

# CONDITIONS' MONITORING TO IMPROVE MAINTENANCE STRATEGIES IN A CHEMICAL PLANT

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## SUMMARY

The research of instruments for Predictive maintenance has been the primary goal for the management of the INEOS (former PE plant) in Rosignano, since the years '90, looking after services and systems able to reduce downtime and preventing potential failures of the process, through conditions' monitoring efforts.

The skillness of field technicians, under the supervision of an evolved plant Engineering, has directed the whole plant management towards reliable and affordable tools for onsite and offsite diagnostic experiences, aiming for an effective TPM.

Among the available techniques, Vibration and Shock Pulse Monitoring were initially selected to detect unbalancing and misalignment of rotating machines, followed by Termography and Oil Analysis, to control early stages of wear modes and contamination control of lubricants.

**Key Words:** Reliability centered maintenance, T.P.M., Wear control, Condition monitoring.

## 1 INTRODUCTION

The Ineos plant in Rosignano is part of the original chemical industrial settling in the Solvay area; mostly dedicated to High Density Polyethylene (HDPE) processing, starting from gas storage, unloaded by tankers mooring at the terminal dock, all the way to polymerization and extrusion of HDPE pellets. The total area of 260.000 m<sup>2</sup>, of which 28.000 m<sup>2</sup> are covered by the installation. The plant was built in the 60s starting with a production of 45000 ton/year of HDPE, until the actual production of 200kt and 185 employees. The range of products is represented by 45 different resins grades for caps, pipes, textile, cartridges applications on 4 polymerization and 4 extrusion lines. A research plant is also part of the site, one of the most important of the group.

## 2 RESULTS

### 2.1 Toward an Integrated System for Oil Monitoring

In the beginning of the program (with former Solvay-PE plant) the oil samples were collected and delivered to the off-site laboratory (located in Firenze) and the analytical results (feed-back) was initially sent through regular mail (hard copies) with a certain delay on follow-up. Data outputs requested a manual transfer in the central system to manage trends and reports. After the introduction of e-mail, the certificates, on a custom made excel file were addressed directly to the supervisor, to be transferred in the internal data base for trending capabilities. With this enhancement, a lot of time was saved and the speeding up of process was considered very cost effective; by improving the reaction in correcting potential damages.

The real innovation took place (year 2002) with introduction of a web based platform capable to manage the samples' flow and the results, as well as corrective actions to be taken. *www.permantenere.it* became a web shared data management system, holding technical information from the field, feedbacks & lab's results. Different levels of reliability team technicians were able to update or simply control the infos.

## 2.2 Oil Analysis Results and Practical Feedbacks

The F881/5 has been considered the main extruder of the site produced by W&P ZSK177 and equipped with a FLENDER gearbox. This equipment has a reduction rate of 1:3.4 and is connected to a 2.8 MW variable speed motor drive. The gearbox is composed by 10 wheels and 8 shafts, supported by 25 ball and roller bearings. This item is considered one of the "bottleneck" systems of all the plant; an eventual sudden failure of this machine may create a severe damage to all the process and activities related. The introduction of online reporting (through Permantenere) has given the opportunity to better evaluate the dynamics of wear and the graphics gave an immediate sight of what was not totally under control. That means that with proper lubrication and load applied there were no signs of impending failures or consistent wear.

Around the end of 2007 we assisted to the very first glimpse of accelerated wear, with both parameters steadily increasing toward 100 ppm for Iron and 20 ppm for copper; these values are not abnormal in itself, but with comparison with previous results, something is coming to the surface, in terms of "weak signals". Immediately after (no more than 3 months) the wear rate detected by oil analysis increased in a very impressive way. Nevertheless, other dynamic parameters (SPM or Vibrations) did not report any alarm. By analyzing the subsequent oil samples with LaserNet Fines (a new technology of particle counting, with a special device to recognize shapes and sizes of contaminants) we have been able to confirm the impending failure in a bearing or bushing component.

