THE INTERNATIONAL CONFERENCE OF THE CARPATHIAN EURO-REGION SPECIALISTS IN INDUSTRIAL SYSTEMS
6th edition

RESEARCH ON THE EFFECTS OF ELECTRICAL DISCHARGES THROUGH ROLLER BEARINGS
PART II - EXPERIMENTAL TESTS RESULTS

Ionut Nacu[1], Alecsandru Simion[1], Cristina Racocea[2], Cezar Racocea[2]
Technical University "Gh. Asachi" of Iassy
[1]Department of Electrical Machines [2] Department of Mechanical Engineering

Abstract:
The present study examines the effects of electrical discharges into the rolling paths and the bearing rolling bodies. The number, the size and the shape of the craters, generated by the electrical discharges, have been microscopically analyzed in different lubrication conditions, while varying the power and the amperage of the discharging electrical current.

This study is essential as a very large part of the electrical rotative machines are withdrawn from usage due to the damage of their bearing components. Very frequently, the above issues are worsening by the power peaks which are a consequence of the function of electronic converters commanded through impulses. These effects are similar with the electrical discharges through bearings. Knowing the causes and to analyzing the effects through laboratory trials lead to very useful information's regarding the decrease or even eradication of these effects.

Key words: *Rolling bearings, electrical current, electrical discharges*

1. EXPERIMENTAL DATA

The tests used roller bearings, type 6206 - 2RSR currently manufactured by KOYO ROMANIA S.A., in Alexandria. The rig was driven by an asynchronous triphase electric motor having the power of 2.2 Kw and a nominal revolution of n= 1425 rev/min., at a frequency of f=50Hz, supplied by means of an ABB ACS 201-4P1-3, which ensures a variable frequency within the range f=0…..500Hz.

This kind of driving ensures a constant and accurate revolution, which will be displayed on the converter's screen, in 0-3000 rev/min. interval. At the same time, this revolution was also checked by an optoelectronic revolution counter.

The tests were carried out both on lubricated and unlubricated bearings. The types of lubricants used, as well as their resistivities are shown in Table 1.

.

Table 1 The types of lubricants

Types of lubricant	**Resistivities**
Beacon 325	9.49E+10 [ohm·mm]
Chevron SRI2	5.18E+12 [ohm·mm]

Mention should be made that the tests were carried out at two voltage levels: 200 [V], and 400 [V], respectively, with 10 shocks being applied on each pair of bearings.

The connecting diagram used in generating the shock to be discharged on the two bearings is presented in fig.3.

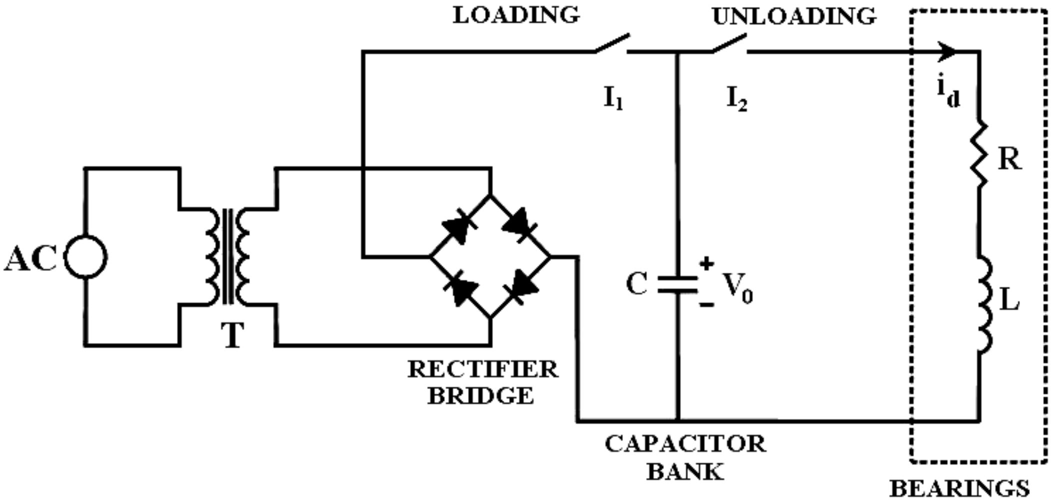


Fig.3 Circuit diagram to create the impulses

As can be seen, the shock is discharged on the bearings by means of the switch I_2, after loading the capacitors battery C from the transformer T by the rectifier bridge, through the switch I_1. We should mention that the two switches are never simultaneously in the “ON” position.

