Process Plant and Equipment UP-TIME for Operators and Maintainers

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Process Control Talk

A Fault Finding Technique that Works

What you will learn from this article.

- Accurate findings from investigations require accurate knowledge.
- Design extra equipment into new plant for problem analysis.
- On existing plant add-in the equipment you need for problem solving.
- Trace problems by going from plant to equipment item to sub-system.

Fixing plant and equipment about which you know little is daunting. Here are a few ideas to help you successfully fault find failed equipment.

WHEN YOU DON'T KNOW THE EQUIPMENT

Your aim is to **understand what you are trying to repair** so you can make considered decisions as to what has gone wrong and what has to be done to fix it.

You will need to educate yourself in its **function and construction**. Read and understand the operating and maintenance manuals. Get hold of drawings. Talk to the manufacturer and supplier. Talk to others who have such equipment. Talk to the people who operate and maintain it. If you can't do the above, find a machine or item that does a similar function and learn how it operates.

THE RIGHT PERSON TO DO THE REPAIR

If you do not have the know-how or equipment to perform the maintenance it is faster and cheaper to get someone with the necessary specialist knowledge.

Here is an example of a car repair gone wrong. The car was a 1993 Jeep Cherokee. It had lost ignition and would not start. The owner followed the repair manual instructions and spent an entire day striping out the ignition system, component by component, only to give up in disgust and visit the local dealership the following morning. The mechanic listened to the tale and advised of an ignition timer trigged from the flywheel rotation that occasionally caused a fault. The owner had not even known of its existence! Sure enough when he followed the mechanic's advice the car started first time.

There are two morals here. First - **only attempt a repair if you understand the equipment** you are working on. Second – **when you can go no further, get expert help**.

WHEN YOU KNOW THE EQUIPMENT

When you cannot locate a fault in plant or equipment of which you are familiar, you need to **progressively trace the failure**. Commence by becoming familiarised with the designed operation of each sub system of the larger item. Access to documentation is critical. Get all the information available from manuals, process and instrumentation diagrams, assembly and component drawings and the like.

Test each sub-system functions as it ought. Use **'telltale' indicators** at selected points in the system to confirm its operation. 'Telltales' are such devices as pressure gauges, flow meters, sample points, ammeters, voltmeters, light emitting diodes, etc. Their purpose is to indicate the function is present during normal operation. If necessary get them installed. As each sub system is proven move to the next until the faulty subsystem is found.

With the faulty sub system isolated, you need to locate the faulty component (maybe more) and replace it. If the fault is not obvious it becomes necessary to trace the system through from beginning to end looking for loss of function. Prove that each component in the system operates, as it should. Again it may be necessary to install or locate 'telltales' for each component.

AN EXAMPLE OF THE METHODOLOGY

The best example of this approach that I have seen occurred in the Blue Mountains of New South Wales, Australia. Our hire car stopped dead after cresting a rise. The hire firm sent out the local roadside service repairman. Upon arrival he lifted the bonnet and began his investigation.

First he checked the electrical system by removing a spark plug and turning the ignition key. The car cranked over and the spark plug fired. This test proved the electrical system functioned properly because a spark was evident at the spark plug.

He then checked the fuel supply. Here he removed the rubber fuel line into the carburetor and cranked over the engine. However in this case no fuel was ejected where it should have been. Moving back along the fuel system, he removed the connection to the fuel pump outlet and cranked the motor. Again no fuel was evident. He checked the fuel level in the fuel tank and it was plentiful. Removing the fuel line into the fuel pump resulted in fuel spilling out on the ground. He had just proven that the fuel pump was broken because the fuel at the inlet was not ejected at the outlet.

RECOMMENDED APPROACH TO FAULT FINDING

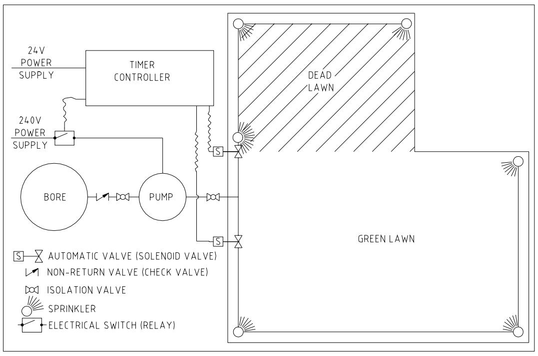
The table below lists the recommended approach.

