The lubricants' parameters monitoring and data collecting

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Abstract. This approach is focused on Machine Intelligence for Diagnosis Automation, a research program, which promotes « preventative maintenance in manufacturing plants through the development of a fully automated prototype for oil analysis and fault prediction. The prototype is based on Artificial Intelligence (A.I.) software and online hardware ». Monitoring the condition of lubricants requires the examination of the physical, chemical and additive states, which maintain the quality of the lubricants, which is necessary for the proper functioning of the equipment. A lubricant monitoring program, especially from a qualitative point of view, will need to focus on both machine tool wear and degradation of lubricants, as well as on detecting and describing abnormal working conditions for both lubricants and machine parts. This goal can be satisfied by examining all the oils used in a company by completing laboratory tests to generate steps and acceptance classes, as well as unplanned contingency analyzes. These laboratory tests can be concentrated and classified into technology-based data sheets based on test-based information and test results, ultimately constituting consistent databases needed to generate monitoring and prevention reports. Data on the condition of the oil parameters used in the hydraulic system for lubricating machine tools have been collected during six months. The data as matrix organized, with 258648 rows (observations) and 21 columns (parameters).

1 Introduction

One of the major causes of premature wear of machines parts, moving or working, under load on the contact surface is the practice of improper lubrication. This includes contamination with foreign particles, the use of improper lubricants, the use of lubricants in excessive quantities or in insufficient quantities. In addition to the quality of lubricants to ensure technological processes under friction, wear and temperature control, lubricants also become diagnostic tools. A lubricant status monitoring program can provide information on additive inefficiency, change in viscosity, water content, coolant, and emulsion losses, and particulate matter contamination [1], [2]. Depending on the objectives and size of the monitoring system with the lubricant analysis, one can observe: control and analysis of the contaminating fluids; fluid properties analysis, metal wear analysis. Typical tests are:

- Number of foreign particles;
- Viscosity;
- Water content;
- Spectroscopy of chemical elements;
- Infrared Spectroscopy (FTIR);
- Measurement of Total Acid Number;
- Wear density (excluding measured particles);
- Analytical Ferrography (exception of the density of wear);

One of the key elements in the lubricant analysis is the ISO Code (ISO 4406). This code for solid contaminants expressly provides for the purity levels of liquids and is internationally recognized. The code provides a reference: the number of particles per volume unit, between 5 and 15 microns.

Table 1. The ISO codes.

Range Code	Particles per milliliter	
	More than	Up to / Including
24	80000	160000
23	40000	80000
22	20000	40000
21	10000	20000
20	5000	10000
19	2500	5000
18	1300	2500
17	640	1300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2.5	5
8	1.3	2.5
7	0.64	1.3
6	0.32	0.64

These two dimensions have some significance, because lower concentration gives an accurate appreciation of particle deposits in oil, and the upper level of 15 microns reflects the type of particle concentration

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from wear. The ISO code is represented by a combination of $R_{5\ microns}$ / $R_{15\ microns}$, according to the reference data in the Table1.Thus, if the analysis resulted in the following data:-400 particles> 5 microns / ml; -65 particles> 15 microns / ml; then the ISO code is: ISO 16/13.

Contamination of lubricants with water is a subject of their analysis. The degree of contamination is expressed in PPM (parts per million) of water content. A percentage (1%) of water is 10000 PPM. The low percentage of water in lubricants means good quality. Viscosity is the critical property to follow in the case of lubricants. An increase in viscosity is more tolerable than a decrease in viscosity. Viscosity does not have an exact value; it varies within certain limits. This is guaranteed by the manufacturer.

The Neutralization Number, or the Total Acid Number (TAN), corresponds to its acidity. Acidity is primarily due to oil degradation. Acidity varies according to oil level.

Most experts in tribology recommend that oil analyzes be made mandatory for all new oils. These must include:
- Quantification of the number of particles in the workshop using porous sites (10 microns, characteristic mesh size);
- Determination of viscosity in the unit of work;
- Water content, using fluid separators;

Another set of laboratory analyzes should be performed on "critical" fluids, such as lubricants used in equipment tested at intervals of 60 to 90 days. Tests performed outside the workshop are:
- Karl Fischer Specialized Laboratory Test;
- Special Spectroscopy Test of Elements;
- Infrared Spectroscopy (FTIR);
- Total Acid Number (TAN).

