MAINTENANCE DIAGNOSTIC FOR PARALLEL ACTING MECHANISM

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Abstract

Life-cycle maintenance has been an important factor in modern companies' competitiveness and operation. The objective of maintenance is to reduce the number of unexpected breakdowns due to failures, which may be catastrophic and may incur huge loss. Achieving effective maintenance could be of benefit to companies, which can increase profit by the reduction of maintenance costs, as well as to customers who can enjoy improvement of service quality

Key words : maintenance, gearbox, CMMS, life-cycle

INTRODUCTION

The objective of maintenance is to preserve the condition of products and to fulfill their required functions throughout their life cycle.

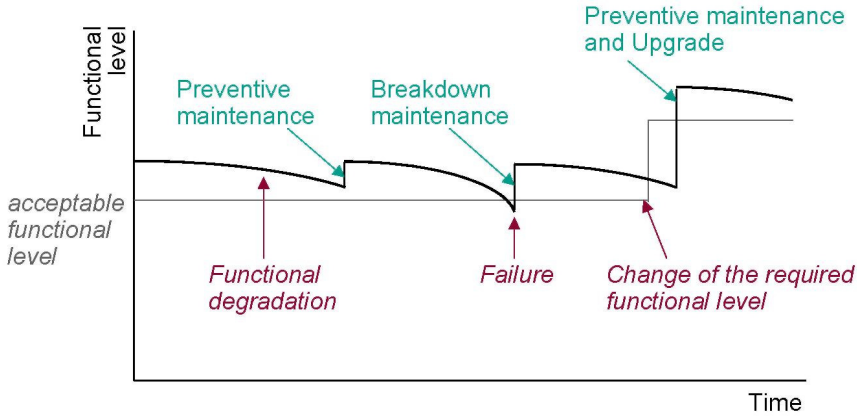


Fig. 1. Maintenance activities

There are two reasons why it is necessary to control the conditions of products: the change in product conditions due to deterioration, and the changing needs of customers or of society. These changes generate gaps between the required function and the realized function. Maintenance is executed to compensate these gaps by means of treatment or upgrading, as shown in figure 1. For this purpose, maintenance should involve the following activities:

1. Maintainability design;
2. Maintenance strategy planning;
3. Maintenance task control;
4. Evaluation of maintenance results;

5. Improvement of maintenance and products;
6. Dismantling planning and execution.

For fulfilling the requirements of life cycle maintenance described above, effective execution of a P-D-C-A (plan-do-check-action) cycle is essential. For this purpose, the framework for life cycle maintenance shown in figure 2 has been proposed.

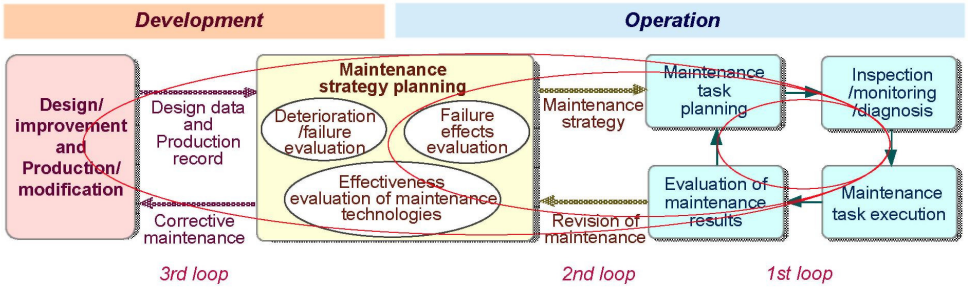


Fig. 2. Framework for life cycle maintenance

MATERIAL AND METHODS

This study concerns the maintenance diagnostic of a parallel acting mechanism which acting elements tower diffusion. Tower diffusion (extraction) is equipment mainly in the output of beet sugar in it taking place diffusion sugar beet in solution technology for obtaining the sugar.

The tower diffusion actuation scheme is presented in figure 3.

