Process, Plant and Equipment UP-TIME

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CONTENTS

Volume 1 Edition 9 topics

- **WELDING PLASTICS**
- **MAKING WALKWAYS & PLATFORMS**

Regular features

- **Asset Management**

Valuable secrets in every work order report.

- **Process control talk**

Radar Level detectors

- **From the mechanical workshop**

Agitator shafts steady bearing problems

Asset Management

Valuable secrets in every work order report.

Reporting back on a completed work order is vital. This task is often seen by tradesmen as a time consuming requirement of little worth. This view is terribly wrong.

Each repair contains valuable information to improve the future performance of the equipment repaired.

But this information is only valuable if the people who can authorise money for plant improvements are alerted to a problem. The work order report is a tradesman's opportunity to tell maintenance management the equipment problems they have to live with and what to do to solve them.

A wise maintenance engineer will read all the work order reports for his section of plant. It gives him additional insight into the plant through other's eyes. If the work order is not read by middle managers in maintenance then improvements to plant and equipment will be slow.

A good work order report tells the reader what the tradesman saw. Such as "There were score marks around the shaft under the bearing inner race." Indicates the inner race had probably spun and there may be too much clearance between the shaft and race or the bearing is getting hot and expanding. This could lead to changing tolerances on drawings or investigating lubrication requirements. Another example is "The rubber in the shaft lip seal was hard and cracked." This may mean the temperature was too much for the seal or the wrong rubber was selected.

The tradesman's comments are critical in the effort to continuously improve plant performance.

A good work order report also tells the reader what the tradesman did to fix the repair. In the example of the shaft bearing "Polished bearing seat and fitted new bearing" tells the reader the problem has not been fixed and it will likely reoccur. But - "Checked shaft tolerance and found it was undersize by 0.05mm. Machined shaft and shrunk fit a sleeve. Machined sleeve to within tolerance and installed new bearing." – says at least one possible problem (an undersize shaft) has probably been eliminated.

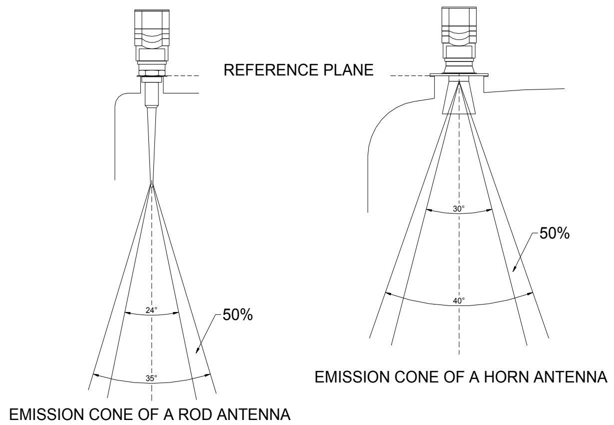
*CMMS –Computerised Maintenance Management System

Process control talk

Radar Level Detectors

Radar is a popular technique for tank level detection of liquids. The radar sends a sub-millionth of a second pulse from an emitter and the return signal is detected at a receiver. The reflection's time lapse is measured and electronically converted to a distance from the liquid surface.

FIGURE 1 Rod and horn style radar detectors



Usually the radar is mounted in a flanged nozzle or socket welded to the roof. It can also be mounted in a pressure-balanced standpipe in those tanks with undulating surfaces. The radar can be mounted directly to the roof provided the liquid full height is below the bottom of the antenna. If the antenna gets below the liquid surface false indication results.

Care must be taken to position the radar to prevent unwanted reflections off tank internal structural beams, wall welds, rivets, etc. Spurious reflections can be electronically separated from the true level reflection but this introduces programming complications better avoided if possible.

Keep the receiver below the bottom of the nozzle so that it is in clear space. Pulses can bounce off the nozzle walls to the receiver and produce false signals.

Foam on the liquid surface deadens the return pulse.

If located inside vigorously agitated tanks the risk exists that the opening of the antenna cone can get blocked by splashed product. This is a problem with products that sublime (evaporate then solidify on surfaces) like sulphur or that crystallise.

Check material compatibles and chemical resistance. Especially over many years so that you don't have reoccurring operating problems.

