

## SPECIFIC STORAGE QUESTIONS

### A -- STORAGE CONTAINERS

#### A.1 WHAT IS FOOD GRADE PACKAGING?

Q: *OK, I'm ready to start my storage program. What should I put the food in?*

A: You should use food grade packaging for storing anything you intend to eat. A food grade container is one that will not transfer noxious or toxic substances into the food it is holding. If you are uncertain whether a package type is food grade you can contact the manufacturer. Ask if that particular container is (US) FDA approved meaning that it is safe for food use. When inquiring be sure to specify the characteristics of the food you are storing; wet, dry, strongly acidic or alkaline, alcoholic or a high fat content. A container that is approved for one of the above types of food may not be approved for another.

The major functions of a food storage container are to:

- #1. Protect its contents from outside environmental influences such as moisture, and oxygen, but possibly also heat or cold, light, insects and/or rodents as well.
- #2. Prevent damage during handling and shipping.
- #3. Establish and/or maintain microbiological stability. The container should not allow microorganisms such as fungi and bacteria from outside the container to come into contact with its contents. This is of critical importance to wet-pack foods such as canned vegetables, fruits and meats.
- #4. Withstand the temperatures and pressures it will be exposed to. This is necessary if the contents are to be pasteurized or sterilized, either immediately before or after filling. It must not have any structural failures nor release any noxious or toxic breakdown chemicals into the food it contains. This is the reason why purpose built canning jars are recommended for home canning and mayonnaise jars aren't. The former are made heavier to withstand high temperatures and handling whereas the latter are not and have an increased risk of breakage if used for that purpose.

Virtually all containers used in home food preservation involving exposure to high temperatures are made of glass or metal, with the exception of some specialized "heat & seal" type of plastic bags. Glass can be used with any food

type providing it is clean and in sound condition but the lids, particularly the liner inside the lid, may not be so you'll need to investigate suitability.

Metal cans are more specialized. They must be intended for food use and must also have a lining or coating of the inside that is suitable for the pH level of the food it will be in contact with.

If the foods are not subjected to some form of heat processing before or after packaging your selection of container types for home use is a great deal larger. Virtually any kind of clean, sound glass jar can be used and many types of new metal containers. Several sorts of plastics have become popular. These various kinds of plastics are each suited for different purposes, making selection a more complex task.

### **A.1.1 WHERE DO I FIND FOOD GRADE CONTAINERS?**

Food grade packaging is everywhere. Every time you go into the grocery store you are surrounded by it. Many well known companies such as Tupperware and Rubbermaid manufacture and sell empty packaging for the express purpose of containing repackaged foods. The kinds of containers you are interested in and the types of foods you want to put in those containers will dictate where you need to look for a particular packaging system.

For food storage purposes most folks are usually interested in five and six gallon plastic pails, certain recycled plastic containers such as soda or juice bottles, glass jars from half pint to gallon sizes, metal containers such as the institutional sized #10 cans, and Mylar or other high barrier property plastic bags. Those are the containers most often used, but virtually anything that can protect foods from outside environmental influences, safely contain something you're going to later eat and have a volume capacity large enough to be worthwhile may be used.

A number of food storage retailers such as those listed in the Resources section sell plastic buckets, Mylar bags and a few even sell new #10 cans with lids. It may also be possible to purchase #10 cans through the LDS Family Canneries and dealers such as *Lehman's Hardware*, *Cumberland General Store* or *Home Canning Specialty and Supply*. On the local scene, plastic five gallon buckets are widely available, but only if you purchase them through a company catering to a food related trade will you likely be able to tell if they're safe to keep food in. If you can locate a customer service number for the manufacturer of a container that interests you call them and ask. Many times manufacturers will make products that are FDA approved and sell them as general purpose containers, but you need to ask to be sure.

Packaging supply houses have large FDA approved packaging lines. Several such companies are listed in the Resources section and a bit of detective work will certainly turn up more. Some require minimum orders and others don't. The cost of shipping the containers will probably play a major role in your decision making. If you are going to package a great deal of food all at once, perhaps for a group, some of the companies that require minimum purchases may save you a fair amount of money and supply packaging you might otherwise have a difficult time finding. Some time spent searching the *Thomas Register*, available both online (<http://www.thomasregister.com>) and in library reference sections, might turn up some valuable leads.

For glass jars, don't overlook flea markets, yard sales, thrift shops and similar places. Canning jars can sometimes be had for very little. Delicatessens, sub shops and restaurants of all sorts can be a source of one gallon glass jars formerly containing pickles, peppers, etc. If the lids are still in good condition, they are well suited to bulk storage and can be reused over and over. When I need new buckets I go to a neighboring town to buy them from a beekeeping supply house which sells them for bulk honey storage. A bit of looking will turn up other potential sources as well.

Metal cans, by and large, are not reusable for food storage, but some companies might be able to sell you new cans. The traditional single use #10 can is only the beginning of what might be available with a little looking. Gallon sized or larger cans with double friction lids (like paint comes in) make excellent storage containers and some companies make them food safe. One gallon and larger cans with wide diameter screw caps are available from some companies as well. You might have seen some of these holding edible oils, soy sauce, honey and other liquid food. If they come with a cap that will seal air tight they would be well suited for bulk storage of grains and legumes, particularly if they come in a four to six gallon size.

Pick up your local phone book, log on to your favorite search engine or head to your local public library and explore the possibilities. Make it clear that what you want must be FDA approved and be up front about how many you need or can deal with. If one company won't deal with you, try another. You'll eventually get what you want.

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*From: Denis DeFigueiredo [ddefig@newhall.com](mailto:ddefig@newhall.com)  
Originally posted in: [rec.food.preserving](#)*

I called Berlin [eds. note, a plastic container mfgr.] 1-800- 4-BERLIN and spoke to them, plus an outfit called Kirk Container (they manufactured some 5 gallon paint buckets I saw in the local hardware store). Both places said that buckets made from High Density PolyEthelene (HDPE) are approved for food. It has to

do with the possibility of interaction between any chemicals in the food and the plastic. As it turns out, Kirk manufactures only one kind of bucket, and then markets it for paint, hardware, food, etc. The price is right on the "paint buckets" - much cheaper than the local restaurant supply house.

High density polyethelene buckets will have HDPE stamped on them, or a recycle symbol with a "2" in the middle.

**DISCLAIMER:** I'm only passing on information I received from the manufacturers. I am in no way professing these things to be absolute fact!

