The Wrong Maintenance Priorities Threaten Corporations

According to this well-known veteran of the reliability trenches, one of the best ways to hone the survival skills industry needs today and into the future is to pay attention to the basics. Taking time–making time–to read is a great way to start.

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Many process plants as-sume that better maintenance strategies will lead to higher equipment reliability. Very often, the primary focus of these strategies is to avoid unnecessary oil changes or to optimize compressor overhauls and the pursuit of other preventive measures. Similarly, many of these strategies hope to help companies avoid equipment damage and costly production interruptions by doing appropriate maintenance "just-in-time."

While these are commendable goals, they do not address the constraints that are built into vast quantities of equipment that incorporate less-than-optimized components. Nor do such strategies remedy the numerous random failures that strain the maintenance budgets throughout industry today.

Staffed by harried employees, shops frequently become adept only at replacing parts in kind. Likewise, relatively few companies position themselves to systematically implement maintenance avoidance measures. We know that, in existing plants and with few exceptions, failure avoidance would be far more profitable than implementing optimized maintenance timing on non-optimized equipment. In new equipment procurement situations, utilizing specifications that eliminate the very components that risk causing frequent maintenance and downtime would provide far greater returns on the incremental investment than fine-tuning an asset management or related program.

Take, for example, the many operating plants today with literally hundreds of thousands of pumps that were purchased from the lowest bidders. It is wistful thinking to expect that all components in these lowest-cost machines represent best-available technology. In the age of downsizing, rightsizing and outsourcing, how realistic is it to assume that all of the various equipment manufacturers and vendors employ seasoned, well-versed, well-read subject matter experts?

Suppose a manufacturer recently sold less-than-optimum equipment. Knowing that we live in a litigious environment, would we really expect this manufacturer to concede that he/she continues to make, sell or market non-optimized equipment or components? If the answer is no, then it is clear that the user/purchaser has to be the driver for identifying and implementing equipment upgrades.

MAKE NO MISTAKE

In our mutual quest to stay informed on reliability-improvement opportunities, many readers among us recently have noted shifts in reliability-related terminology. Today, we are finding more and more old maintenance philosophies being marketed in newly packaged expressions and acronyms.

Whether they refer to adaptations or re-named versions of old strategies, the label on each of these repackaged philosophies is the proponent's choice, However, it's not much different than automobile dealers calling used cars "pre-owned," or TV networks promoting re-runs as "encore presentations."

The accompanying article is not meant to be contentious, nor to imply that the re-examination and streamlining of traditional asset-management or maintenance approaches has no merit. Instead, it is meant to convey a serious concern that the mere repackaging of certain approaches is not helpful to industry. Many of these maintenance initiatives are not new. In fact, they've been practiced by best-of-class companies for decades. Repackaging them, though, offers little in the way of real additional value for most struggling refineries and process plants– those many facilities that continue to seek magic procedural solutions while overlooking and neglecting the basics.

Make no mistake about it: There is ample evidence that inattention to the basics is severely limiting the profitability of thousands of companies. In some instances, the continued existence of industrial enterprises is threatened if all they do is search for new strategies instead of implementing the fundamental hardware, basic training and procedural changes needed for survival.

This urgent issue must be brought to the attention of corporate managers truthfully and without the usual sugar-coating. Unfortunately, the matter cannot be explained by many consultants who know even less about equipment upgrade opportunities than do the mechanics or maintenance technicians who have not read any relevant texts since leaving school years ago.

. . . Heinz Bloch

Trends that lead nowhere vs. trends for best-of-class performers

At the risk of inviting irate responses from benchmarking companies, we contend that the trend towards increased benchmarking will, ultimately, add little value to many enterprises. A recently published article mentioned four so-called perspectives, labeling them *Operations, Reliability, Work Management* and *Safety & Environmental.* Goals were specified for each and 60 different key performance indicators (KPIs) were listed as useful for managing risk and improving profitability.

At best, each one of those 60 benchmarks may give plants an indication of where they are in the game. Yet, not any of these listings specified even one of the many precise steps that really represent lasting improvement. What good is it to tell a facility it is re-working too many pumps, if nobody is able to explain the root cause reasons for this "excessive reworking" at that plant? While it's nice to point out the fact that *"there must be a problem somewhere,"* far more value would be derived by adequately describing the root causes and solutions.