Mike Sondalini – Maintenance Engineer

WELDING PLASTICS

Written with assistance from Ben Karel of **Fusion Engineering Plastics Pty Ltd.** Unit 1, 7 Dobra Rd, Yangebup WA ph (08) 9494 1004

WHY USE PLASTICS

Plastics have some wonderful engineering properties that can be used to great benefit.

- they handle a vast range of chemicals;
- they don't rust;
- some of them are very slippery and little sticks to them;
- they are extremely cheap compared to the exotic alloys required to match some of the properties;
- they don't transmit electricity or heat easily
- some are tough and will deform instead of breaking under impact
- they are so easy to fabricate that people can be trained in a week to join plastics well.

Their major drawbacks when compared to metals are:

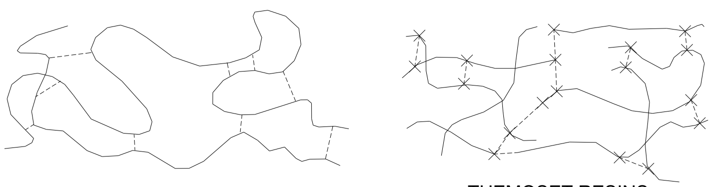
- most soften at comparatively low temperatures;
- they cannot take high tension continuously;
- some can expand greatly when heated;
- they breakdown in sunlight unless protected.

THE TWO FAMILIES OF PLASTIC

Plastics are broadly grouped into two distinct families – thermoset and thermoplastic. Thermosets can only be molded once. After their first melt they set permanently. A thermoplastic can be melted a number of times and the shape changed. Welded plastics are thermoplastics.

The difference between the two families of plastic results from how the macromolecules (See July 2000 article on Polyethylene) bond together at the atomic level. Thermoset molecules are triggered by heat to chemically react and join. Thermoplastic molecules are attracted to each other but do not chemically bond. Figure 1 shows the difference in the type and numbers of bonds between thermoset and thermoplastic materials.

FIGURE 1 Bonding in plastics



THERMOPLASTIC RESINS

FORCES OF ATTRACTION (....) HOLD THE MOLECULES TOGETHER. HEATING OVERCOMES THE ATTRACTIVE FORCES LEADING TO MELTING OF THE PLASTIC.

THEMOSET RESINS

THERMOSET MOLECULES WITH REACTIVE SITES (X). INITIAL HEATING CAUSE THE RESIN TO SOFTEN AND FLOW. ADDITIONAL HEATING STARTS THE CROSSLINKING REACTION (SETTING).

HEAT JOINED PLASTICS

The common plastics, which are joined together using heat, are PE (polyethylene), PP (polypropylene) and PVC (Polyvinylchloride). At the exotic end PVDF (polyvinylidene fluoride) and PTFE (polytetrafloroethylene) can also be welded.

JOINING PLASTIC TOGETHER

Heating the contact surfaces above their melting point and then pushing them together firmly till they set joins thermoplastics. When the molten faces come together the macromolecules intertwine and bond together on cooling.

The three critical factors for a good join are - achieving the right melt temperature; sufficient pressure when pushing the faces together; the length of time the join is allowed to cool before releasing the pressure.

METHODS TO JOIN PLASTICS USING HEAT

Several methods are available to heat join plastics.

<u>Butt-welding</u> is used to join pipes. The pipe ends are held in a special clamping rig, then cut and faced square with a cutting tool. A hot plate set to the melt temperature is inserted between the two ends and the pipes pushed onto the hot plate. Once enough time has passed to melt the pipe ends the hot plate is removed and the ends pushed together under pressure. After a time ranging from a few seconds to a few minutes, depending on the thickness of the pipe, the pressure is released. The pipe is then left to cool down. This may take from a few minutes for small-bore pipe and up to an hour and a half for large pipes with 50mm wall thickness.

<u>Socket welding</u> is done by using heated tools to melt the outside of the first few centimeters of a pipe end and the first few centimeters on the inside of the socket fitting. The pipe is pushed inside the socket and held in place till it cools.

<u>Electro-socket</u> welding is the same as socket welding except an electrical wire is installed in the fitting when it is made. The pipe is pushed into the socket and the wire connected to a power source. The wire heats up and melts the plastic surfaces. When the power is removed the plastic cools down.