New oils must have an ISO code as well as a water content equal to or better than prescribed in the technical documentation of the machine tool.

Efficiency and cost-effectiveness calculations have highlighted the savings of up to 10% of operating costs if contaminated oils are changed in time, i.e., before the affected equipment is introduced into the service, repair or repair process. Regarding the benefits of investment and reliability, one can say that the key elements of a program for the monitoring, evaluation, and analysis of the state of the oils in a company with specific machining are:
- Acceptance criteria for new lubricants
- Acceptance criteria for servicing oils
- Defining storage conditions
- Clear storage procedures
- Handling and transport procedures
- Oil change procedures
- Ensure the filtering process
- Ensure the filtering process on the tool machine
- Specific airing conditions

Worldwide, the yearly damage to machinery due to wear is equivalent to the destruction of about 20% of their total. Tribology, science dealing with the study of the phenomena and processes of friction, lubrication and wear occurring in the superficial surfaces of the machine organs in contact with relative motion, seeks to prolong the duration of operation of machines and installations by

combating or eliminating wear, both by knowing the causes (friction phenomenon) and by preventing or reducing wear by using proper lubrication.

Some preliminary considerations on how to behave in a relative movement of the machine parts with direct reference to the immediate surroundings of the couples formed in the manufacturing process and machine tools: After surface lubrication, the friction may be:
- dry - in case of direct contact between the two coupling elements without lubrication (friction coefficient $\mu > 0,3$);
- at the limit (unctuous) - in this case, the interposition of molecular layers of lubricant occurs, the oil film reduces the contact between the elements of the coupling, but does not remove it, the lubrication exists but is at the limit ($0,1\ \mu < 0.3$);
- mixed (semifluid) - when the lubricating film has a thickness corresponding to the leakage of the fluids, but due to the roughness of the surfaces it breaks and recovers, at high frequencies, part of the normal load is taken over by the fluid film. Percentage, this assumption of normal forces, is estimated at several percentages, which are significant in the case of components with large, non-dimensional masses. In this case, the lubrication is called partial ($0.05 < \mu < 0.1$). This type of friction is encountered when starting and stopping sliding bearings, hydrostatic assembly of tightening assemblies, etc.
- fluid - when the joint surfaces of the coupler are separated, through a continuous lubricant film. The lubrication is fluid ($0.01 < \mu < 0.05$).

It has been found in industrial manufacturing practice that most machine parts are not destroyed by both mechanical and thermal stresses, especially wear, due to sources of uncontrolled friction and inappropriate lubrication. Not always, inappropriate lubrication is due to design mistakes or non-conforming operations. These can also occur due to correct operation, but the composition of the machine tool materials in contact, as well as oils or lubricants, is inappropriate for various reasons. Some of these reasons may also be the deterioration of the properties and technical characteristics of the lubricants, but also of the materials of the machine parts in contact. By definition, the wear finds its physical expression in the loss of material on the contact surfaces of the relative moving bodies, resulting in the modification of the dimensions, the geometric shape and under certain temperature conditions, even leading to structural changes in the superficial layers [3] . The wear in lubricated friction contacts is influenced by:

1.1 - Rheological lubrication regime

The characteristic process values of the rheological lubrication regime are the gs viscosity parameter and the elasticity parameter g_e:

$$g_v = \frac{\alpha \cdot \omega}{R} \cdot \left(\frac{\omega}{\mu_0 \cdot V}\right)^{\frac{1}{2}} \qquad (1)$$

$$g_e = \left(\frac{\omega}{E \cdot R}\right)^{\frac{1}{2}} \cdot \left(\frac{\omega}{\mu_0 \cdot V}\right)^{\frac{1}{2}} \qquad (2)$$

