TANK LINING INSPECTION & MAINTENANCE STRATEGY

Blair Rubber Company recognizes the need to avoid long and costly shutdowns through prompt and proper maintenance of the lining. Although the recommendations included here are based on extensive experience in maintenance and prolonging the life of rubber lined equipment, the primary responsibility for observing safe and proper procedures shall remain with those persons actually doing the inspection or repair work.

From a business management viewpoint, a vital question regarding tank lining repairs will usually be, is this economically feasible? Is it an effective expenditure of funds?

Closer to the corrosion protection task itself, those responsible will ask, are these repairs the best way to keep us running? Cost is certainly a consideration but meeting a production schedule or other output pressures must enter into this judgment. In rubber linings handling strong acid/alkali environments, the rubber repairs must be correctly accomplished or the time and expense will be for naught.

On the following pages, various aspects of the repair of tank linings will be reviewed, including inspection, justification and techniques. At this point, however; it is evident that any rigid policy reflecting only lining replacement is erroneous.

ANALYZING THE SITUATION (AS TIME ALLOWS)

The points below regarding a repair decision are interrelated in many situations. A general commentary follows:

* How extensive is the failure?
* Is replacement of the rubber lining a better option?
* What time frame is required?
* Is temporary repair feasible?
* If a repair is preferable, what techniques should be used?
* What supplies are available?
* What personnel are available?
* Are demurrage and other additional costs a consideration?
* What facilities and equipment are necessary to complete the job?

First, consideration must be given to personal safety to accomplish the rubber lining inspections on used equipment. The vessel should be neutralized and rinsed thoroughly and aired out overnight. The tank shall be tested prior to entrance to insure the atmosphere has the correct oxygen content and that toxic fumes have been emitted. Also, the electrical equipment, light and voltage testers to be utilized shall conform to safety codes.

Once all has been determined to be safe for inspection, the lining inspector shall be knowledgeable of rubber and have the necessary equipment to make a complete inspection. It is recommended that a general drawing of the equipment be available for marking areas of repairs. One should have a good light source, chalk, clipboard with drawing, durometer, spark tester, etc. for proper inspection. Generally, it's best to wear disposable coveralls, hard hat, safety glasses and plastic gloves and, if required, the appropriate respirator.

Lining inspection can be complex; one never knows exactly what he may be confronted with and, for this reason, we are going to assume various conditions ranging from minor to major failures. Generally, it's best to take a cursory look around the entire tank to determine the overall general conditions.

The general appearance may show the lining to be in good condition where the rubber surface shows either the polyethylene embossing pattern or liner used to roll up the rubber. Where the rubber surface looks good and durometer range approximates the hardness expected for the services usually means the lining is in good condition without need of repairs. The voltage tester may be used to verify that no leaks are present. For spark testing, it is recommended the voltage tester be set low, 8,000/10,000 volts.

Assuming a small repair is required - areas less than 18" in width shall be filled and overlayed. Repairs are recommended to be made using a minimum 45° skive. A repair may be 6" x 6" or 2" x 72". The normal recommended procedure for small repairs is to fill in the area using the same gauge rubber as the original lining and to then overlay this area with the lining extending 2" beyond the fill-in patch. If more than one repair is in close proximity, it is recommended that both areas be filled and the two overlayed with one larger section of rubber to maintain good appearance in the tank.

The reason a single fill-in patch is not recommended on small repairs is that the rubber has a tendency to lift in one corner area of the repair, resulting in leakage. On small work areas it is difficult to make a good tapered skive, whereas on a large area one can produce a good skive with a grinding tool. Thus, on small repairs a fill-in and overlay patch is recommended.

On large rubber repairs, the single sheet rubber layer is more forgiving since it doesn't receive the stress as in a small repair. Where a good wide angle skive can be accomplished, it is quite appropriate to have a single sheet patch repair, especially on areas larger than several square feet.

Where the lining has shown surface deterioration (surface oxidation) several options may be considered. One being if the lining isn't causing solution contamination, leave the lining as is, and continue to monitor it on a scheduled basis. Another possibility is to lightly wash or scrub the lining down to reduce particle contamination. This generally provides short term relief, and may require additional maintenance. The most positive way is to buff the entire lining surface and overlay the total lining with the appropriate material. It is best to check the rubber lining manufacturer for there may be a lining that would solve or reduce the surface deterioration.

One of the major means for lining to fair in years of service is where the lining develops light surface cracking. With continued age, the cracking progresses deeper and deeper. Age is not always the culprit for the cracking; sometimes cyclic processes cause expansion and contraction that result in rapid crack fatigue. Regardless, rubber lining cracks need to be thoroughly inspected and analyzed for maintenance control. If the cracks are just of the hair line nature, they should be monitored. Cracks progressing one fourth of the lining thickness are best to be repaired. The surface must be buffed below the cracks and overlayed with the appropriate lining. The selected gauge of the overlay rubber should take into account the original lining years of service, and just how long one is trying to maximize the lining life. For example, it may be best to repair with 1/4" if one is trying to optimize service performance; on the other hand, why use 1/4" when 3/16" will suffice if one is just planning to extend the life for a short period with the intent of changing the process or chemical.