Beware that the metal heating wire can come into contact with the process chemical in the pipe. If the chemical is incompatible with the metal it will corrode the filament and leak out along the wire track.

<u>Extrusion welding</u> is used to weld plastic sheets together. Plastic wire from 2mm to 6mm in diameter, depending on the size of the extruder, is fed through a heated barrel where it melts. The tip of the extruder heats the plastic sheet and melts the surface. The molten wire in the extruder is forced onto the melted surfaces and joins the edges of the sheets together. The extruder is gradually fed along the joint melting the surfaces and laying the filler material as it goes.

Extrusion welded joints are de-rated to 80% of the parent material's strength.

<u>Hot air gun welding</u> is used for light duty fabrication and tacking large fabricated items together before finally extrusion welding them. With this method a hand-held plastic wire is pushed into the joint made by the corner edges of the two parts. The hot air gun is used to melt the corner edges of the plastic and the hand-held plastic wire.

The operator watches for the melt to develop and forces the wire into the weld. The hot air gun is kept ahead of the moving melt and the plastic wire continuously rolled forward into the puddle. Cooling is rapid and by the time the operator's hand passes a point the plastic has joined together.

GOOD PLASTIC WELDING PRACTICE

The secret to a high quality plastic weld is cleanliness. Contamination must be avoided. For example water will cause voids and bubbles in a weld. The contacting faces or edges must be clean. Before heating a butt or socket weld acetone is used to wipe the end of the pipe clean.

Recognised procedures need to be properly followed and operators trained and tested to the procedures. Most plastic welding procedures are based on German standards.

The quality of butt welds can be checked by tensile tests. A sample of a butt-welded pipe is held at each end in a machine and stretched. The force is measured and the weld must stay together up to the required load.

A spark test can be used to check extrusion welds. A voltage created by an electrically charged plate on one side of the sheet and an oppositely charged hand held wire brush on the other side will cause a spark to jump if a hole is present.

Good practice is to always test welds with water under full operating pressure. In the case of piping this will confirm its integrity and with tanks it will locate leaks.

Mike Sondalini - Maintenance Engineer

MAKING WALKWAYS & PLATFORMS

Here are the things to watch out for when you need to fabricate platforms and walkways.

Stairs, walkways, platforms and ladders are required to be made to Australian Standard AS 1657-1992. This standard specifies the design requirements and the materials of construction to be used.

Unless a structure meets this standard it could be considered unsuitable and may need to be rebuilt. The standard specifies when and what type of access structure to use depending on the slope needed for accent. Figure 1 shows the allowable angles for the types of access.

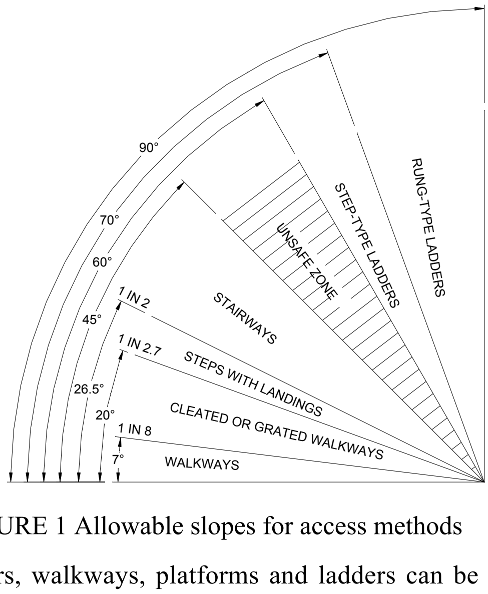


FIGURE 1 Allowable slopes for access methods

Stairs, walkways, platforms and ladders can be made from timber, aluminium, concrete, masonry or steel. Each material has characteristics and limitations that must be accommodated in the design of the structure.

ALLOWABLE LOADS

The standard sets the allowable loads for floors on walkways and platforms as the dead weight load of the structure <u>plus</u> a live load of 250kg/sq. m or a 100kg load at any point, whichever produces the worst deflection. If the loads are higher than this then AS 1170 Part 1 - Dead and live load combinations – is to be used.

