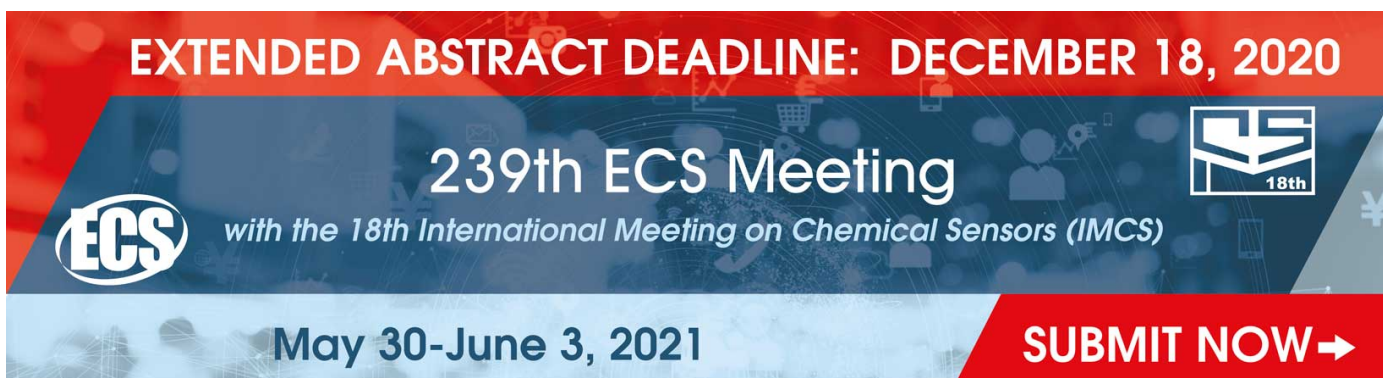


PAPER • OPEN ACCESS

Experimental investigation of conveyor idlers operational characteristics

To cite this article: R M Mitrovic *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **659** 012067

View the [article online](#) for updates and enhancements.



EXTENDED ABSTRACT DEADLINE: DECEMBER 18, 2020

239th ECS Meeting
with the 18th International Meeting on Chemical Sensors (IMCS)

May 30-June 3, 2021

SUBMIT NOW →

The banner features a red top section with white text, a blue middle section with white and red text, and a red bottom right corner with white text. It includes the ECS logo, a stylized 'ECS' logo with '18th' below it, and a background of faint icons related to science and technology.

Experimental investigation of conveyor idlers operational characteristics

R M Mitrović¹, Ž Z Mišković¹, Z V Stamenić¹, N D Soldat¹, N S Matic¹, M R Ristivojević¹ and A R Dimić¹

¹ University of Belgrade, Faculty of Mechanical Engineering, Kraljice Marije 16, 11120 Belgrade, Serbia

E-mail: zmiskovic@mas.bg.ac.rs

Abstract. The efficiency of thermal power plants significantly depends on the efficiency of belt conveyor systems. Conveyor idlers, as key parts of belt conveyors, are often the main cause of bulk material transportation systems failures. Testing the operational characteristics of conveyor idlers in laboratory and exploitation conditions is a prerequisite for any progress in the field of increasing energy efficiency of conveyor systems. This paper describes an analysis and discussion of testing results for different types of conveyor idlers, in terms of their performances under the act of predefined radial load. Tests were conducted on a new conveyor idler's testing machine developed at the University of Belgrade - Faculty of Mechanical Engineering. The presented tests are performed in order to determine the quality of carrying and return conveyor idlers. The obtained results will help in solving the key problems in the critical areas of conveyor systems and will increase their energy efficiency. Finally, the expected results can potentially reduce the financial and energy losses which conveyor idlers cause in belt conveyor systems, as well as in the whole system of thermal power plants.