Today, truly best-of-class performers use asset management and streamlined maintenance strategies as "icing on the cake." They realize that these approaches add value only if the basics are in place and being practiced with consistency and forethought. As an example, best-of-class owner/purchasers are not likely to buy from the lowest bidder. They generally look at several competing offers and carefully examine which of them have "designed out" maintenance and failure risk. Best-of-class companies rarely, if ever, enter into lopsided alliances with suppliers. They will always use well-thought-out specifications that clearly describe and explain specific "upgraded" component materials, configurations, lubricant application methods, etc. Thus, the most important attribute of true best-in-class performers is their ability to provide authoritative answers to two questions:

1. **Can a component be upgraded to resist failure?**
2. **If upgrading is feasible, is it also economically justified?**

These are primary. . . these are the basics. Everything else is of lesser importance. Best-of-class performers know this to be a fact and are organized accordingly. Moreover, they are staffed so as to have a person—*a designated and responsible individual*—who can answer these two questions quickly and with great accuracy.

Why upgrading is often best

Unfortunately, even now, buying from the lowest bidder remains the predominant procurement mode. Equally disappointing is the fact that those responsible for shortsighted decisions are often the ones that block access to systematic failure-avoidance measures. Consequently, even the otherwise desirable life cycle costing (LCC) methodology is an academic exercise unless the person doing the comparison is in a position to answer the two previously-asked questions.

A facility which assumes that improvement initiatives spring forth from the original equipment manufacturer, or OEM, often will be disappointed. When, in 1986, a representative of a prominent pump manufacturer was asked why its designers didn't engineer better pumps, the answer was that most customers selected pumps primarily based on cost and schedule. Accordingly, sales success was linked to cost and schedule, not long-term quality.

More recently, at a symposium in Houston, another pump manufacturer claimed that general-purpose pumps were designed to be overhauled or repaired every 18 months. To keep costs low, two pump manufacturers said they couldn't afford to upgrade their pumps.

And, just last spring, at the 2005 NPRA Maintenance and Reliability Conference in New Orleans, several panel members touted key performance indicators that were largely based on not having production interruptions. To this day, a large number of managers and reliability engineers seem to be unconcerned if their pumps fail far more frequently than those at a competitor's facility. The thought was even expressed that keeping pump failures at (relatively) high levels was one of the "safeguards" preventing upper-level managers from cutting the maintenance budget.

At the same NPRA conference we met with a presenter of asset management strategies. We attempted to argue the monetary merit of failure reductions by selective upgrading. When the speaker suggested that his organization was very effective in identifying and recommending the various upgrade options, we challenged his claims. We have yet to find asset management consulting companies that identify the needed upgrade measures to the degree of detail urgently needed by industry.

In support of our beliefs, we cited lube application in pumps as one of the many examples of industry not even being made aware of tangible reliability risks. This example deals with the use of oil rings in literally millions of equipment bearing housings, most of them in centrifugal pumps. Recall that the entire issue centers on our contention that industry is losing knowledge and application of the basics. Changing or fine-tuning management approaches will not bear the promised fruits unless the approaches are interwoven with systematic upgrade efforts. The following cases illustrate the type of dilemma with which industry is wrestling.

Case #1: Lifting oil with bicycle chains

While working with a client to determine the root causes of sludge in an oil sump and bearing failure in a pump, an experienced consultant (who was formerly employed as director of new pumping machinery development for two noted manufacturers) found a bicycle chain in the bearing housing. Its purpose, of course, was to feed lube oil to the bearings. Chances are that the bearing housing was simply too narrow to accommodate oil rings or similar means of lube application—a serious reliability risk.