The weight of an 80kg person carrying a toolbox will be close to the allowable live loads for walkways and platforms. If equipment is also to be mounted on the platform then a thorough engineering design will be needed. Wind loads are added to the weight loads when sizing the members.

The guard rails around walkways and platforms are required to handle a 55kg point load or a 33kg per meter load, whichever produces the worst deflection, applied at any position or direction on the top rail.

ACCEPTABLE DEFLECTIONS

The allowable loads carried by walkways and platforms must not over stress the materials used in its construction. For steel walkways and platforms a rule-of-thumb is to limit the maximum deflection along a span to

$$\frac{\text{Length of unsupported span}}{250}$$

This represents a 10mm deflection per 2.5 meters. The overall deflection for a span should be kept to a maximum of 10mm – 15mm. Greater deflections scare people and they will consider the structure unsafe, though it is unlikely to be.

The allowable deflection can be used to select steel members. By putting a length of structural steel between supports spaced a span apart, and loading the steel member at the center with its maximum load, you can use the 10mm deflection criteria to check the steel beam's strength. Once the whole structure is fabricated it will be stiffer and will deflect less than the individual members selected this way.

REQUIREMENTS FOR STAIRS

Stairs are safer to use than ladders but expensive to make. Stairs are used where much traffic will pass over the walkway or platform or a safe and quick access is required.

The length of a stair is limited to 18 rises after which a landing is required. A change of direction is needed every 36 rises to prevent a person falling further unless the landing is more than two meters long. The width of a stair is to be a minimum of 600mm between the inside edge of the handrail.

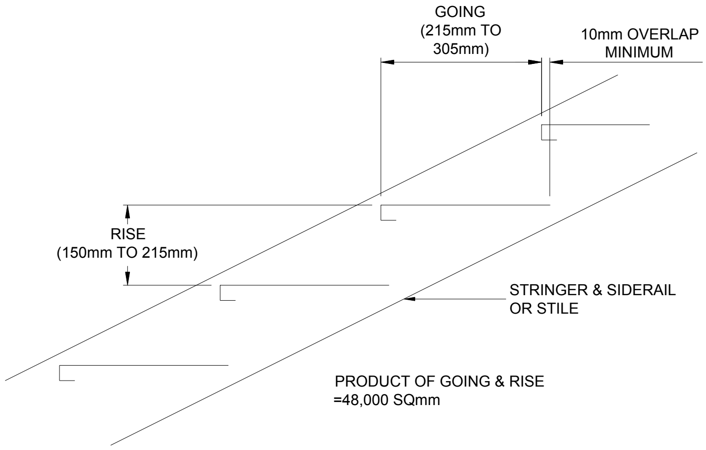


FIGURE 2 Stairway treads requirements

The angle of the stairs is limited to a range of allowable goings and rises. The rise must be between 150mm and 215mm with the going between 215mm and 305 mm <u>and</u> the multiplication of the rise and going in millimeters must be between 45,000mm^2 and 48,000mm^2. Figure 2 shows the necessary tread requirements for stairs.

REQUIREMENTS FOR LADDERS

Ladders are used where there is an occasional requirement for access. They need to be positioned clear of neighbouring objects so the user can get up or down with comfortable clearance to all parts of their body.

Rung ladders are limited to a length of 6 meters between landings and positioned so a person can fall no more than 6 meters before coming to rest. The width of the ladder between styles is 375mm to 525mm. Styles can be of flat material 50mm to 80mm wide and thickness 6mm to 30mm, or pipe with a diameter between 40mm and 65mm. The styles on step-through ladders open out to between 525mm and 675mm so a person can pass through comfortably.

The rungs are to be at least 20mm diameter and be able to match the load carrying capacity of a 20mm low-carbon steel solid bar. The rungs are to be fully sealed to the styles. The ladder is to be hot-dip galvanised if tubular rungs are used. Rungs ought to be spaced between 250mm and 300mm apart with a 5mm tolerance either way.

Even though landings may be present, a ladder cage is required where a person can fall more than 6 meters. This can be superceded by local legislation, which can require a ladder cage where a person can fall more than 2 meters.