in which: α is the viscosity-pressure coefficient; ω is the normal force per unit of contact width; R is the radius of curvature of the contact surface; E represents the effective elastic modulus; μ_0 is the viscosity under normal conditions, and V is the relative speed between the contact surfaces [1-4]. The values of these parameters must be within the ranges: g_v <1.5, and g_e <0.6. If these conditions are not complied with due to the operating process, this is called the elastohydrodynamic lubrication process, characterized by the g_s speed parameter and the g_l load parameter, which must be within the following limits:

$$1.8 < g_s = \alpha \cdot \left(\frac{E^3 \cdot \mu_0 \cdot V}{R} \right)^{\frac{1}{2}} < 100,$$

$$1.0 < g_l = \alpha \cdot \left(\frac{\omega \cdot E}{2 \cdot \pi \cdot R} \right)^{\frac{1}{2}} < 100$$

respectively.

1.2 - Functional lubrication regime

This is characterized by the minimum thickness of the oil film in the case of the pressed surfaces and is calculated by the formula:

$$h_0 = 4.9 \cdot \frac{\mu_0 \cdot V \cdot R}{\omega} \qquad (3)$$

where the coefficient "4.9" refers to a solid rigid with a lubricant isoviscosity. In the case of elastohydrodynamic conditions, the minimum thickness of the lubricant film shall be calculated with the formula:

$$h_0 = 2.65 \cdot \frac{\alpha^{0.54} \cdot (\mu_0 \cdot V)^{0.7} \cdot R^{0.43}}{\omega^{0.13} \cdot E^{0.03}} \qquad (4)$$

In the case of point-like contact of smooth surfaces, the minimum thickness of the lubricant film is:

$$h_0 = 0.84 \cdot (\mu_0 \cdot \alpha \cdot V)^{0.74} \cdot R^{0.41} \left(E / \omega \right)^{0.074} \quad (5)$$

If the process takes place by sliding the contacts on a thin film of lubricant, it is necessary that this regime is not considered a rheological one and the ratio lambda: $\lambda = h_0 / S$, where $S = \frac{R_1 + R_2}{2} = 1.11 \cdot R_a$ and R_a, is the height of the surface roughness. If $\lambda > 3$ then it can be considered that there is a fairly consistent likelihood that this contact of asperities is insignificant, so adhesive bonding is impossible to achieve. Otherwise, if $\lambda < 1$, then the operating mode takes place at the extreme limit of lubrication, which implies the presence of wear and tear wear, respectively. Therefore, in this situation, lubrication conditions must be reconsidered. If this is practically impossible, the contact mode at the asperity limit must be determined by examining the plasticity index:

$$\psi = \frac{E}{P_y} \cdot \left(\frac{\sigma}{\beta} \right)^{\frac{1}{2}} \qquad (6)$$

where E is the modulus of elasticity; P_y is the normal pressure on the contact surface; β- the asperity dispersion factor, σ -the mean standard deviation of the asperity height.

Thus, in the case of the mixed lubrication regime in which $1 < \lambda < 3$, in which most of the machine tools exhibit sliding or sliding / rolling contacts, the total load is divided between the asperity load and the lubricant film, respectively in this case only the load on the roughness contributes to the generation of wear. If $\psi < 0.6$, contact between the asperities can be considered as elastic under any type of loading, and if this plasticity index $\psi > 1$ then the contact can be considered partially elastic, even at low loading forces. If the plasticity index is in the range of 0.6 $< \psi < 1$, the contact mode is a mixed one, and an increase in the loading force can generate a change of the elastic-to-plastic contact. If $\psi < 0.6$, there is a predominant metal-metal contact due to the fluctuation of the absorbed lubricant, and the idea of approaching the defects of the fractionated lubricant film should be considered.

1.3 -The fractional lubricant film defect

A property with measurable influence, which has a critical effect on wear in lubricated contacts, is the heat absorbed by the lubricant. This feature is valid in the case of adhesion, resulting, in practice, from direct metal-metal contact between roughness. If the lubricant molecules remain attached to the contact surfaces, then the probability of forming a prononced wear is extremely low. In physical terms, the film fractionation and the occurrence of fractionation defects of the oil film, respectively, b, can be defined as the ratio between the number of unrealized contacts, between the roughness, and the actual total number of contacts between the possible asperities:

$$\beta = \frac{A_m}{A_r} \qquad (7)$$

in which A_m represents the contact area, metal to metal, and A_r represents the real contact area.

