Technical Case Study

Industry: Steel

Technology: Vibration and Oil Analysis

Machine: Conveyor System

Vibration Analysis | Conveyor System | Introduction

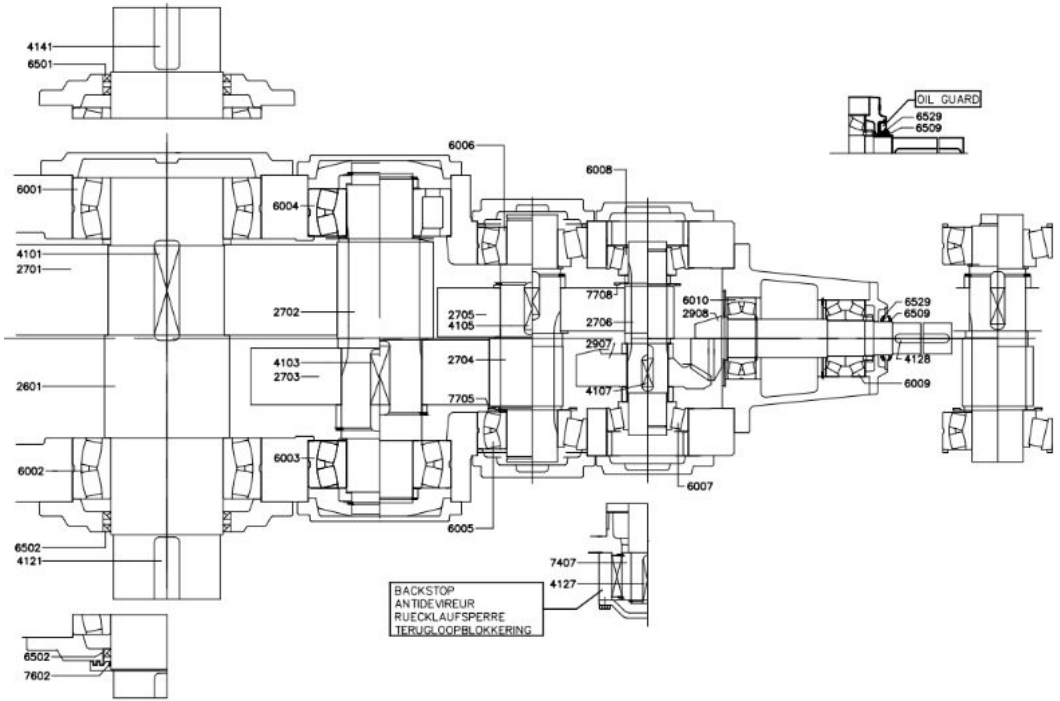
A highly critical **conveyor**, pictured, is measured quarterly, as part of a global periodic vibration monitoring program in **steel production plant.**
Note: 7,6 RPM (gearbox output speed)

The drive of a conveyor system in this steel mill shows an unstable behaviour, which can both be seen in a low frequent oscillating movement and unstable motor current. The **oscillation** has a period of **±0,7s or 1,4Hz.**

However, it was difficult to predict where this vibration was coming from and how it would evolve in the near future. For that reason, and because of the criticality of the conveyor for production, an expertise was done on the asset.

