Brüel & Kjær Vibro

Application Note

Case study – Effective off-line machine fault detection and diagnosis at the Tabriz Petrochemical Complex

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ABSTRACT

Unnecessary downtime and maintenance costs can be major factors that determine how competitive a plant is running in the petrochemical industry. This applies to all plants, but for this plant it is especially crucial since foreign exchange earnings from export of petrochemical products play such an important role in the national economy, and the high cost of spares is prohibitive. This plant took on the challenge by installing an off-line monitoring system that has proven itself to be effective yet simple to use.

Major polystyrene exporter

The Tabriz Petrochemical Company (TPC), commissioned in 1997, produces almost 450,000 tons of olefin, polyolefin and other chemical products each year in the Islamic Republic of Iran. Using naphtha and LPG from the nearby Tabriz Oil Refinery, A wide range of raw material products are made for use in domestic downstream plants, such as styrene, polyethylene (linear low density and high density), propylene, ethylene as well as other petrochemical products. Polystyrene (general purpose, high-impact and expandable grades) is the primary export product.

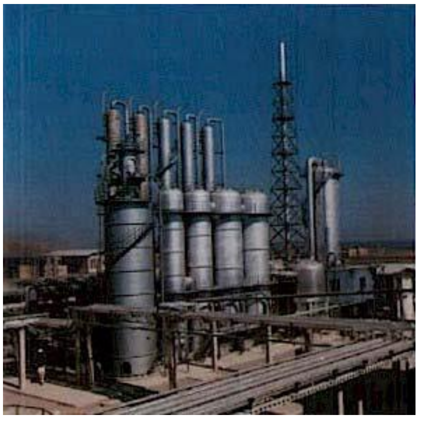
TPC is one of nine petrochemical plants in Iran under the state-owned National Petrochemical Company (NPC).
It is responsible for all of the country's petrochemical industry operation and development, and with a total annual production capacity of 10,5 million tons, it is the second largest producer of petrochemicals in the Middle East.

The state-owned Petrochemical Commercial Company (PCC) is Iran's major exporter of petrochemical products.

Because petrochemical exports account for one of the top foreign exchange earnings in Iran, over 30 projects have been started in NPC's strategic development plans to modernize existing plants and double production capacity by 2005. Plans are also underway to privatize these plants. Therefore there is considerable demand for the plant as well as the others to operate competitively in order to attract international private investment and joint ventures.

The condition monitoring department is relatively new in the organization, but it has grown consider-ably in time. Initially a single Brüel & Kjær Vibro portable instrument was obtained for off-line machine diagnosis, balancing and alignment. Two additional ones with data collection capability were then added shortly after together with two operators and a diagnosis specialist. Today, more than 3000 rotating machines are monitored by the group.

The condition monitoring department is still expanding and long-term projects include upgrading to an on-line system and extending the monitoring strategy to include thermal analysis, sound intensity



measurements, oil analysis, etc. Other plants in Iran are being investigated to benchmark the solutions they are using. In any case the older time-based maintenance intervals for many of the machines at TPC are quickly being replaced by predictive maintenance using condition monitoring.

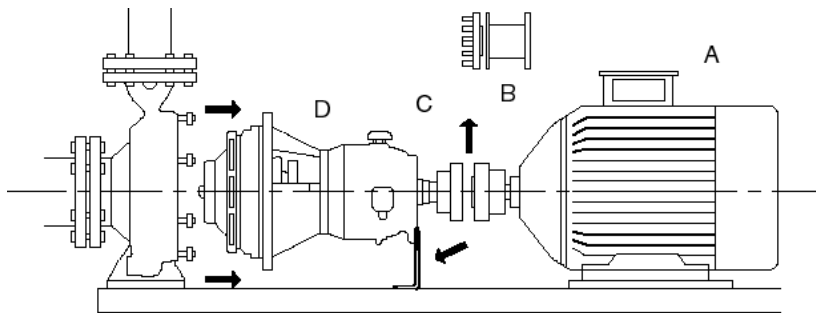


Figure 1. Motor-driven centrifugal pump in water pre-treatment plant.

