Productivity Fluid Management as a Tool for Saving Money in Manufacturing

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Abstract – The following paper discusses the benefits arising from introduction of productivity fluid management (PFM) and their impact on the performance of machinery and equipment. It discusses the benefits and impacts of introduction of oil maintenance for machines and their components and it also addresses the economic and the technical objective of PFM introduction. Based on real examples from practice it highlights the benefits of a PFM introduction into service in company and what is the cost savings after the introduction, due to maintenance, unplanned downtime reduction.

Keywords – Productivity Fluid Management, oil, manufacturing.

1. Introduction

The issue of fluid management solves problems in technical fields as well as in the field of medical engineering. In the technical field, the problems of heat transfer fluids (HTF) [1,2] are solved and also the problems concerning the oil crud- productivity fluid management (PFM) [3,4]. The medical engineering deals with management of body fluids [5,6].

This study deals with a case application of lubricant maintenance and its impact on the economic side of production in terms of production plants. The issue invites attention of the plants due to the increasing requirements on production costs or more precisely on production quality which is closely connected with machines and device servicing. In practice, we have to realize that technical problems associated with friction and wear are advanced to tribological problems, which means problems associated with quality and degree of lubrication of the oil system.

Reduction of confusion in production, reduced cost, increased production, increased quality of production, all of these outputs become reality with proper oil care. In operation these links realize only a small percentage of operators. In practice, there are more likely to pay attention to particular problems machinery and equipment such as a control system (wrong triggering a long break), distributions (blockage, rupture), cooling system (cooling poorly at higher temperatures in summer), and pumps (loss parameters).

For what reason do we encounter these problems? Where to find their genesis? Where to find the instigation of their origin? Are we able to inspect the problems and reveal their formation? Is it possible to formulate and technically excerpt these problems? Can we ultimately reduce their impact, or completely eliminate it? On the basis of simple statistics the negative manifestation of machinery and equipment such as downtime instance, replacement of an oil components can clearly monetize financial costs of these negative manifestations over a certain period of time. Practice has proved that we could save 70-95% of spent funds used for these negative phenomena by proper oil care. In practice we especially encounter the particular methods that deal with the oil level, but most of them do not define the cause of operational machinery problems [7].

Productivity Fluid Management gives us the opportunity of detailed insight into these issues. During full operation of machinery and equipment we can initiate proper care for the oil, and respectively, the whole oil system. After the introduction, the values can be stabilized, therefore the machines, equipment and individual components cannot be contaminated, depreciated or depleted. The oil thus becomes a very important indicator. Thanks to this indicator and the help of various tribotechnical analyses, we can define an instant picture of the internal condition of the equipment or the machine.
The achieved level of purity of the oil system is becoming a standard value etalon for the next period of operation, and all the variations of the analyzed values (for example, particle size), which can be almost immediately identified. Consequences of the analysis can highlight the "Bottleneck" and on what maintenance has to focus its attention. PFM's main asset is speed and exactness problem identification. Failure of machinery and equipment can be therefore already detected in advance. Frequently used tribotechnical methods such as vibrodiagnostics, detect undesirable attribute. In the detection of such disorders it is usually too late. The elimination of these disorders entails a high cost and in most cases, unplanned disguises.

2. The impact of maintenance oils to reduce costs

Pure (technical) oil is an important requirement to avoid quick wear of the machine parts. Since the first use of the oil system, there have been problems associated with breakdowns in various industries. As demonstrated by a research which was carried out in all industrially developed countries, these problems are caused in 70-95% by oil crud [8]. Users of the machines are then in a very difficult situation. Lubrication and hydraulic oils affect quality and quantity of the production. Therefore, it is very important to understand the relation between quality of the production on one hand and oil purity on the other, or more precisely, of the entire oil system. Higher oil purity and better production eventually leads to costs reduction and eliminates various problems caused by oil crud. The development trend in all areas of industry leads to a continuous increase in productivity and production efficiency [9]. More complex and technically more demanding machines with higher parameters must be used for fulfillment of these main economic indicators. The users require machines with high reliability, long life and low energy requirements, for an acceptable price, with low operating costs and with a minimal impact on the environment. Operation of the machines is influenced by the quality of lubrication.

The change of the approach of the pure oil and crud evaluation is the result of increasing the technical parameters (e.g. increase of operating pressure of the hydraulic system to about 35-45 MPa), accuracy and surface areas (honing and lapping) and free motion and tolerance (0,001 mm). The size and the structure of particles causing the cruds which affect reliability and operating lifetime of the machines have changed considerably. However, not much has changed in orthodox approach of some technicians to problem solving and oil treatment [9].

Costs reduction and at the same time increase in productivity is generally recognized terms of production facilities. This means penetrative reduction or annulment of the main and most important technical problems:

- Oil leak: operator does not have available information, the state of the machine is considered as "normal";
- Filters replacement: mostly downtime is required;
- Oil change and cleaning of access parts: dirty work, machine downtime;
- Pump problems: high costs, machine downtime;
- High operating temperatures: raises of investment- reconstruction, or intensification of cooling.

In the next step it is necessary to reduce or nullify the main and most important production time losses caused by:

- Unpredictable downtime of machines, machine failure, erratic movements of machines;
- Time to machine setup, preparation of machines and the slower start;
- Machine speed (change in cycling) and slower machine movements;
- Short intermittent operation of machinery, marshaling and preparation;
- Defective (nonconforming) products and their repair, short operational interruptions, stick-slip;
- Constantly extending machine start after shutdown.