Vibration Analysis | Conveyor System | Introduction

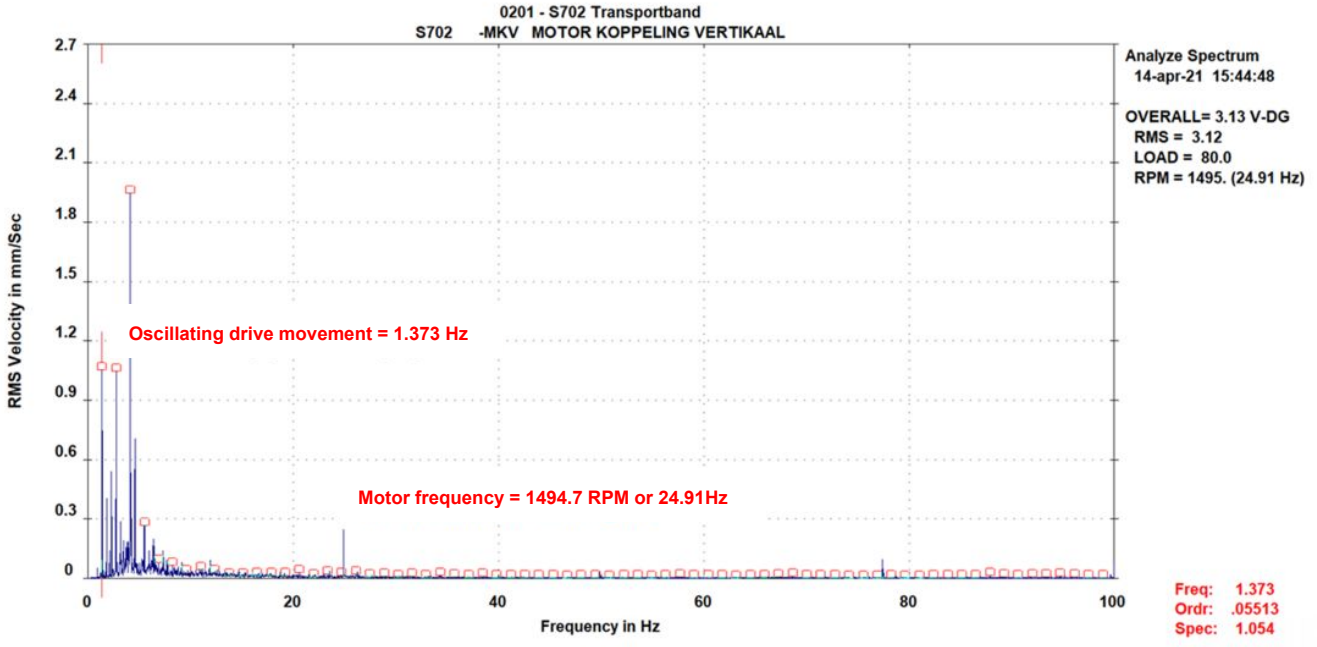
The conveyor is driven by a **75kW motor and 5-shaft gearbox** (reduction i = 195.28). Full technical details of the gearbox are (initially) unknown.



Vibration Analysis | Conveyor System | Data Analysis

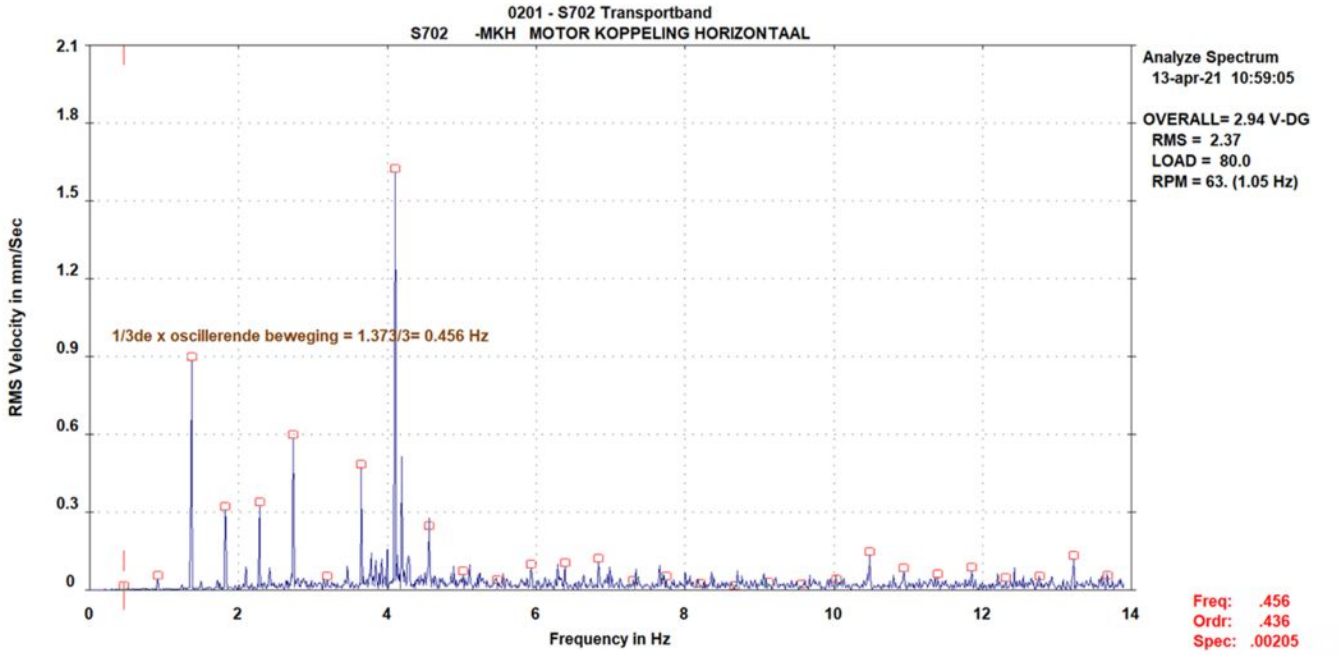
Thanks to on an-site assistance, a full vibration analysis has been done with some highly valuable information :

First of all, a low frequency measurement is performed on the motor and gearbox, to visualize the low frequent oscillating movement. It clearly shows vibration at **1.373Hz** and multiples.