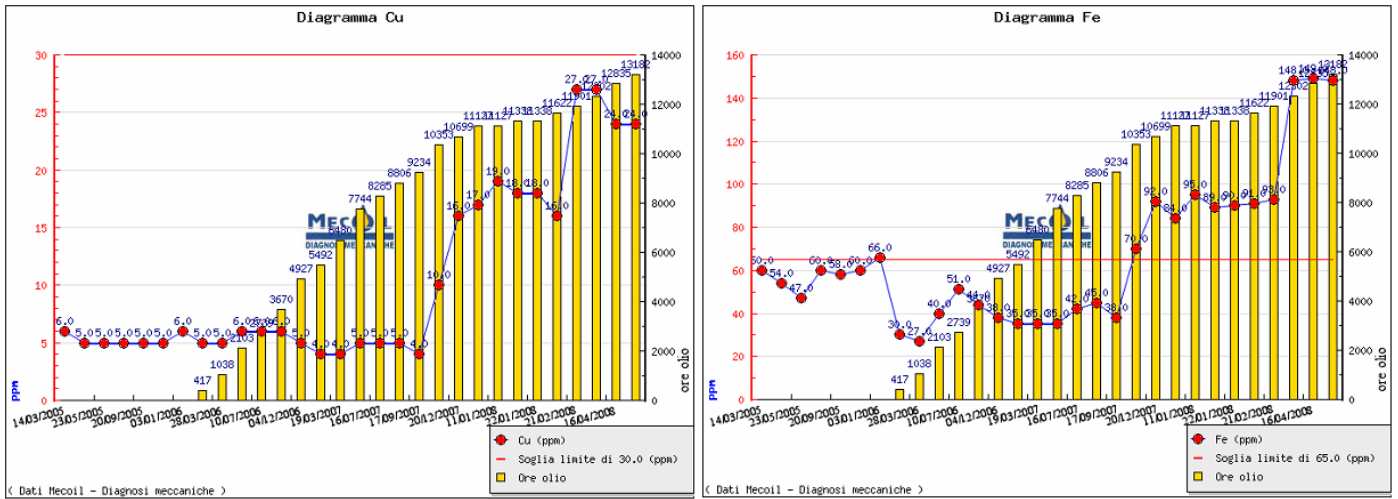


Fig. 1: Iron and Copper trend graphs.

Figure 1 shows a steady increase in Iron trend (steel), since the end of year 2007. It should be noted how consistent is the behaviour in the previous two years, never exceeding the 50/60 ppm (g/Ton). The same pattern is shown in the Copper (and Zinc or Tin) trend. The small percentage of these soft metals reveals the presence of an alloy, Brass mostly, involved in the wear process.