If these problems persist, downtime occurs and the unproductive time is very expensive. (Fig.1.) suggests real opportunities to cost reduction awarded treated oils = reduction problems with machines about 70-95%. Subsequently, the expected actual costs for maintenance are not consumed/spent/ and
the machines are in perfect condition. It remains therefore in the form of savings (profits) for further use [9].

3. PFM objectives

Major objectives:

PFM helps to reduce and eliminate:

- Production with downtime-cost of unplanned downtime for repairs and accidents;
- Nonconforming production-the cost of scrap losses, incurred accuracy pollution, control elements;
- Warranty repairs- the cost of repairing defects of the product returned by the customer
- Delivery without delay- costs related to overtime, compliance with contractual deadlines, endangered downtime, financial penalty for failing to meet deadlines;
- Destroy time to sort-unproductive time associated with defective production;
- Restricted downtime because of filter replacement-oil and spare parts;
- Downtime,-planned repairs, service, and replacement of parts.

Technical duties:

Maintenance and repairs PFM reduce and eliminate:

- Problems with the pump, the cost of pump replacing or repairing,
- Problems with the valves-the cost of replacing and repairing the cleaning valve;
- Problems with the hydraulic cylinder-the cost of replacing and repairing hydraulic cylinders;
- Problems with bearings-the cost of replacing and repairing bearings;
- Problems with cooling-costs due to reduced efficiency of cooling by dirt from the oil - reaction to higher temperatures;
- Leakage problems-costs caused by shortening seal life (abrasion);
- Oil consumption-purchase, storage, disposal of used oil, used sorption materials, tank cleaning - machine downtime;
- Trouble status of machinery and equipment;
- Consumption of spare parts and filters;
- Power consumption;
- General part wear.

Economic objectives:

- Reduction of operating costs (optimization of machines);
- Return to shareholders (profit on capital employed);
- Return on investment (efficiency);
- Cash flow accounting (self-financed independently of the loan);
- PFM protects the environment;
- Reduction of oil leakage - sanctions for the leak by state authorities;
- Reduction of oil consumption by 80-95%);
- Minimized handling [10,11].

Three basic PFM pillars:

1. Care of oil: Superior care given to them without downtime of machinery and equipment, thus full operation.
2. Analysis: used tribotechnical diagnostics with links to the state machinery and equipment, technical service, for example, control of lubricants, their suitability, and replacements.[11,13].

In the implementation of the PFM, an experiment was performed using a bypass filtration (the system is at present in patent pending, more details cannot be specified) by measuring in company XY and in the subsequent verification of establishment PFM has been found that the system helps to better reduction of impurities in the oil which results in a reduction of downtime and saving financial funds.[12]. As seen in Figure 2., the reference values were determined in accordance with ISO 44406 before the introduction of PFM and subsequently measured values of the oil cleanliness after bypass filtration.

![Figure 2. Decrease of particles in oil by using bypass filtration process](image-url)

In the Table 1. and Figure 3., we compare the oil cleanliness according to ISO 4406 before and after introduction of PFM, and the used measurement of electric energy consumption and consumption reduction due to the introduction of PFM and other necessary steps.
Table 1. Comparison of the measured values before and after the PFM [14,15]

<table>
<thead>
<tr>
<th>The measured values according to ISO 4406 before the introduction of PFM</th>
<th>The measured values according to ISO 4406 after the introduction of PFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>20/19/17</td>
<td>15/11/7</td>
</tr>
<tr>
<td>NAS 1638</td>
<td>NAS 1638</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
</tr>
</tbody>
</table>

100 x magnification, 1 segment = 10 μm

Figure 3. Level of cleanliness before and after introduction of PFM

Introduction of PFM is quickly recoverable and therefore profitable (Table 2. and Figure 4.). The return is usually below 1 per year. Comparing the period before the introduction of the PFM (2009, 2010) to the period after the introduction of the PFM, we see a reduction in downtime of more than 65%, which implies that the machines do not consume financial resources in the planned amount and then remain in the company as financial savings.

Table 2. Example of decrease downtime in minutes after the introduction of PFM

<table>
<thead>
<tr>
<th>Year</th>
<th>Machine 1</th>
<th>Machine 2</th>
<th>Machine 3</th>
<th>Machine 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>2097</td>
<td>2976</td>
<td>2532</td>
<td>2097</td>
</tr>
<tr>
<td>2010</td>
<td>3825</td>
<td>3164</td>
<td>2993</td>
<td>3825</td>
</tr>
<tr>
<td>2011</td>
<td>987</td>
<td>2203</td>
<td>2105</td>
<td>987</td>
</tr>
<tr>
<td>2012</td>
<td>425</td>
<td>1120</td>
<td>1074</td>
<td>425</td>
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<tr>
<td>2013</td>
<td>152</td>
<td>593</td>
<td>587</td>
<td>152</td>
</tr>
<tr>
<td>2014</td>
<td>652</td>
<td>247</td>
<td>253</td>
<td>652</td>
</tr>
</tbody>
</table>

Figure 4. Characterization of downtime after the introduction of PFM

4. Conclusion

In PFM, there is an associated complex of services, the possibility of transferring externally on internal activities. In the first phase, we acquaint with the aspects and factors that adversely affect the behavior of machinery and devices thus directly affecting the production from the qualitative and the quantitative side. With the help of Productivity Fluid Management there are set current costs. The next step is to perform summarization and optimization of established facts and proposing technical solutions supported by the empirical knowledge and calculation of payback. The results of the analyses are presented to the customer as a basis for the further decision-making process.
References


[15]. NAS 1638: 1964, Contamination level classes.