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Maximise air compressor energy-efficiency with high-performance lubricants

Klüber presents three ways to increase reliability, reduce maintenance cost and maximise the energy efficiency of air compressors with high-performance lubricants.

The number of air compressors installed at a cement plant can range from 5-40 units, or even more, depending on the size of the plant and the size of the compressor units. Usually, there is a central air compressor room, which houses multiple units, as well as additional units spread across the plant. Constant availability of sufficient compressed air at the required pressure is critical for the continuous production of cement. This requires air compressors to operate with maximum reliability and as little maintenance downtime as possible.

However, compressed air systems are notorious for burning through energy and money, which has led to a plethora of literature that deals with improving their energy efficiency. About 70-90% of the operating cost of an air compressor comes from its electricity consumption. This makes the energy efficiency of air compressors a focal area for optimising total cost of ownership. This can offer substantial bottom-line savings, as the electricity used for compressed air usually amounts to 10-30% of a cement plant's electricity costs. It can be the second highest electricity cost driver after grinding mills.

Using the correct high-performance lubricant can significantly improve the operation of air compressors in a cement plant by providing the three following benefits: Maximised reliability, lower maintenance costs and increased energy efficiency. Their potential often remains unexploited, even though they are easy to implement, do not require additional capital expenditure, improve the reliability of compressors and can save operating costs of US$30,000-80,000/yr, depending on the prior choice of lubricant.

1. Maximised reliability

Best practice #1: Using high-performance lubricants to maximise the reliability of compressors that are exposed to contaminants, humidity and elevated ambient temperatures.

High machinery availability and low downtime rates are targets that every compressor operator strives for. However, the dirty and dusty environment in cement production can present a significant challenge for equipment. Dust that is sucked into the compressor system with the intake air, in combination with elevated humidity levels and high ambient temperatures, contributes to machinery failures and can lead to unexpected compressor downtime.

The elevated temperatures and contaminants accelerate the build-up of varnish and residues on the rotors, bearings, shafts and housings of the compressor, as well as in downstream components like separators and piping. Strong varnish and residue build-up lead to elevated operating temperatures and compressor failures.

Therefore, the use of high-performance synthetic lubricants is recommended, as these oils contribute significantly towards maximising machine reliability, the reason being that high-performance

Right - Figure 1: Screw-type compressors operated with mineral oil (left) and high-performance oil (right). The conveyor using high-performance oil is sludge and varnish free, bringing the plant operator higher compressor efficiency and lower maintenance costs.

synthetic oils provide much better oxidation stability and resistance to elevated temperatures, moisture and the ingress of contamination. The compressor system runs visibly cleaner, the tendency to build up residues and varnish decreases drastically and the likelihood of a compressor shutdown also falls.

2. Reduced maintenance efforts and cost

Best practice #2: Use of high-performance lubricants to minimise the maintenance work needed for compressors and to reduce TCO.

It is not only the improved reliability of the air compressor and a consequently higher productivity that can be easily achieved by changing the compressor lubricant. There is also a clear savings potential in terms of maintenance tasks. By choosing the right type of oil, in particular high-performance synthetic oils, the general maintenance cycles between two service actions can be extended from 2500hr with standard mineral oil based lubricants to 8000-12,000hr with high-performance lubricants. Fewer service actions on site throughout the year create less demand for lubricant and lower service costs for the operator.

Durable clean and sludge-free machinery reduces time consuming dismantling and cleaning actions and keeps machinery efficiency at a constant high level. Also, additional serviceable parts (e.g. filters, valves, oil separators), which are normally exchanged with the oil, can be used for longer and provide additional maintenance cost savings.

Changing over to high-performance compressor oils is a simple business case for the operator, bringing immediate annual savings in maintenance efforts such as oil volumes, spare parts and labour. Table 1 compares a cement plant's annual maintenance costs assuming 10 compressors operated for 7000hr/yr with an oil fill volume of 60L each.

Cost driver	Standard Mineral Oil	High Performance Synthetic Oil
Compressor oil volume (L)	60	60
Oil price (US$/L)	6	10
Cost of oil for one filling (1 compressor) (US$)	360	570
Oil filter cost (US$)	200	200
Air filter cost (US$)	150	150
Oil separator cost (US$)	900	900
Cost of spare parts (1 compressor) (US$)	**1250**	**1250**
Manpower per oil change per compressor (hr)	6	6
Manpower cost (US$/hr)	40	40
Manpower cost per oil change (1 compressor) (US$)	**240**	**240**
Minimum operating life of oil = maintenance cycle (hr)	2500	10,000
Oil change frequency per year	2.8	0.7
Total cost per oil change (1 compressor) (US$)	1850	2060
Total service cost per year (1 compressor) (US$)	**5180**	**1442**
Total service cost per year (All 10 compressors) (US$)	51,800	14,420
Savings on service cost per year (US$) (All 10 compressors)	**37,380**	

Above Top - Table 1: Comparison of a cement plant's annual maintenance costs assuming 10 compressors operated for 7000hr/yr with an oil fill volume of 60L each.

Electricity costs (US$/kWh)	Power rating of air compressor (kW)							
	25	**50**	**75**	**100**	**125**	**150**	**175**	**200**
0.03	263	525	788	1050	1313	1575	1838	2100
0.04	350	700	1050	1400	1750	2100	2450	2800
0.05	438	875	1313	1750	2188	2625	3063	3500
0.06	525	1050	1575	2100	2625	3150	3675	4200
0.07	613	1225	1838	2450	3063	3675	4288	4900
0.08	700	1400	2100	2800	3500	4200	4900	5600
0.09	788	1575	2363	3150	3938	4725	5513	6300
0.10	875	1750	2625	3500	4375	5250	6125	7000

Above - Table 2: Electricity cost savings resulting from a single air compressor in relation to its power and the plant's electricity costs, assuming 7000hr/yr of operation and energy savings of 5% achieved through high-performance lubricants.

Green background indicates most common scenarios.

3. Increased energy efficiency

Best practice #3: Using energy-efficient compressor lubricants to save electricity costs and support CO_2 emission reduction goals.

Compressed air is often the most expensive form of energy available in a cement plant because of its poor efficiency. Most of the energy needed to convert electrical power into compressed air and back into mechanical energy is lost as heat. The typical overall efficiency of such systems is 10-20%.

Energy-efficient, high-performance lubricants can help to increase the energy efficiency of an air compressor by 3-7% compared to conventional mineral oils. Table 2 shows the electricity cost savings resulting from a single air compressor in relation to its power and the plant's electricity costs assuming operation of 7000hr/yr and energy savings of 5% achieved through high-performance lubricants. The absolute cost savings per unit is substantial. Assuming an average number of 10 installed units, this can translate into cost savings of US$10,000-45,000/yr.

Summary

High-performance compressor lubricants can significantly improve compressor operation and help increase an operator's profits. They improve the reliability of compressors as they handle typical challenges found in a cement plant better than conventional mineral oils. They reduce maintenance efforts, lower TCO and free up workforce. Finally, they increase the energy efficiency of compressors and contribute to significant bottom-line and CO_2 savings. All in all, these improvements can result in additional profits of U$30,000-80,000/yr.