramic) should be used in this procedure. Another method to promote fast tank cleaning, which does not involve acidic chemicals, is by using Tumbling Expeditor / "Grit" (GMC #45055) which is discussed later in this bulletin. (See "Tumbling Steel Tanks").

REMOVING THE TUMBLING MEDIA: After tumbling operations have been completed, the media and adjunct cleaner must be removed from the tank. This can be a laborious and dirty job without proper materials and methods. The actual process is described in detail later in this bulletin but at this point it's worth denoting some special tools that GMC manufactures for this work: #42020 is a tall, Tank Draining Stand to hold the cylinder in an elevated and inverted position. A Tank Purge Air Gun (GMC #42225), is used to swiftly eject the tumbling debris from the inverted cylinder into a suitable receptacle. Various "catch pans" and media-cleaning devices will be described later.



RINSING/DRYING PROCESSES: Now that the media / slurry has been removed, the tumbled cylinder must receive a thorough internal rinsing with clean water. Rinsed steel cylinders should then receive a brief treatment with a solution containing an anti-oxidant that will prevent "flashing" during drying. "Flashing" is a thin layer of bright red rust that often forms when a wet, highly polished steel surface is exposed to flowing air from the dryer. While experts suspect that flash rust DOES NOT lead to serious metal degeneration, its presence in dive tanks usually disturbs VIP inspectors and tank

owners alike. In short, flash rust within "finished" tanks makes your work appear suspect and unprofessional. The astute dive shop should avoid the potential problems associated with flash rust!

While tanks can be hand-rinsed with hoses or various home made rigs, this usually becomes a time-consuming, physical hassle, especially if numerous tanks are involved. The GMC Tank Washer (#42120) is a rugged metal stand that holds a cylinder in an inverted position while a perforated probe projects into the internal cavity. Connected to this probe is a short hose that can be attached to a water faucet. Simply place the Tank Washer in a sink or over a drain, attach the hose, turn on the water, and this internal sprinkler system will effortlessly flush the cylinder clean in just a few minutes! A colander or pan can be placed under the Tank Draining Stand to catch the few remaining media granules that might be flushed from the tank and down the drain. Finally, proper drying can be achieved by using a commercial heat-dryer or by circulating compressed air within the inverted tank. The GMC Tank Dryer (#42030) employs an industrial heat gun to blow hot air into the wet tank while it is inverted in a metal stand.

MECHANICS OF THE TUMBLING PROCESS

Recent studies using electron microscopes and other sophisticated instruments have elucidated the actual mechanics of tank tumbling. It is a time driven process, dependent on the formation of a "cutting or active slurry." After the tumbling media and the adjunct liquid cleaner have been placed in the tank, the abrasive activity slowly escalates as a slurry forms from the media, the liquid detergent, and the fine material being ground from the tank walls and the media itself. Several hours are required to produce a "cutting slurry." From that point, the cleaning activity accelerates until certain limiting boundaries are reached. Therefore, any change or variation of the process that might adversely affect the formation or quality of the slurry, might seriously hamper the cleaning activity! This is powerful testimony for NOT tinkering with a process that works.

OTHER CLEANING METHODS

WHIPPING & BOTTOM BRUSHING: Occasionally tanks may contain light coatings of rust or scale that do not warrant a full tumbling procedure. In such cases, the use of a Tank Whip (GMC #42170) may be the solution. This is a broom-like device possessing a cluster of long, ceramic-coated bristles crimped onto an aluminum rod. The free end of this rod is chucked into an electric drill and the broom end is inserted into the tank. When the drill is activated, the abrasive bristles flare out and flail the internal tank walls. The whip can be used dry or with a little soapy water. (Use dishwashing liquid or diluted GMC Special Cleaner.) The Whip is available in both a full size model (#42170) and a smaller version (#42175) for use on pony bottles.

SPECIAL NOTE: CARE SHOULD BE EXERCISED DURING TANK WHIPPING OPERATIONS

IT IS ADVISABLE TO WEAR SAFETY GLASSES WHEN USING ANY TYPE OF DRILL BRUSH OR WHIP.

BE SURE TO TURN OFF THE DRILL BEFORE WITHDRAWING WHIP FROM THE TANK; OTHERWISE, DAMAGE TO IT OR THE OPERATOR MAY OCCUR!