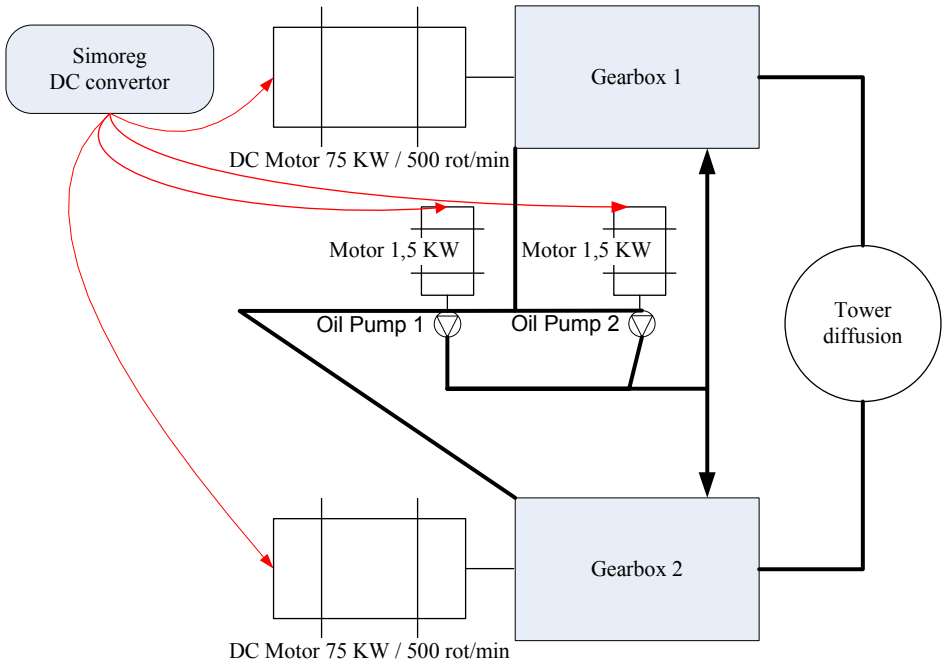


Fig. 3. Parallel acting mechanism

The main features of the diffusion equipment are diameter = 5800 mm, height = 16450 mm, capacity = 3600 to/day. The height of the ground level at which this mechanism operates is 22 m.

The equipment is driven through very big wheels (4 m diameter) by two groups of gearbox powered by a DC converter. Each gearbox (figure 4) contains the following wheels, on orders from engine they are: $z_1 = 40$ (V), $z_2 = 226$, $z_3 = 37$ (V), $z_4 = 162$, $z_5 = 14$, $z_6 = 43$, $z_7 = 21$, $z_8 = 144$, final $z_9 = 21$ (located outside of gearbox), $z_{10} = 157$ ($\Phi_{ext} = 4000$ mm).

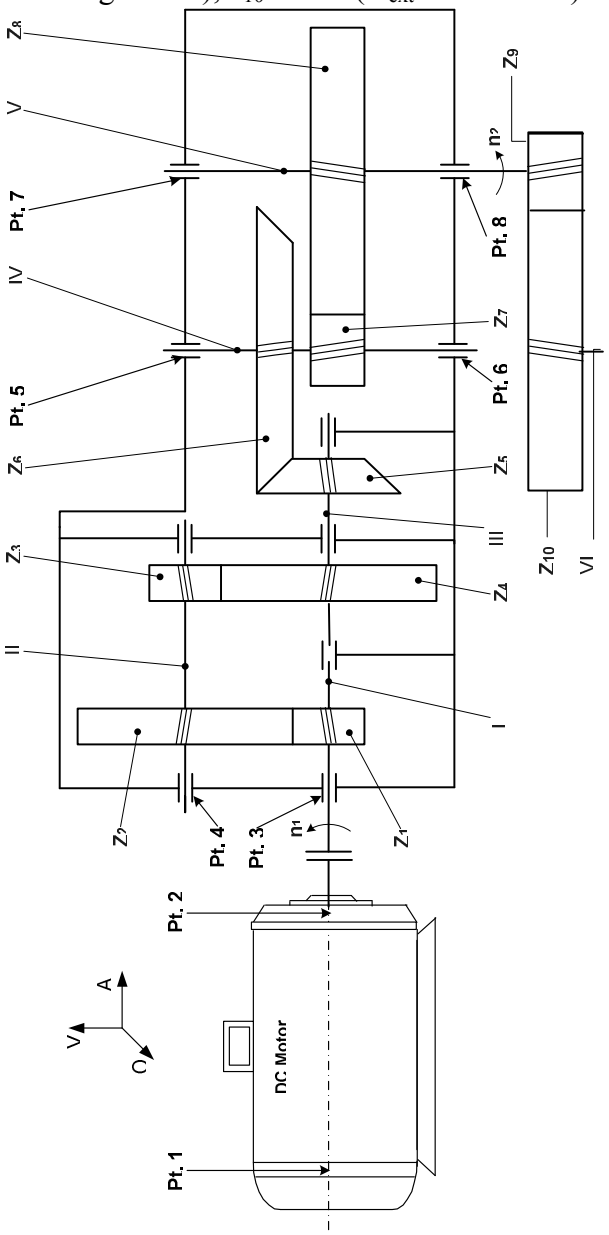


Fig. 4. DC motor and the gearbox

In figure 4 there are used the following notation: PT.1 - PT.8 - points of vibration measuring; V, O, A - the direction of measurement: V-vertically, O-horizontally, A-axial.