Linings having deep cracks, at least one half or more of the lining thickness, are considered not to be cost effective or worthy of repairs. Besides the cost, it is doubtful that an effective repair can be accomplished. The reason being is that one would need to extend the lining repair above the liquid level because one cannot effectively buff out the cracks and there is the potential risk of a crack to opening more, letting the acid enter behind the repair.

Then, it is almost impossible to determine the entry mode that caused the hole in the bottom of the vessel.

The following table was constructed to cite several of the most common types of failure, provided the recommended repair techniques and the method of cure were considered acceptable.

Admittedly, there is more than one means to accomplish the repair task. Generally, it is not recommended to make vulcanized or exhaust steam cures on linings that have aged with service.

Chemical cured linings or recured rubber bond with contact adhesives are the normal accepted repair methods. However, on vacuum vessels, internal pressure curing is the standard and the preferred procedure. Here too, precured rubber has also been used satisfactorily.

There are many factors, lining conditions and repair techniques to consider in making reliable rubber lining repairs. Hopefully, this brief review will offer helpful guidelines for inspection, determine the type and to what extent repairs are required to yield the lining service performance desired.

RUBBER LINING CONDITIONS & RECOMMENDED REPAIRS

LINING CONDITION	REPAIR RECOMMENDATION	METHOD OF FIELD REPAIR EXHAUST	CHEMICAL	CURED
Small Defect - Hole	Filled in and overlay	X	X	X
Oxidized Surface - Causing Contamination	Scrub down or buff lightly			
Large Repair	Cut out and single fill	X	X	X
Cracking				
a. Light Surface Cracking 1/8 of lining thickness	None recommended			
b. Medium Surface Cracking 1/4 of lining thickness	Buff and overlay	X	X	
c. Severe Surface Cracking 1/2 of lining thickness	Replace lining			
Ply Delamination	Buff and overlay	X	X	
Lining Separation Soft Rubber from Hard	Buff and overlay	X	X	
Lining Bond Failure				
a. Blisters less than 2” diameter	Test to determine solution behind lining. If solvent or water, may be best to leave and monitor.			
b. Blisters over 2” diameter	Cut out, fill and overlay	X	X	

PLEASE NOTE: THE ABOVE CONDITIONS ARE CONSIDERED TO BE NON-VACUUM SERVICE.

CARE AND MAINTENANCE

Where brick sheathing is required, great care should be exercised during removal of and/or installation of the brick. Bricks should be laid in the tank, not thrown or dumped. Workmen should wear overshoes or rubber soled shoes without nails while working inside the tank.

If tank covers are removable, they should be placed and removed with great care. Sudden drops by a crane may cause distortion of the steel, crack the lining, and possibly interfere with proper fit of covers.

A minimum clearance of 2” should be maintained between live steam pipes and all rubber lining. No pipes, such as acid, water, etc. should come in direct contact with the rubber lining as vibration will chafe a hole in the lining.

PREMATURE AGING

Probably the greatest single factor in the premature aging of rubber lining and it’s accompanying shortened service life, is excessive heat. Temperatures of over 200 degrees Fahrenheit have a definite deteriorating effect on the lining. Every attempt is made in the design of rubber lined equipment to protect the lining against excessive heat and also, against physical damage. For instance, brick sheathing in pickle tanks is used to serve both these purposes. Tank covers and exhaust ducts do not have the benefit of this protection and are made more vulnerable by the fact that very often the solution vapors are more destructive than the solution itself. The only protection that can be given to the lining in these pieces is to see that the design of the covers and exhaust system provides for movement of a sufficient quantity of air. In recent years, with the advent of much higher operating temperatures, this feature has been given increased attention. Operating personnel can greatly increase the service life of the equipment by watching closely that thermocouples and other temperature controls operate properly, thus avoiding temperatures in excess of those for which the equipment was designed and by seeing that all covers, curtains, etc. are in place so that the exhaust system can function as designed.

Other enemies of rubber lined equipment which seriously threaten service life are the various oils, solvents, oxidizing solutions and other contaminants which are often present in process solutions. Where possible, these contaminants should be kept to a minimum. Probably the worst offender of these, in pickling equipment, is oil. The presence of oil from re-runs has a definite deteriorating effect on rubber, and every precaution should be taken to keep the pickling solution free from oils of any kind.

MAINTENANCE

A program of constant inspection and maintenance should be set up for the exterior of rubber lined equipment. Yellowish or green stains are an indication of acid seepage attacking steel. As corrosion progresses, a moist, frothy deposit will build up until finally a definite leak appears. In most instances, extensive metal repairs can be avoided by correcting the condition at the first indication of seepage. A simple expedient, where acid or other corrosive liquid has been spilled or splashed on the metal, is to flush thoroughly with water to dilute and wash away such spillage. The metal should be thoroughly protected with asphalt paint or some other acid resisting paint. Areas where the paint has been affected by acid spillage should be thoroughly wire brushed, the metal neutralized, and fresh paint applied.

