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PROACTIVE MAINTENANCE - THE NEW TECHNOLOGY FOR COST EFFICIENT CONTAMINATION CONTROL OF MECHANICAL MACHINERY

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Abstract: It has been proven that almost all mechanical failures are caused by contamination; hard particle contamination to be specific. Once the root cause of machine failure has been defined, a program to correct these failures, extend machine life, and reduce maintenance costs must be developed. Such a program has been developed; it is called Proactive Maintenance.

Proactive maintenance is a three-step program that begins with the individual mechanical equipment and setting target cleanliness levels (benchmarks). The second phase deals with the system design, adequate filtration, and contamination exclusion techniques. The final step involves system monitoring. This process of continual monitoring is to ensure fluid and system cleanliness.

This paper is directed toward companies and manufacturers that have an interest in an efficient, cost effective maintenance program. To achieve total maintenance excellence, one must start at the beginning by taking an aggressive approach to maintenance technology.

Key Words: Abrasive wear; Contamination control; Contaminant monitoring; Fluid cleanliness; Machine life extension; Proactive maintenance; Root cause analysis.

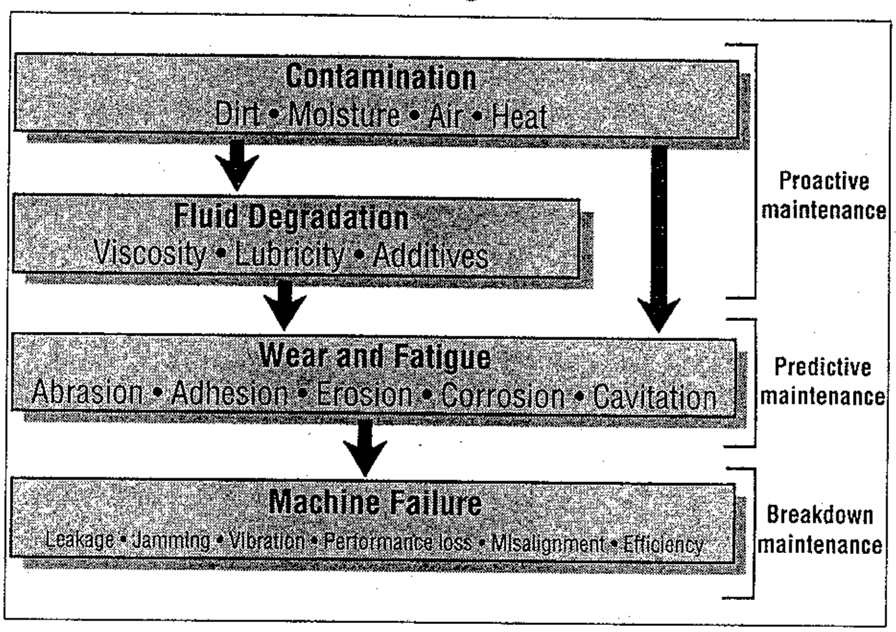
Introduction: Today, hydraulic and lubrication systems are being built more efficiently than before. Most hydraulic systems come equipped with filters as a standard and are not offered as an accessory. These better-made systems are by no means meant to last "forever." The theory of "buy it and leave it alone," tends to incur high contamination problems, downtime, and maintenance repair costs. Often times the blame for this short machine life is placed on faulty machine design, but the fault really lies with poor service and maintenance techniques.

These inadequate maintenance services fall into the category of *Breakdown maintenance*, which is essentially waiting for equipment to become inoperable before any maintenance is observed. Another form of ineffective maintenance is *Preventive maintenance*. This maintenance philosophy is dependent upon a specific date or number of cycles and the availability of money and/or maintenance personnel. *Predictive maintenance* is a more current form of maintenance that uses non-destructive instruments to help predict a failure that is already in progress. This maintenance is less than optimal, because a failure has already begun. Using predictive maintenance, this failure will not lead into a catastrophic breakdown, but there will be maintenance costs, downtime, and production loss.

A new age of maintenance philosophy has come about in the 90's. The philosophy of maintaining higher fluid cleanliness levels, extending machine life, and defining the root causes of failure. This *Proactive maintenance* philosophy needs to be adopted for companies and manufacturing firms to achieve total quality and cost effective maintenance. Proactive maintenance is aimed at identifying and correcting failure root causes, extending individual machine life, and reducing maintenance costs. This can be achieved through a simple three-phase strategy listed below:

Phase One: The first phase begins with the training and understanding of proactive maintenance and its goals. Proactive maintenance is a condition-based maintenance strategy, as such maintenance is dependent upon the real-time needs of the machine. Maintenance is prescribed when changes occur to specific operating conditions (failure root causes), and these changes present a risk to a machine's health.