When the consultant questioned the appropriateness of using a bicycle chain

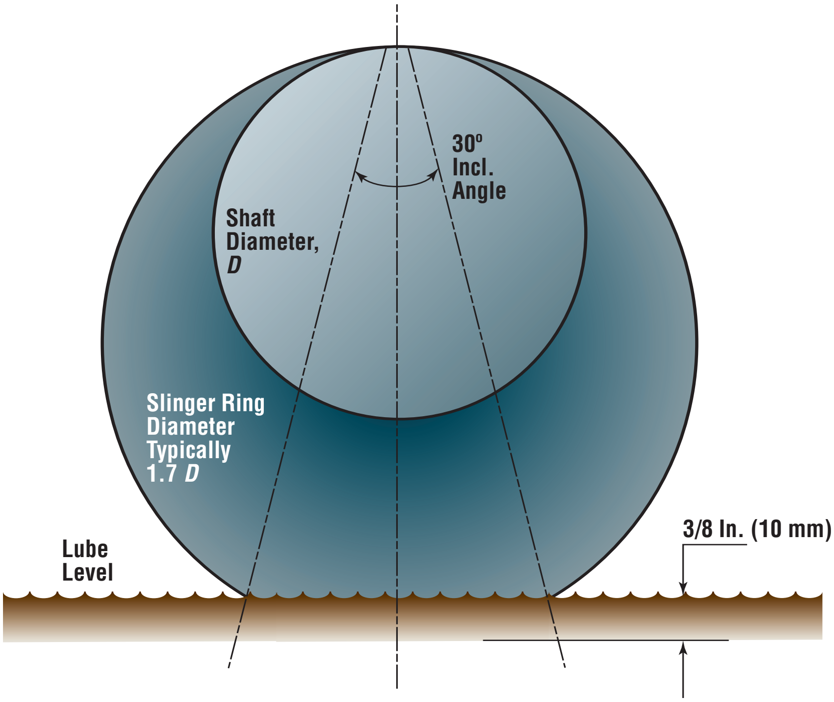

Fig. 1. Oil ring ("slinger ring") and typical dimensions

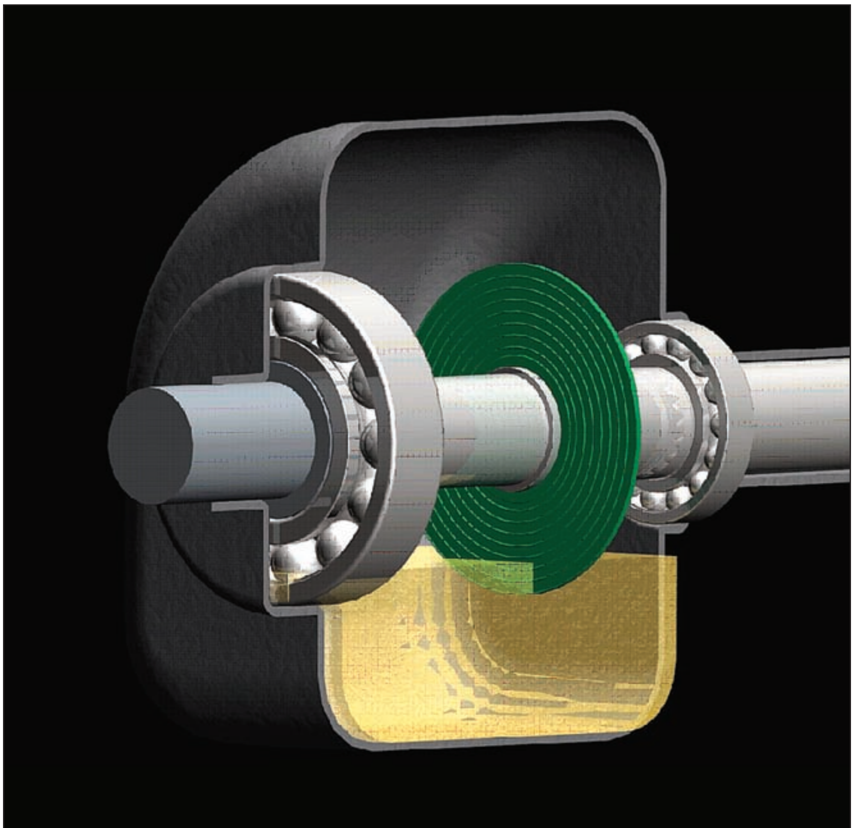

Fig. 2. Flinger disc mounted on pump shaft (Source: www.tricomfg.com)

in this manner, the pump manufacturer objected to the criticism and claimed "*that's the way we generally do it. . .we hear no complaints.*" Basic science, or the most elementary application of engineering formulas, though, would show that the chain would have no chance of moving at the peripheral speed of the shaft at anything other than—*for process pumps*—unusually slow speeds.

