



## THE EFFECTS OF THE WRONG LUBRICATION METHOD OF THE GEAR TRAIN

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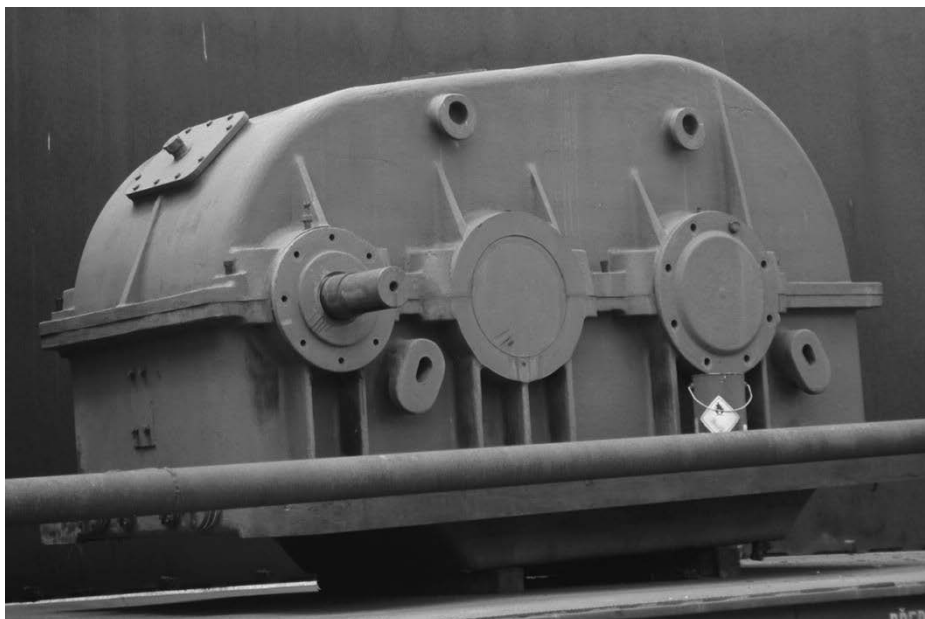
### Abstract

*In the article it is presented the remanufactured gearbox of the ball mill drive in the cement works. The first stage of the gearbox gear trains is wrong lubricated in operation. And the consequences of this error in lubricating are shown and analyzed in the article.*

**Key words:** lubrication, gear train, pitting, bearing.

### INTRODUCTION

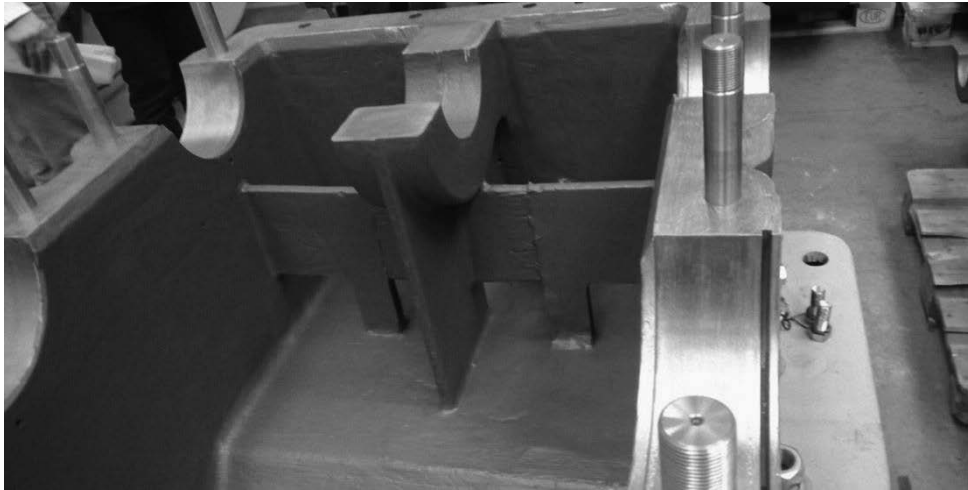
In the framework of the raw material mill exchange in the cement plant was purchased the remanufactured gearbox TS with output of 800 [kW] and rated gear ratio of 6.3. It was the older gearbox, widely deployed in the Czechoslovak industry in the 1970s and 1980s. Repairs to the gearbox included replacement of shafts, covers, bearings, seals, new gear and bearing lubrication, and more. The gearbox in question is shown in Fig. 1.