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*From: "Jenny S. Johanssen" johanssen@matnet.com  
Originally posted in: rec.food.preserving*

Denis - saw your comments on food grade buckets and thought I'd offer my solution. My son cooks at a local Mexican restaurant. They get all their strawberries (for the strawberry margaritas at the bar) in 3 gallon plastic buckets. Now you know how many margaritas pass through a Mexican bar each night - lots. So I asked my son to save me some buckets. They are ideal for storing flour, rice, I made (from my home grown raspberries) a delicious raspberry cordial in one of the buckets, another I made Raspberry wine in. My motto is why buy when you can recycle! Thanks for giving me the time and space to add my two-bits worth. - Jenny

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*From: Woody Harper lager@primenet.com  
Originally posted: rec.food.preserving*

...I get topping buckets from Dairy Queen and I have to make sure there is no trace of the strawberry syrup left. A little detergent and elbow grease followed by a chlorine solution bath keep everything nice and clean.--

## **A.2 PLASTIC PACKAGING**

Before we can discuss plastic packaging it is necessary to understand what is the substance we call "plastic." Plastics are produced from basic polymers called "resins", each of which have differing physical properties. Additives may be blended in for color or to modify particular properties such as moldability, structural rigidity, resistance to light or heat or oxidation. Additionally, it is common for several different kinds of plastic to be laminated together each performing a particular desired task. One might offer structural rigidity and the

other might be more impermeable to the transfer of gasses and odors. When bonded together a rigid, gas impermeable package can be made.

Whether that package is safe for food use will depend on the exact nature of the additives blended into the plastic. Some of them, notably *plasticizers* and *dyes*, can migrate from the packaging material into the food it's containing. This may be exacerbated by the food it's in contact with especially if it is high in fat, strongly acidic, or alcoholic in nature. Time and temperature may also play a prominent role in the migration of plastic additives into food. For this reason, the (US) FDA assesses the safety of packaging materials for food contact and conducts toxicological studies to establish safety standards. Only plastics that are FDA approved for a particular food type should be used for direct contact with that food.

Being FDA approved, however, may not be all of the story. It must still be determined whether the particular plastic in question has the physical properties that would make it desirable for your purpose.

As mentioned above each base resin has somewhat differing physical properties that may be modified with additives or combined by laminating with another plastic or even completely unrelated materials such as metal foils. An example of this is "Mylar", a type of polyester film. By itself, it has moderate barrier resistance to moisture and oxygen. When laminated together with aluminum foil it has very high resistance and makes an excellent material for creating long term food storage packaging. One or more other kinds of plastic with low melting points and good flow characteristics are typically bonded on the opposite side of the foil to act as a sealant ply so that the aluminized Mylar can be fashioned into bags or sealed across container openings. The combined materials have properties that make them useful for long term storage that each separately do not have.

The most common plastic that raises suitability questions is *High Density PolyEthylene* (HDPE). It's used in a wide array of packaging and is the material from which most plastic five and six gallon buckets are made. It has a moderate rigidity, a good resistance to fats, oils, moisture and impacts, a fair resistance to acids, but is a relatively poor barrier to oxygen.

Whether it is suitable for your purpose depends on how sensitive to oxygen your product is and how long you need it to stay in optimal condition. Foods such as whole grains are not particularly delicate in nature and will easily keep for years in nothing more than a tightly sealed HDPE bucket. Most legumes are the same way, but those that have high fat contents such as peanuts and soybeans are more sensitive to O<sub>2</sub>. Other foods such as dry milk powder might only go a year before deleterious changes are noticed. If that milk were sealed in an air-tight aluminized Mylar bag with the oxygen inside removed, the milk would keep for much longer. Better still would be to seal the milk in a metal can or glass jar. HDPE alone can be used for long term storage with one or more of the following

precautions to keep a high food quality: The food should either be put on a shorter rotation cycle than packaging also using a second gas barrier such as Mylar; be periodically opened and re-purged or fresh absorbers should be inserted.

Another common plastic used in food storage is *polyethylene terephthalate* commonly known as PETE or PET plastic. Used to make soda, juice, and some water bottles among other products it is available for recycling into food storage containers in nearly every home. Properly cleaned and with intact screw-on lids PETE plastic containers will serve for keeping nearly any kind of food providing the containers are stored in a dark location. PETE has good barrier properties against oxygen and moisture and when used in combination with oxygen absorbers presents a complete dry-pack canning system in itself. About the only drawbacks to PETE plastics are that they are nearly always transparent to light, container volumes typically are limited to a gallon or less, and when used in conjunction with oxygen absorbers the sides will flex sufficiently to make stacking difficult though you could simply lay them on their sides.

There are other plastics and plastic laminates with good oxygen and moisture barrier properties that are suited for long term food storage, but they are not as easy to find, though some used containers might be available for reuse.

### **A.2.1 HOW DO I GET THE ODOR OUT OF PICKLE BUCKETS?**

I've had fairly good luck doing it in the following way. As vinegar is the primary smell in pickles and it's acidic in nature, we use a base to counteract it. First we scrubbed the bucket well, inside and out, with dish detergent, most any sort will do. Then we filled the buckets with hot water and dissolved a cup of baking soda in each. Stir well, get the bucket as full as you can and put the top on. Put the bucket in the sun to keep it warm so the plastic pores stay open as much as possible. In a couple of days come back and empty the buckets. Rinse them out, fill with warm water again and add about a cup of bleach and reseal. Put back in the sun for another couple of days. Empty out and let dry with the tops off. We completely eliminated the vinegar smell this way. It might be possible to cut the time down a lot, but we haven't experimented that much.

### **A.3 METAL CANS**

Metal cans and glass jars being heat resistant, can both be used for heat processed, wet-pack foods and for non-heat treated dry pack canning. Relative to glass jars though, metal cans have several disadvantages for the do-it-yourselfer. They are hard to come by, and they need specialized equipment to seal them that can be

difficult to locate. The greatest flaw which makes them unpopular for home canning is they can only be used once. As the commercial canning industry is not interested in reusing the containers, metal cans make great sense for their purposes. The cans are both cheaper (for them) and lighter than glass jars. This adds to the economy of scale that makes canned foods as cheap as they are in the grocery store.

For home canning, glass jars are better because even the smallest of towns will usually have at least one business that carries pressure and boiling water canners along with jars, rings and lids. With metal cans a sealer is also necessary which usually has to be ordered from the manufacturer or a mail-order distributor. A few of which are listed in the Resources section.

Tin cans are not really made of tin. They're actually steel cans with a tin coating on the inside and outside. Some kinds of strongly colored acidic foods will fade from long exposure to tin so an enamel liner called "R-enamel" is used to forestall this. Certain other kinds of food that are high in sulfur or that are close to neutral in pH will also discolor from prolonged contact with tin. For those foods, cans with "C-enamel" are used.

The excellent food preservation book, *Putting Food By* Chapter 6 (see reference list) has a section on the use of metal cans for wet packed foods as does the *Ball Blue Book*.