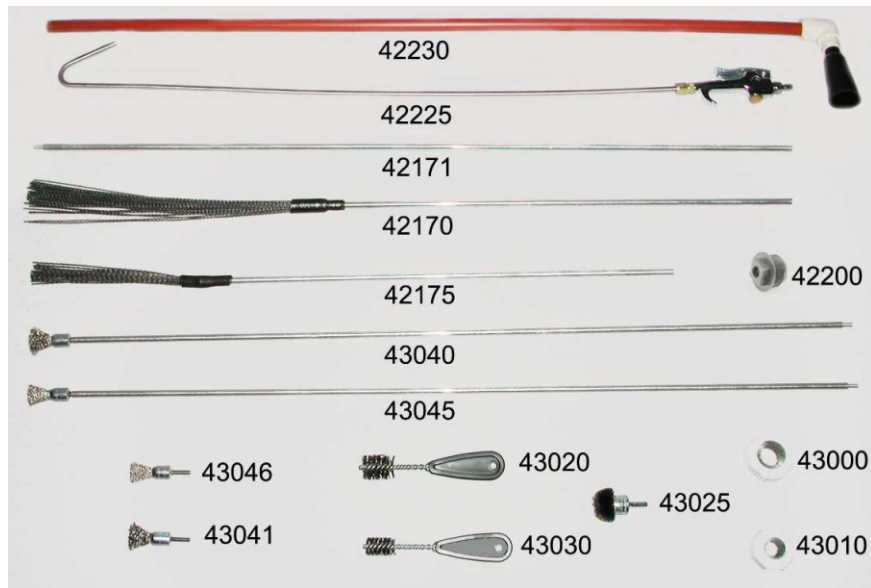
DO NOT STORE THE WHIP IN ANY MANNER WHICH SHARDS OR CRUNCHES THE BRISTLES BECAUSE THEY MAY BECOME CRACKED OR DEFORMED AND WILL THEN READILY BREAK OFF.

CERTAIN WHIPS MARKETED IN PAST YEARS WERE CONSTRUCTED FROM HEAVY CABLE OR CHAIN AND WERE INTENDED TO SCOUR OUT THICK-WALLED INDUSTRIAL CYLINDERS. THESE DEVICES SHOULD NOT BE USED FOR CLEANING BREATHING AIR TANKS.

The proper use of whips requires some practice. Whips are quite effective on minor contaminations such as Bayerite deposits in aluminum cylinders or light flash rust on steel models. However, they do NOT WORK WELL ON HEAVILY RUSTED OR PITTED TANKS CONTAINING EXTENSIVE CONTAMINANTS. A simple guideline to apply: If about 5 minutes of whipping has not removed the substance in question, it's probably a contaminant that a whip will NOT take out.

During whipping operations, care must be taken not to jam the whip too forcibly against the bottom sides of the cylinder. Excessive "whip pressure" can cause fracture of the bristles. One way to prevent this potential problem is the use of a whip guide. This device is a suitably threaded plug that has a 3/8" hole drilled through its center. After the whip is inserted into the tank, but before the drill is attached, the plug is slipped over the rod and screwed into the cylinder's neck threads. As the whipping procedure is carried out, the rod is moved up and down through the guide hole that controls and limits the angle and travel of the whip, thereby preventing bristle damage. GMC offers a Plastic Whip Guide (GMC #42200) for tanks with 3/4" NPS neck threads. Homemade guides can also be fabricated with PVC-plastic pipe plugs available in most hardware and farm supply stores. These plastic plugs usually have tapered pipe threads (3/4" NPT), but

they will engage the tank neck threads without harming them. Avoid using any metal plugs unless their threads are exactly equivalent to those in the tank neck.



Occasionally aluminum cylinders develop "spot contaminations" such as Bayerite pustules on the bottom. Due to their location, such deposits may be difficult to remove by whipping. In such instances, the use of a wire brush GMC Bottom Brush may be the answer. These small brushes screw onto aluminum rod that is rotated by an electric drill. They are available with a fine stainless wire (Light-Duty Bottom Brush w/ Rod - GMC #43040) or with coarse stainless wire (Heavy-Duty Bottom Brush w/ Rod - GMC #43045). Replacement brushes only are also available as Light-Duty (GMC #43041) or Heavy-Duty (GMC #43046) models. In general, the fine wire model is used on aluminum cylinders, whereas the coarse type is employed on steel tanks. The brushes will fit cylinders with narrow necks such as the high-pressure steel models.

Sometimes during VIP's or whipping/brushing operations loose debris, such as filter media, Teflon tape or metal thread shavings, is discovered inside tanks. Usually tumbling is not required, but purging these pollutants from the neck aperture is often difficult, even from an inverted cylinder. Particles can often adhere electrostatically to the wall, making their removal a major project. A slick way to overcome this problem involves the use of a shop vacuum cleaner. Using a suitable probe attached to the vacuum's hose, the tank bottom can be quickly and effectively cleaned of loose debris. GMC's Vacuum Attachment (GMC #42230) is a simple and inexpensive probe that will fit any small shop vacuum with a 1-1/4" diameter hose. This probe can be inserted into any breathing air cylinder and used to thoroughly clean the tank's bottom. (Homemade versions can also be fabricated with plastic pipe and fittings.) Light residues can be removed by vacuuming, whereas heavier ones may require a water-rinse as described in later sections.

TUMBLING TECHNIQUES

"To Tumble" or "To Hydrotest?" The first judgmental after discovering a contaminated tank is one of procedural order: What comes first... tumbling or hydrotesting? There is no easy answer to this question and various experts have differing opinions. Obviously, this dilemma is largely eliminated if the dive shop can do its own hydrotesting. If the tank is first tumbled, but later fails hydrotest, the cleaning operation was wasted time and money. On the other hand, a grossly rusted and pitted tank might be visually condemned even before hydrotesting. (It is perfectly legal for a licensed hydrotest agency to visually fail a badly contaminated cylinder). To complicate matters, thick rust can trap compressible air bubbles that may throw off the hydrotest, resulting in a false failure. Thick rust can also hide serious pitting.