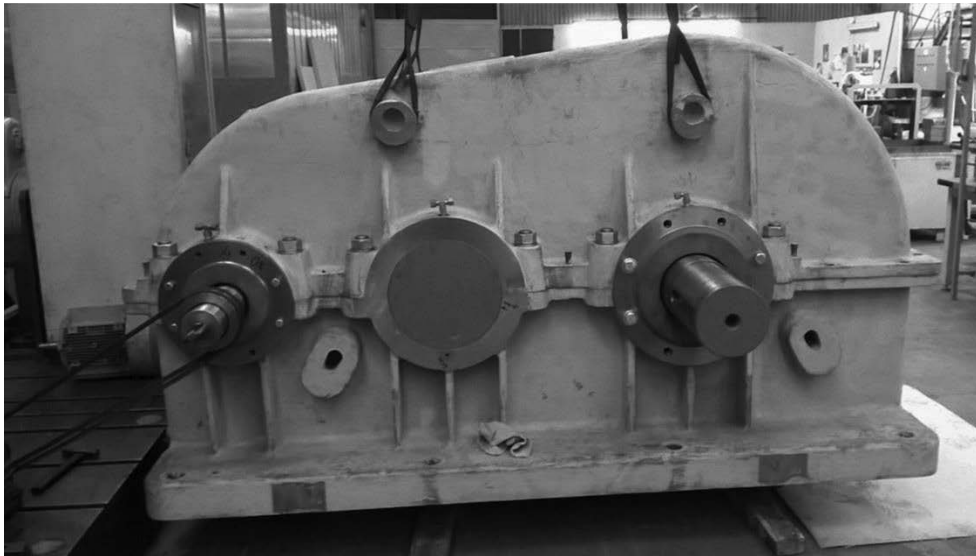
**Fig. 1** Gearbox TS before repassing

### MATERIALS AND METHODS

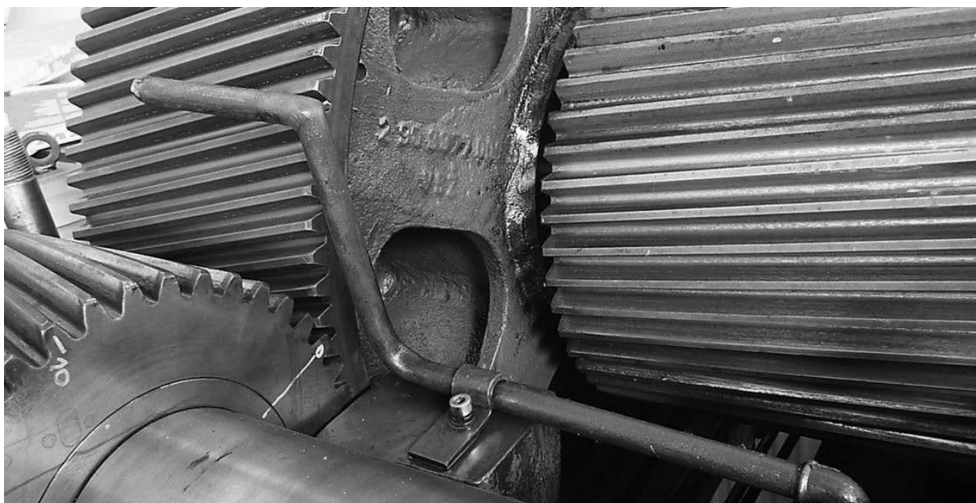
The gearbox repairs concerned the complete disassembly, pressing out shafts, removing rust from all parts, the repair of the shafts and the lids, the complete replacement of the bearings, the seals and the fasteners, machining dividing plane, machining bearing seats in the gearbox, design a new way of the lubrication of the first stage of the gear trains - circulation-system (the second stage of the gear trains is oil-bath lubricated), the restoration of the interior and exterior coats of the case body, coating and conservation, the complete assembly and testing (pressure test and run), as shown in the Fig. 2,3,4.