Probably the most common use of metal containers is the #10 cans such as are used by the LDS Family Canneries discussed below. This is not the only way metal containers may be used though. It will probably take a bit of searching, but there are various food grade metal containers available of sufficient volume to make them useful for food storage. They usually have double friction lids similar to paint cans or screw caps like jars that can achieve an air-tight seal. If you can find them with a sufficient volume capacity they can be of real use for storing bulky foods such as grains, legumes and sugar. Smaller cans of a gallon or less would be useful for storing items like dry milks. If properly sealed, metal cans have a far higher barrier resistance to gasses such as oxygen, CO<sub>2</sub>, and nitrogen than any plastic.

Although they can hardly be considered portable the use of clean metal drums (not garbage or trash cans), either themselves food grade or used with food grade liners, is also a possibility. A fifty five gallon drum of grain will weigh several hundred pounds, but may make for a much easier storage solution than multiple buckets. The advantage of using such a large container is that a great amount of a single product can be kept in a smaller amount of space and fumigating or purging the storage atmosphere would be simpler. The disadvantages are the difficulties of moving it and rotating the stock in the drum. If using oxygen absorbers make sure the drum you want to use is capable of making an air-tight seal, otherwise you should stick with carbon dioxide fumigation.

### **A.3.1 POOLING RESOURCES: THE CHURCH OF JESUS CHRIST OF LATTER DAY SAINTS -- THE MORMONS**

Although the purchase of a can sealer and metal cans for home use is not generally economically feasible for most people there is one method by which it can be made practical. This is by pooling community resources to purchase the equipment and supplies. It may even not be necessary to form your own community to do this. If you live in the right area your local Latter Day Saints church may have facilities they will allow you to use. They may even have suitable food products to sell you. This is an offshoot of the church's welfare programs and is done in their Family Canneries also known as Home Storage Centers. Rather than using plastic buckets they have gone over to using metal cans and aluminized Mylar bags church-wide for dry-pack canning. By sharing the cost of the equipment and purchasing the cans in bulk quantities, they are able to enjoy the advantages of metal cans and professional equipment over plastic containers while minimizing the disadvantages of cost.

--- Please see [\*VI.D.1 Organizations. The Church of Jesus Christ of Latter Day Saints -- LDS Family Canneries\*](#) for more information about where LDS Family Canneries may be found and how best to approach using them. ---

Any food products you want to have sealed in cans or pouches will need to fall within the LDS cannery guidelines of suitability for that type of packaging. This is for reasons of spoilage control as many types of foods aren't suitable for simply being sealed into a container without further processing. If you purchase food products from them, they will already be within those guidelines. A brief treatment of these guidelines may be found in [\*VI.D.1 LDS Family Canneries Guidelines\*](#).

Once you have your foodstuffs on hand, either supplying your own or by purchasing them from the cannery you're ready to package them. It is here that using some forethought concerning your packaging system can save you much time and aggravation.

**IMPORTANT NOTE:** Please keep in mind that the individuals responsible for the family canneries are all *volunteers* with demands on their time from many areas. Be courteous when speaking with them and, if there are facilities for use, flexible in making arrangements to use them. You will, of course, have to pay for the supplies that you use, cans and lids at the least, and any food products you get from them. As a general rule they cannot put your food in storage for you. Be ready to pay for your purchases in advance. They do not take credit cards and probably cannot make change so take a check with you.

The following is a list of suggestions to make the most efficient use of your access time:

**#1** - Make your appointment well in advance. *If you are a non-LDS member be sure to ascertain whether you are allowed to use the facilities.* Possibly you may be able to go with a church member if you cannot go for yourself alone. Many people may be trying to make use of the canneries so making advanced reservations is a must.

**#2** - Have enough people to set up an assembly line type operation. Make sure each of your people knows what they need to do and how to do it. At least four people for any serious amount of food is a good number. Ask the cannery volunteer to go over the process with you and your crew.

**#3** - Make sure you have enough muscular helpers to do the heavy lifting so you don't wear yourself out or hurt your back. Some of the supplies you will be working with, such as wheat, come in fifty pound bags and a box of #10 cans or pouches full of sugar or other weighty food is heavy.

**#4** - Make labels in advance for any foods you bring with you to pack that the cannery does not carry. This will save time and possibly much confusion after the cans or pouches are filled. Once sealed one anonymous looking can or pouch looks like another.

**#5** - Take out only as many as oxygen absorbers as you will use in fifteen minutes. They use most of their adsorptive capacity within two to three hours depending on temperature and humidity so you don't want to waste any by soaking up the oxygen in the room. The ones you don't use right away should be tightly sealed in a gas proof container.

**#6** - Save powdery food items such as dry milk powder, pudding mixes, grain flours and meals till last. They can be messy to can and this will keep them out of your other foods. Dust masks may not be a bad idea.

**#7** - Leave time to clean up after yourself. The cannery is doing you the courtesy of allowing you to use their equipment and selling you the supplies at cost. You should return the favor by leaving the place *at least* as clean as you found it. If they give you a set amount of time to work in then *finished or not* honor that time slot. Others may be waiting to use the equipment too.

**#8** - Always keep in the back of your mind how much volume and weight your vehicle can haul. You'd hate to find you had canned more than you could carry home.

### **A.3.2 PREVENTING EXTERIOR CORROSION OF CANNED GOODS**

Some areas have difficulty storing metal canned goods for long periods of time. This is usually caused by high humidity or exposure to salt in a marine environment. If this is a problem, it is possible to extend the life of metal cans by coating their outsides. I've seen this used on boats here in Florida, especially when loading for a long trip. There are at least five methods that can be used to do this, but for cans that require a can opener only the paraffin or mineral oil methods should be used.

PARAFFIN METHOD: Using a double boiler, paraffin is melted and brushed on the clean, unrusted cans. Be certain to get a good coat on all seams, particularly the joints. If the can is small enough, it can be dipped directly into the wax. Care must be taken to not cause the labels to separate from the cans. Do not leave in long enough for the can contents to warm.

MINERAL OIL METHOD: Use only food grade or drug store (medicinal) mineral oil. Wipe down the outside of each can with only enough oil to leave a barely visible sheen. Paper labels will have to be removed to wipe underneath with the contents written on the outside beforehand with a marker or leave the under label areas uncoated. Even with a barely visible sheen of oil the cans will tend to attract dust so you will need to wipe off the can tops before opening.

PASTE WAX METHOD: Combine 2-3 oz. of paste or jelly wax with a quart of mineral spirits. Warm the mixture CAREFULLY in its container by immersing it in a larger container of hot water. DO NOT HEAT OVER AN OPEN FLAME! Stir the wax/spirits thoroughly until it is well mixed and dissolved. Paint the cans with a brush in the same manner as above. Place the cans on a wire rack until dry.