1.4- Dispersion of loads in the contact

For the discussion of this situation, it is considered a lubricated contact, in which only adhesion wear is present. The solution to the problem is based on the theory of partial elastohydrodynamic lubrication. According to this theory, both the contact between the asperities and the lubricant film contributes to the absorption of the dynamic loads. Thereby:

$$W_c = W_s + W \qquad (8)$$

in which W_c represents the total load on the contact surface, W_s represents the charge taken up by the lubricant film, and W represents the load assumed by the asperities. According to experimental data, only part of the total load is considered responsible for adhesion. Analytically, the size of the contact pressure, empirically given by the relationship:

$$p = {}^{2}\!/_{3} \cdot E \cdot (Nr\sigma) \cdot (\sigma/r)^{\frac{1}{2}} \cdot F_{\frac{3}{2}}\left(d_e/\sigma\right) \quad (9)$$

The total pressure resulting from the total load W_c is given by:

$$p_c = 0.39 \cdot E^{\frac{2}{3}} \cdot W_c^{\frac{1}{3}} \cdot R_e^{-\frac{2}{3}} \quad (10)$$

What determines the following ratio calculation:

$$p/p_c = 1.7 \cdot R_e^{\frac{2}{3}} \cdot W_c^{-\frac{1}{3}} \cdot E^{\frac{1}{3}}(Nr\sigma) \cdot$$

$$\cdot (\sigma/r)^{\frac{1}{2}} \cdot F_{\frac{3}{2}}\left(d_e/\sigma\right) \quad (11)$$

in which $R_e^{\frac{2}{3}}$ is the relative radius of curvature of the contact surfaces, E- is the effective elastic modulus, N- the relative density of the asperities, r- is the mean radius of curvature of the asperity peak, σ- is the standard deviation of the peaks, $F_{\frac{3}{2}}\left(d_e/\sigma\right)$ is a statistical function, and d_e is the mean distance of separation between the tip of the asperities and the smooth surface.

The ratio between the lubricant pressure taken and the total pressure on the contact surfaces is given empirically by:

$$p_s/p_c = \frac{1}{\lambda}\left(\frac{h_0}{h}\right)^{6.3} \quad (12)$$

where λ is the specific thickness of the lubricating film, h is the average height of the oil film in the case of rough surfaces, and h_0 is the height of the oil film in the case of smooth surfaces.

1.5- A mathematical model of adhesion wear

Theoretically, the amount of adhesion wearing should be expressed by a function of the metal to the metal contact surface and the slip distance:

$$V = k_m \cdot A_m \cdot L \quad (13)$$

Where k_m is a non-dimensional constant specific to friction materials and independent of contaminants or lubricants. Expressing the actual contact surface, as a function of loading W and P, the flow pressure, taking into account the oil film fractionation defects, β, obtains:

$$V/L = k_m \cdot \beta \cdot \left(W/P\right) \quad (14)$$

This equation has a special meaning for the terms it contains. Thus k_m characterizes the tendency of shrinkage of the surfaces by wear, and the parameter β indicates the ability of the lubricant to reduce the metal to the metal contact surface, taking values in the interval [0,1].

2 Operational Objective: Integration of the whole system, prototype development, testing

The first of the directives of this operational objective is certainly to build a hardware system that can support the new requirements of the intended use range. In industrial practice, there is obviously a major requirement, namely that technology is structured so that it is "safe", without any risk to the work environment, and at the same time offers the opportunity to store and transmit in a way efficient information retrieved from sensors located on industrial equipment.

