VIBRATION ANALYSIS ON A CONVEYOR DRIVE UNIT IN CONVEYOR TRANSPORT SYSTEM FOR COAL

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Abstract: The subject of research in this paper is a conveyor drive unit from a conveyor coal transport system that is used by SM "Brod - Gneotino" to SM "Suvodol" (Power plant REK Bitola-Macedonia) because of its existing signs of increased vibrations. Vibration measurements of the drive transporter T5 was obtained to determine the vibration state of the drive unit. Each driveline (electric motor – hydro clutch - gear reducer) has ten measuring points - probes to monitor temperature and ten measuring points - probes for monitoring the vibration of the electric motor bearings and bearings of the gear reducer.

Through proper FFT analysis of the vibration signal that has been obtained by the probes we will determine further conclusions and recommendations regarding the state of the elements of the system and their dynamic stability.

KEYWORDS: CONVEYOR DRIVE, UNIT LIMITED CAPACITY, DYNAMIC STABILITY, VIBRATION, DETECSOPY

1. Introduction

The main transport system for coal from PK "Brod - Gneotino" to PK "Suvodol" consists five conveyors (different lengths, different height differences between the drive and return station ...) and are therefore equipped with a different number of identical drivelines (ten of them in total).

![Fig1. Satellite map of the route for GTS T2-T6 and schematic](image1)

![Fig2. The image shows plant transporters of GTS](image2)

2. Material and methods

The main goal of the research in this paper is to define the dynamic stability of drive group – gearbox with FFT analysis of the measured vibration characteristic places.

In literature there are norms and standards that treat this issue in gear units, but each is based on models that depend on the direction in which we want to exercise our research.

Power plant REK Bitola-Macedonia adopted standard ISO-10816-3 as a criterion for assessing the condition of the bearings and the recommendations of the manufacturer of SKF bearings that are fitted to the drive groups and other appropriate places.

In addition to Table 1 is given a diagram of the ISO - 10816-3

Table 1.ISO-10816-3 - VELOCITY

<table>
<thead>
<tr>
<th>Velocity</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>in m/s</td>
<td>1.1</td>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Mach</td>
<td>0.44</td>
<td>0.71</td>
<td>0.93</td>
<td>1.1</td>
</tr>
</tbody>
</table>

For defining the goal of this research we will make comparative measurements of the vibrations of the gearbox approximately in same operating conditions and compared the results to find the causes of the increased vibration of gearbox in drive groups. This approach and methodology for gathering results of comparative analysis should serve as a benchmark in further measurements of these and similar drive groups.

First, the measurement of the vibrations of the drive transporter T5 are taken in order to determine the vibration state of the drive.

![Fig3. Drive transporter T5](image3)
The gearbox which is the subject of analysis is running at speed 1500min⁻¹, which means working with 25 Hz own frequency. This is especially important when reviewing and analyzing vibrations.

For the measurement is used an on-line system for tracking the status of the reducer, meaning that we have fixed probes of individual measuring points which will be analyzed properly as they stand.

![Fig. 4 Schematic representation of the measuring points of gearbox with a cross-section](image)

With the intention to define the optimum frequency range, several measurements in the range of 0 to 1000 or 2000 Hz has been made. Because of the dynamic behavior of the transmitter that has not stationary character, the level of vibration is variable over time. Therefore three complete measurements are made and by each measurement eight averaging results are registered.

Each drive group (electric motor - hydro coupling - gearbox) has ten measuring points - probes to monitoring temperature and ten measuring points - probes for monitoring the vibration of the electric motor bearings and bearings of the gearbox. This system is fully automated. Management and monitoring of the operation of this system is performed from the control room.

In the control room via the SKF software we have visually monitoring the vibration of the electric motor bearings and gearboxes of all drive group transporters through probes.

Selected amplitude of vibration displacement (PEAK TO PEAK) to be the parameter that will be followed and obtained directly from the instrument, and it is registered in the corresponding software that is supplied with the instruments used for diagnosing and monitoring the condition of the drive group. Also acceleration vibration is a necessary parameter in separate calculation and need to be registered.

### 3. RESULTS AND DISCUSSION

The provided results of the measurements by the SKF software from the drive of the Transporter T5 are shown below.

![Fig.5 Measuring point V1H](image)

Figure 5 present the measuring point V1H (horizontal), of the probe that is placed on the input shaft. This image is a table of SKF software showing the measuring point for V1H example:

- **Date**: Time 28.06.2012 / 16:05:52
- **Summary FFT, Overall**: 0,046 mm / s
- **Position**: 91

Analyzing this vibration give us only a part of the real picture because it doesn’t contain information of the bearings or the shaft situation at a given measuring point. Therefore, this figure below presents two graphs. The first graph represents a movement of vibration over time or changes in vibration in a given time interval called Trend.