1	**Divide the equipment into logical systems.**
2	**Test each system functions to specification.**
3	**Test each component in the failed system operates as it ought.**

4 Use 'telltale' methods to prove the presence of the function at various parts of the system.

FAULT FINDING PRACTICE

In the drawing below of a reticulated lawn, one portion has died due to a fault. How could this have occurred? How could your suggestions be tested?



Mike Sondalini - Maintenance Engineer

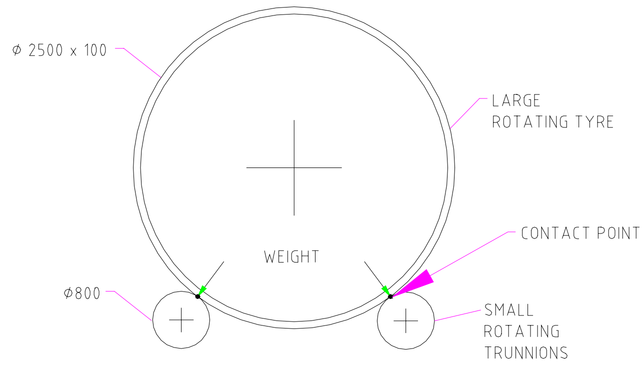
Rotating Tyre and Trunnion Wear Basics

What you will learn from this article.

- Metal tyres and trunnions in contact work harden as they roll.
- Unequal hardness between metal surfaces rolling quickly causes the softer one to wear fastest.
- The correct steels to use for rolling metal tyres and trunnions.

Roll mills, drum dryers, kilns, ball mills and rotating reactors usually turn on metal tyres and trunnion rollers. Eventually the tyres and rollers wear out or fatigue and require repair or replacement. Usually the equipment manufacturers keep material specifications as proprietary information and one is forced to buy the parts from them.

In situations where supply from the original manufacturer is impractical you will be forced to find alternate materials and suppliers. They will require a materials specification from



you to fabricate or cast a replacement.

WEAR MECHANISM

When properly aligned the rollers carry the weight of the drum and product on a very narrow contact line formed between the tyre and roller (FEED FORWARD Volume 1 No 5). The sketch below shows the location of the thin contact line formed between tyre and roller.

The stress created on the contact line fluctuates as the drum rotates and the contents move. This high, fluctuating stress causes work hardening of the roller and tyre surfaces.

EXAMPLES

Tyres on a twin tyre, 2 meter diameter, rotating drum dryer of three tonne operating weight had to be replaced after several years of service revolving at 6 RPM. The rollers were 150mm wide and 500mm diameter turning at about 24 RPM. The tyres were repaired in-situ as they could not be removed. They were re-skinned by welding two rolled half rings of boilerplate to the remnants of the old tyre. (Make the mating ends at 45 degrees to the axis so the hard weld rolls over each roller in point contact and do not cause an abrupt impact as would occur if the weld was made axially.)

Some months after repair it was noticed that the tyres were wearing faster than expected. Upon investigation it was found that the trunnion rollers were made of 4140 steel and had a surface hardness of 320HB while the fabricated boiler plate tyres had a surface hardness of less than 250HB.

Contrast this to a 3 meter diameter rotary reactor of 35 tonne operating weight rotating at one third revolution per minute mounted on trunnion rollers of 800 mm diameter. The 200 mm wide rollers turned at 2 RPM. The tyres were made of Bisalloy 80 with a rolling surface hardness 310 HB while the 4140 steel rollers were 360 HB. However in this case, after two years in operation, there was no evident wear.

On review it appeared that the wear rate for rotating metal tyres and trunnions was influenced by the surface hardness, the disparity between surface hardness and surface velocity.

SPECIFYING STEELS FOR ROLLING SURFACES

Fortunately the choice of steels to use in making tyres and rollers is very similar to the steels used to make railway lines and locomotive tyres. These are made from carbon steels with a carbon content about the 0.5% to 0.8% and initial surface hardness of about 280 HB to 320 HB. The surface hardness increases with usage.