1. Introduction

Due to increasing global energy crisis and lack of natural resources, increasing the reliability and energy efficiency of mechanical systems in energetics is constantly in the focus of scientific research. Energy efficiency is one of the key elements in energy policy today, because it contributes to the improvement of economy globally and extends the lifetime of conventional energy sources, since the greatest part of total electrical energy is generated by fossil fuels, [1, 2]. Despite the increasing percentage of utilization of alternative energy sources, mostly still use the energy of fossil fuels, especially coal. Today's coal mining on open pit mine requires use of complex machinery with high productivity which allows continuous process of exploitation without unexpected malfunction with unplanned costs. For this reason, the tendency for daily analysis of existing and development of new, improved constructions of conveyor idlers is growing. An indicator of the actuality of the problem in our country is the fact that open pit mine in Kostolac has about 100,000 conveyor idlers in operation of which 10% need to be repaired or replaced. Existing level of quality production of conveyor idlers made by domestic manufactures don't satisfy the requirements of working conditions on open pit mine. Conveyor idlers made by reputable worldwide manufacturers have up to three times longer service life than domestic. Development of domestic industry, keeping of existing or creation the new jobs requires new approach to the design and manufacturing of conveyor idlers [2, 3]. A prerequisite for progress in field of improving energy efficiency of technical systems is introducing the testing of behaviour of conveyor idlers in laboratory and exploitation conditions.



Exploitation tests take a very long time and it can't be fast enough to provide information helped user to decide which of the offered product should use in transport system. Therefore, special attention is paid to the development of laboratory methods and test rigs for accelerated testing of conveyor idler quality. The subject of this paper is analysis and discussion of testing results for different types of new and repaired conveyor idlers, in terms of their performances under the act of radial load.

2. Testing of conveyor idlers operational characteristics

Because of the large influence of conveyor idlers on the performance of the overall belt conveyor system, there are many national standards dealing with this issues [4]. For the purpose of the quality and reliability inspection of conveyor idlers which are produced in our country, a methodology for accelerated testing and comparison of conveyor idlers performance under the action of the radial load of constant intensity was developed. This methodology was used to provide estimation for qualitative comparison between different types of conveyor idlers – new and repaired, domestic and imported, conveyor idlers with different greases applied etc. [5, 6]. According to this methodology, the basic parameters for determining the transport idlers quality are:

- Temperatures in idler's rolling bearings,
- Deceleration during rotation stopping,
- Reaction on rotation movement,
- Vibrations of idler's rolling bearings,
- Noise.

The analysis of existing constructions of conveyor idlers produced by the company PRIM - Kostolac is performed in order to obtain a full assessment of their quality. Beside results and appropriate conclusions of holding analysis, conveyor idlers' operation should be monitored in exploitation on the surface pit mine or through specific tests under laboratory conditions if more complete objectivity in assessment of the quality of existing and new conveyor idlers solutions is necessary.

3. Conveyor idler's testing machine and methodology

The procedure for determination of load capacity of conveyor idlers have been realized on a test rig SIV 300, which was developed in cooperation with thermal power plant and pit mines Kostolac. Its basic look and operation principle are shown in Figure 1. Laboratory installation is designed for comparative testing of conveyor idlers (quality assessment), and for measuring changes of their operational characteristics over time (temperatures and vibrations). All tests have been performed under the action of radial load of different intensity. Two pneumatic cylinders are used for radial force generation. They are controlled by system for data acquisition specifically developed for this purpose [7]. Therefore, a load distribution which is in accordance with exploitative one could be simulated by changing of pneumatic pressure. During the testing the idler shell is deformed because of its thin walls, so the loading value should be carefully selected. It is possible to test a large spectrum of conveyor idlers dimensions, with a diameter up to 200 mm and lengths up to 1000 mm. During accelerated tests, the data acquisition of micro-vibrations, temperatures and noise of rolling bearing of tested samples are performed – and results of analysis of obtained results are presented and discussed in the next section of this paper. Based on the result of experimental tests of conveyor idlers it is possible to estimate their service life in different load conditions. Due to time constraints, these tests are carried out with increased intensities of radial load. After the testing and processing of test results in one of the common software packages, it is possible to determine:

- sensitivity of specific types of conveyor idlers to radial loads,
- sensitivity of conveyor idlers from different manufacturers to radial loads,
- influence of different greases to conveyor idlers' service life,
- correlation between measured operational characteristics of conveyor idlers,
- temperature change in conveyor idlers during the examination.