The designed system, which has begun this research, has some clear drawbacks, especially as regards the speed of adder acquisition, as well as its transmission and processing. This system was totally lacking in the possibility of data transmission, i.e., communication, of the local area networks(LAN) type, which revealed a fundamental deficiency in the intention of interfacing the system in the current industrial context. It was obvious that the system had to be rethought in terms of a new neural network approach, with the application of genetic algorithms, with the avoidance of traditional, high-risk switches or connectors. It was obvious the need to reorient the power supply to a mains or power source, max. 24 VDC, through LEMO connectors (fiber optic). It would have been desirable to involve an external touch screen, a smartphone model, through which the basic operations of the activation functions, display parameters, etc. could be performed. Considering these requirements, using specialized literature and specific search engines, a rigorous selection of appropriate component manufacturers was needed, so that the model of this system, which is prefigured, would allow a wide range of options and facilities to suit the intended purpose, and objectives listed.

A testing phase of a working model took place at the Mecoil (Italy) headquarters, in the company's lab, on a demo system with controlled parameters. The elements that were tested (physicochemical parameters) were evaluated in a first stage, on a single level. As the data was collected, based on predefined scenarios, "event / error modules" were interleaved on one level to test the system's response speed. The data was then processed and interpolated, at which point the contribution of "IA" became essential to evaluate the infinitesimal transformations (those that can escape the eye of a technician) of the multiparametric elements. The system was thus tested to detect between the "n" elements to be taken into account simultaneously, and to evaluate in real time both the evolution and the trend of the monitored parameters, being "learned" to detect essential anomalies or possible failures . The overcoming of this early phase allowed the decision to install the system designed and physically installed on industrial installations (pilot systems) at EMSIL Techtrans SA-Romania, as well as in four other locations in Italy, to Mecoil partners, [6].

2.1 Activities carried out

In order to remove the obvious limitations shown by the first version of Monitoil's (Fig. 1.) monitoring system, it was decided to restructure the equipment by approaching a reasonable option for industrialization in the idea of efficient and logical improvement of the electronic components that would validate the project from the point

of view of its operation under an environment of real, industrial thing.

Fig. 1. Monitoring system Monitoil

Using advice with specialists in preventive maintenance, networking and robotics design (DM Electronics and Rodolfo Facchini), the planned activities were channeled towards the preliminary design of the acquisition board and the sensor work pattern, paying attention all possible causes of "distortion" of the signal and environmental and electrical interference. In this respect, consideration was given to the evaluation of a Raspberry type interface, with emphasis on data acquisition and sensing response checking. In addition, TecService Italy's TecService Italy consultancy has been used to build a first-ever version of the Machine Intelligence for Diagnosis Automation (MIDA), with both industrial and IP67 protection restrictions for these work environments, [6], (Fig. 2).
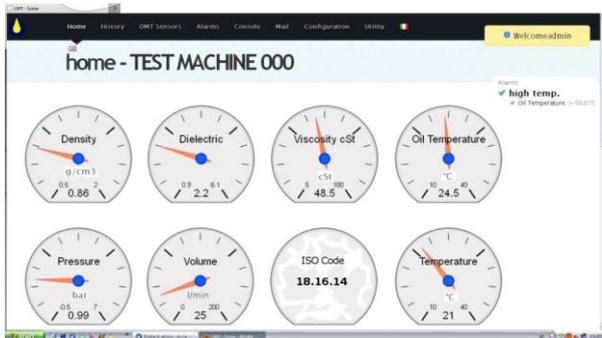

Fig. 2. Virtual Command Dashboard (www.mida-project.eu)

Fig. 3. The installation of MIDA on a machine tool at EMSIL Techtrans SA Oradea

Testing and tuning of the final phase algorithms were made possible by collecting and making available to the Project partners a set of observations data from the installation of MIDA on a machine at EMSIL Techtrans SA Oradea (Fig. 3.). Starting from the scheme of the first

prototype, the Mida's miniseries were made. In addition to the test prototype test at EMSIL Techtrans SA Oradea, 4 other units were sent to Mecoil customers and partners to validate the device's operation under industrial conditions and obtain new test databases for artificial intelligence. The exploitation and testing of this equipment for many users simultaneously played an essential role in identifying problems, but also in evaluating the datalogger design phase(Fig. 4.).