However, it is usually a safe bet to clean a very dirty tank prior to hydrotesting. This is because very few tanks actually fail hydrotest, even if they were extremely dirty or rusty prior to cleaning. In the case of light contaminations that do not interfere with the detection of pits or cracks, probably makes little difference in which order the procedures are done. Traditionally, repairmen were concerned that the tumbling process itself might weaken the tank walls, so it was believed that mandatory hydrotesting must always FOLLOW tumbling. However, recent research has shown that tumbling a steel tank continuously for over two weeks removes so little metal that NO significant decrease in wall strength occurs! Clearly, normal tumbling times and procedures should NOT harm a tank. The upshot of this is that hydrotesting is NOT absolutely mandated after normal tumbling! On the other hand, any serious pitting or other internal degeneration that is exposed by the tumbling process may dictate a subsequent hydrotest even if the tank is not "out of date".

The bottom line is that each shop must work up a set of guidelines regarding hydrotesting versus tumbling based on both experience and common sense. When both operations are done by the same facility, this is a fairly simple matter. When several facilities are involved, a co-operative agreement is usually possible. Obviously, overall safety should ALWAYS be the overriding concern whenever doubt occurs.

TUMBLING STEEL TANKS: Alloy steel cylinders were the mainstay of sport diving for about 30 years until they were largely displaced by aluminum types in the mid-1970s. Notably, they are now making a strong comeback. High-pressure (3500 psi) steel cylinders, usually equipped with DIN valves, have become very popular with TEK divers, as have a variety of imported steel models, all of which are DOT approved. The special alloy used in some of these tanks is shown a propensity to form internal surface rust when exposed to even minor levels of moisture.

The neck openings on steel cylinders range from about 5/8" in diameter on the high pressure steel models with O-ring seals (likewise on older 1/2" NGT pipe thread types) about 1" on the common tanks with 3/4"-14 NPS threads. This "standard" thread is a straight pipe thread which seals with a large, 90-durometer (hardness) O-ring (GMC #48714). Here are some straight-forward considerations for choosing an abrasive medium for cleaning steel tanks: Because of their small size and aggressive action on steel, aluminum oxide nuggets are generally the abrasive of choice for tanks with narrow apertures. Due to their elongated shape, silicon carbide pellets are more difficult to get into such tanks. However, both types of pellets are equally easy to use in cylinders with large necks. Both media give good results. Bottom line: aluminum oxide is inexpensive and easy to handle, so it's the most popular material.

Since tumbling is carried out in a horizontal position, a tank must be a little over half-full of abrasive to get complete cleaning of the bottom and the upper neck areas. Easy filling can be accomplished by placing a large funnel into the tank neck and pouring in the media with a slow swirling motion to prevent it from jamming upon entry. Merely dumping media into the funnel will usually result in a pellet jam in small-necked cylinders! Obviously tanks possessing different internal volumes will likewise require differing amounts of media to be properly filled. For example, a 120 cu. ft. cylinder will need about 32 pounds of media, whereas a 72 cu. ft. model will require only 25 pounds. With a little experience, the technician will become familiar with the quantities needed to service common cylinders of various sizes. Once the correct amount of abrasive is determined for a given vessel, that quantity can be saved for future use in tanks of that size. Maintaining containers of pre-measured chips for tanks of specific sizes is a time saving technique used by very busy and savvy repair departments.

Next, add 1-2 quarts of cleaning solution consisting of water containing GMC Special Cleaner (GMC #4042) or equivalent alkaline degreaser. Dilute at a ratio of 1 part cleaner to about 100 parts of hot water (or 1 oz. cleaner to 1 gallon or 10 ml to about 1 liter of water). This solution suspends the debris abraded from the dirty tank walls and promotes thorough flushing during the rinsing process. The strength of the solution can be adjusted as desired but stronger solutions often cause excessive gas and foam formation during tumbling. Use of more than 2 quarts of solution is also undesirable because it interferes with the formation of an effective "abrasive slurry". Cleaning solutions containing common dishwashing soap or various alkaline degreasers can also be used, but they may be less effective than the Special Cleaner solution. When using degreasers other than GMC "Special Cleaner", the technician must determine the proper dilution based on its manufacturer's recommendations.

To prevent spillage during tumbling, proper sealing of the tank is essential. Any tank can be sealed with a matching valve, if a junk one is available for such use. Older tanks with 1/2" -NGT threads can be closed with 1/2" pipe plug available at any hardware store. Hi-pressure steel tanks present a unique problem because they contain an unusual 7/8"-14 hydraulic port thread. GMC sells a special plug (GMC #42205) for these tanks, as well as one (GMC #42210) for the common O-ring sealed dive tanks with 3/4"-14 straight pipe threads. For these latter tanks, a home-made seal can also be made by simply using a PVC plastic 3/4"-NPT pipe plug, easily obtained at a hardware store. Although the pitch of the plastic threads is slightly different than those of the tank neck, the plug will seal adequately and the plastic threads will not harm the metal cylinder threads. Emergency plugs can also be fabricated from shaved wooden dowels. This is considered a last-resort method.