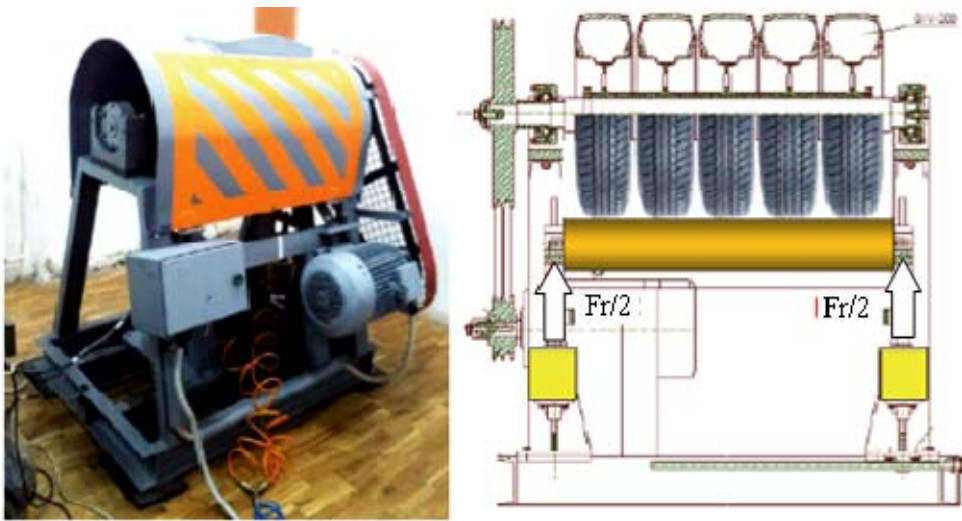


Figure 1. Test frame for performance testing of conveyor idlers under the action of radial load of constant intensity.

4. Test samples and experimental setup

The conveyor idler test samples are provided by thermal power plant and pit mines Kostolac. The type of conveyor idlers with outer diameter of 159 mm and labyrinth seal are the most widely used on open pit mines systems, both in our country and abroad. Delivered test samples of different types of conveyor idlers are given in table 1.

Table 1. Conveyor idlers test samples.

Type of conveyor idler	Dimensions	Designation
Carrying idler	Ø159x670	NVPM
Carrying idler	Ø194x750	DVPM
Return idler	Ø215x1150	PV

All delivered test samples were produced by company PRIM Kostolac, except return idlers of type Ø215x1150 mm, which are manufactured by company ANSAL STEEL with rubber coating (cover) in the shape of concentric rings, non-uniformly distributed along idlers' length.

Experimental conditions for conveyor idlers testing were:

- Carrying idler Ø159x670 mm, radial load: ~9 kN, rotational speed: ~1116 RPM – testing acceleration: ~21,2 times;
- Carrying idler Ø194x750 mm, radial load: ~9 kN, rotational speed: ~905 RPM – testing acceleration: ~18 times;
- Return idlers Ø215x1150 mm, radial loading: ~2 kN, rotational speed: ~824 RPM

Evident signs of corrosion in all carrying idlers were observed by visual analysis during the preparation of test samples. This is a result of inadequate storage conditions, and has influence to accuracy of measurements of radial run-out.

5. Results review and discussion

During the conveyor idlers experimental testing, all listed operational characteristics were recorded in time domain – using specific data acquisition system. The examples of obtained diagrams are presented at Figure 2.