Peter Laczko of Peter Laczko Pty Ltd (ph 61 8 9370 5343) offers this advise on selecting material for rollers - "The rollers are best in a pearlitic steel at about 320 to 360 HB hardness. This can be achieved by casting 1050 carbon steel oil quenched and tempered, or by casting in AS 2074 L2B high carbon chrome steel normalised and tempered. If forged steel is used then 1050 carbon steel can be used as above, or 4150 normalised and tempered can be used. If castings are used they must not be welded on the running surface at any stage because uneven wear results in the weld and HAZ (heat affected zone) leaving marks in the tyre and rough rotation of the kiln."

CONTACT A METALLURGIST

In situations where the material composition is unknown you may need help from a metallurgist. Most of the steel supply companies have access to a metallurgist who can advise you or else contact an independent metallurgist. The details they will require of the equipment concerned are its function, duty and conditions in which it operates.

SURFACE LUBRICATION

To help minimise tyre and trunnion wear, dry lubricant blocks rubbing against the tyre can be used. These are available from specialist lubrication companies.

Mike Sondalini - Maintenance Engineer

SOME GOOD ADVICE

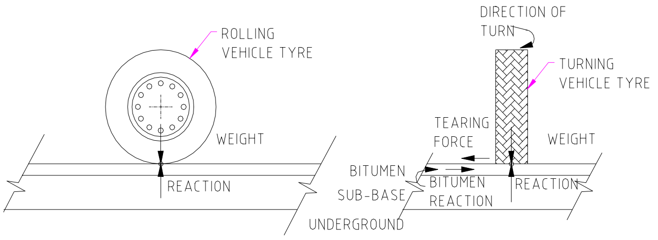
In all things, success depends on previous preparation, and without such preparation there is sure to be failure.
Confucius.

Bitumen Roadway Repairs

What you will learn from this article.

- The life of a road depends on the vehicle wheel loading.
- Aggregate size determines the strength of the tarmac.
- The sub-base below the tarmac distributes wheel forces.
- Slope the surface to prevent water pooling.

Bitumen tarmac repairs are a common daily occurrence. To get long life from a bitumen repair there are several issues to consider. This article reviews the major considerations.



The drawing above shows a typical cross-section through a road and highlights the forces produced by a wheel contacting the surface.

TRAFFIC LOADS

Heavier loads passing over roadways require deeper and stronger sub-base preparation and a thicker asphalt surface. Straight flowing car traffic requires bitumen thickness of about 20 mm and a sub-base of 150 – 200 mm whereas trucks would require 30 mm bitumen and a 250 – 300 mm sub-base.

TURNING VEHICLES

A turning wheel causes a side thrust on the surface aggregate in the asphalt. This tearing thrust has to be transmitted through the top surface and into the underlying sub-base. The asphalt and sub-base on turns and turning circles are made thicker, about 40 mm, or structurally stronger for this reason.

TOP SURFACE THICKNESS

The surface membrane of asphalt must be thick enough to resist turning, braking and impact stresses from traffic. This is particularly important where there are sharp turns. Consideration of the effects of heavy braking by vehicles may necessitate thickening the asphalt further.

ASPHALT AGGREGATE SIZE

Course aggregates lock-in with neighboring aggregate and is less likely to be lifted from the road. On turning circles a larger aggregate may be needed than would be required on straight sections.

SUB-BASE STRENGTH

The load carrying capacity and the impact strength of a tarmac surface is proportional to the depth and firmness of the sub-base. The sub-base supports the tarmac and acts to dissipate forces and spread wheel loads over a wider area. Low structural strength in the sub base allows it to be overstressed and deform. This movement is then transmitted through to the top surface which breaks-up.

SUB-BASE MATERIALS

Commonly the sub base is either graded limestone or blended granite aggregate. Each material has different structural properties that affect the depth and construction of the sub-base. This choice has major cost implications.

SUB-BASE CONSTRUCTION

A strong bond across the interface between the asphalt course and the sub-base is required. This is achieved by using sub-base materials with a high proportion of aggregate and a low proportion of sand. Excess sand inhibits development of the bond to withstand the tearing stresses.

In situations with a thin sub-base on a turning circle the most cost effective option may be to use 14 mm aggregate bitumen, 65 mm thick, over the existing sub-base rather than rebuilding the entire turning circle.