Appropriate tumbling times are generally learned through experience, but light rust can usually be removed in 3-4 hours while heavier contamination may require an overnight tumble. Overnight tumbles are particularly convenient because the technician can put the dirty cylinder on the tumbler before leaving the shop and then remove it the next morning. Extremely heavy contaminations may take a full day or more of tumbling to rectify. If the steel cylinder is not clean after a 1-2 day tumble, it is probably a hopeless case!

To expedite or enhance the cleaning of steel tanks especially very dirty ones, Global Acidic Tank Cleaner (GMC #42070) can be used WITH CERAMIC MEDIA. Ceramic must be substituted for aluminum oxide media because the acid will attack the latter and produce serious gassing. **Even when ceramic media is used, considerable gassing can occur, and APPROPRIATE CAUTION, INCLUDING THE USE OF FACE AND CLOTHING PROTECTION,**

SHOULD BE USED WHEN UNSEALING THE TUMBLED TANK Instead of adding the previously described cleaning solution, use the acid diluted to 5 -10% strength with water. When compared to previously discussed methods, the time of tumbling will then be reduced to 1-3 hours. However, due to the aggressive nature of this procedure, timing the operation becomes more critical. **REMINDER: ACIDIC CLEANER MUST NEVER BE USED ON ALUMINUM TANKS BECAUSE IT WILL VIGOROUSLY ATTACK THAT METAL! ALSO, REMEMBER AN OLD RULE OF CHEMISTRY: WHEN DILUTING ACID, ALWAYS ADD ACID TO WATER...NEVER THE REVERSE. (GO BOOM!)**

Another, and perhaps more preferable, method for speeding the process of cleaning steel tanks is to employ GMC's NEW Tumbling Expeditor (GMC #42055). This fine, abrasive grit augments the cleaning activity in steel tanks when used in conjunction with aluminum oxide or ceramic media (See previous "Mechanics of the Tumbling Process" section). Only a couple of teaspoons are required per tumble. Not only does it speed the tumbling process in particularly dirty tanks, but it also produces a high sheen finish in most cylinders being cleaned. It is highly effective on pitted tanks. Consequently, GMC now recommends it for steel tank tumbling operations whenever a very dirty or pitted cylinder is encountered.

TUMBLING ALUMINUM TANKS: Aluminum tanks are generally easier to clean than steel models. The main contaminants involved are: strange odors, oil or carbon deposits, moisture or salt water, filter media escaped from faulty compressing/filtering apparatus, and Bayerite deposits. The last material is a crystalline form of aluminum oxide that usually occurs as a white powder, but sometimes hydrates to form clumps or sticky white blisters on the tank walls or bottom. These types of contaminants are most easily removed by a "Tumbling Wash", consisting of a tumble augmented with a suitable detergent. If the contamination is quite light, whipping or bottom brushing may be the preferred cleaning method.

To conduct a Tumbling Wash, use 5 to 25 pounds of ceramic or aluminum oxide chips with about 2 qts. of washing solution. The exact quantity of media to use depends upon how much of the volume of the tank must be cleaned: if little bottom cleaning is needed, 5- 8 pounds of media will usually do the job; if the entire inside must be scoured, 25 pounds or more may be required. The washing solution is GMC Social Cleaner (#42100), or other suitable alkaline degreaser, that is diluted at a ratio of 1 part cleaner to about 100 parts of hot water (or 1 oz. cleaner to 1 gallon or 10 ml to about 1 liter of water). Tumbling times are short, usually 15 -30 minutes, depending on the degree of pollution. A gain experience will allow the technician to fairly accurately predict the time and materials needed to remove different types and degrees of contamination. Lengthy tumbles of aluminum cylinders are NOT recommended by the manufacturers.

STRANGE ODORS: Aluminum tanks are very susceptible to the development of strange internal smells during prolonged storage (over a year). Repeated air fills, flushing, or simple detergent washes usually WILL NOT remove these odors because the offending molecules occlude "chemically" to the tank walls. A Tumbling Wash will effectively eliminate them because the abrasive agitation on the walls destroys the bonding activity and flushes out the offending contaminants! Similar smells can also develop in steel tanks, but longer storage times are usually required for them to occur. As with aluminum cylinders, a Tumbling Wash will deodorize steel models.

SPECIAL NOTE: Tumbling washes to remove odors or oil vapor contamination from tanks can be performed as described previously, using 8-10 pounds of media. Better yet, use 8-10 pounds of Glass Beads (GMC #4245) with the specific cleaning solution. Spherical glass beads will agitate the tank walls very thoroughly, but do any cutting action and therefore cannot damage internal tank linings or factory prepared surfaces.