In figure 5 is presented the current electrical acting scheme.

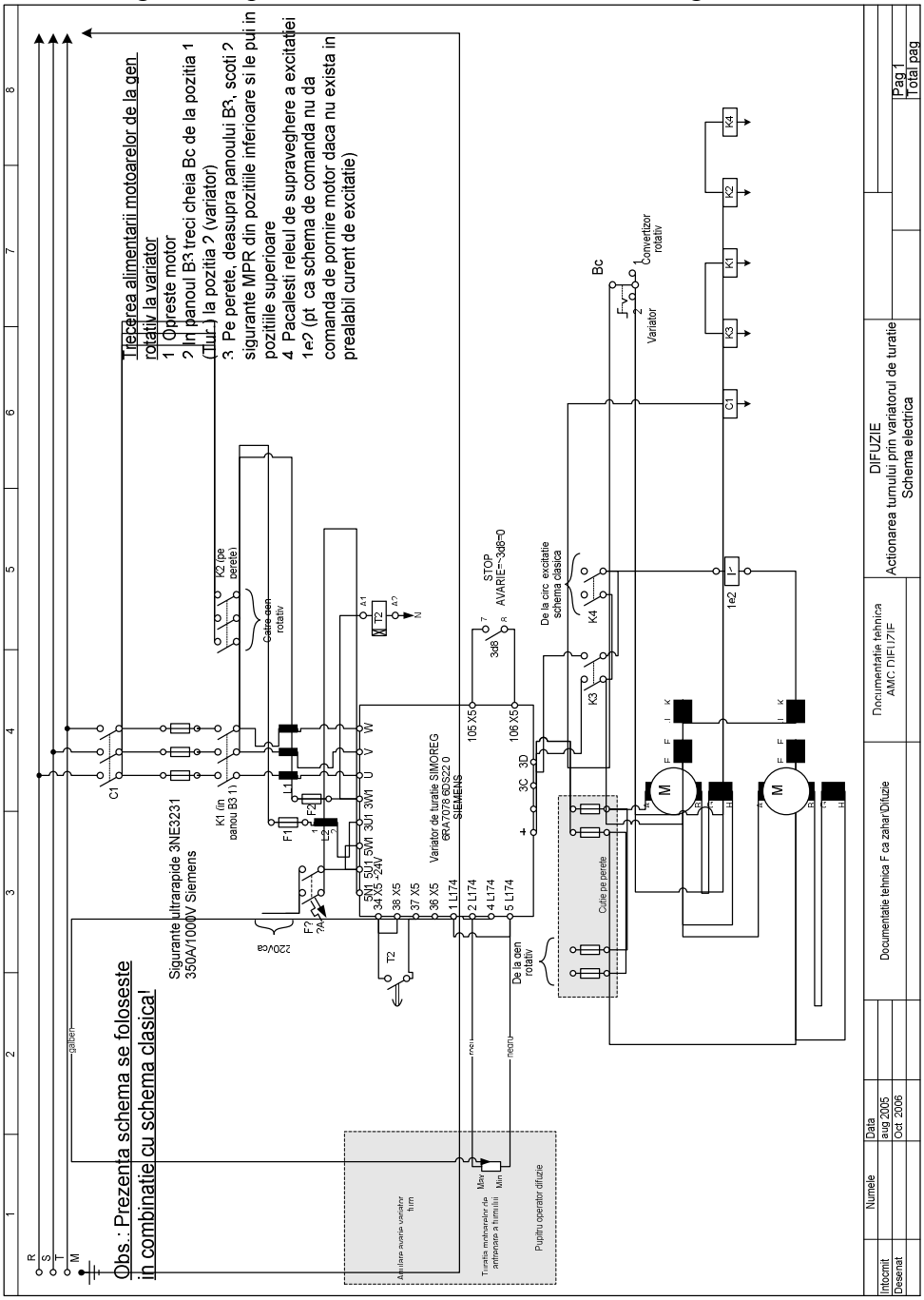


Fig. 5. Current electrical scheme

DC motors are HINZ type GS 315 Mb-41 (P = 75 kw, I_{max} = 245 A, n_{max} = 500 rot/min, U = 120 - 380 V c.c.), connected in series and supplied by Siemens DC converter Simoreg type 6RA7078-6DS22-0.

Measurements of vibrations were made with mobile device Impaq produced by Benstone Instruments Inc. USA, and thermal images with an infrared camera Flir i50 produced by Flir Systems USA.