SPRAY SILICONE: A light coating of ordinary spray silicone may be used to deter rust. Spray lightly, allow to dry, wipe gently with a clean cloth to remove excess silicone.

CLEAR COATING: A clear type of spray or brush on coating such as Rustoleum may be applied. This is best suited for larger resealable cans, but will keep them protected from corrosion for years.

### **A.4 GLASS JARS**

Compared to metal cans, glass jars are very stable, although they obviously don't take being banged around well. Fortunately the cardboard boxes most jars come in are well designed to cushion them from shocks. The box also has the added bonus of keeping damaging light away from food.

The major advantage of glass jars is they are reusable. For wet-pack canning the lids should be replaced, but the rings can be reused until they finally rust away or become too dented to use. For dry pack canning even the lids may be reused nearly indefinitely if you're careful in removing them. In my personal experience I've grown to prefer Ball lids rather than Kerr, especially for vacuum sealed dry pack canning. The red sealing compound Ball uses seems to more reliably achieve a seal than the gray compound Kerr uses.

When you get right down to the bottom line, it is seldom practical strictly in terms of dollars and cents to wet-pack your own food in jars. When you count the cost of your equipment, including the jars, rings, lids and all the rest, along with a not inconsiderable amount of your personal time, the cost of purchasing or growing your produce, you'll almost always come out ahead to buy food canned for you by the commercial canning industry. That said, forget about the strict bottom line and examine more closely why you want to put up your own food. For many, gardening is a pleasure and they have to have something to do with the food they've grown! There's also the fact that for many, you simply cannot buy the quality of the food you can put up for yourself. The canning industry tries to appeal to a broad spectrum of the general public while you can put up food to your own family's specific tastes. Home canning is not so much about saving money as it is about satisfaction. You get what you pay for.

If home canning appeals to you, please allow me to point you toward the [rec.food.preserving FAQ](#) where much good information about methods and techniques may be found.

Dry-pack canning using glass jars, on the other hand, may well make a great deal of economic sense. It is usually far cheaper per pound to purchase dry foods in bulk quantities, but often unsuitable to store it that way. Breaking the food down into smaller units allows for easier handling and exposes a smaller quantity to oxygen and moisture before it can be eaten. Of course, packaging used for doing this can be made of many different materials, but glass is often the easiest and most convenient to acquire and use. Used containers are often free or of little cost. One source of gallon sized glass jars are sandwich shops and restaurants that use pickles, peppers and other sandwich condiments. There are also half-gallon canning jars, though they are sometimes difficult to find. Both Ball and Kerr make these jars and I have a local Ace hardware order mine.

## A.5 MYLAR BAGS

The word "Mylar" is a trademark of the DuPont corporation for a special type of polyester film. Typically made in thin sheets, it has a high tensile strength and is used in a wide variety of industrial settings.

In food storage, particularly for the long term, it is commonly found as a laminate with Mylar as the top layer, a very thin aluminum foil in the middle and one or more other types of plastic films on the bottom acting as sealant plies. This laminate combination possesses a high resistance to the passage of oxygen, carbon dioxide, nitrogen, other gasses, water vapor, and light which is what makes it valuable for our purposes. Unfortunately, it has a poor puncture resistance so must be used as an interior liner for more puncture resistant containers rather than as a stand-alone package.

Food grade aluminized Mylar complies with US FDA requirements and is safe to be in contact with all food types except alcoholic.

For food use, Mylar is most commonly available as pre-made bags of various sizes. Flat sheets or rolls of the material might also be found from which bags could be fashioned as well.

When Mylar bags are used by the storage food industry they are generally for products sealed in plastic buckets. The reason for doing this is the High Density PolyEthylene (HDPE) from which the pails are made is somewhat porous to gasses. This means that small molecules, such as oxygen (O<sub>2</sub>), can slowly pass through the plastic and come into contact with the food inside. The problem is further compounded if oxygen absorbers are used, as the result of their absorbing action is to lower the air pressure inside the container unless it has first been carefully flushed with an inert gas such as nitrogen. How fast this migration activity will occur is a function of the specific plastic formulation, its wall thickness and the air pressure inside the container. In order to gain the maximum possible shelf life a second gas barrier, the Mylar bag, is used inside the pail.

Whether the use of these bags is necessary for your home packaged storage foods depends on how oxygen sensitive the food item is and how long you want it to stay at its best. If the container is made of a gas impervious material such as metal or glass then a second gas barrier inside is not needed. If it is HDPE or a plastic with similar properties and you want to get the longest possible storage life (say 10+ yrs for grain) then Mylar is a good idea. If you're going to use the grain in four to five years or less then it is not needed. Provided the oxygen has been purged from the container in the first place, either with a proper flushing technique, or by absorption, there will not have been sufficient O<sub>2</sub> infiltration to seriously impact the food. Particularly oxygen sensitive foods such as dry milk powders that are to be kept in plastic containers for more than two years would

benefit from the use of Mylar. Naturally, storage temperature and moisture content is going to play a major role as well.

There is also the question of the seal integrity of the outer container. If you are using thin walled plastic buckets in conjunction with oxygen absorbers the resulting drop in air pressure inside the pail may cause the walls to buckle. If this should occur, there would be a risk of losing seal integrity, particularly if the buckets are stacked two or more deep. If the food was packed in Mylar bags with the absorbers inside this would keep the vacuum from seriously stressing the container walls. Better still would be not to have the problem at all by either using containers of sufficient wall thickness or flushing with inert gas before sealing. Heavy wall thickness is one reason why the six gallon Super Pails have become so widespread. It should be noted that Mylar is not strongly resistant to insect penetration and not resistant at all to rodents. If mice chew through your buckets, they'll go right through the bags.

#### **A.5.1 HOW DO I USE MYLAR BAGS?**

Sealing food in Mylar bags is a straight-forward affair, but it may take a bit of practice to get it right, so purchase one or two more bags than you think you'll need in case you don't immediately get the hang of it.

**#1** - The bags typically sold by storage food dealers look rather large when you compare them to the five or six gallons buckets they are commonly used in. That extra material is necessary though if you are to have enough bag material left over after filling to be able to work with. Unless you are sure of what you are doing, don't trim off any material until after the sealing operation is completed.

**#2** - Place the bag inside the outer container and fill with the food product. Resist filling it all the way to the top. You need at least an inch or so below the bucket rim left open to get the lid to seat completely. If you'll be using desiccants and oxygen absorbers together place the desiccant on the bottom of the bag before filling.

**#3** - When the pail seems to be full, gently thump it on the floor a few times to pack the product and reduce air pockets. Add any makeup food necessary to bring level back to where it should be.