INTERNAL LININGS: Over the years, STEEL tank manufacturers used a variety of methods to protect the inside of dive tanks from contaminants. These applications ranged from painting to epoxy coating to plastic bags. In the early 1960's, several companies used white or gray paint to internally coat steel tanks. In 1962 - 64, U. S. Divers employed a blue epoxy coating known as Vertronizing. From 1964 to the early 70's, a brown epoxy covering, much like today's no-stick Teflon was utilized by several companies. In the early 70's, AMF employed an inflatable plastic air bag in some cylinders.

In general, all these linings failed for various reasons: As they aged, many cracked, became loose, and produced free debris within the tank! Sometimes a leached lining developed significant rust beneath it where detection and removal became an extremely difficult task. In short, most linings became part of the very problem they were designed to solve.

Today the repair technician is often faced with requests to remove troublesome linings that have started to deteriorate. Unfortunately, there is no easy, safe, and economical way to do this. Chemicals which can dissolve the epoxy materials are highly toxic, nasty to handle and store, and are very expensive. Since most of them are on the EPA toxic substance "hit list," their use in dive tanks is unwise at best. Sometimes tumbling can remove linings, but such prolonged times are required that it is not cost-effective and might conceivably damage the tank itself.

One satisfactory and simple way to handle most flaking linings is the following two-step system :

1. First, give the tank a light tumble (1-2 hours maximum) to remove any obviously loose material. Longer tumbles will seldom remove ALL the lining but, in fact, may loosen areas that are presently adhering securely and posing no problem.
2. Next, if the valve has only one opening in the bottom of the particle stem, squeeze this orifice halfway closed in a vise. Be sure that the valve is shut off, and then drill a hole (about 1/8" diameter) completely through the stem about 1/2" up from the tip. Repeat this procedure approximately 2" further up the stem and at right angles to first drilling. Finally, open the valve and back-blow it with air to purge any metal chips from inside the particle stem. There is now a total of 5 discrete points of air entry to the valve, so the likelihood of any loose material occluding all the air orifices simultaneously is very small indeed.

Of course, the repairperson should always exercise good judgment whenever very loose, flaking linings are discovered. Certain liners, such as Vertronizing, often release large amounts of tiny chips once deterioration begins. Whenever safe use is doubtful, the tank should be condemned. In cases where a cylinder is currently deemed safe, but a suspect lining is encountered, a 6-month VIP cycle should be instituted. In addition, a stern warning should be issued to the owner to give the tank strict maintenance and exercise care during its use. The prudent repairperson should condemn or refuse to service, any lined cylinder when its continued safe use is a questionable matter.

In recent years, concern has been raised about the use of lined steel tanks for specialty oxygen applications. At this time, use of lined steel tanks with pure oxygen is considered unwise. The oxygen compatibility, or lack thereof, of the internal coatings with pressurized oxygen is unknown, but most of them would burn readily if ignited in an oxygen atmosphere. Sensible technicians should not clean / prepare lined steel tanks for oxygen service! See GMC's bulletin Converting Dive Tanks for Oxygen Service with GMC Oxy-Safe Products (GMC #42125).

Aluminum tanks do not contain linings like those in steel ones, but they do possess TREATED internal walls. Inner walls of aluminum tanks of 1970's vintage were chemically altered and appear dark gray upon inspection. This process, known as "Alrock", is a controlled form of oxidation that produces a self-limiting corrosion barrier. In the 1980's, "Alrock" was used interchangeably with a process called "Irridite" which produces shiny and very reflective inner walls. Irridite and similar processes are used at the present time. Aluminum tank manufacturers report that internal tank walls can range in appearance from dark gray to almost black or brown up to light grayish-white and reflective. Streaked patterns are also common. All of these described states are considered to be perfectly normal!

Because the interior walls of aluminum tanks have these protective surfaces, the technician should use minimal tumbling operations whenever possible. Fortunately, these treatments do have inherent self-healing properties and the oxidative coating can regenerate itself even after notable damage! Nonetheless, the prudent technician will employ the least aggressive procedures so as to minimize any damage to these factory-prepared internal surfaces.

POST-TUMBLING OPERATIONS

REMOVING MEDIA AND RINSING TANKS: After tumbling operations are completed, the media must be removed and the cylinder thoroughly rinsed internally. This can be difficult because the media often jams in the neck aperture and obstructs drainage. Tanks with small necks filled with ceramic pellets can be especially troublesome in this regard. A handy trick to overcome such situations involves the injection of low-pressure compressed air into the tank which is inverted in a Tank Draining Stand (GMC #42020). The gas slightly pressurizes the area behind the pellets, causing them and the liquid to be rapidly expelled from the neck. GMC's Tank Purge Air Gun (GMC #42225) is the tool to perform this task. Snap this air gun onto any pressurized BC hose, place the curved tube nozzle into the neck of the inverted tank and inject a steady flow of air to expel the media. The pressure created will quickly get a slurry of liquid and media into a suitably-sized receptacle placed beneath the Tank Draining Stand. If a perforated container is set inside the "catch pan", the tumbling chips can be collected and quickly separated from the waste liquid. A cornmeal-sized colander works well for this purpose.