In most instances, the bicycle chain would slip relative to the shaft surface

This is not meant to imply that the re-examination and streamlining of traditional approaches has no merit.

and, by virtue of the total downward-acting weight of the heavy chain, the side plates of the links would rub on the shaft. Wear-related oil contamination would almost certainly result, as was found and documented by the consultant. All of this begs the question: *Would your asset management consultants have the basic knowledge to alert you to this?* Or would your consultants limit their contribution to the rather obvious, i.e. telling you that you're spending too much money on maintenance, and that you have "X% more" or "Y% less" shop backlog than the industry-recommended average? That would be nice to know, but where's the real solution?

Case #2:
The limitations of oil rings

Pump bearings in best-of-class U.S. oil refineries fail—*on average*—every 10 years. In certain other U.S. oil refineries, the failure rate is three times higher, with the average pump mean-time-between failures (MTBF) closer to three years. Let's re-state our earlier point: To really add value, asset management consulting firms will have to authoritatively advise and advocate specific component upgrades. These firms must know, and must tell, the user-client, that oil rings (Fig. 1) impose a key limitation on the MTBF of many pumps.

While perhaps representing one of the least expensive means of applying lube oil to bearings, oil rings are rarely a wise choice for the reliability-focused. From about 1840 until 1990, they were furnished in brass or bronze. More recently, and for reasons we wish to subsequently spell out, some manufacturers have experimented with plastic and aluminum rings (Ref. 1). The results are mixed,

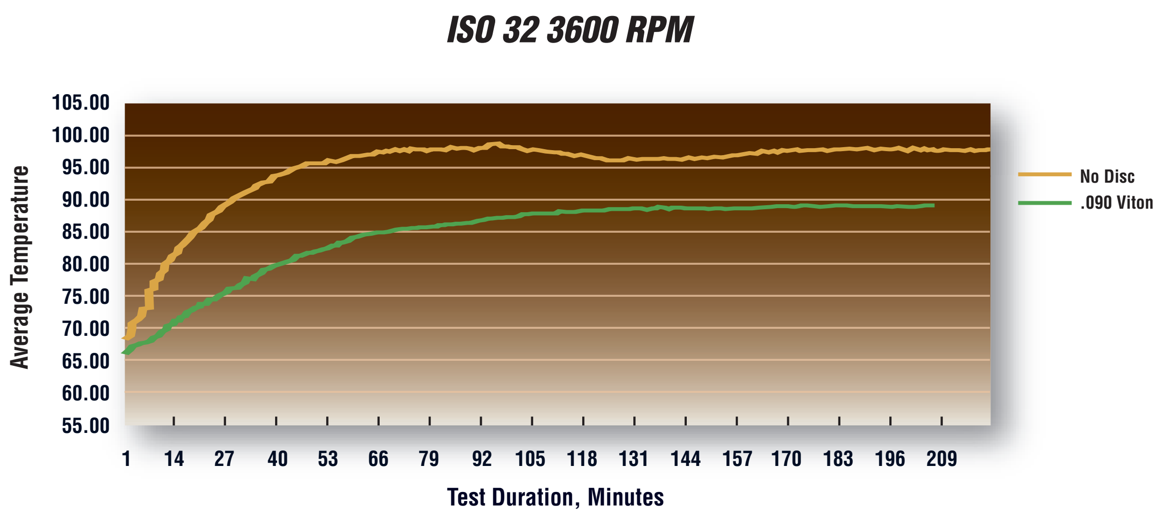

Fig. 3. Flinger disc tests, ISO Grade 68, 3,600 rpm, Average Temp. vs. Time (Source www.tricomfg.com)