**#4** - Take the bag by the corners and pull out any slack in the material so that all sides can be pulled together evenly. Place your oxygen absorbers inside if you are going to use them. Now place a board over the top of the bucket and fold the bag end down over it

keeping it straight and even. Place a piece of thin cotton fabric such as sheet or t-shirt material over the edge of the bag mouth. Using a clothes iron set on the cotton, wool or high setting run it over the cloth-covered Mylar about a half-inch from the edge for about twenty seconds or so until it seals. You'll probably have to do the bag in sections. Temperature settings on irons vary so experimenting on a left-over strip to find the right setting is a good idea.

**#5** - When you've done the entire bag allow it to cool then try to pull the mouth of the bag open. If moderate pressure doesn't open it, fold the bag down into the pail until you feel the trapped air pillowing up against the material and wait to see if it deflates. If it stays buoyant, your seal is good. You can seal on the bucket lid at this point or take the further step to vacuum or gas flush the bag.

Once a seal has been obtained the bags can be left as-is, vacuum sealed or gas flushed. To obtain the most efficient oxygen removal the bags can be first drawn down with a vacuum pump and then purged using an inert gas.

### **Vacuum Sealing Mylar Bags**

Once you have obtained a good seal on the bag, pulling a vacuum on the contents is straight forward.

First you'll need something to make a vacuum with. This can be either a regular vacuum pump, a vacuum sealer such as the Tilia Food Saver or even the suction end of your household vacuum cleaner. The end to be inserted into the bag will need to be of fairly small diameter in order to keep the hole in the Mylar from being any larger than necessary. This means that if you use a vacuum cleaner you'll need to fashion some form of reduction fitting. One such that I've seen is a plastic film canister with a hole drilled in the bottom and a piece of plastic tubing epoxied in place.

Cut a hole into the Mylar bag on a corner, making the opening only just large enough to admit the vacuum probe. Insert the nozzle and using a sponge, or something similar, push down on the material over the probe to make a seal. Now draw down a vacuum on the bag. When it's drawn down as much as possible, run a hot iron diagonally across the cut corner resealing the bag.

### **Gas Flushing Mylar Bags**

Flushing with inert gas works essentially like vacuum sealing except that you're putting more gas into the bag rather than taking it out. You'll want to keep the entry hole small, but don't make a seal around it as above. Beyond that, follow the directions as given in *Section III.B.2 - CO<sub>2</sub> and Nitrogen*. When you feel that

the bag has been sufficiently flushed, run the iron across the corner as above to seal.

Flushing with dry ice can also be done, but it is important to wait until the frozen carbon dioxide has completely sublimated into gas before making the final seal otherwise the bag will burst like an overfilled balloon.

## **A.6 REUSING OR RECYCLING PACKAGING**

In an effort to save money or because new packaging may be hard to come by, it is common for many people to want to re-use previously used containers. There is nothing wrong with this, but it is sometimes more complicated than using new containers would be. Here are some general rules if you have an interest in doing this.

**#1.** Do not use containers that have previously contained products other than food. There are two risks this can expose you to. The first is that the particular package type may not have been tested for food use and may allow the transfer of chemicals from the packaging into your food. The second is that all plastics are porous to some degree. Small amounts of the previous contents may have been absorbed by the packaging material only to be released into your food, particularly if it is wet, oily or alcoholic.

**#2.** Previously used containers should only be used with foods of a similar nature and exposed to similar processes. This means that if a container previously held a material high in fat, such as cooking oil, then it should not be used to store a strong acid such as vinegar. Nor should a container be exposed to extreme conditions, such as heat, if the original use of the package did not subject it to that treatment. An exception to this is glass which is covered below. Generally speaking, dry, non-oily, non-acidic or alkaline, non-alcoholic foods may be safely contained in any food safe container. An example of this is keeping grains and legumes in HDPE buckets formerly containing pickles.

**#3.** Glass may be used to store any food provided it is in sound condition and has only been used to store food previously. The lid or cap, however, that seals the jar is subject to the cautions given above. Glass jars not specifically made for home canning, either boiling water bath or pressure canning, have a significant risk of breakage if used for that purpose.

#4. Porous packaging materials such as paper, cardboard and Styrofoam should not be reused. Their open texture can trap food particles and are difficult to adequately clean. Packaging formerly holding raw meats, seafoods, or egg products are particularly at risk.

#5. Containers previously holding odorous foods may trap those odors and transfer them to foods later stored. Pickle flavored milk leaves a lot to be desired. Foods such as dry milk powders, fats and oils, flours and meals will absorb any odors seeping from your container material. Be sure to get the smell out before you fill them.

## **B – CARBON DIOXIDE AND NITROGEN**

Carbon dioxide (CO<sub>2</sub>) and nitrogen (N<sub>2</sub>) are commonly used in packaging both fresh and shelf-stable foods, in order to extend their shelf lives. Fresh foods are outside the scope of this work so attention shall be focused on those foods suitable for use in storage programs.

The most common use of these gasses is for excluding oxygen (O<sub>2</sub>) from the atmosphere contained inside of a storage container (called head gas). When head gas oxygen levels can be dropped below 2% the amount of undesirable oxidation reactions in stored foods can be greatly decreased resulting in longer shelf lives. Actually achieving this is not a simple matter when limited to the equipment and facilities typically available in the home. Still, with careful technique and proper packaging materials it is possible to achieve useful results.

In order for either gas to be used most effectively it should be contained inside of packaging with high barrier properties to prevent outward diffusion over time or allowing oxygen to infuse in. Examples of this kind of packaging are aluminized Mylar or other high barrier property plastics, metal cans or glass jars. Buckets made of HDPE plastic are relatively poor gas barriers and will, over time, allow oxygen to infuse into the container. In order for foods to be kept for their maximum shelf lives the containers would need to be re-purged every three to four years. Foods that are particularly oxygen sensitive, such as dry milk powders, should not be stored in HDPE without a secondary gas barrier. It is possible to use HDPE buckets alone when gas purging if a shorter rotation period is used. An example would be using wheat in four to five years instead of the eight to ten that would be achievable if a high barrier container were used.

Purging efficiency can be greatly improved when used with a vacuum device. By first drawing down the head gas of the container and then flooding with the purging gas much more oxygen can be removed. Repeating the process once more will improve removal efficiency even more. If a true vacuum pump is not available, the suction end of a home vacuum-cleaner can be made to serve and still achieve useful results. With careful technique, oxygen levels can be dropped to between 0.5-2%. Finely textured materials such as grain flours and meals, dry milk powders, dry eggs, and similar textured foods will purge poorly and are better packaged with oxygen absorbers. Instructions for vacuum usage are given in *A.5.1 Using Mylar Bags*. Instructions for gas purging are given below in *B.1 Dry Ice* and *B.2 Compressed Nitrogen*.