UNDERGROUND CONDITIONS

Below the sub-base, the ground must be sufficiently compacted, moisture free and void free. Poor ground conditions several meters below the roadway will eventually cause the surface to fail. For example, car bodies will have to be removed, buried builder's rubble prevents proper ground compaction and accumulated water underground causes 'sponginess' and requires draining.

FALLS AND SLOPES

The tarmac slope must promote easy water runoff. Pooled water can seep through hairline cracks in the asphalt surface and collect under the tarmac. This water causes separation between the sub-base and the surface layer.

Pooled water can sit between the surface aggregate and produce hydraulic impacts on neighboring aggregate when hit by a fast moving wheel. The continuous hammering leads to aggregate being popped out of the bitumen surface.

DOING A REPAIR

Before repairing tarmac determine why it failed. At times you may need to get an expert to assist.

Once the investigation is complete decide on how to cost effectively repair the tarmac long-term. Insure the selected materials, the extent and depth of the repaired area, the sub-base and ground conditions will fix the problem.

Mike Sondalini - Maintenance Engineer

From the Mechanical Workshop

GREASE – USE THE RIGHT ONE FOR THE JOB

What you will learn from this article.

- Grease is made from oil into which a thickener is added.
- Additives are added to the grease to provide specific required characteristics.
- Grease has specific advantages over oil lubrication provided the correct grease is selected.

Classification, Selection and Application

As long ago as 1400 BC., the Egyptians used greases made of olive oil and lime to lubricate their wooden wagon axles. With the beginning of the Industrial Age, the development of modern greases progressed from sodium greases (1872) through calcium and aluminium greases (1882), to calcium complex soap greases (1940) and lithium soap greases by Shell in 1942.

The first aluminium, barium and lithium complex soap lubricating greases were patented in 1952. Since then, a large number of lubricating grease patents have been granted, due to the large number of thickeners, base oils, and additives that can be used. New or improved lubricating grease production processes were also developed.

The quantity of lubricating greases sold in Australia amounts to approximately 13 million kilograms in 1994 - is only a small fraction of the total lubricant consumption of 500 million Litres.

The situation is similar in other industrialised countries. The relatively small proportion of grease sales belies the enormous importance of lubricating greases for business and technology, which can be attributed to the high level of quality they have achieved and the performance characteristics which have resulted. Metal soap greases are the clear leaders in grease sales statistics, while non-soap greases as a group are of little importance in quantitative terms.

In engineering terms, however, and in terms of "modern and intelligent lubricating grease design," non-soap greases, for example those containing synthetic organic thickeners and synthetic base oils, are more modern, promising products.

Classification of Lubricating Greases

The classification of lubricating greases is not uniformly regulated. Because of the versatility and the variations in their composition, greases are essentially classified on the basis of their base oil or thickener.

THICKENER	SHELL EXAMPLE	SPECIAL PROPERTIES
LITHIUM SOAP	ALVANIA EP2	ALL ROUND PERFORMER, COST EFFECTIVE
MIXED SOAP (Ca & Li)	SUPERPLANT M	GOOD WATER RESISTANCE & MECHANICAL STABILITY
LITHIUM COMPLEX	LITHPLEX L & M	EXCELLENT ALL ROUND PERFORMER ESPECIALLY FOR HIGH TEMPERATURES.
CLAY (BENTONITE)	DARINA M & R2	GOOD HIGH TEMPERATURE GREASE, OTHERWISE OF LITTLE USE.
POLYUREA	STAMINA U2	EXCELLENT ALL ROUND PERFORMER WITH LONG LIFE, LATEST TECHNOLOGY IN GREASE..
CALCIUM	GRAPHITE GREASE 3	GOOD WATER RESISTANCE.
WAX	PETROLEUM JELLY	PHARMACEUTICAL USE.

Base Oils

The oil present in lubricating grease is referred to as its base oil. The proportion of base oil can vary depending on the type and quantity of thickener and the intended application of the grease. For most greases, the base oil content is between 85% and 97%.

The type of base oil gives greases some of its typical characteristics.

Thickeners

Thickeners are divided into soaps and non-soaps, and give lubricating greases their typical properties as well. Soap greases can be divided into simple and complex soap greases, each of which are referred to by the name of the cation on which the soap is bases (e.g. lithium, sodium, calcium, barium, or aluminum soap greases).