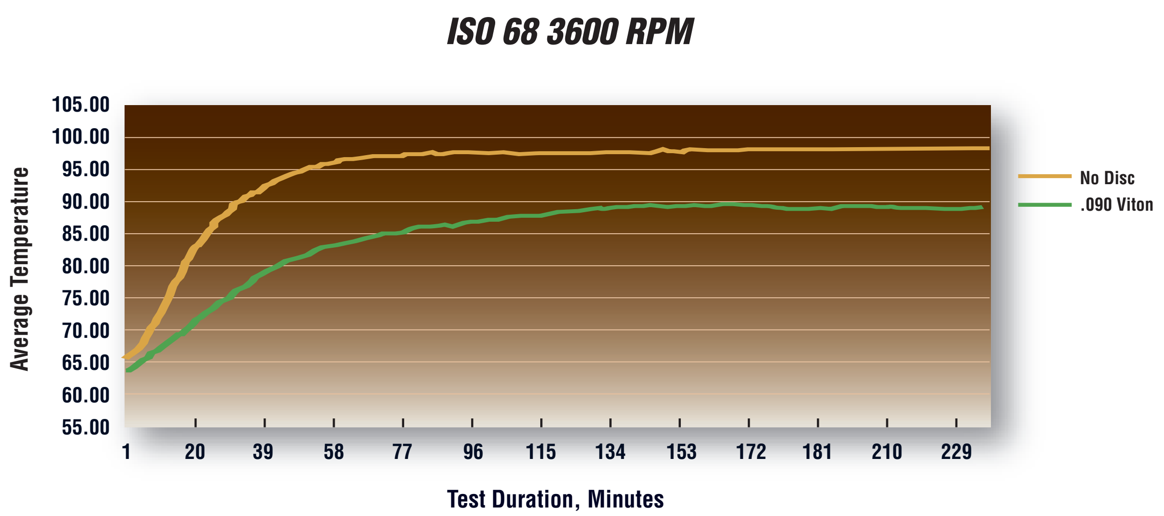

Fig. 4. Flinger disc tests, ISO Grade 32, 3,600 rpm, Average Temp. vs. Time (Source www.tricomfg.com)

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at best. In any event, oil rings suffer from a number of limitations that are rarely recognized by equipment suppliers and users (Ref. 2). Reliability-focused users avoid oil rings because these components represent an undue reliability risk. Here's why:

- Even some of the most advanced laser-optic shaft alignment systems will not have provisions ensuring that the shaft centerlines are absolutely horizontal. Visualize, therefore, how oil rings installed on shaft systems that are not totally parallel with the true horizon will run downhill. Doing so, an oil ring will make frictional contact with either a groove machined in the shaft, or some stationary surfaces associated with the bearing housing. The oil ring now tends to slow down, feeding less oil into the bearing. Many observers have also seen oil rings that showed clear evidence of edge wear and metal loss. Needless to say, the lost metal shavings end up contaminating the lubricant—*not a desirable condition by any measure.*
- oil-ring movement and circumferential speed are affected by the degree of immersion in the lubricant and by lubricant viscosity. Typical immersions are shown in Fig. 1, but

Heinz Suggests

For reliability-focused readers, Heinz Bloch has supplied the following book reviews. . .

In 2001, Stephen Thomas' 246-page book, *Successfully Managing Change in Organizations* (Industrial Press, New York, NY, ISBN 0-8311-3149-7), became available. We paid extra attention when, in 2005, his highly relevant second book, *Improving Maintenance Reliability Through Cultural Change* (Industrial Press, ISBN 0-8311-3190-X, 356 pages) came out.

Thomas is an experienced professional who continues to serve his process industry clients. He knows that, by themselves, reliability improvement philosophies differ from actual implementation and that careful planning and execution of the actual work are needed for a successful outcome.

Nothing is more prevalent in industry today than change. Some of these change initiatives happen as organizations evolve, and often require little intervention. Others are more far-reaching. They involve efforts specifically designed to improve organizational functions.

You probably have experienced these process design changes in your business, maybe more times than you care to think about. What is important to recognize is that this condition we call "change" is probably the one constant in business today. To further complicate matters, change not only affects our businesses. It has a very real and personal effect on each of us–*some of them positive, some otherwise.*

We become involved in the change process in many ways and for many reasons. Some of us have been asked to lead change efforts. Others have been assigned the responsibility. Many of you may have openly attempted to initiate change in order to make things better. Whatever your reason for being involved, you probably have had occasions when you knew you needed to do something, but could not figure out the next step. From the personal examples that Thomas provides in both books, you can see that he has been in the same place where you are today.