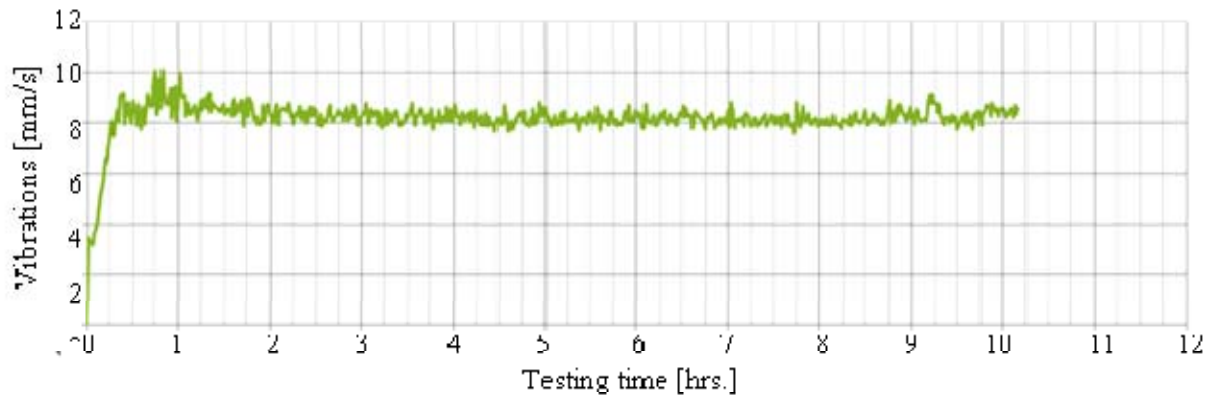


Figure 2. Example of obtained results (time domain diagram) for experimental testing of conveyor idlers vibrations – test sample NVPM3.

The processed results of experimental testing of carrying and return idlers operational characteristics in described loading conditions after 5 and 10 hrs. of testing (respectfully) are shown in table 2 and table 3.

Table 2. Results of accelerated experimental testing of carrying conveyor idlers.

Sample	The cumulative testing time [h]	V [m/s]	T1 [°C]	T2 [°C]	Noise level [dB]
NVPM1	5	3.571	52.538	54.736	4.404
	10	8.359	47.654	54.464	85.133
NVPM2	10	7.930	63.693	54.769	87.194
NVPM3	10	8.486	68.787	55.442	87.795
DVPM1	10	6.396	52.039	54.920	79.185
DVPM2	10	5.772	63.694	55.900	82.071
DVPM3	10	5.628	65.131	44.372	80.164

Table 3. Results of accelerated experimental testing of return conveyor idlers.

Sample	The cumulative testing time [h]	V [mm/s]	T1 [°C]	T2 [°C]	Noise level [dB]
PV1	10	3.079	54.076	48.834	69.656
PV2	10	2.823	62.260	50.771	73.755
PV3	10	4.585	57.900	44.958	70.273

Performance testing of conveyor idlers under the acting of radial load of constant intensity gave the following results:

- All tested conveyor idlers (carrying and return idlers) operate without failure after 10 hours of the accelerated test conditions, so it could be conclude that prescribed manufacturing technology was respected during conveyor idlers production,