These metal soaps are made from fatty acids, which are products obtained from animal or vegetable oils and fats.

These fatty acids are a mixture of a wide variety of chemically defined fatty acids. They are split into fatty acids and glycerides by hydrolytic decomposition. The fatty acids are then combined with the corresponding metal hydroxides to form the metal soaps used as thickeners for lubricating grease production.

Additives

Additives counteract wear and corrosion, provide additional friction reducing effects, improve the adhesion of the grease, and prevent damage under boundary and mixed friction conditions.

Additives therefore affect the quality, potential applications, and ultimately the practical value of the grease. Additives can be solid, polar, or polymeric.

Solid Additives

Graphite, Molybdenum Disulfide, Zinc Sulfide, talc, polytetrafluoroethylene, etc. are incorporated into greases in powder form or as pigments. They act in the boundary and mixed friction regions. Solid additives improve running-in and emergency operating characteristics.

Polar Additives

Polar substances are hydrocarbon molecules that behave in an electrically non-neutral way because of their molecular structure (i.e. by incorporating other elements such as oxygen, sulfur, or chlorine), and are retained on metal surfaces as if they were magnetic. The presence of polar substances increases adhesion of the lubricant film, since pure hydrocarbons are "non-polar".

Polymer Additives

Additives can influence the correlation between temperature and the viscosity of mineral oils. These additives consist of organic polymers with molecular weights of between 10,000 and 200,000. At moderate temperatures their chain-like molecules are tangled together, but at high temperatures they extend into elongated threads. By simultaneously switching to a low-viscosity base oil with a higher viscosity index (VI), the viscosity-temperature curve can be flattened. The presence of polymers makes the viscosity of a base oil dependent on the shear rate.

Polymers generally improve the wear protection offered by lubricants. Polymers used as adhesion additives for greases include polyisobutylenes, olefin polymers, and others. They improve the grease's adhesion to surfaces.

Additive	Typical Compounds	Purpose
Extreme Pressure Additives (E.P)	Sulfur, chlorine and phosphorus compounds, sometimes combined with graphite or MoS_2	Protect metal surfaces against cold welding
Anti-wear Additives	Organic phosphates or phosphites, zinc dithiophosphates, graphite, MoS_2	Reduce wear of metal surfaces
Corrosion Inhibitors	Organic compounds containing active sulfur, phosphorus or nitrogen, such as phosphites, metal salts or thiophosphoric acid, sulfated waxes, or terpenes	Protect against corrosive attack on bearing materials or metallic contact surfaces
Anti-oxidants (Anti-aging)	Phenols, aromatic amines, sulfated phenols, zinc dithiophosphates	Delay oxidative decomposition
Friction-reducing Additives (Friction Modifiers)	High molecular weight compounds such as fatty oils, oxidised waxes or graphite and MoS_2	Reduce friction under boundary and mixed friction conditions
Adhesion Improvers (Tackifiers)	Polyisobutylenes, olefin polymers, latex	Improve surface adhesion

Advantages Of Grease Lubrication Over Oil Lubrication

- Reduced design complexity
- Less maintenance is often required, since lifetime lubrication is possible.
- Less risk of leakage and simpler seal design
- Sealing effect is reinforced by used grease overflow ("grease collaring" or labyrinth).
- With high-speed greases, metered grease quantities, and a running-in period, low bearing temperatures can be achieved at high revolutions.

Disadvantages Of Grease Lubrication Compared With Oil Lubrication

- Less heat dissipation possible
- Contaminants are captured by the grease film and not removed, especially with grease lubrication of minimal quantity.
- At present, limiting speeds or speed factors are lower than with oil injection and oil/air lubrication.

Peter Haig - Shell Lubricants WA engineer

Asset Management

The continuous improvement of Thomas Edison

ABSTRACT
The Continuous Improvement Method of Thomas Edison. There is a good chance you can make astounding changes and achieve incredible performance improvements from your plant and equipment. It can be done with the method used by Thomas Edison to solve his problems and make his discoveries. Improvements in the order of 20% maintenance savings with 100% on-time achievement of production plans are possible. The method is that of continuous improvement. You start by proving it works for yourself first and then, once you are sure it works you introduce it to your people.
Keywords: continuous education,

We Miss Our Biggest Opportunity.