Step ladders have the same height and fall prevention requirements as rung ladders. Their width is to be no less than 450mm between stiles. Well-supported metal handrails no less than 30mm diameter are needed on each side.

GUARD RAILS

Guard rails at a height between 900mm and 1100mm are needed. If an object can fall more than 2 meters, a toe-board is to be fitted. A mid-rail spaced between the top of the toe-board and the top rail is also required. Steel guardrail posts can be 65x65x5 angle or 48.3mm OD pipe of suitable thickness, the top rail of 50x50x5 angle or 33.7mm OD pipe of suitable thickness, the mid-rail of 40x40x5 angle or 50x5 flat bar or 26.9mm OD pipe and the toe-board 100x6 flat bar.

Openings in guardrails must be protected. Hinged, sliding or removable sections are permitted.

CONNECTIONS

All bolting must be of a suitable structural grade at least 12mm diameter and larger. If connections are in tension, or the load is off-center, two bolts are required per connection.

All welding must meet the applicable Australian Standards relating to the material of construction.

Mike Sondalini - Maintenance Engineer

From the mechanical workshop

Agitator shafts steady bearing problems

Here is a modification to an 80mm agitator shaft thrust bearing that went wrong.

An agitator gearbox was being replaced because of bearing failure. It was decided to convert the thrust bearing taking the weight of the shaft and blades from a bronze plain bearing rubbing face to a thrust ball bearing. The intention was to decrease the torque and forces on the gearbox.

The original design is shown in Figure 1 and the new design in Figure 2. The bearing sat in a bracket bolted under the top of the tank and the shaft was coupled to the gearbox.

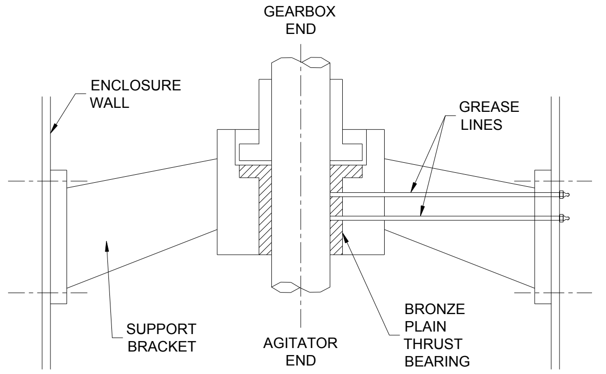


FIGURE 1 Original plain thrust bearing design

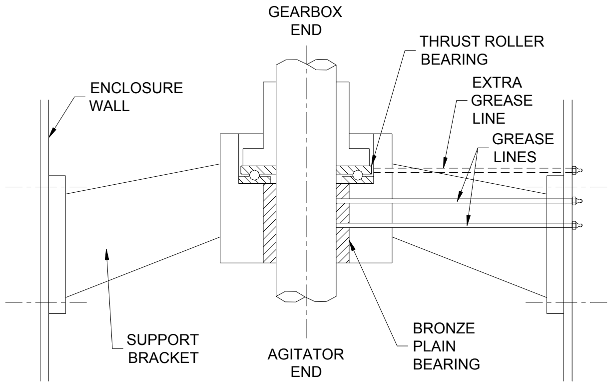


FIGURE 2 New roller thrust bearing design

The new arrangement lasted only 8 months before the thrust ball bearing collapsed. On investigation it was found that the bearing had not received enough grease and what grease there was had been contaminated.

A close inspection of the bearing arrangement and the environment in which it had to operate highlighted:

- There was no grease injection direct to the new bearing. The expectation that grease would work its way into the bearing from the existing grease ports had not occurred.
- The new bearing sat in a pit in which condensation and product collected and contaminated the grease;
- The old bearing had used the grease injected into the journal to also lubricate and seal the thrust faces thus keeping out product and condensation.

It was clear the old design was the more satisfactory for the situation. To overcome the drawbacks with the new design an additional grease port was added to inject grease into the trust roller bearing. A shaft seal should also have been fitted to keep out contamination, but time was limited and it was left to the grease to build-up on top of the thrust bearing and act to seal it off. This was a very unsatisfactory outcome.

The best option would have been to return to the original plain bearing design, as it was inherently simpler and more suited to the environment.