A less common, but important use for carbon dioxide is fumigation. This is killing or retarding insect life contained in a product. Many chemical fumigants are available to do this but are not thought desirable by many who have foodstuffs they want to put into storage. CO<sub>2</sub> is not as certain as the more toxic fumigants, but it can be made to work and will not leave potentially harmful residues behind. It is possible for nitrogen to work in a similar manner, but it must be in a head gas concentration of 99%+ whereas carbon dioxide can be effective over time at levels as low as 3%. The precise amount of time necessary for the gas to do its work will vary according to the specific insect species and its growth stage along with the temperature and humidity level of the product being fumigated. In general, the more active the growth stage and the warmer the temperature the more effective CO<sub>2</sub> is in killing weevil infestations. The gas also exhibits bacterial and fungal inhibiting properties, but for our purposes this will be of little moment since all foods should be too dry to support such growth in the first place.

The procedure for fumigating foodstuffs with carbon dioxide is precisely the same as the one used in purging oxygen from storage containers mentioned below. The only change is that for the fastest effectiveness the sealed container should be left in a warm place for a week or so before moving it into its final storage location. The gas is still effective at cooler temperatures, but because insect life is slowed by lower temperatures the carbon dioxide takes longer to complete its mission.

**NOTE:** Both Mitsubishi Gas-Chemical, maker of the Ageless line of oxygen absorbers, and Multisorb, manufacturer of the FreshPax D 750 absorbers, state the their products should not be used in a high carbon dioxide environment. There are absorbers that will work well in high carbon dioxide atmospheres but they require an external moisture source which would make them difficult to use for our purposes.

## **B.1 DRY ICE**

Using dry ice to displace oxygen from food storage containers is straightforward. To get the best results it is recommended that all foodstuffs and packaging materials be put in a warm location for a few hours before beginning the purging process. The reason for this is that the cold CO<sub>2</sub> sublimating from the dry ice will be denser than the warmer, lighter oxygen containing air. The cold gas will tend to stay on the bottom, gradually filling the container and pushing the warm air out the top.

When you first pick up your dry ice from the supplier, put it in a moisture proof container so that air humidity will be less able to condense and freeze on it. The sublimating gas will prevent you from achieving a tight seal, but you can slow down the water ice accumulation.

Gather your containers and any interior packaging materials. Break off a piece of dry ice of sufficient size for the volume to be purged. One pound of dry ice will produce about 8.3 cubic feet of carbon dioxide gas so approximately two ounces per five gallon bucket will do. Wipe off any accumulated water frost which should look whiter than the somewhat bluish frozen gas. Wrap in a paper towel to keep foodstuffs out of direct contact. Place in the bottom of the container that will actually contain the food, i.e. the bag. Fill the package with the food product, shaking and vibrating while doing so to achieve the maximum packing density.

If a vacuum process is not to be used then place the lid on the container, but do not fully seal. If a liner bag is being used then gather the top together or heat seal and cut off a small corner. This is to allow the air being purged to escape as it is pushed upward by the expanding gas from the dry ice. Do not move or shake the container while the ice is sublimating so as to minimize turbulence and mixing. After about two hours feel the bottom of the container immediately below where you put the ice. If it's not still icy cold complete the seal. Check the container every fifteen minutes or so to be sure that a pressure build up is not occurring. A small amount of positive pressure is OK, but do not allow the container to bulge.

If a vacuum process is used then cut off a corner of the bag and insert the probe or place the container in the vacuum chamber. Draw a vacuum and when it has reached the desired point shut it off, but do not allow air back inside. When the dry ice has finished sublimating seal the container. If a slightly larger piece of dry ice is used this process may be repeated once more to improve oxygen removal. Watch for pressure signs as above.

**NOTE:** It is natural for some grains and legumes to adsorb carbon dioxide when stored in an atmosphere with high levels of the gas. This will result in a drop in head space air pressure much like using oxygen absorbers will cause as they absorb oxygen. Precautions should be taken in thin walled containers against buckling and possible loss of seal integrity. When the food products are removed from the container they will release the adsorbed CO<sub>2</sub> and suffer no harm.

**WARNING:** Dry ice is extremely cold (about  $-110^{\circ}$  degrees F.) and can cause burns to the skin with prolonged contact. Because of this you should wear gloves whenever handling it. Also, dry ice evaporates into carbon dioxide gas, which is why we want it.  $\text{CO}_2$  is not inherently dangerous, we breath it out with every breath we exhale, but you should make sure the area where you are packing your storage containers is adequately ventilated so the escaping gas will not build to a level dangerous enough to asphyxiate you. If you must pack your containers in a coat closet, leave the door open <grin>.

**IMPORTANT NOTE:** Because dry ice is very cold, if there is much moisture (humidity) in the air trapped in the container with your food, it will condense. Try to pack your containers on a day when the relative humidity is low or in an area with low humidity, such as in an air-conditioned house. Use of a desiccant package when using dry ice to purge storage containers may be a good idea.

### **B.1.1 DRY ICE SUPPLIERS**

Dry ice may be found at ice houses, welding supply shops, some ice cream stores, meat packers or you could look in your local phone book under the headings "ice", "dry ice" or "gasses". If you are still unable to locate a source, contact your local hospital and ask to speak to the laboratory manager. Ask where the hospital gets the dry ice they use to ship biological specimens. You may be able to use the same source.

You may also want to check out *Dry Ice Info.com* (<http://www.dryiceinfo.com>) and click on the directory link to find a dry ice retailer in your area. While you're there check out some of the other uses for dry ice on the site. It's an interesting place.

## **B.2 COMPRESSED NITROGEN**

### **B.2.1 TYPES OF AVAILABILITY**

Both nitrogen ( $\text{N}_2$ ) and carbon dioxide ( $\text{CO}_2$ ) are commonly available in the form of compressed gas in cylinders. In food storage,  $\text{CO}_2$  is mainly used in the form of dry ice (see above) which is often easier to acquire with much less necessary equipment. Because of this, I'll be limiting this section to the use of compressed nitrogen. If for some reason you prefer to use compressed  $\text{CO}_2$  the information given below will work for both, though cylinder sizes may differ.

In the U.S. there are about eight principal suppliers of compressed gasses: Air Liquide, Airco, Linde, Air Products, Matheson, Liquid Carbonic, MG Industries,

and Scott. One or more of these producers should have compressed gasses available in virtually every area of the United States and Canada.

Locating a source of compressed nitrogen is probably as easy as looking in your local phone book under the headings "compressed gas suppliers", "gasses", or "welding supplies". Other sources might be automotive supply houses, university or college research departments, vo-tech schools, and medical supply houses.