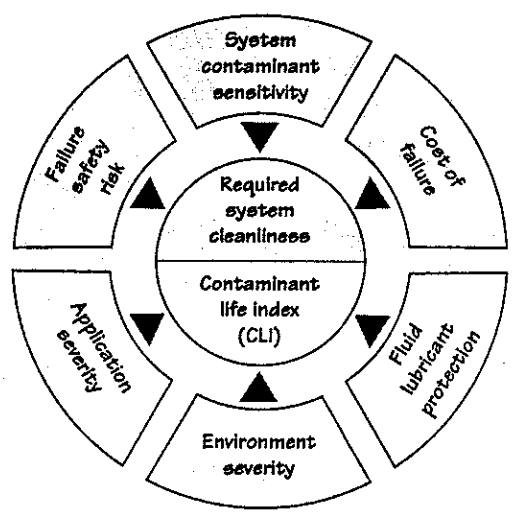
One of the main conditions that present a great risk to a machine's operating health is excessive contamination. There are four types of contamination that are dangerous to any machine's operational life, and they are air, dirt, heat, and moisture (Figure 1).



These contaminants are easily classified as root causes of failure. The first phase of proactive maintenance is to identify and correct the main failure root causes in a machine. Dr. Leonard Bench of Pall Corporation, states that 70% - 85% of all mechanical failures are caused by hard particle contamination and 90% of these failures are caused by abrasive wear. A recent report published by Lubricant Engineering magazine leads to the conclusion that more than 82% of wear related losses are contaminant induced. Notice that the largest portion of this is abrasive wear. From these findings, it would be advantageous to concentrate maintenance activities on correcting hard particle contamination, which causes 82% or more of the mechanical failures, than spreading the maintenance time out between three other root causes which would only eliminate 18% or less of the breakdowns.

Now that hard particle contamination has been defined as the root cause of failure, something must be done to correct it. Phase one consists of the setting up benchmarks for each individual machine. These benchmarks are actually goals; fluid cleanliness level goals for individual pieces of equipment. To have a condition-based maintenance program, one must know the current condition of the machines and also have a known benchmark that is to be achieved. This known target cleanliness level is extremely important. A fluid cleanliness benchmark must be set according to each individual machine. The Contaminant Life Index (CLI) is a simple method to achieve this benchmark. The CLI is a set of ten questions based on the factors that can influence a machine's cleanliness level needs (Figure 2).

Contaminant Life Index



Another method to identify a cleanliness benchmark is to use the Life Extension Method (LEM). This method uses the aid of three different tables. The appropriate table is selected to match the machine type. The benchmark is represented in International Standard Organization - ISO Code.

Phase Two: Once a cleanliness benchmark has been obtained, the next phase is to achieve and maintain that goal. Phase two is mostly dependent upon proper filtration and contaminant exclusion techniques. Before filtration needs are specified, exclusion techniques must be discussed. Initially, it is less costly to keep the contaminants out of the fluid altogether, than to remove them once they are in the fluid. The first step to contaminant exclusion is to identify the sources of contaminant ingression and then correct them. For hydraulic equipment, cylinder wiper seals is the most common entry point. The best way to combat this ingression is to use boot seals and good wiper seals. Unnecessary component repair and replacement is another source of contaminant ingression. Try not to open up any sealed components if possible and when repair is necessary, flush and clean the components at low levels before putting them back into service. This flushing technique is also good for getting rid of built-in contaminants in new equipment. New oil is a large source of contaminant ingression. Keep the fluid suppliers honest by checking their new oil cleanliness.

Proper filtration means the accurate selection, location, and installation, or upgrading of current filtration, to achieve the aforementioned cleanliness benchmark. The filter selection must be application, environment, and machine specific. This can be accomplished through the use of a Filter Selection Chart (FSC). This methodical means of filter selection consists of questions somewhat like the CLI. After answering the questions and doing a little math, the FSC will identify the proper filter to be installed. Some companies depend upon a filter salesperson to supply this information, but more often than not, the salesperson is not equipped to select filters objectively. One other fact that is often overlooked when dealing with filters is tank breathers. High efficiency breather filters should be used on tanks and reservoirs.

Phase Three: The final and maybe the most important phase in implementing proactive maintenance is to set a rigorous contaminant monitoring schedule. This contaminant monitoring technique is critical to effective contamination control. The control is achieved by monitoring the individual machines providing regular feedback on contaminant levels.. Maintenance personnel are able to check and insure that the cleanliness benchmarks are being maintained and that the filters are operating properly. Continual monitoring allows for the condition and health of any machine to be known, present or past. Continual contaminant monitoring has proven to be cost efficient, because the operating life of a machine is actually extended since it is not allowed to progress towards failure.

Proactive Maintenance: The condition-based philosophy of proactive maintenance meets the objectives of identifying and correcting failure root causes, extending machine operation life, and reducing maintenance repair costs. The three phases: 1) Setting benchmark cleanliness levels, 2) Selecting and installing proper filtration, and 3) Monitoring fluid contaminant levels; are cyclical and must all be implemented at the same time. These three phases prove to be very dependent upon each other if a truly cost efficient contamination control program is to succeed.

When a total quality and cost effective maintenance program is being considered, such as proactive maintenance, a total turn-key installation should be considered. This proactive philosophy must be used at all times during the training, installation, and assignment of field personnel to the job of maintaining hydraulic and lubrication machines. An Installed Proactive Maintenance Program (IPMP) is the most timely and cost efficient strategy to use in contamination control.

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