The amplitude was determined by measuring the voltage drop on a copper wire having a section of 19.24 [mm^2] and a length of 0.7 [m].

Table 2 shows the values of the discharge currents obtained consequent to the three types of tests at both levels of voltage.

Table 2 The values of the discharge currents

	200[V]				**400[V]**		
Number test	Beacon 325	Chevron SRI2	Without lubricant		Beacon 325	Chevron SRI2	Without lubricant
	Imax [A]				Imax [A]		
1	2256,928	2141,435	2208,806		3859,395	3907,517	4749,654
2	2136,622	2083,688	2155,871		x	3921,953	4783,339
3	2155,871	2102,937	2213,618		3873,831	3878,643	4783,339
4	**2280,989**	2025,942	2189,557		x	**4191,437**	4754,466
5	2122,186	2151,059	**2218,43**		3849,77	3931,578	4619,724
6	2189,557	**2242,491**	2136,622		3758,338	4071,132	4759,278
7	2141,435	2151,059	2194,369		3724,653	3830,521	**5023,95**
8	2179,932	2194,369	2208,806		**4023,01**	3965,263	4740,03
9	2146,247	2117,374	2184,745		3902,705	4032,634	4682,283
10	2151,059	2093,313	2189,557		4008,573	3897,892	4788,152
Average	**2176,0826**	**2130,3667**	**2190,0381**		**3875,03438**	**3962,857**	**4768,4215**

It can be seen that in all types of tests the highest value of the current is recorded after the third shock.

In order of succession are presented several images seen at the microscope, during the analysis of the bearings components under load (in some photos we have used processed variants for a better visualizations of the deterioration produced).

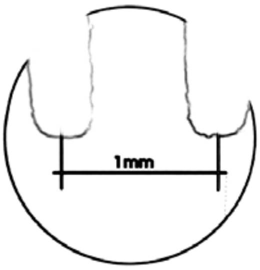
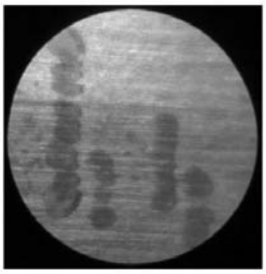


Photo 1 Microscope scale



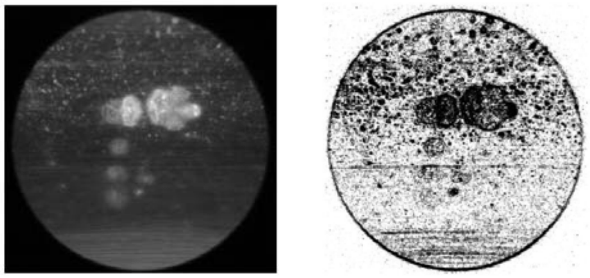
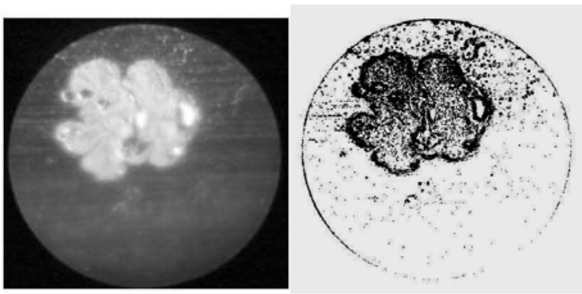


Photo 2 Beacon 325, 200[V] inner ring -

Photo 3 Beacon 325, 200[V], outer ring



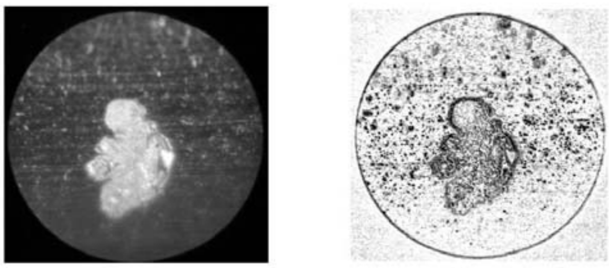
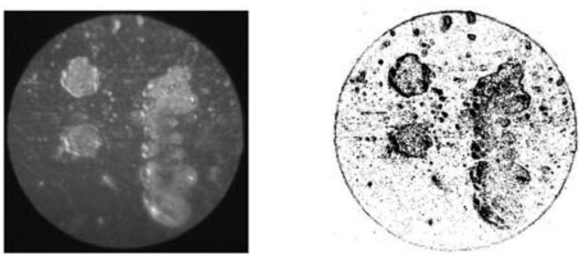