Many of us make the biggest mistake of our lives when we finish schooling. Whether it is when we finish high school, college or university, the mistake is thinking we no longer need to keep developing our knowledge. Instead of remaining proactive students we become reactive employees.

We mistakenly begin to use the 'hard knocks' of life and business as the only way to learn. No longer do we bother to use practical, purposeful education and training to fill the gaps in our knowledge. Unintentionally we start to hand-over the responsibility for business, mental, spiritual and interpersonal growth to circumstance.

The 'school of 'hard knocks' is a poor teacher. It is a slow, expensive and random way of getting an education. By only learning through mistakes you will waste 80% of your life, time, money and efforts. It cannot be any other way. Great waste will be the result if one is just waiting about for something to happen and then reacting to it without knowing what is the proper thing to do!

Do what Thomas Edison did.

But this situation does not need to continue. You can do what every great leader, innovator and inventor does. They keep learning. They read, study and think about what they want to see happen in their lives, their businesses and with their discoveries. It is said that Tomas Edison became a great inventor without much schooling. But that is not the real story, it is a huge half-truth, a falsehood.

Edison may not have had much formal schooling, but he was a prolific reader. He would get hold of every book and piece of information he could get on the subject he was working on. He studied the subject endlessly, thought about it and around it, and then came up with an idea to try. No, he did not finish school - but he kept on getting educated. He took it upon himself to continue developing his mind and his knowledge. This is the way of all great people.

There is no schooling available that teaches 'greatness' as a subject. That must come from within each of us. And it is done by the continuous improvement of ourselves. It will work for anyone, anything and everything in our world.

Personal Continuous Improvement First

Now that you know one of the 'great secrets' you can put it to use for yourself. You do not need to go back to school, unless you want to. First it is necessary to decide on one thing you want to see happen in your life. Then you decide on one thing that you want to see improved at work. Write them down so they become real and you can point your finger at them. Just a few works to clarify you mind.

Your next step is to learn more about both topics – the one for your life and the one for your job. Get books on both subjects, go and talk to persons that know more than you on those topics, get educational videos and view them, go to seminars on the subjects, get subscriptions to relevant magazines. Get ideas of what to do to move forward from where you now are. When you get an idea start to implement it. Try a little bit of it, do a test and sample the effect. Continue with it if it works; modify it if it doesn't work. This was what Thomas Edison did. It worked wonderfully well for him, and it will work for us.

You may realise that you need to go back to 'school'. But now that you know what you want to do and why you are doing it, it will make all the difference to your enthusiasm for study!

Then Continuous Improvement for Your People.

When you have proved that the process of continuous improvement works for you, you can then look at introducing it to your people. They are most likely in the same situation that you were in. Just waiting for things to happen to them. Now you can lead them to a better place.

To start them off, find a way to get them reading more about their jobs and their business. Nothing 'heavy'! You cannot force them to learn. You can only lead them. Offer them opportunities to attend training. Get a knowledgeable person to have a 15-minute 'tool box talk' with them on the topic. One-by-one take them with you to the seminars you attend. Find creative ways to expand their knowledge on the thing you want them to know more about.

For example if you have chemical reactors in your operation, teach your operators and maintainers the chemistry of the reaction, teach them the metallurgy of the reactor, teach them about the critical factors that make for a good reaction, teach them about the machinery that makes the reactor work. Teach them why things work as they do, why it is important to do things certain ways.

Once they know all about the reactor they will also have learnt 80% about everything else in the plant. The next lot of training and education will go much faster.

You want to develop your people's engineering and business understanding so that if 'hard knocks' hit their equipment or the business demands become heavy, they don't waste time, money and effort doing pointless things, but will instead focus on the important, high pay-off actions.

When you see anyone of your people make a standout performance – encourage it. Give them the opportunity to learn more about it.

Personal and Team Victory.

As you go about expanding your people's minds and knowledge they will 'discover' the best ways to run the plant and their part of the business. With your support and direction they will find the ideal ways to do their work with least cost, time and effort. They will be victorious in the battle for high performance and efficiency.

When your people get to that level of expertise you can then stand back, take pride in the good work you have done through them and go onto the next thing you want to improve.