Fig. 4. The virtual MIDA dashboard (by web reachable)

3. Results

The data are matrix organized, with 258648 rows (observations) and 21 columns (parameters). The data refer to the analyzes made on the manufacturing line on the following parameters: density, viscosity, dielectric, water, oil degradation, temperature, ISO4, ISO6, ISO14, with obvious importance for the oil condition, but also for the operation of the industrial equipment being tested .

Particle sensors (Fig. 5) may be of several types: particle count or particle detector. The two are listed below:

a)-particle counters

b)-particle detector

Fig. 5. Sensors used

Water sensors or moisture sensors can be of several types. Some are mounted on the pressure pit at others on the return circuit of the installations. Water or humidity sensors continuously monitor water / humidity in

hydraulic and grease oils. They were designed especially for preventive maintenance of installations and machines. Reporting is done in% relative humidity of the water content, giving the user how close is the saturation point oil. Data on the condition of the oil parameters used in the hydraulic system for lubricating machine tools have been collected for six months. The data are matrixed, with 258648 rows (observations) and 21 columns (parameters). The parameters are presented in Table 2:

Table 2 The parameters collected

id	measure identifier
postgresql_timestamp	writing time
time	writing time
raw_data	Maybe neglected, it is not important (data before process starts)
icm_isocode	ISO code 4406 (icm_iso4/ icm_iso6/ icm_iso14)
icm_rh	water saturation%
icm_flow	oil flow through particle counter
icm_temp	particle counter electronic temperature
icm_iso4	ISO 4406 code class particles >4 µm
icm_iso6	ISO 4406 code class particles >6 µm
icm_iso14	ISO 4406 code class particles >14 µm
icm_pc4	number of particles >4 µm
icm_pc6	number of particles >6 µm
icm_pc14	number of particles >14 µm
fps_vcst	viscosity [cSt]
fps_v	viscosity [cP]
fps_density	density
fps_dielectric	dielectric constant
fps_temp	oil temperature
oh_temp	Oilhealth electronic temperature
oh_parama	Oilhealth paramA (not important)
oh_paramb	Oilhealth paramB (not important)
oh_paramc	Oilhealth (not important)
oh_od	Index of degradation OD%
Date	day of analysis
time	hour/time of analysis

4. Conclusion

The activities carried out at this stage by the project partners were focused on the development and testing of prototype variants; analyzing continuous signals to identify the relevant signal characteristics and determining the useful data collection (Table 3) space to be able to provide an accurate estimate, or as close as possible to accuracy; Support Vector Machines training algorithms were developed to read the signal characteristics based on "learning". Numerical experiments have been conducted in different ways of using data through on-line analysis[5], [7]. Alternatively, the signal was divided into a larger number of frames that overlap partially (at the limit, NK-1 frames, provided that the first contains the data between 1 ... K, the second zone 2 ... K + 1, etc.). In this way, the data is partially superimposed on a given order, but the advantage is that the data set becomes a time series of parameters in a smoother regression and therefore easier to extrapolate.

Acknowledgment

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Table 3. Data collected- the first 30/ 258648 rows and all columns of the database, are showed