The importance of effective diagnosis

A large number of faults have already been detected and diagnosed in the span of only a couple of years using the off-line system. Diagnosis plays an important role in the condition monitoring strategy and some of the important considerations, listed below, are demonstrated in the following case story:

- Diagnoses have to be done for several faults that sometimes occur at the same time
- Diagnosis is not only necessary for determining which components have to be repaired, but also which components should NOT be touched.
- Diagnosis should be complete enough to find out how to avoid that the fault occurs again

Case study - Multiple faults

A 55kW motor-driven centrifuge pump (2985 rpm) in the water pre-treatment plant is off-line monitored once a month.

For several months the vibration velocity RMS value for this pump was within the VDI 2056 limits (maximum of 1.98 mm/s), but during a routine monitoring round, there was a sudden increase to 7.8 mm/s. Diagnostic measurements were then immediately done using FFT spectra and BCS (bearing condition signature/selective envelope detection) to find out the cause of the high vibrations.

It was immediately obvious that there was severe misalignment by looking at the first few harmonics in Figure 2. Although not apparent because of the plot scaling, there was also indication in the plot that something was wrong with the coupling as shown by the increased vibration energy in the 600 to 1000 Hz range.

A work order was issued to Maintenance to immediately align the pump shaft and check the condition of the coupling. An envelope spectra suggested that although there was severe misalignment, there was no apparent consequential damage to the rolling-element bearings so these did not have to be replaced or even checked.

The Maintenance group quickly corrected the misalignment, but put the pump back into operation without checking the coupling. Shaft vibrations were less after measurements were done again (from 7.8 mm/s to 3.2 mm/s), but this was still too high for this particular pump. FFT spectra was done afterwards (Figure 3) and indicated the misalignment problem had been corrected but there were still high vibrations at the coupling frequencies.

After disassembly, it was observed that rubber pads of the coupling were damaged. After replacement, measurements were done again and the overall vibration decreased to 1.8 mm/s, which was acceptable. The FFT measurements also looked better (Figure 4). Although the pump was now fully operational, further investigation was still needed to determine what caused the misalignment and damaged coupling.

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Investigations revealed that a 2" line was welded from the suction end of the pump to discharge header to satisfy process requirements two weeks earlier. This caused piping strain that misaligned the shaft and later damaged the coupling. If this situation was not corrected in time, severe damage could have occurred to the motor and/or pump that could have resulted in both lost production and expensive spares. Since this problem was corrected, the pump has been functioning well the last eight months.

MAINTENANCE ACTIVITY	TRANS.	MEASUREMENT POINT ON PUMP			
		A	B	C	D
Before alignment	Horiz.	3.20	3.70	7.81	4.23
	Vert.	3.72	6.81	5.76	3.11
	Axial	7.20	6.55	3.63	-
After alignment	Horiz.	1.80	1.35	3.70	2.18
	Vert.	0.88	1.75	2.62	1.78
	Axial	1.50	1.38	2.21	-
After replacing coupling pads	Horiz.	1.11	1.28	1.75	1.25
	Vert.	0.45	0.92	1.22	1.18
	Axial	0.85	0.75	0.79	-

Table 1. Overall velocity vibration measurements of pump (m/s).