The lining on the interior of the equipment should be inspected at every opportunity. At least twice yearly is recommended for this inspection, where operating conditions permit. The lining should be examined at the seams to see that it is down tight, inspected for raised areas of 'blisters', indicative of gas pockets behind the lining, inspected for surface cracking (surface oxidization) and, if practical, the entire surface should be gone over with a spark tester, in a search for 'pin hole' leaks. The spark tester, however, should be operated only by an experienced person, as it is quite possible to burn leaks in the rubber if not properly used.

As mentioned earlier, excessive heat and/or concentration of certain solutions can have very detrimental effects on rubber. Therefore, a close check should be maintained on operating procedures and conditions at all times. In some cases, the solution for which the tank was lined will have little detrimental effect on the rubber while the increase of a few percentage points in the concentration may have a definite deteriorating effect. This is especially true in cases where temperatures are increased, for as the temperature rises, the corrosive action of most acids increases, while the resistance of the rubber decreases at temperatures above the specified range.

STORAGE OF RUBBER LINED EQUIPMENT

ALL-WEATHER STORAGE

1. Rubber linings should never be exposed to direct sunlight or direct outdoor weathering, for periods longer than a few days. Exceptions are Chlorobutyl, Hypalon and Neoprene linings which probably can be exposed for extended periods without harm. All other linings, including hard rubber, should be protected from sunlight. If no other alternatives are possible, linings should be periodically painted with Chlorobutyl, Neoprene or Hypalon based coatings or Ageguard.

SUMMER STORAGE

1. If possible, store in shaded areas away from hot afternoon sun.

2. Paint outside of tanks with aluminum or white paint, or cover with a tarpaulin.

3. Closed tanks should be kept ventilated.

4. Tanks to be stored for long periods after having been in service, should be partially filled with a diluted solution of the chemical they were designed to contain (a 1-3% concentration probably will be sufficient, though it would be preferable to check with the supplier of the tank lining).

WINTER STORAGE

1. Equipment should be protected as much as possible from the elements by covering with tarpaulins, erecting temporary shelters, etc.

2. Tanks containing solutions must be emptied if temperatures drop below the freezing point (of the solution contained therein).

3. Equipment should be handled very carefully and protected from subjection to external forces (sudden blows, flexing, twisting, etc.). Sudden temperature changes also are to be avoided. There precautions are most important for semi-hard rubber linings.

IDLE OR STANDBY EQUIPMENT STORAGE

1. Idle or standby equipment (especially semi-hard lined) should be protected against excessive drying out and temperature changes. The best way to accomplish this is to fill the tanks with a 1-3% solution of acid, preferably H2S04, and hold at ambient temperature. This will help keep the lining more flexible and minimize the expansion and contraction problem as well as decrease the possibility of thermal shock when the equipment is put back into service.

2. Recommendations listed above for summer and winter storage of tanks are also pertinent for idle tank cars.

JOB SITE PROTECTION

There are many sources for potential problems with rubber lined equipment at job sites. A partial, but not all inclusive, list of those sources is as follows:

1. Ozone from welding.
2. Ozone from portable generators, power relay stations and electric motors.
3. Fumes from generators such as nitrous oxide.
4. Arcing from electrical equipment and hook-ups.
5. Oils and liquids of many types.

Problems may occur from any one or more of the above sources and can occur either inside or outside of the structure being erected and suitable protection must be provided. Some suggested means for protection are:

1. Rubber installation should be as near to the end of the construction phase as possible.
2. Openings to rubber lined equipment should be closed as much as possible to prevent attack from hazards such as those noted above.
3. The ends of rubber lined pipe should be blanked off and kept that way until ready for use.
4. All portable rubber covered items should be covered for protection.
5. Additional protective measures are available from RMA, ASTM and other Blair publications.

JOB SITE ASSEMBLY

Listed below are recommendations for gasketing and bolt tightening rubber lined pipe flanges and equipment. Care should be taken to ensure that the rubber lined flange is not damaged by being cut or crushed during assembly. The flange rubber should not compress more than 1/3 the thickness or the lining could tear away from the metal surface causing a leak.

1. The gasket thickness should be equal to or slightly less than the rubber lining but not less than 1/8".

2. The gasket hardness should be equal to or slightly less than the hardness of the rubber lining, but not greater than 60 Shore A.

3. The surface of the lining in contact with the gasket should be treated with a release coating which will allow disassembly without damage to the lining.

4. All bolts should be initally tightened until they are snug. Then each bolt should be torqued down to 15 ft-lbs using standard cross pattern techniques.

5. After 24 hours, bolts should be checked to ensure that 15 ft-lbs is maintained.

6. After the line or equipment is put in service, check to insure that there are no leaks. If a leak is observed, tighten bolts evenly and only enough to stop the leak.

7. For high pressure applications (greater than 300 psi) flanges may require a high pressure design vice the typical flat face design.