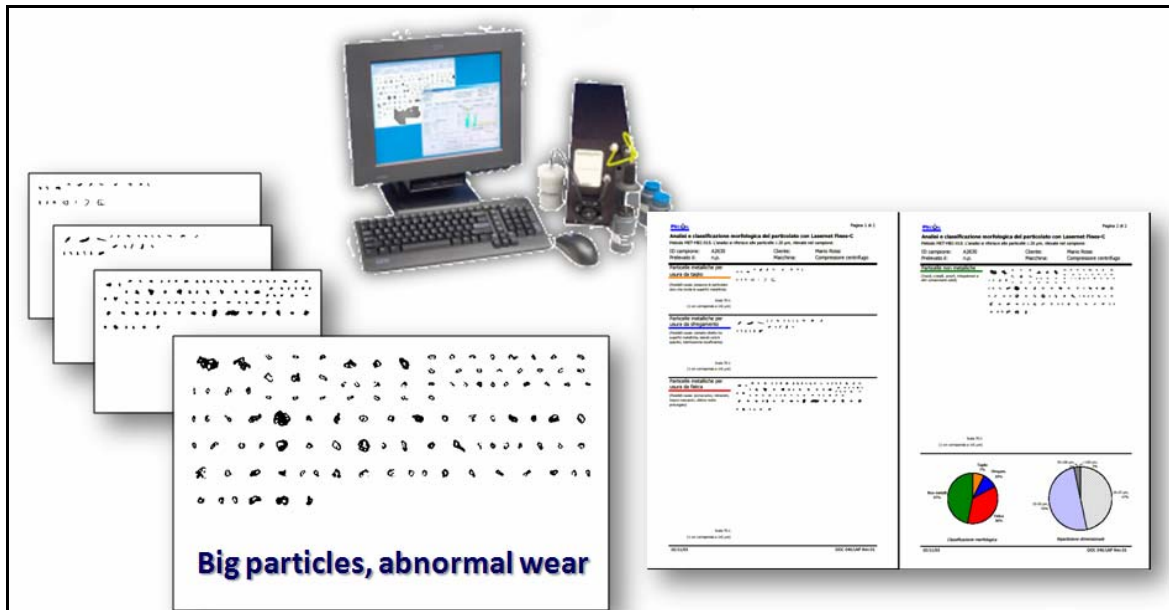


Fig. 2: LaserNet Fines

As already mentioned the other “Predictive” parameters related with Vibrations did not show any abnormal behaviour, but the Plant Direction decided anyhow to take the advantage of a routine stop to deeper investigate with an endoscopic probe, to detect possible internal wear signs of the roller bearings in the slow & high speed shafts. At this point the need for a more radical intervention was addressed to the production management, in order to program a stop, for the necessary corrective actions to be taken.

### 2.3 Overhaul

The decision was made to start the planned intervention by May 19, having already in stock all the required materials for this scheduled, forecasted replacements. Among them the following items/spare parts:

N° SK		PC
95002939	BEARING QJ 230 N2 C3	1
95002936	BEARING NU 2230 C3	1
95002938	BEARING NU 2236 EMC1	1
70132025	BEARING SL 185040 C2	1
70132028	BEARING SL 182236 C3	1
71032005	BEARING 89456	1
70172007	BEARING NU 234 EC3	1
70132006	BEARING 81122	1
95002937	BEARING 29412E	1
70132031	KIT GASKET 1° STADIO	1
95009383	MOBILGEAR 600 XP 320	900 LT

Table 1: Spare Parts

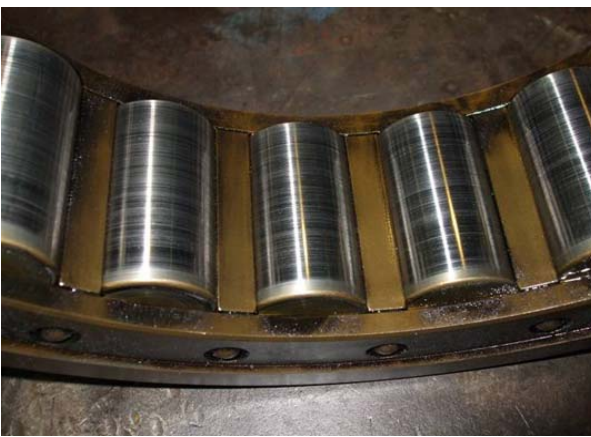
After dismantling several levels of shields, components and gears/bearings, as well detailed in the pictures taken (Figures 3 through 6), the evidence of several major signs of wear related with pitting, fretting and in site spinning was found on few roller bearings.



*Fig. 3 - Crankcase after removal of top cover;*



*Fig. 4 - High speed shaft removal;*



*Fig. 5 - 152 Bearing with deep scoring;*



*Fig. 6 - 151 Bearing with circular wear signs;*

The work with final tests came to conclusion by May 23rd, and since that moment, the machine is running fine. No more unscheduled maintenance works have been requested since that moment. Oil Analysis and all the other controls (extended conditions' monitoring) revealed that trends became normal.

### 3 CONCLUSIONS

The above presentation of a real case history in a critical component of process industry, shows how different approaches are sometimes required, in order to "pick" the actual problem, since the very beginning of the latter.

In the actual situation, given the thickness/size of some components/shields, not all the vibrations and dynamic pulses could be detected in the due time. Probably the very slow rotation of some gears and the related dull signs, with interferences caused by non-uniform loads, are responsible of such lack of early detection.

Used oil analysis has been very helpful to supply this tribological support to detect early stages of wear for the management, in order to strategically schedule the required corrective actions.

This part of the procedure has to be considered the start up of a whole new approach toward an RCM strategy, including the enhancement of tools like performances indicators and highly engineered Maintenance procedures to improve availability of the plant, upfront reduction of costs.

Some of the new steps are actually under testing, among them the introduction of a more powerful SIM to deduct in due time the real costs associated and benefits from Conditions' monitoring application. In terms of Proactivity in many of the not critical assets have been introduced a new permanent (online) magnet right in the oil stream, to capture wear debris and eventual contamination, occurring after major overhauls. These probes can be visually inspected and the amount of coarse steel entrapped can be measured to determine the severity of the contamination, versus an impending failure.

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