On the lower graph is shown the frequency in Hz depending on the displacement (speed) expressed in mm / s. From this graph it can be analyzed the source of the vibrations. It can be concluded that the source of the problem is in the poor performance of the machine. This graph is called Spectrogram.

In the present case we have amplitude of 0,43 mm / s at a frequency of 25Hz, and since the gearbox operates on the same frequency by the number of revolutions it means that the amplitude is the first harmonic.

In most cases this kind of a problem comes from not impaired centric or centric clutch electric motor - gear or loose foundation, ie, non-tight with the same strength bolts with nuts from the base.

A second characteristic of the amplitude 0,35mm / s is located about 470-480Hz, or 19th harmonic. This harmonic usually happens if there is a problem with a broken tooth (fxz1 = 25x19 = 475 Hz), but in the present case there might be a local bump on the side wall of the conical gear teeth and therefore this amplitude occurs.

Third characteristic amplitude of 0,34 mm / s to about 8Hz, presents us i.e. overlapping frequency sub-harmonic. This phenomenon usually occurs in the slack of the shaft relative to the bearing. In the present case this amplitude is negligible for further analysis.

![Fig.6. Measuring point B8V](image)

Since the second shaft are two probes (measuring points) B2V and B8V they will be analyzed together.

![Fig.7 Measuring point B2V](image)
Here we have a typical amplitude of 1.34 mm/s of 8.75Hz located in sub-harmonic analysis means applies third amplitude of measuring point B1N.

A second characteristic is the amplitude 0.75mm/s and is located approximately 80Hz, or third harmonic. In this case when we have a high suppressor harmonic and third harmonic in most cases the loose foundation. In this particular case where we have small values has not analyzed.

The first characteristic of this range measuring point is 0.52 mm/s of 25Hz, or the first harmonic. Feature first harmonic analyzed previously, and mainly occurs in non centric, unbalance or looseness.

A second characteristic amplitude is 0.46 mm/s of 12.5Hz, or ½ harmonic (sub-harmonic). Sub-harmonic commonly occur at some laxity whether the foundation or the shaft.

A third characteristic is the amplitude of 0.25 mm/s to 50Hz, or second harmonic. The second harmonic is expressed in non centric link electric motor - gearbox. But in this particular case when the power train is seen as a whole, it tells us that there is some laxity of the foundation. Given the small values of the vibration they are not taken for analysis.

Analogous to the second shaft analyzes the third shaft, ie together they considered the measuring points B3V and B7V.

The first characteristic amplitude of 1.21mm/s to 1.56Hz, i.e. 0.06 sub-harmonic. The occurrence of sub-harmonic is explained in the above measuring points (B1H, B2V, B8V).

The second characteristic is the amplitude 0.97 mm/s to 9.4Hz, i.e. 0.4 sub-harmonic. The occurrence of sub-harmonic is explained in the above measuring points (B1H, B2V, B8V).

The second characteristic is the amplitude 0.25mm/s of 25Hz, or first harmonic. The occurrence of the first harmonic is the same as for measuring point’s B1H, B8V.

First characteristic amplitude of 0.91 mm/s of 25Hz, i.e. the first harmonic. Second amplitude characteristic of 0.68 mm/s of 10Hz, i.e. 0.4 sub-harmonic. Here it is evident that have similar values as the measuring point B3V substituted are the locations of the first and second characteristic frequency.

Analyzed as a whole measuring points B3V and B7V in this case occurs at slack foundation, but because we have small values they do not analyze them.

Analogously third shaft analyzes and fourth shaft. Characteristic of the fourth shaft is that the probes are placed in two different directions, vertically and horizontally as recommended in the analysis of vibration, compared with the second and third shafts where probes are placed in the same plane.

The first characteristic is an amplitude 1,21mm / s to 1,56Hz, i.e. 0.06 sub-harmonic. The second characteristic is the amplitude 1,00mm / s of 25Hz, i.e. the first harmonic. The analysis of this measuring point is the same as the measuring point B3V.

The first characteristic is an amplitude 14,4mm / s to 1,56Hz, i.e. 0.06 sub-harmonic. The second characteristic is the amplitude 1,00mm / s of 25Hz, i.e. the first harmonic. The analysis of this measuring point shows registered high vibration in the unauthorized area. Therefore together is analyzed the measuring point B5A (Figure 12) where it is proven that the first characteristic amplitude is 4,34mm / s, the 1,56Hz, i.e. 0.06 sub-harmonic. The second characteristic is the amplitude 1,00mm / s of 25Hz, i.e. the first harmonic.
4. CONCLUSION

The conclusion taken by the vibration analysis is the existing of the eccentric on the link gearbox-drum. The Drive groups: Electric motor - Hydraulic coupling – Gearbox are connected with rigid link to the drive drum. The output shaft of the gearbox with shaft of the drum through the rigid coupling should and must be centric to have dynamically stable operation against ISO standard.

REFERENCES


