

SCREW COMPRESSOR WEAR

The energy efficiency of a screw compressor depends on the integrity of a fine edge on the tip of the compressor rotors, and the clearance between this edge and the compressor bore. This efficiency can be compromised by damage resulting from numerous factors including poor maintenance, excessive bearing wear, capacity slide damage, and erosion.



Figure 1 - Old Stal screw compressor package.

FACT BOX: SCREW COMPRESSOR FALLACY!

Unlike reciprocating compressors, screw compressors do NOT regain full efficiency after a rebuild! This is because during the rebuild of a screw compressor, the compressor bore, rotors and slide mechanisms are not replaced/repared, and therefore the existing wear remains. This is a fallacy which only exists because the lack of reliable compressor testing means that it cannot be readily be refuted.

While the reduction in efficiency resulting from this damage is not always readily identifiable, it can explain differences in performance results of compressors.

SCREW COMPRESSORS VS RECIPROCATING COMPRESSORS

Refrigeration plants either have screw compressors or reciprocating compressors. Generally, screw compressors have replaced reciprocating compressors due to lower maintenance costs and minimal requirement for regular refurbishment. However, unlike reciprocating compressors, there is no simple compressor test that can be conducted in order to determine the condition of a screw compressor. This is because the tip clearances the amount of oil, viscosity of oil and tip speed are all factors contributing to the sealing of compressed space within a screw compressor. Therefore when there is low rotor speed, the sealing of this compression space is ineffective and a static compression test is not possible.

The result of this is that compression tests are not undergone for screw compressors and hence their efficiency reduction is difficult to determine. Therefore, while screw compressors incur lower

maintenance/rebuilding costs, the inability to test their wear often means that reduced efficiency negates these savings.

Since September 2012, Refrigeration Engineering Consultancy Company Minus40 Pty Ltd has been undertaking live compressor testing and analysis and has been able to determine screw compressor degradation to within 90% confidence.

Based on an initial testing of 27 screw compressors, 84% were more than 10 years old and showed degradation in excess of 20%, with average degradation levels of 30.4%. The highest degradation levels observed were as high as 55%. An example of how compressor degradation can impact a site and enable energy savings to be found is shown below.

Example

The energy savings resulting from replacement of two old screw compressors with 20%, 30% and 40% degradation (based on actual operating hours) at a meat processing site in Queensland are shown in the table below. Degradation tests conducted on site indicated 30% degradation of both compressor, such that compressor block replacement at a cost of \$156,600 would have offered a 1.2 year payback on investment. Even a complete unit replacement at a capital cost of \$270,600 would have achieved a payback of 2.07 years.

	20% degradation	30% degradation	40% degradation
Baseline electricity consumption (kWh)	8,907,000		
Excess electricity consumption due to compressor degradation (kWh)	580,000	870,000	1,160,000
Post-Implementation savings (assuming 15c/kWh)	\$87,000	\$130,500	\$174,000
Project cost, block replacement	\$156,600	\$156,600	\$156,600
Payback (years)	1.8	1.2	0.9
Project cost, unit replacement	\$270,600	\$270,600	\$270,600
	3.11	2.07	1.55

WHAT CAN BE DONE?

Depending on the extent to which degradation has occurred, it can be commercially viable for the compressors to be replaced rather than refurbished, especially where the compressor block is still available and can be replaced whilst retaining the remainder of the compressor unit. Some compressor models and makes are no longer available as block replacements and must be replaced with alternative new units. But even in such cases, unit replacement projects can be commercially attractive. In fact, some pharmaceutical and food processing firms in Europe have policies stipulating that screw compressors should be replaced after 100,000 hours of operation, which corresponds to a lifetime of 10-15 years.