- During the tests, the observed parameters of all tested conveyor idlers had approximately the same trends, representing a high level of uniformity of their production quality,
- The measurement variables of all tested conveyor idlers (carrying and return idlers) entered to the stationary state after 3-4 hours of accelerated tests,
- For all samples of tested conveyor idlers, it is observed that there is a significant difference between temperature measured at places of the first bearing and the second bearing (for each sample individually), and this applies for the measured macro-vibrations. This can be explained by manufacturing conditions, as the first and second ball bearings do not assembled in the same way,
- The results analysis leads to the conclusion that in initial stage of failure the macro vibration or noise levels does not come to change, but only the temperature of bearing registered changes. Bearing temperature of conveyor idlers was in the range of 40 to 70 °C after 10 hours of testing.
- Allowed vibration value (10 mm/s) of carrying idlers type Ø159 / 670 mm is exceeded only in the sample NVPM2 - after 8.5 hours of testing,
- Allowed noise value (85 dB) is exceeded in all samples of idlers bearing type Ø159 / 670 mm for ~4 dB, which fits into measurement uncertainty of test device (± 5 dB) - it can be concluded that noise of tested samples is at the permissible value limits,
- Allowed noise value (85 dB) during test of carrying idlers type Ø194 / 750 mm is not exceeded in any of the sample,
- Allowed vibration value (10 mm/s) during test of return idlers is not exceeded in any of the sample - it was observed that vibration value has a significant amount of oscillates during test, which can be explained by significant radial run-out of tested samples,
- Allowed temperature value of bearing of return idlers samples (70°C) is exceeded only in the sample PV2 - after 3 hours of testing,
- Allowed noise value (85 dB) during test of return reverse idlers is not exceeded in any of the sample - as in the case of vibration measurements, it was observed that this value has a significant amount of oscillates during test, which can be explained by significant radial run-out of tested samples,

Results of comparative analysis of test results show the following:

- Repaired conveyor idlers made by domestic manufacturers have higher values of operating temperatures for 7°C, in comparison with new conveyor idlers,
- New conveyor idlers made by domestic manufacturers have higher values of operating temperatures for 5°C, in comparison with conveyor idlers made by foreign manufacturers.

6. Conclusion

Implemented tests provide important information about the quality level of a large number of different types of conveyor idlers commonly used in open pit coal mines serving the thermal power plant Kostolac. The described conveyor idler testing methodology and equipment were developed in order to achieve potential increasement of conveyor idlers service life and reliability, reducing unnecessary and unplanned failures of belt conveyors as a system. The information on specific conveyor idler operational characteristics will allow the improvement of the regular maintenance of the entire transportation system planning. Obtained results will also contribute to improvement of the quality as well as energy and financial loses reductions which are caused by conveyor idlers – both in belt conveyors and in the entire system of thermal power plants.

Acknowledgment

Results presented in this paper were realized within the Project TR35029 so authors would like to express their sincere gratitude to the Ministry of Education, Science and Technological Development of the Republic of Serbia, as well as to the company thermal power plant and pit mines Kostolac (Serbia).

References

- [1] Ristić L 2012 *Development of the algorithm for energy efficiency improvement of belt conveyor system on open pit mines*, University of Belgrade, Serbia, Doctoral Thesis.
- [2] Mišković Ž 2017 *Exploitational contamination particles concentration influence on rolling bearing's operational characteristics*, University of Belgrade, Serbia, Doctoral Thesis.
- [3] Mitrović R, Mišković Ž, Tasić M and Stamenić Z 2014 Conveyor idler's turning resistance testing methodology, *Machine design* **6**(4) 107-112
- [4] Frittella A and Cohen G 2008 *Conveyor idler standards*, Melco Mining
- [5] Mitrović R, Mišković Ž, Tasić M., Stamenić Z, Soldat N and Matić N 2012 *Conveyor idlers testing machine*, 29th Danubia-Adria-Symposium on Advances of Experimental Mechanics, Belgrade, Serbia, Sep. 26 – Sep. 29, pp. 278-281
- [6] Mitrović R, Tasić M, Ivanović G, Mišković Ž and Stamenić Z 2009 *Test frame for radially loaded conveyor idler accelerated testing*, Industrial prototype, Faculty of Mechanical engineering at the University of Belgrade and company 'Termoelektrane i kopovi Kostolac', Belgrade, Serbia
- [7] Mitrović R, Tasić M, Mišković Ž, Stamenić Z and Jovanović D 2013 *Data acquisition and automatisisation of a conveyor idler test stand*, Advanced Materials Research: Advances in Engineering Materials, Product and Systems Design (Special topic volume with invited peer reviewed papers only), Trans Tech Publications