RESULTS AND DISCUSSION

After the measurements of temperature and vibration there were prepared two measuring reports according with standard ISO 10816/3-2009, which are listed in table 1 and table 2. The result of measurements confirmed that the method of driving the tower is not the optimum for one of the groups (who actually played the role of master), being in the minimum level of functioning.

Table 1

Bulletin to measure the overall level of vibration no 1

1. Effective values measured. Measurements of vibrations were made with the machine loaded. The parameters of measurement are speed and movement of vibration in the field of frequency 10-1000 Hz, 2-1000 Hz.							
Points of measuring		Direction of measurement					
		Vertical		Horizontal		Axial	
		[mm/s]	[µm]	[mm/s]	[µm]	[mm/s]	[µm]
Pt. 1		1	15	1,2	13	1,4	5
Pt. 2		1,6	23	1,3	26	-	-
Pt. 3		0,5	6	0,6	9	0,5	11
Pt. 4		0,4	7	0,6	11	0,4	10
Pt. 5		0,2	4	0,4	11	0,4	7
Pt. 6		0,2	5	0,4	8	-	-
Pt. 7		0,2	6	0,3	9	0,3	9
Pt. 8		0,3	9	0,3	9	0,2	6
2. Grade operating under ISO 10816/3-2009							
Machine type		Average machine 15<P<300 [kW]				Average machine 15<P<300 [kW]	
Foundation		Rigid				Rigid	
Measurement Unit		[mm/s]				[µm]	
Grade operating	Good	<1.4				<22	
	Utilizable	1.4 – 2.8				22-45	
	Placed under surveillance	2.8 – 4.5				45-71	
	Forbidden	>4.5				>71	
3. The technical state of the equipment							
Machine type	P [kW]	n [rpm]		U [V]		Grade operating	
Parallel acting mechanism	75	400		380		Good	
4. Diagnosis of vibration							
Grade functioning of the group is: usable. Operation of bearings is good.							

Radial deviation is not allowed to exceed 0.11 mm, and the angular deviation is not to allowed to exceed 0.13 under recommendations of Hamer USA and Pruftechnik Germany.

Table 2

Bulletin to measure the overall level of vibration no 2

1. Effective values measured. Measurements of vibrations were made with the machine loaded. The parameters of measurement are speed and movement of vibration in the field of frequency 10-1000 Hz, 2-1000 Hz.							
Points of measuring		Direction of measurement					
		Vertical		Horizontal		Axial	
		[mm/s]	[µm]	[mm/s]	[µm]	[mm/s]	[µm]
Pt. 1		3.2	48	0.9	15	1.4	5
Pt. 2		1.6	27	1.8	40	2.1	33
Pt. 3		0.5	9	0.6	13	0.7	12
Pt. 4		0.5	12	0.6	10	0.6	12
Pt. 5		0.3	6	0.5	11	0.4	13
Pt. 6		0.3	8	0.4	6	-	-
Pt. 7		0.2	4	0.4	8	0.3	12
Pt. 8		0.4	6	0.3	8	0.4	6
2. Grade operating under ISO 10816/3-2009							
Machine type		Average machine 15<P<300 [kW]				Average machine 15<P<300 [kW]	
Foundation		Rigid				Rigid	
Measurement Unit		[mm/s]				[µm]	
Grade operating	Good	<1.4				<22	
	Utilizable	1.4 – 2.8				22-45	
	Placed under surveillance	2.8 – 4.5				45-71	
	forbidden	>4.5				>71	
3. The technical state of the equipment							
Machine type	P [kW]	n [rpm]		U [V]		Grade operating	
Parallel acting mechanism	75	400		380		Good	
4. Diagnosis of vibration							
Grade functioning of the group is: admitted under supervision. Operation of bearings is good.							

