**Reduction of Electrical Consumption using Oil-less Compressors in Air Conditioning Systems**

Currently, compressors used for air conditioning (A/C) systems have metal on metal contact points and require a lubricating oil added to the refrigerant to prevent mechanical failure, with the concentration of oil in the refrigerant typically falling in the range of 10-20% (1). A numerical study conducted by Li *et al.* compared an oil-less compressor to compressors with up to 7% oil concentration and found that the coefficient of performance (COP) of an A/C cycle decreases as the concentration of oil in the refrigerant increases (2). The savings in electrical consumption and cost would be significant if oil-less compressors could be used in A/C systems. The annual savings is calculated here by comparing an oil-less compressor using pure refrigerant to a compressor with a 7% concentration of oil in the refrigerant, representing current A/C systems in the USA.

According to the U.S. Energy Information Administration, the annual residential usage of electricity in 2020 was 1.465 x 109 MWh (3) and 15.5% of residential electricity consumption was devoted to space cooling in 2021 (4). Thus, an estimated 2.27 x 108 MWh is used for residential A/C systems each year. Additionally, the EIA reports that the commercial electrical consumption in 2020 was 1.287 x 109 MWh and 11.4% of commercial electricity was used for space cooling in 2021 (3,4). Thus, an estimated 1.47 x 108 MWh is used for commercial A/C each year. The combined total for residential and commercial electrical usage for A/C is 3.74 x 108 MWh annually. Considering the 2021 cost of electricity of 13.72 cents/kWh = $137.20/MWh (5), the annual electricity cost for residential and commercial A/C is $5.13 x 1010, or $51.3 billion.

The investigation by Li *et al.* found that the COP of a compressor increased from about 1.1 when the oil concentration was 7%, to about 2.0 for an oil-less compressor, an astounding performance improvement of 45% (2). Thus, for the same amount of cooling capacity, an oil-less compressor requires 45% less work input, electricity, than the compressor with 7% oil. In fact, if oil-less compressors were implemented in all A/C systems in the USA, the estimated electrical consumption would decrease from 3.74 x 108 MWh to 2.06 x 108 MWh annually, and the cost would decrease from $51.3 billion to $28.2 billion annually. Thus, an oil-less compressor could save 1.7 x 108 MWh in electricity and $23 billion every year.

An experiment with an oil-less linear compressor prototype was also conducted by Li *et al.* to validate the numerical model. A linear compressor is a small compressor sometimes used in home refrigerators. These compressors are more likely to fail without lubricating oil and typically operate with oil in the system. It is very unlikely a compressor of this design could be operated without oil in a A/C unit as they would quickly burn up. A compressor designed to operate without oil in an A/C system would lead to enormous savings in electrical consumption and cost.

In conclusion, if an oil-less A/C compressor was developed that was capable of increasing the Coefficient of Performance by 45%, and 100% of compressors in the USA were operated with this new compressor, the savings in both electrical usage and dollars would be impressive.  Based on the studies used for this paper and the calculations shown above, an oil-less compressor could reduce the annual usage of electricity in the USA by 1.7 x 108 MWh and this reduction would save consumers $23 billion each year.

References

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Brian Davis: 8/3/22

Reviewed by Sarah Desotell PhD, Ripon College Physics