Photo 4 Chevron SRI2, 200[V], outer ring

Photo 5 Chevron SRI2, 200[V], inner ring



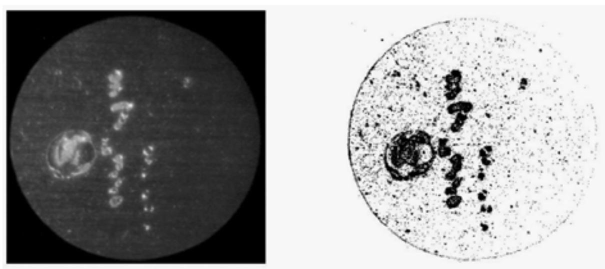


Photo 6 Without lubricant, 400[V], outer ring

Photo 7 Without lubricant, 400[V], inner ring

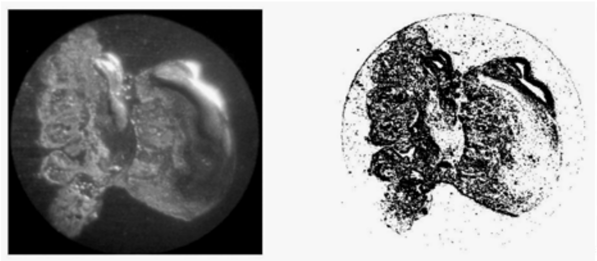


Photo 8
Chevron SRI2, 400[V], inner ring

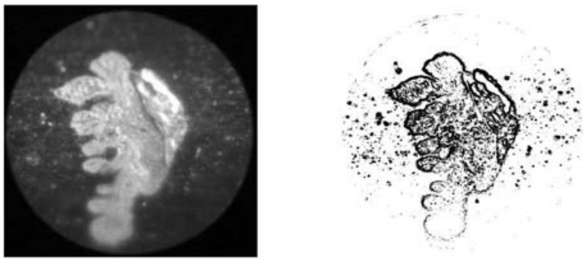


Photo 9
Chevron SRI2, 400[V], outer ring

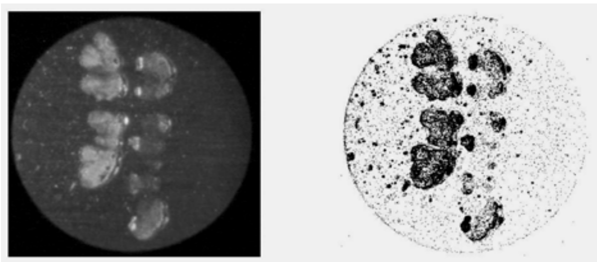


Photo 10
Beacon 325, 400[V], inner ring

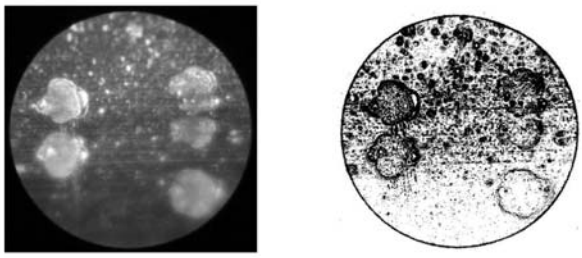


Photo 11
Beacon 325, 400[V], outer ring

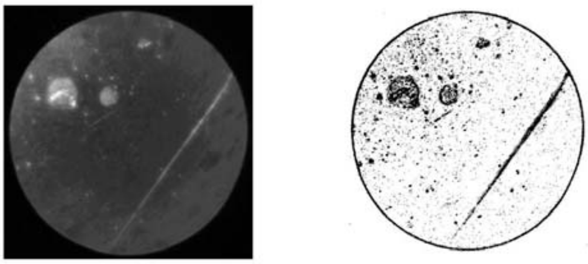


Photo 12 without lubricant. 400[V]

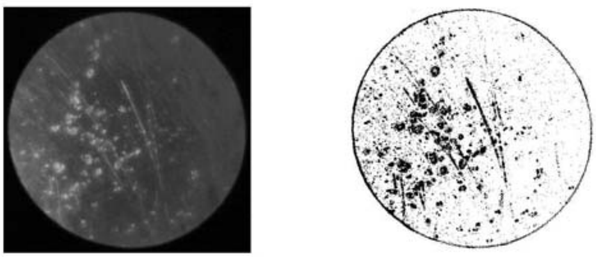


Photo 13 Without lubricant., 400[V]