Suppose you find yourself in this position. Take note of the few ways to solve your problem. The first is to work with someone in your own company who has experience with the change process, either formally or through having already done the same work that you are trying to do. These individuals can help, but their perspective is usually limited to the functional areas where they have experience.

The next and probably most prevalent solution is to hire a consultant. There are both good and bad points about this approach. If used correctly, however, a consultant can be of value and can help you through the process. The plus side is that what you are asking them to do is their area of expertise. They usually have a great deal of experience working with firms undergoing change. The down side is that this is their business. They most likely have created a process model that they follow–*a model that may or may not fit your particular needs.* Another problem with the use of consultants is that many firms tacitly transfer their responsibility for the effort to the consultant. This withdrawal or transfer can hurt. As good as some consultants are, they eventually have to leave you on your own. When that happens, you need a good blueprint. Thomas provides that in his books.

His second book is especially innovative. Although a stand-alone volume, it ties into the theme of the first book. It neatly explains how to improve your maintenance and reliability performance at the plant level by changing the organization's culture. This book is intended for middle managers in the manufacturing and process industries. It demystifies the concept of organizational culture and links it with the eight elements of change: *leadership, work process, structure, group learning, technology, communication, interrelationships and rewards.* If you want to break the cycle of failed improvement programs and instead use cultural change to help make significant and lasting improvements in plant performance, this book will show you how.

Overall, if you and/or your company are confronted by change issues, you may find what Stephen Thomas has to say on the subject to be of particular value.

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recommendations may vary for different types of equipment. Clearly, a more deeply immersed oil ring or oil rings contacting an excessively viscous lubricant will not perform as intended. Also, for good tracking and to revolve with reasonable consistency, oil rings must be concentric within 0.002 inches (0.05 mm).

- Oil-ring operation is affected by shaft surface velocity. As an experience-based rule, authoritative texts (Refs. 3 and 4) caution that shaft velocities as low as 2,000 fpm (~10.16 m/s) might represent the safe, or practical, field-installed (non-laboratory) limit for many oil rings. At 3,600 rpm, this limit infers a maximum shaft diameter of approximately 2.125 inches (~55 mm). It represents a "DN" value of 7,650, where DN is the product of shaft diameter (inches) and speed (rpm).
- Reliability-focused users recommend flinger discs. Since flinger discs are secured to the shaft, they are not subject to the compounded influences of shaft horizontality, oil viscosity, depth of immersion and ring concentricity. They are a vast improvement over oil rings and are, in fact, available in many pump models presently marketed by U.S. and European suppliers. Ref. 1 contains an illustration from a 1960s-vintage catalog issued by a then prominent, major U.S. pump maker. The page shows the flinger discs furnished with this manufacturer's pumps and states, rather pointedly, *"anti-friction oil thrower (meaning flinger disc) ensures positive lubrication and eliminates the problems associated with oil rings."*

Indeed, oil rings were problematic in the 1960s, and, more than 40 years later, they are still causing problems in many field installations. Retrofit flinger discs (see Fig. 2) are available as cost-effective upgrade and retrofit options. Made to oversized dimensions, they can be easily trimmed to the required diameter. Their elastomer will fold into an umbrella shape during insertion through a narrow bearing-housing bore and will then snap back into its regular disc shape.

In 2003 and 2004, thorough testing was done on a Viton® disc'sconfiguration at different speeds and with oils of different viscosities (Ref. 2). Two results of this testing are shown in Fig. 3 and Fig. 4 for ISO Grade 32 and 68 lubricants at 3,600 rpm shaft speed.

In each case, with flinger discs installed, the oil and bearing temperatures were compared against operation with the flinger disc removed and lube oil reaching the center of the lowermost bearing ball. From the graphs, it can be seen that, at higher pump speeds, lowering the oil level and using the trimmable flinger disc will reduce oil temperatures. Reduced oil temperatures will slow the rate of oil oxidation (Ref. 3) and tend to more closely maintain lubricant viscosity. Incidentally, with premium synthetic lubricants and operation at typical process pump speeds, the rate of oxidation is extremely slow. In that case, concern over oxidation issues on hermetically closed pump bearing housings are of very academic interest.