Nitrogen is generally available in a number of forms ranging from gas intended for welding, to various purity assured types, to gas mixtures where N<sub>2</sub> would be one of the components.

Unless you are knowledgeable about compressed gasses and the equipment needed to use them it is strongly recommended that you not use any gas mixtures in your food storage, but rather to stay with pure nitrogen gas. Use of compressed gas mixtures requires knowledge and equipment beyond the scope of this FAQ.

**IMPORTANT NOTE:** Welding nitrogen is essentially a pure gas, but it has one important caveat. When a cylinder of welding gas is used there is an unknown possibility that some form of contaminant may have backfed into the cylinder from a previous user. Possibly this could happen if the tank was being used in an application where the cylinder's internal pressure fell low enough for pressure from whatever the tank had been feeding to backflush into the cylinder. Alternatively, the tank pressure may have become depleted and was repressurized using ordinary compressed service air. The most likely contaminants will be moisture, carbon monoxide, carbon dioxide, oxygen and hydrocarbons, but there is the remote possibility of something even more exotic or toxic getting into your tank. Welding gas cylinders may not be checked by the gas supplier before being refilled and sent back out for use. It is this remote, but unknown possibility of contamination that causes me to recommend against the use of welding grade nitrogen in food storage. If your supplier is willing to certify that welding gas cylinders are checked before refilling then they would be OK for use.

The varying types of purity assured nitrogen gas are slightly more difficult to find and slightly more expensive in cost, but I believe this is more than made up for by the fact you know exactly what you're getting. Air Liquide, as an example, offers seven types of purity assured nitrogen ranging from 99.995% to 99.9995% pure with none having a water vapor content over 1 part per million (ppm) or an oxygen content over 3 ppm. Any of them are eminently suited to the task so the most inexpensive form is all you need buy.

As you might expect, compressed gas cylinders come in a number of different sizes. For the sake of simplicity I will address only the most common cylinder sizes since they will almost certainly be the most inexpensive as well.

Again using Air Liquide as an example, it is their size 44 and 49 cylinders that are the most common. There are other cylinder sizes of smaller physical dimensions and capacities. However, the logistics of compressed gas production and transport being what they are, they frequently will cost as much or even more than the larger, more common sizes. The actual gas inside the cylinder is cheap. Filling and moving the heavy cylinders around is not.

Cylinder Size	Capacity Cubic Feet	Filled PSIG	Weight Lbs	Height Inches	Diameter Inches
44HH	445	6000	339	51	10
44H	332	3500	225	51	10
49	304	2640	165	55	9.25
44	234	2265	149	51	9
16	77	2000	71	32.5	7

**Legend:** The "H" suffix means high pressure.

PSIG = Pounds per Square Inch on the Gauge, this does not reflect atmospheric pressure which would be Pounds per Square Inch Absolute (PSIA). PSIA is the absolute pressure of atmospheric and internal cylinder pressure combined.

Although it is not a common size, I left the #16 cylinder in the above table in case someone really wants or needs to use a smaller cylinder.

Alphagaz (Air Liquide)	Airco	Air Products	Linde	Liquid Carbonic	Matheson	MG Industries	Scott
49	300	A	T	J	1L	300	K
44L	200	-	K	H	1A	200	A
44	200	B	-	-	-	-	-
44H	-	BY	3K	-	1H	2HP	-
44HH	500	BX	6K	-	1U	3HP	-
16	80	C	Q	M	2	80	B

**Legend:** [1] Alphagaz (Air Liquide) [2] Airco [3] Air Products [4] Linde [5] Liquid Carbonic [6] Matheson [7] MG Industries [8] Scott

Reference: *High Purity Specialty Gases and Equipment Catalog*; copyright 1995, Air Liquide America Corporation, Houston TX USA; pages 6 and 7.

As you can see, the size 49 cylinder from Air Liquide has an equivalent from all eight manufacturers. This size is the one commonly seen being used to fill helium balloons at county fairs and ball games.

### **B.2.2 OBTAINING THE GAS AND NECESSARY EQUIPMENT**

Although you can purchase your own the most inexpensive way to use nitrogen is to rent a cylinder from your gas supplier. This may require filling out an application, paying a refundable cylinder deposit, and buying the gas contained in the cylinder. Tank rental periods can vary, but the most common is for thirty days.

Having rented or purchased the cylinder you must now get the thing home. Delivery by the supplier can often be arranged or they may assist you in getting the cylinder into your vehicle. The preferred method of transportation is for the cylinder to be chained, clamped or otherwise solidly secured in a vertical position in the transporting vehicle with the cylinder cap in place. Transportation requirements vary from nation to nation, state to state, and even city to city so your best bet is to inquire of your gas supplier to find a safe and legal means of moving the tank.

**IMPORTANT NOTE:** The major expense in using compressed gas is not the cost of the gas itself, but in the equipment needed to safely handle and control it. Unless you can borrow the appropriate mechanisms they will have to be purchased, new or used, and even the cheapest regulator and gauge are not inexpensive. There is a temptation to forgo the expense and not use a regulator, but I must caution strongly against this. As Table 1 above shows, a full cylinder of compressed gas will have an internal pressure of 2000+ PSIG. Normal atmospheric pressure is about 15 PSIA. If the cylinder valve was opened only slightly too far a great deal of high pressure gas will flow through the delivery hose and metal wand and the potential for serious injury when it began to whip around would be high. For your safety, get the necessary equipment. If you purchase your own regulator/gauge cluster and/or your own cylinder, there is necessity for periodic maintenance. Regulators and gauges need to be calibrated (using a water deadweight calibrator) and cylinders need to be hydrostatically tested, typically every ten years for both. Your gas supplier can provide you with more detailed information.

The only equipment that will come with your cylinder is the cylinder cap. "Don't leave home without it" and they mean it. All of the common cylinder sizes will use the CGA-580 (Compressed Gas Assembly) cylinder fitting. The downstream side of this fitting can be obtained with different threads, but a 1/4" NPT (National Pipe Thread) nipple is normally needed to mate with the regulator body. The nipple is really nothing more than a short length of high pressure pipe.

The CGA fittings come in a variety of metal compositions such as carbon steel, stainless steel and brass. The best choice is one which matches the composition of the regulator body. If the CGA fitting and regulator are to be used only with dry, non-oxygen gasses, in a dry environment then galvanic corrosion can be disregarded so the most inexpensive metal composition can be used even if it is not the same as the regulator. If it is to be used in a wet area, or with oxygen containing gasses then matching metal composition becomes important.

When the tank is to be returned there must be some residual pressure still in the cylinder or the renter may have to pay a surcharge or lose their deposit. This is particularly true of purity assured gasses because the residual gas composition will be analyzed. This is done for the safety of all cylinder users.