Another approach is to drill a series of small holes in the "catch pan" itself so that the waste liquid can drain away. The disadvantage to this method is that now the entire media-removal-washing operation must be carried out in a sink or over a floor drain. Since tanks filled with media and liquid are extremely heavy and awkward to handle, they can be difficult to wrestle into a sink. Therefore, many technicians prefer to use the first method described or to simply later transfer the captured media / slurry into a perforated container for eventual separation, rinsing and drying of the media.

Sludge adhering to the inside of the tank must be flushed out. This can be accomplished by partially filling the cylinder with clean, cold water, agitating, and emptying it. This rather physical job can be greatly automated by using the Global's Tank Washer (GMC #42120) previously described. Of course, the creative technician can also fabricate a "homemade rig" composed of a tank stand, water-injecting probe, and hose.

Sometimes after tumbling a cylinder, excessive gassing or foaming is discovered inside when the neck plug is removed. This is due to complex chemical reactions between cleaning solutions and the various contaminants that may be present. Exactly how much foaming/gassing may occur per given tumble is very hard to predict because of the many factors involved. One simple method to reduce this unwanted activity is to merely cut back on the strength of the cleaning solution. For example, when GMC Special Cleaner is used as the solvent, change the dilution ratio to 05 parts cleaner to about 100 parts of hot water (or 1/2 oz. cleaner to 1 gallon or 5 ml to about 1 liter of water).

FLASH RUST PROBLEMS: Considerable care must be exercised during the rinsing operations so that flash rust is not produced in newly cleaned steel tanks. The highly polished metal walls will surface-oxidize VERY quickly. Therefore, a steel tank should be promptly rinsed with COLD WATER and then treated prior to drying with an approved anti-oxidant such as GMC Oxy-Safe Rust Inhibitor / Compound O (#42220). Failure to do so will probably result in flash rust in 50% or more of the steel tanks that have tumbled clean! Obviously, flash rust is never a problem in aluminum tanks, and no rust inhibitor treatment is required during their service.

SPECIAL NOTE: GMC previously offered a rust inhibitor designated Compound B. It has been discontinued and replaced by Compound O (GMC #42220). Because Compound B is NOT oxygen-compatible and is unsuitable for cylinders to be utilized for Nitrox / O₂ applications, it has been replaced with the equally effective, but oxygen-compatible Compound O. Compound B was a very effective product, which was quite popular for tumbling operations for many years and may still be found in some dive facilities. Chemically, Compound O is diethanolamine, whereas Compound B was sodium nitrite. Because that preparation is not oxygen compatible, GMC suggests that dive shops that are servicing Nitrox/O₂ tanks rid their service departments of any remaining Compound B so that it could not be mistakenly used in an oxygen cylinder. Compound O comes as a liquid concentrate, yellowish-green in color.

Follow this procedure for using Compound O to pre-treat steel tanks prior to drying :

1. Dilute Compound O concentrate by putting 1 oz into one gallon of water (8 ml into 1 liter). The use of distilled water for this purpose will insure the elimination of any unwanted contaminants in the water that may interfere with its rust inhibiting activity. This diluted solution will remain active for approximately 30 days, whereas the shelf life of the concentrate is indeterminate.
2. Immediately after the rinsing process, pour about 1 pint of diluted Compound O into the damp tank; return the cylinder to the tumbler for 3-5 minutes to evenly wet the interior with the inhibitor.
3. Pour out the liquid, return the tank to the rinsing apparatus, and flush for **another 5 SECONDS ONLY . CAREFUL TIMING OF THIS FINAL RINSE IS VERY IMPORTANT** to remove most, but not all, of the Compound O. Trace remaining will halt flash rust and be dissipated during drying. However, **EXCESSIVE RINSING WILL NEGATE THE ANTI-RUST ACTIVITY**. Remove the tank and **IMMEDIATELY** dry it by usual methods.

Some technicians have expressed concern about the trace of Compound O that may be left within the cylinders following this rinse. If this procedure is performed properly, the minute amount of remaining residue will be dissipated during drying. Compound O is not considered hazardous or toxic in trace amounts. From a historical standpoint, this method has been successfully used for years with both Compound O and B without occurrence of any health problems.

Occasionally a repairperson will properly follow all the above procedures and still encounter a case of flash rusting. While numerous variables inherent in tank cleaning can contribute to occasional failures, they are often traced to water quality or to drying techniques. Unquestionably, both water chemistry and quality vary greatly in different geographic areas. The mineral content can interfere with Compound O or leave residues within the tank. In such cases, changing water sources may eliminate the interference reactions that allow flash rust to form.

In past times as an economy measure, some technicians would collect the anti-rust rinsing solution from the treated cylinder and reuse it in other tanks. Chemically, this was feasible as long as the solution maintained its yellow color. GMC considers this practice unwise due to the chance of cross-contaminating cylinders. Furthermore, because anti-rust rinse solutions are used at such high dilutions, a gallon of the concentrate goes a long way (treats at least 1000 tanks)! In short, the practice is really extra work for false economy.