Ball bearings

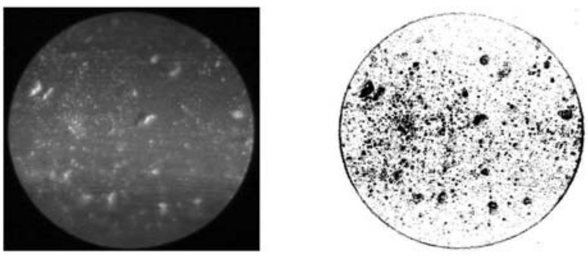


Photo 14 Without lubricant, 400[V], outer ring

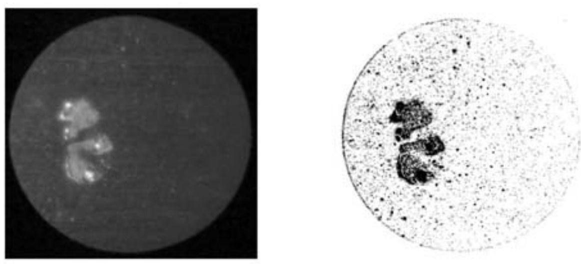


Photo 15 Without lubricant, 400[V], inner ring

2. EXPERIMENTAL TESTS

The microscopic study has led to the results shown in tables 3 and 4.

Table 3

200[V]						
Number craters	Beacon 325		Chevron SRI2		Without lubricant	
	Inner ring	Outer ring	Inner ring	Outer ring	Inner ring	Outer ring
1	6	26	9	10	11	17
2	4	7	-	-	8	8
3	9	3	-	-	8	7
4	10	2	-	-	5	4
5	3	-	-	-	4	2
6	3	3	-	-	8	-
7	1	1	-	-	2	-
8	-	-	-	-	2	-
9	-	-	-	-	-	-
10	1	-	-	-	2	-
13	-	-	-	-		-
14	-	-	-	-	1	-
Number discharges	**37**	**42**	**9**	**10**	**51**	**38**

Table 4

400[V]						
Number craters	Beacon 325		Chevron SRI2		Without lubricant	
	Inner ring	Outer ring	Inner ring	Outer ring	Inner ring	Outer ring
1	9	15	20	21	15	8
2	8	18	6	2	7	9
3	4	9	2	3	5	9
4	13	-	1	-	3	3
5	3	-	-	-	7	3
6	2	-	-	-	6	1
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	1	-
10	-	-	-	-	-	1
13	-	-	-	-	1	-
14	-	-	-	-	1	-
Number discharges	**39**	**42**	**29**	**26**	**46**	**34**

3. **REFERENCES**

1. **Chao B., Dezheng W., Quan J., Zhejie L**., Automatic Learning Control for Unbalance Compensation in Active Magnetic Bearings, IEEE TRANSACTIONS ON ON MAGNETICS, VOL. 41, NO. 7, PAG. 2270-2279, JULY 2005;
2. **Chul K. L., Byung I. K**., Design of Post-Assembly Magnetization System of Line Start Permanent-Magnet Motors Using FEM, IEEE TRANSACTIONS ON ON MAGNETICS, VOL. 41, NO. 5, PAG. 1928-1931, MAY 2005;
3. **Khoo W. K. S.,** Bridge Configured Winding for Polyphaze Self-bearing Machines, IEEE TRANSACTIONS ON ON MAGNETICS, VOL. 41, NO. 4, PAG. 1289-1295, APRIL 2005;
4. **Nacu I, Racocea C.C., Racocea C.R., Hostiuc L**, Study of Phenomena Generated by the Passing of Electric Current Through Ball Bearings. Preliminary Tests on the Test Rig With Two electrical Serially Connected Rolling Bearings , Buletinul Institutului Politehnic Iaşi, Tom L(LIV), Fasc.6A, Secția: Construcții de Maşini, 2004;
5. **Racocea C.C., Racocea C.R., Hostiuc L., Nacu I**., Test Rig for Study of Phenomena Generated by the Passing of Electric Current Two Electrical Serially Conected Rolling Bearings, The First Internationel Conference „Advanced Concepts in Mechanical Enginnering" Iassy, 8-10 july 2004.
6. **Racocea C**., Influența câmpului electric şi magnetic variabil asupra fiabilității rulmenților maşinilor electrice, Teză de doctorat, Universitatea Tehnică Iaşi 2003.