Oil rings will not perform well unless they are:

- Installed on shafts that are unrealistically close to perfect horizontality
- Immersed in the lubricant just the right distance
- Operating in a lubricant with closely controlled viscosity
- Not eccentric by more than 0.002 inches
- Manufactured with a bore finish reasonably close to 32 RMS

Economic value explored

Upon close examination, and with competent failure analysis, many observers have reached the conclusion that a large percentage of oil rings show signs of severe abrasion. It is undisputed and well known that the resulting lube oil contamination is reflected in premature bearing failures. Based on these observations, it has been estimated that at least 5% of the centrifugal pumps installed in the average petrochemical plant suffer from oil-ring deficiencies of sufficient magnitude to reduce bearing life from an assumed achievable six years to typically only three years. Other pumps may experience oil-ring degradation that reduces bearing life from five years to four years, and so forth. The issue is so intuitively evident that, to date, no one appears to have seen fit to spend research funds on scientific studies. Accordingly, empirical observations will have to suffice.

In any event, expanding on this conservative estimate, we might be dealing with a plant comprising 600 pumps. Suppose that of these, 18 "suspect" pumps were being repaired every three years to the tune of $6,000 per incident. This would require an expenditure of $36,000 per year. If, using trimmable flinger discs, the MTBR (mean-time-between-repairs) could be extended to six years, this expenditure would drop to $18,000 per year for the affected 5% of the plant's pump population. Needless to say, if one paid $50 per flinger disc, the 18 discs would have cost $900 and the investment would have had a payback of $18,000/$900 = 20:1. It is certainly no stretch to foresee greater savings and even more significant payback than demonstrated in this example after one or two years of operation.

Belaboring the point

The issue at hand is important enough to be highlighted again. Management often doesn't seem to get it. Our view is simply that asset management and maintenance strategies are rather pointless if oil rings and flinger discs, the pitfalls of millions of inadequate old-style constant level lubricators and a veritable host of other basic issues are either not known or not addressed.

Much money is lost when the basics are not understood. If each of 10 important or failure-prone components, practices, commissions or omissions in a pump were to reduce its reliability by 10%, raise 0.9 to the tenth power and convince yourself that you get less than 35% overall reliability. Staying with vulnerable components and not upgrading is a very poor choice indeed. Before looking for "high tech" and whatever else might be "icing on the cake," a reliability-focused organization will learn to view every repair event as an opportunity to upgrade! (Ref. 5)

Furthermore, if a manager is really serious about upgrading the knowledge base of a reliability workforce, he or she will cheerfully spend a few hundred dollars on solid textbooks that explain hundreds of these upgrade opportunities. He or she will know, or at least accept as fact, that implementing one or more of a number of highly cost-justified upgrade examples will definitely avoid failures. Since the average API pump failure event costs U.S. refineries in excess of $10,000 (Ref. 2), a single avoided failure represents a three-week payback for, say, a modest $600 spent on books.

A good manager will probably insist that his/her reliability staffers read 200 textbook pages per year–*this adds up to a single page per work day*. A good manager will not tolerate any excuses.

Surely, a professional who has neither the time nor motivation to read a page a day will never help his employer move ahead.

In the words of Mark Twain: *"A man who chooses not to read is just as ignorant as a man who cannot read."* To which we might add that managers who choose not to make their people learn would serve their stakeholders better by going on permanent vacation.

Before encouraging or allowing subordinates to simply "decorate the cake," a good manager will see to it that the underlying foundation, that is, the cake itself, is edible. That implies that the basics are in place.

References:

1. Bloch, Heinz P.; "Slinger Rings Revisited," *Hydrocarbon Processing*, August 2002

2. Bloch, Heinz P. and Alan Budris; (2004) *Pump User's Handbook: Life Extension,* The Fairmont Press, Inc., Lilburn, GA 30047, ISBN 0-88173-452-7

3. Wilcock, Donald F., and Richard E. Booser, "Bearing Design and Application," (1957), McGraw-Hill, New York, NY

4. Bloch, Heinz P.; "Centrifugal Pump Cooling and Lubricant Application—A Technology Update," International Pump User's Symposium, Texas A&M University, Houston, TX, 2005

5. Bloch, Heinz P., (1998) "Improving Machinery Reliability," Third Edition, Gulf Publishing Company, Houston, TX, ISBN 0-88415-661-3

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