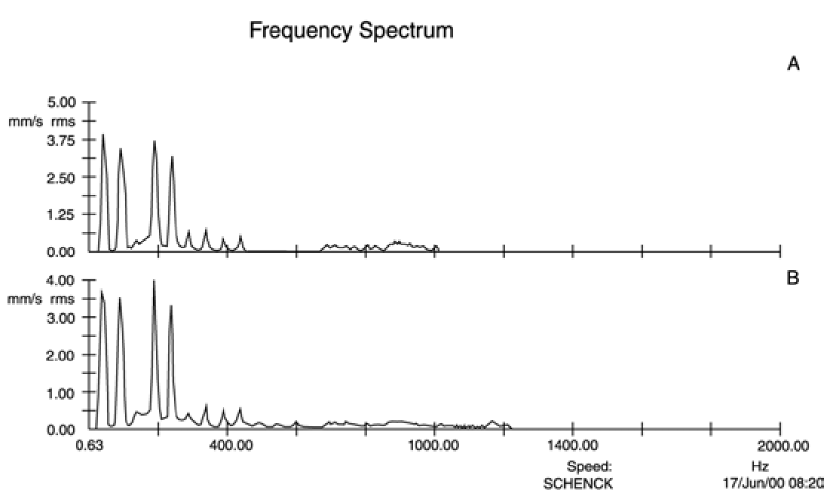

Figure 2. Spectrum at point C (in Figure 1) before alignment.

Conclusion

The Brüel & Kjær Vibro data collectors have proven to be simple to learn and use by the technicians in the relatively new condition monitoring group, yet very effective. Not only has there been improved machine availability and reduced maintenance expenses during the last two years, it is also apparent the condition monitoring expertise has greatly improved. There is much better machine awareness and understanding of machine faults.

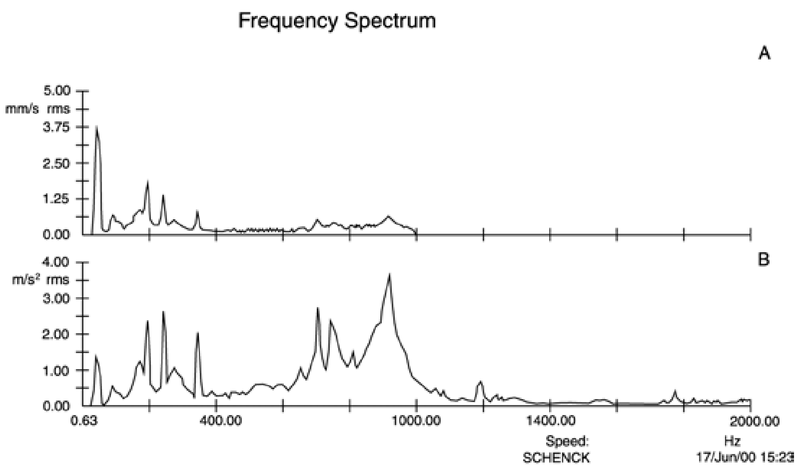

Figure 3. Spectrum at point C (in Figure 1) after alignment.

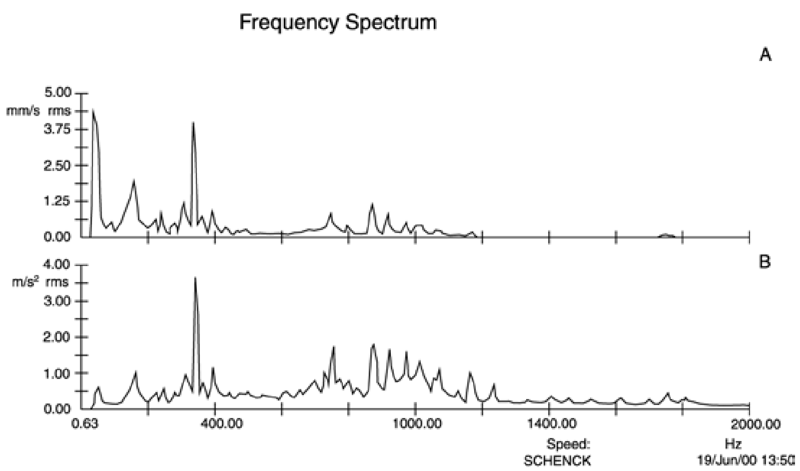

Figure 4. Spectrum at point C (in Figure 1) after replacing new rubber pads.

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