Vibration Analysis | Conveyor System | Data Analysis

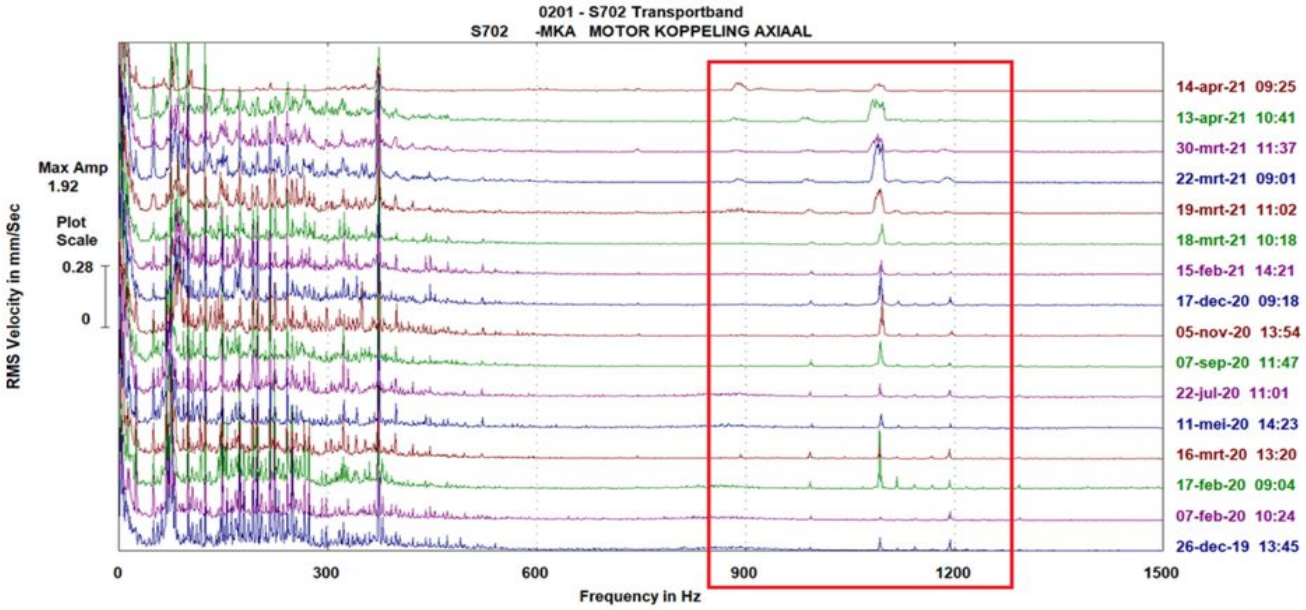
Thanks to all the data acquired on site, a more detailed analysis has been done and could reveal that the **vibration corresponds** to **0.456Hz and multiples**, with the 3rd harmonic and multiples being the dominant component.



Vibration Analysis | Conveyor System | Data Analysis

It is also observed that the electric frequencies in the high frequency part of the spectrum (slot pass frequencies) are smeared, since the oscillating movement of the drive is noticed, in March 2021.

This indicates an unstable speed and can explain the unstable motor current.



Vibration Analysis | Conveyor System | Conclusions

Following the first step of vibration analysis, here are our conclusions :

- *Observed vibration*: **0.457Hz**, with dominant 3rd harmonic and multiples:
  - **1.373Hz, 2.746Hz & 4.119Hz**.

- *Known frequencies*: Motor RPM: **24.91Hz**
  - Output speed: **0.1276Hz** (= 24.91/195.28)
  - Chain mesh frequency: **4.21Hz** (= 0.1276 * 33 teeth)

1st Conclusion :

Unfortunately, none of the known machine frequencies match the measured vibration so a deeper analysis is required.

Vibration Analysis | Conveyor System | Conclusions

This first conclusion raised some doubts about the technical datas that we had about this gearbox. We decided to go deeper in the analysis.

- The technical data in SAP mentions both a (generic) reduction of 200/1 and (detailed) reduction of 195.28/1.

- However, if the calculation of the chain meshing frequency is performed with a 200/1 reduction, it results in:
  - Chain mesh frequency: 24.91Hz / 200 * 33 teeth = **4.11Hz**, which corresponds exactly to the 3rd harmonic of the oscillation frequency: 4.119Hz.