Drying must be done immediately and rapidly. If it appreciably delayed or carried out by very slow methods, flash rusting may occur. In one example of an improper technique, technicians trickled a slow stream of compressed air from a scuba regulator through a newly cleaned, upright scuba cylinder. Flash rusting still occurred. Using that same procedure with a rapid blast of air into an inverted tank (just short of launching it out of the stand) gave rust-free results because of the speed of drying.

SPECIAL NOTE: Dive shops that contract out their tank testing to hydrotest services often complain that steel cylinders which were clean prior to hydro, are returned with flash rust. This is because many hydrotesters do not fully understand the additional requirements and nuances for breathing air tanks. Consequently, they do not employ air-tight treatments prior to drying. Dive shops have solved this problem by either providing anti-flash chemicals to the hydrotest agency or encouraging the facility to purchase the anti-flash treatment and incorporate its use as standard procedure. Any additional costs incurred can be figured into retail pricing.

MEDIA CONTAMINATION: Be aware that your media can become contaminated with the residue from previous tumbling operations. If media is not cleaned frequently, contaminants will be carried from one operation to the next and may promote undesirable interference reactions such as media decomposition, foaming, or flash rust formation! Therefore, you should periodically wash dirty media with hot, soapy water. This can be done most effectively by placing the media into a colander, a mesh-screen container, or a pan with perforated bottom. Set the container into a large sink where running water is handy. Add a little detergent to the media, turn on the hot water tap, and flush the media for 5 minutes, stirring occasionally. Rapid permeation and drainage through the material should occur.

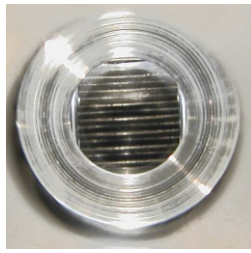
SPECIAL NOTE: Because tumbling media does acquire some degree of contamination, abrasives used in air tanks should NOT be interchangeably utilized in Nitrox/O₂ tanks. The possibility of crossover contamination is very real, so abrasives used for oxygen service should be dedicated to that purpose!

DRYING CYLINDERS: Immediately after tumbling and rinsing, prompt drying and re-valving of tanks is important to prevent recontamination. Inverted wet tanks can be successfully dried by means of a jet of low-pressure compressed air. This can be air released from a scuba tank, air storage bank, or large compressor. A valve or regulator must be employed to control the airflow to the tank so that it is not accidentally "blown" by excessive pressure. Nevertheless, considerable airflow must be maintained to achieve proper drying without flashing.

Most common dryers, such as the GMC #42030, utilize a gun to blow hot air into the inverted cylinder to purge/evaporate the moisture quickly. Since heatings involved, some care must be taken to supervise the temperature because most guns can attain a muzzle temperature of 500° F or more. While this temperature would not harm a steel tank, aluminum ones are a different matter. Sustained temperatures above 350° F can remove the temper from T6 aluminum thereby severely weakening the cylinder and creating the possibility of explosive failure. Therefore, aluminum tanks should be dried on "NO HEAT" OR "LOW HEAT" settings, or by some other closely supervised procedure. Some technicians alter between the "heat" and "no heat" settings, using 3-5 minutes on each setting. Obviously, this procedure still requires reasonable supervision to prevent accidental over-heating. Luxfer, a principal manufacturer of aluminum scuba tanks, provides the following data regarding heat resistance: 280° F can be tolerated for 24 hours; 280° to 320° F for 90 minutes; and 320° to 350° F for 30 minutes.

This data suggests that, while a 500° F heat gun could damage an aluminum tank, an appreciable period of heating would be required to get the entire mass to a critical temperature. Still, the prudent technician should carefully and cautiously manage the drying of aluminum tanks! Steel tanks should be dried on full heat until the bottom of the inverted tank feels quite warm to the touch. After a tank has been completely dried and received a final internal inspection, it can be revalved and filled.

CLEANING AND REINSTALLING VALVES: Whenever a tank is tumbled, it is sensible and typical to inspect and service its valve at the same time. The valve may require a complete overhaul with new internal seals and seat, or at the very least, replacement of the main O-ring seals. The large O-ring, which mates the valve to the tank neck, almost always deforms under pressure into square or triangular shapes. Such malformed O-rings should never be reused. Replace them with new ones of the proper size and hardness. Beware that the industry has recently gone to specifications of increased hardness for this application because of the higher service pressures of modern dive tanks. Use GMC #48714 for common 3/4-14 threaded valves, and #48616 for high-pressure (3500psi) steel models.



Carefully inspect the neck threads by standard VIP procedures or by using GMC's NEW Tank Inspection Pipe /T.I.P. (GMC #42215), an optical thread magnifier that offers a sharp, detailed view of cylinder's threads and neck region. Remember that any suspicious thread damage may be reason to condemn the cylinder and that rethreading a DOT pressure vessel is forbidden! Valve threads are always lubricated prior to installation, and most tank manufacturers recommend Dow 111 silicone grease for this purpose. This is a very thick, sticky compound that lubricates and protects both the valve and tank threads from electrolysis. Such a compound is known as a dielectric. Another chemical sometimes used for this purpose is Molykote 557.