The regulator/gauge cluster should be carefully removed using the same procedure that is described below to put it all together. Care should be taken not to damage the cylinder valve threads. Replace the cylinder cap and transport in the same manner as you brought it home.

### **B.2.3 PUTTING IT ALL TOGETHER**

If the fitting and regulator are bought separately then some 1/2" wide Teflon tape is recommended for assembly since it is a clean and inexpensive way of sealing pipe joints. Looking into the open end of the nipple wrap the tape clockwise around the threaded end for 1.5 to 2 turns, working from the open end backwards. If you want to do a neat looking job, the tape may be slit lengthways to make it 1/4" wide, but this is not a requirement. A brass nipple may shrink somewhat during tightening and need a bit more tape than a harder metal like stainless steel would. The Teflon tape should only be used on the end of the nipple that attaches to the regulator body, NOT to any part of the cylinder end.

The regulator end has tapered threads and uses them directly for sealing. The cylinder end has straight threads and depends upon the precision mating of machined metal surfaces to seal. The cylinder end threads simply apply the clamping force.

Before attaching the CGA fitting to the cylinder the user should put on safety glasses and good hearing protection. The cylinder valve can then be cracked slightly to blow out any dust or debris. After closing the valve, inspect the cylinder valve and nipple for any abrasions, nicks, gouges, embedded particles, etc., before attachment is made.

You will need two wrenches (not adjustable pliers) to equalize the torque, particularly on the cylinder valve where it should be minimized. Put one wrench on the fitting and the other wrench on the cylinder valve and make the join.

Once the regulator/gauge cluster has been mated to the cylinder, the delivery hose can now be fitted to the regulator and the metal wand to the other end of the hose. The wand is nothing more than a short length of metal tubing at least six inches greater in length than the depth of the buckets to be filled. Copper water line works well.

When the joins have been made, a mixture of a short squirt of dish washing detergent and water can be used to check for leaks. Be certain the detergent does not contain ammonia which can be corrosive. Pour some on each fitting working from the cylinder end outward, opening each valve and pressurizing as you go. Once the leak check is finished rinse off and wipe down all surfaces to minimize the chance of accidents in the future.

If the gas is not to be used at that time then the cylinder valve should be closed and all pressure should be drained to zero in the regulator and gauge. This should be done any time that the tank is not in actual use. If you have purchased your own cylinder then it is a good idea to also acquire one of the plastic valve plugs, similar to those seen with propane cylinders, in order to protect the cylinder valve threads and keep dust, debris and insects out of the valve.

**WARNING:** Care should be taken that the cylinder is used and stored in such a way as to minimize the risk of the tank falling over. With the regulator and gauge attached there is an increased likelihood of damage occurring to the cylinder valve should the tank fall. Catastrophic failure of the cylinder valve will turn the tank into a high-energy, unguided rocket with the capability of doing great damage and/or serious injury.

#### **B.2.4 PUTTING IT INTO USE**

Having assembled and tested your gas system, you are now ready to begin the work of packaging your food. You'll need containers, and food grade plastic or Mylar bags that are a bit larger in internal volume than the container. Next is the dry food you intend to package and a pack of matches or a cigarette. You'll also need to wear the safety glasses and hearing protection you wore when you put the gas system together.

Take the containers you are going to use to store your food in, the bags that will line them and the food you are putting up and place them in some warm (not hot) area long enough for them all to equalize to that temperature. This will mean that the air contained inside them will also be at a warm temperature and make it more likely that it will stay on top when the cool gas from the nitrogen cylinder begins to flow in. The warm gas being on top will be the first to purge from the container, taking a good deal of the oxygen with it.

Line the interior of the container with a plastic bag or Mylar bag. Fill the container with the food product shaking to get it as full as possible. Don't forget to put your desiccant package on the bottom if you're going to use one. You don't want any pockets left between the plastic bag and the container. Once you have gotten it full to just short of not being able to fully put on the lid, gather the top of the plastic bag together or heat seal the edges. If you have sealed it, cut a small corner off of the bag just large enough to allow a probe to enter.

At this point you can either simply flush the bag as described below or draw a vacuum on it first and then flush. If using a vacuum the suction probe should be kept at the top of the bag, just inside of the opening. The gas wand should be inserted to the bottom of the container, taking care not to poke any holes in the liner bag. Once both instruments are inserted, draw the vacuum. When it has reached a satisfactory level, shut off the suction, maintain the seal and turn on the gas.

Open the cylinder valve and set the regulator to a very slow gas flow and begin to fill the bag with gas. You want the container to fill slowly so you can minimize turbulence and mixing as much as you can. It'll take a little while to fill each container, a minute or two per bucket. Just as with dry ice, the idea here is for the cool gas to displace the warmer atmosphere from the container. The bag should puff a bit. When I think it's full I'll hold a lit match above the bag in the air that is escaping from it. If it snuffs right out then I let it run for about several minutes longer to flush out more of any remaining oxygen and remove the wand.

For the most efficient oxygen removal, repeat the suction/gas flushing procedure one more time. When satisfied, tie or heat seal the bag off and seal the bucket. Again, you want to have the bucket as full as possible so that there'll be only minimal air space. You should monitor the containers for an hour or two after filling to check for any signs of bulging or other pressure build up as the cool gas inside gradually warms and expands. A slight positive pressure is OK, but serious bulging will need some of the pressure released.

**NOTE:** Although the procedure for flushing a container with nitrogen is straightforward enough, actually getting a good purge of the container is not. Nitrogen flushing works best when the food particles are fairly large in size so the gas flow around and through the food is free and unrestricted. Foods such as the larger sized grains (corn, wheat, barley, long grain rice, etc.), legumes and non-powdered dehydrated foods are best suited to this technique. Foods with small particle sizes such as flours, meals, and dry milks will flush with mediocre results.

Because of the difficulties in purging sufficient oxygen from a container to lengthen the shelf life of the food it contains many commercial suppliers have dropped this technique in favor of using oxygen absorbers. There is no reason that inert gas flushing and oxygen absorbers cannot be used together and one good reason that they should. If you are using five gallon plastic buckets as your

storage containers, it has been observed that absorbers used in unlined pails can cause the air pressure inside the bucket to drop enough for the walls to buckle, possibly leading to a seal breach or a stack collapsing. For this reason, flushing with inert gas (nitrogen or CO<sub>2</sub>) might be a good idea, in order to purge as much oxygen as possible so that the pressure drop caused by the absorber removing the remaining oxygen will not cause the bucket to buckle. Liner bags can ameliorate the vacuum problems.

*A big note of thanks to Lee Knoper for his assistance in putting together the above compressed gas information.*