- It is recommended to **re-verify the exact reduction** of the gearbox.

```
Tandwielkast Hansen P4, type QHRJ4
Identisch aan fabrikagenummer : R05A.259836
Asschikking CRN
Standaard reduktieverhouding : 200/1 (juist 195,28/1)
```

Vibration Analysis | Conveyor System | Conclusions

- The gearbox ratio of 195.28/1 is confirmed as the correct reduction and **full detailed technical data is requested** to the manufacturer of the gearbox.

- A technical specialist of the customer commented : "*The visible oscillation **can never be caused by a defect in the gearbox**, as the complete structure (motor+gearbox+conveyor) is deformed. This is also confirmed by the fact that the motor current has hardly increased (90A).*"

- We then decided to perform an **oil analysis on the gearbox** the get additional data.

- This **oil sample** shows an **increase in metallic content** which was above the tolerance for such analysis.

Vibration Analysis | Conveyor System | Conclusions

Later the same day, full technical details from the gearbox were provided.

S702			2de harm.	3de harm.	4de harm.	5de harm.	6de harm.	9de harm
Motortoerental	**1494,7 RPM**	24,91Hz						
Toerental as 1- ingaande as	1494,7 RPM	**24,91Hz**	49,82Hz	74,74Hz	99,65Hz	124,56Hz	149,47Hz	
Ingrijpfrequentie tandwielen (z=15/47)		**373,68Hz**	747,35Hz	1121,03Hz	1494,70Hz	1868,38Hz	2242,05Hz	
Toerental as 2 - tussenas 1	477,0 RPM	**7,95Hz**	15,90Hz	23,85Hz	31,80Hz	39,75Hz	47,70Hz	
Ingrijpfrequentie tandwielen (z=19/75)		**151,06Hz**	302,12Hz	453,18Hz	604,24Hz	755,30Hz	906,36Hz	
Toerental as 3 - tussenas 2	120,8 RPM	**2,0141Hz**	4,03Hz	6,04Hz	8,06Hz	10,07Hz	12,08Hz	
Ingrijpfrequentie tandwielen (z=15/66)		**30,21Hz**	60,42Hz	90,64Hz	120,85Hz	151,06Hz	181,27Hz	
Toerental as 4 - tussenas 3	27,47 RPM	**0,4578Hz**	0,92Hz	1,37Hz	1,83Hz	2,29Hz	2,75Hz	4,119821
Ingrijpfrequentie tandwielen (z=17/61)		**7,78Hz**	15,56Hz	23,35Hz	31,13Hz	38,91Hz	46,69Hz	
Toerental as 5 - uitgaande as	7,65 RPM	**0,1276Hz**	0,26Hz	0,38Hz	0,51Hz	0,64Hz	0,77Hz	

Observed vibration: **0.457Hz**, with dominant 3rd harmonic and multiples:

- **1.373Hz, 2.746Hz & 4.119Hz**.

Once we received all the technical data and ratio, we were able to calculate all the theoretical frequencies linked directly to each shaft on the gearbox and we immediately noticed that the observed frequencies were perfectly in line with the calculated values. Which means that there should be a **gear defect on the 4th shaft.**

It was recommended to immediately **perform a visual inspection** of the **fourth shaft.**

Vibration Analysis | Conveyor System | Conclusions

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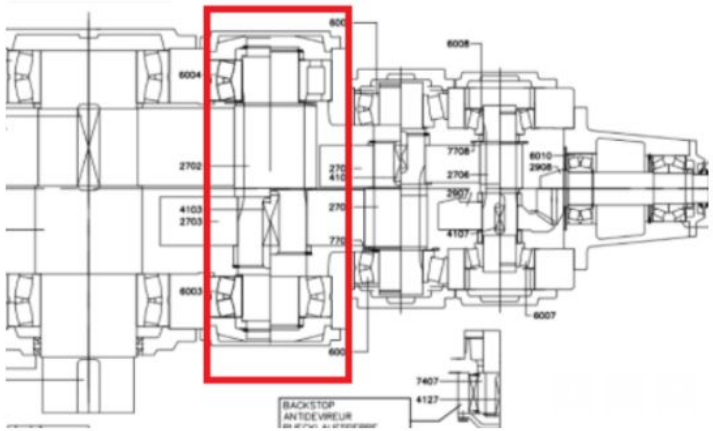

Vibration Analysis | Conveyor System | Conclusions

Thanks to the high precision data, it was possible to detect very low frequencies under the standard frequency range with low values.

These vibration levels were critical and not acceptable and even without the right data, we were able to convince the customer and the manufacturer to check their information.

After deeper analysis and strong reliable data acquisition, we were able to **detect a defect on the fourth shaft** and after visual inspection, it appeared that this **gear has to be replaced**. Hopefully, the other parts of the gearbox were not affected.

In conclusion, it is extremely important to have the **right technical data** for the assets to reveal the cause of the vibration and to be able to make the right recommendations.

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