id	icm_isoco	icm_rh	icm_flow	icm_temp	icm_iso4	icm_iso6	icm_iso14	icm_pc4	icm_pc6	icm_pc14	fps_vcst	fps_v	fps_densi	fps_dielec	fps_temp	oh_temp	oh_parama	oh_paramb	oh_paramc	oh_od
1 0/0/0	0		-327.67	0	0	0	0	0	0	0	0	-1.982	0	0	-272.999	26	27519	36395	20366	28
2 15/13/4	11.38	140	32.88	15	13	4	19932	4662	10	654.309	1298.497	1.985	7.917	30.312	27	27501	36368	20349	28.05
3 15-10-05	11.38	284	32.93	15	10	5	21560	857	30	654.309	1298.497	1.985	7.917	30.312	27	27477	36334	20345	28.11
4 15-12-04	11.38	283	32.97	15	12	4	18156	2235	15	654.309	1298.497	1.985	7.917	30.437	27	27477	36333	20342	28.11
5 15-11-04	11.3	339	33.02	15	11	4	18512	1305	9	654.309	1298.497	1.985	7.917	30.5	27	27472	36338	20353	28.12
6 16-12-06	11.31		33.06	16	12	6	32408	3027	45	654.309	1298.497	1.985	7.917	30.5	27	27472	36338	20353	28.12
7 16-12-06	11.31		33.06	16	12	6	32408	3027	45	654.309	1298.497	1.985	7.917	30.531	27	27472	36338	20353	28.12
8 15-12-00	11.31	264	33.08	15	12	0	24192	2466	0	654.309	1298.497	1.985	7.917	30.562	27	27481	36342	20337	28.1
9 15/13/7	11.22	307	33.09	15	13	7	27409	6171	83	654.309	1298.497	1.985	7.917	30.594	27	27499	36357	20366	28.05
10 15-11-00	11.22	318	33.13	15	11	0	22096	1498	0	654.309	1298.497	1.985	7.917	30.719	27	27449	36306	20343	28.13
11 15/13/5	11.22	279	33.13	15	13	5	22897	4306	19	654.309	1298.497	1.985	7.917	30.625	27	27459	36318	20346	28.15
12 15-11-00	11.22	180	33.15	15	11	0	21265	1053	0	654.309	1298.497	1.985	7.917	30.656	27	27470	36360	20368	28.09
13 15-11-05	11.22	331	33.15	15	11	5	16916	1798	31	654.309	1298.497	1.985	7.917	30.687	27	27443	36290	20323	28.2
14 15-12-03	11.22	233	33.15	15	11	6	19463	1100	56	654.309	1298.497	1.985	7.917	30.781	27	27448	36295	20332	28.2
15 15-11-04	11.22	242	33.18	15	11	4	20907	1069	14	654.309	1298.497	1.985	7.917	30.75	27	27472	36319	20338	28.13
16 0/0/0	0		-327.67	0	0	0	0	0	0	152.186	116.517	0.766	2.187	30.812	27	27449	36306	20346	28.18
17 15-11-03	11.22	308	33.09	15	11	3	20284	1296	6	159.888	120.877	0.756	2.195	30.594	27	27449	36306	20346	28.18
18 15-12-06	11.22	290	33.09	15	12	6	21749	3042	38	153.414	117.537	0.766	2.194	30.656	27	27449	36306	20346	28.18
19 15-12-07	11.22	268	33.13	15	12	7	18982	2228	86	153.689	117.457	0.764	2.193	30.656	27	27449	36306	20346	28.18
20 15-12-05	11.22	204	33.15	15	12	5	25114	2577	23	152.075	116.437	0.766	2.193	30.687	27	27442	36300	20333	28.19
21 15/13/10	11.22	261	33.13	15	13	10	24649	5550	579	152.075	116.437	0.766	2.193	30.687	27	27442	36300	20333	28.19
22 15/13/10	11.22	233	33.15	15	11	6	19463	1100	56	152.075	116.437	0.766	2.193	30.656	27	27448	36295	20332	28.2
23 16-10-06	11.15	244	33.18	15	12	6	18196	2256	38	158.056	120.177	0.76	2.193	30.656	27	27465	36305	20328	28.15
24 15-11-06	11.22	351	33.15	15	12	6	17524	2714	19	156.459	118.877	0.76	2.187	30.687	27	27465	36305	20328	28.15
25 15-12-05	11.22	351	33.15	15	12	5	17524	2043	0	153.039	117.077	0.765	2.187	30.75	27	27459	36316	20342	28.14
26 15-12-00	11.14	364	33.15	15	12	0	20388	1688	22	151.294	117.057	0.764	2.187	30.719	27	27476	36341	20171	28.1
27 15-11-05	11.22	251	33.18	15	11	5	20201	1688	0	150.589	115.557	0.767	2.187	30.719	27	27453	36307	20342	28.17
28 15/13/0	11.15	320	33.18	15	13	0	30875	6317	26	152.556	116.717	0.765	2.187	30.687	27	27478	36345	20362	28.1
29 15-11-05	11.16	374	33.18	15	11	5	27842	1247	26	152.556	116.717	0.765	2.187	30.719	27	27453	36316	20353	28.17