**Fig. 2** Gearbox after repassing



**Fig. 3** Gearbox testing

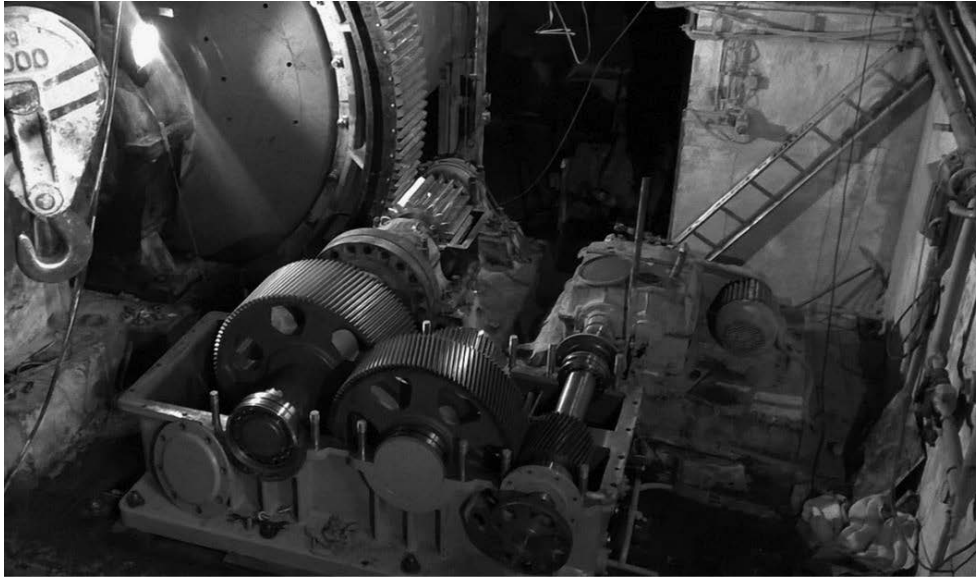


**Fig. 4** Forced lubrication of the first stage of the gear trains



## RESULTS AND DISCUSSION

Installation of the gearbox into the ball mill drive in cement works is shown in the Fig. 5. The gearbox was operated in the opposite direction of rotation. The lubricant was pushed out of the first stage of the gear trains and sprayed on the viewing window as shown in the Fig. 6 and Fig. 7



**Fig. 5** Installation of the gearbox



**Fig. 6** Splash lubrication with the opposite direction of rotation



**Fig. 7** Viewing window sprayed with the grease



Due to the wrong lubrication of the gear, a pitting gear was formed, which caused considerable vibration. During operation, the gear unit in question was monitored and diagnosed each month. Diagnostic measured data of the vibrations and bearing condition are presented in Tab. 1,2,3.



**Fig. 8** Pitting gear

**Tab. 1** Envelope Vibration Acceleration ENV [gE], 500-10 kHz filter

Measurement number	ENV3	ENV4	ENV5	ENV6
1	14,95	13,1	4,94	4,93
2	15,82	10,17	10,91	6,59
3	<b>20,83</b>	14,28	12,56	7,83
4	<b>20,82</b>	14,13	8,74	5,64
5	<b>24,14</b>	17,75	11,34	10,22
6	<b>26,66</b>	13,04	13,63	7,63
7	<b>26,05</b>	18,02	13,59	10,72
8	<b>43,21</b>	<b>30,62</b>	19,71	13,79
9	<b>60,35</b>	<b>42,28</b>	<b>28,54</b>	18,81

**Tab. 2** Effective value of vibration speeds in axial direction [mm/s]

M.n.	Prv3A	Prv4A	Prv5A	Prv6A	Prv7A	Prv8A
1	3,41	3,64	4,20	4,13	4,12	4,29
2	4,47	4,44	7,93	5,59	5,84	4,58
3	6,31	4,26	8,89	7,72	9,42	7,24
4	5,69	4,70	9,94	9,54	12,64	8,30
5	6,62	4,83	10,16	7,32	11,33	8,91
6	7,91	6,43	11,43	8,74	8,74	9,69
7	7,34	5,94	10,65	9,46	9,21	6,95
8	7,30	7,40	9,61	8,97	11,75	8,92



**Tab. 3** Effective value of vibration speeds in vertical direction [mm/s]

M.n.	Prv3V	Prv4V	Prv5V	Prv6V	Prv7V	Prv8V
1	4,99	4,30	4,13	3,24	3,77	4,29
2	5,49	4,82	8,37	3,50	3,86	4,67
3	6,25	5,33	5,82	5,90	4,81	4,86
4	6,73	5,63	6,55	6,25	4,78	5,46
5	7,21	5,55	8,03	7,59	4,19	4,99
6	9,07	7,29	9,64	7,21	4,63	5,65
7	10,50	7,83	9,76	7,53	7,05	7,65
8	10,69	9,44	10,11	8,03	7,10	6,67

## CONCLUSIONS

Measured data shows the progress of bearing damage and transmission. The condition of bearings and gearboxes was rated according to ČSN ISO 10816-1. The evaluations are summarized in the Tab. 4,5.

**Tab. 4** Classification of bearing conditions according to ČSN ISO 10816-1

Measurement number	Bearing condition
1	acceptable
2	acceptable
3	unacceptable
4	unacceptable
5	unacceptable
6	unacceptable
7	unacceptable
8	unacceptable
9	unacceptable

**Tab. 5** Classification of gearbox vibration conditions according to ČSN ISO 10816-1

Measurement number	Gearbox vibration condition
1	satisfactory
2	satisfactory
3	satisfactory
4	unacceptable
5	unacceptable
6	unacceptable
7	unacceptable
8	unacceptable

Damaged input shaft bearing on the engine side is shown in Fig. 9



**Fig. 6** Damaged input shaft bearing on the engine side

The wrong way of lubricating the gears damage not only gearing itself but also bearings, shafts, seals. Practically it destroy the entire transmission.

#### **ACKNOWLEDGMENT**

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