One disadvantage to Dow 111 is that it can be displaced into the interior cavity of the cylinder by a combination of heat and pressure surging. Since the O-ring seal is at the upper end of the straight valve threads, there is no barrier to prevent the grease from entering the tank itself. During hot weather, warmed grease can be pushed by pressure into the vessel interior where it forms long, sticky "runs" down the inside of the walls. This can happen easily if the tank is rapidly pressurized by a so-called "jet-fill". When displacement of the valve lubricant is a problem, the use of Molykote 557 may be preferred. This brush-on liquid forms a pasty residue on the threads which is resistant to pressure displacement; it also has good dielectric properties. However, Molykote 557 contains a naphtha-based solvent that must be allowed to evaporate before the valve is re-installed.

The 1/2"-NGT pipe thread valves used in the 1950's and 60's must be sealed in place using Teflon tape. About 3-4 wraps around the threads are usually sufficient. The first 1-2 threads should remain un-taped since this prevents bits of the tape from extruding into the tank cavity. As the valve is screwed into the tank with a large wrench, no squeaking or rasping sounds should be heard. Any thread "noise" during insertion indicates that metal particles are impinging the threads, and an air leak past them will almost always occur during filling! If such noises are heard, remove the valve, clean both set of threads, re-tape the valve and reinstall it. (INCIDENTALLY, NEVER USE TEFLON TAPE ON O-RING SEALED VALVES).

Be sure to clean both the tank and valve threads before revalving any tank. This can be done quickly with GMC's special brushes designed for this purpose. There are brushes for both 1/2" and 3/4" valves (GMC # 43000 and #43010) and for the corresponding tank neck threads (GMC #43020 and #43030). For rapid operations, brush #43025 can be used in an electric drill for cleaning 3/4" tank necks and their O-ring grooves.

CLEANING TANKS FOR OXYGEN SERVICE

The cleaning or converting of normal scuba tanks for oxygen service requires some special chemicals and procedures that are different from those described in this bulletin. Some of the materials described herein are **NOT OXYGEN COMPATIBLE** and their use in O₂ cylinders could create very hazardous situations. GMC has developed simple techniques and specialized oxygen compatible products for converting air tanks for pure O₂ and Nitrox use. A separate bulletin on this subject, **Converting Dive Tanks For Oxygen Service With GMC Oxygen-Safe Products** is available in our Web page Library at www.gmcscuba.com or by ordering GMC product #42125.

GMC Tank Cleaning & Tumbling Product Reference

A suggested guide for the dive shop wishing to purchase the equipment and materials required to professionally service diving cylinders. The equipment and supplies needed to do proper VIP's is not listed.

* Indicates those items that should be considered mandatory for the setup of a professional tank cleaning and tumbling service center.

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Tank Tumbling / Cleaning Hardware :

- [] #42000 Tank Tumbler Machine*
- [] #42030 Tank Draining Stand*
- [] #42120 Tank Washer*
- [] #42030 Tank Dryer*

Tank Tumbling Media & Chemicals :

- [] #42050 Ceramic Media, 30 lb. per tank being tumbled (re-useable)
- [] #42040 Aluminum Oxide, 30 lb. per tank being tumbled (re-usable)*
- [] #42055 Tumbling Expeditor, 2-3 Teaspoons per tumbler*
- [] #42100 Special Cleaner, gal.
- [] #42070 Acidic Tank Cleaner, gal.
- [] #42220 Compound O, gal. *

Tank Whips / Bottom Brushes & Accessories :

- [] #42170 Tank Cleaning Whip*
- [] #42175 Pony Tank Cleaning Whip
- [] #42200 Whip Guide*
- [] # 43030 Light-Duty Bottom Brush w/ Rod*
- [] # 43041 Light-Duty Bottom Brush Only
- [] # 43045 Heavy-Duty Bottom Brush w/ Rod
- [] #43046 Heavy-Duty Bottom Brush Only*

Miscellaneous Supplies :

- [] #42210 Standard Tank Plug per tank being tumbled *
- [] #42205 Genesis Tank Plug per tank being tumbled *
- [] #42225 Tank Purge Air Gun*
- [] #42230 Tank Vacuum Attachment*
- [] #43020 Tank Thread Cleaning Brush, 3/4"
- [] #43030 Tank Thread Cleaning Brush, 1/2"
- [] #43000 Valve Thread Cleaning Brush, 3/4"
- [] #43010 Valve Thread Cleaning Brush, 1/2"
- [] #43025 Tank Neck Thread Drill Brush*
- [] #42140 Molykote 557 Valve Sealant or #43210 Dow 111 Silicone Grease Valve Sealant
- [] #48714 O-ring – 3/4" valve to tank interface*
- [] #48616 O-ring – HP "Genesis" valve to tank interface*
- [] #48814 O-ring – standard valve to regulator interface*
- [] #48612 O-ring – steel tank valve to regulator interface*
- [] #42080 Tank Vise*
- [] #42085 Tank Vise Optional Base Plate
- [] #42130 Bulletin: Tank Tumbling Tips
- [] #42125 Bulletin: Converting Dive Tanks For Oxygen Service With GMC Oxy-Safe Products