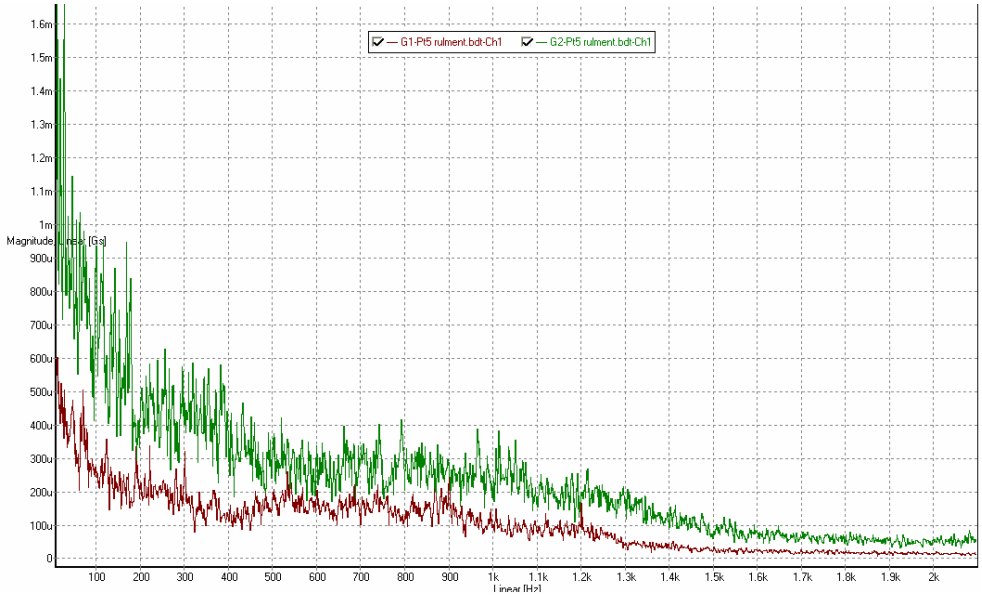


Fig. 6. Spectrum comparison for point 5

In figure 6 are presented for comparison, the spectrum at the point 5 from both groups.

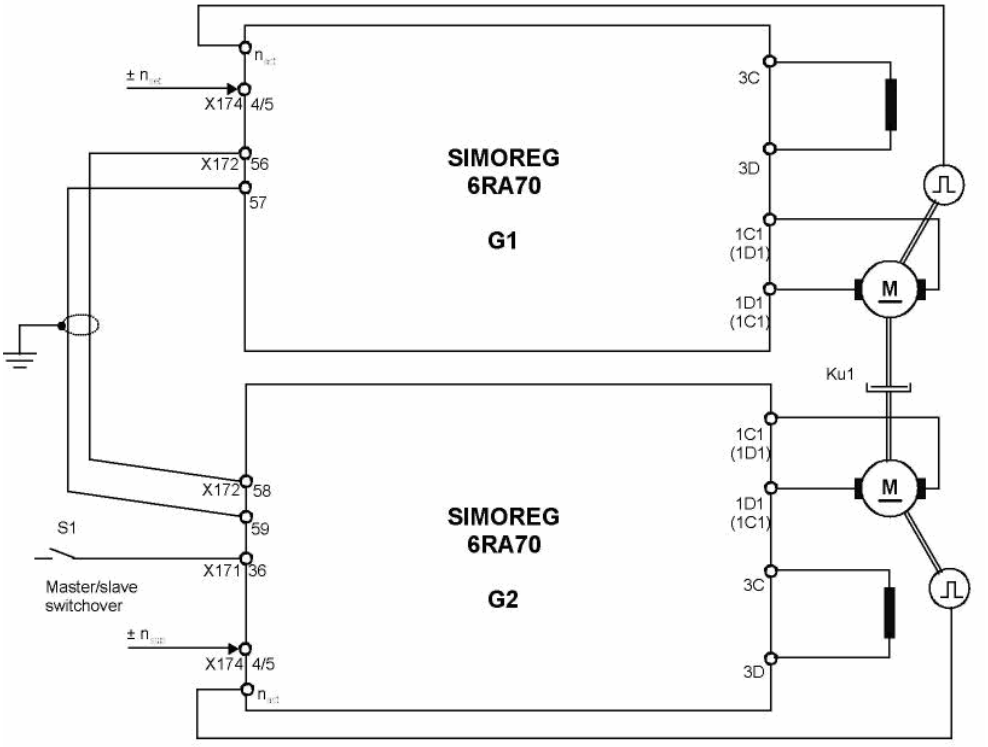
The main problems are as follows:

- stopping machinery lead to big financial losses,
- equipment is not at today technology,
- maintenance operations do not improve the operation in long term,
- it is not possible to cut the maintenance costs.

The only possibility is to upgrade the mechanism with new technology.

The cheapest solution, shown in figure 7, it is the of one more Siemens Simoreg DC converter to ensure the synchronization of the two engines in regime master slave.

The ideal solution is replacement of DC motors and converter with AC motors and AC converter.



Ku1 Mechanical coupling
S1 Contact closed if Ku1 closed
$\pm n_{set}$....Speed setpoint
$\pm n_{sup}$....Supplementary speed setpoint

Fig. 7. Recommended electrical scheme

CONCLUSIONS

Because investments in new machines are pretty small in Romania, it is a major consideration in the operations of maintenance to upgrading machinery and equipment. An investment that is recommended, are pays off in two years of operation, leading to reduction the costs and risks of accidental failure.

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