



A Holistic Approach to The Use of Ultra-Low Viscosity Lubrication in The Modern Combustion Engine and Associated Engine Architecture

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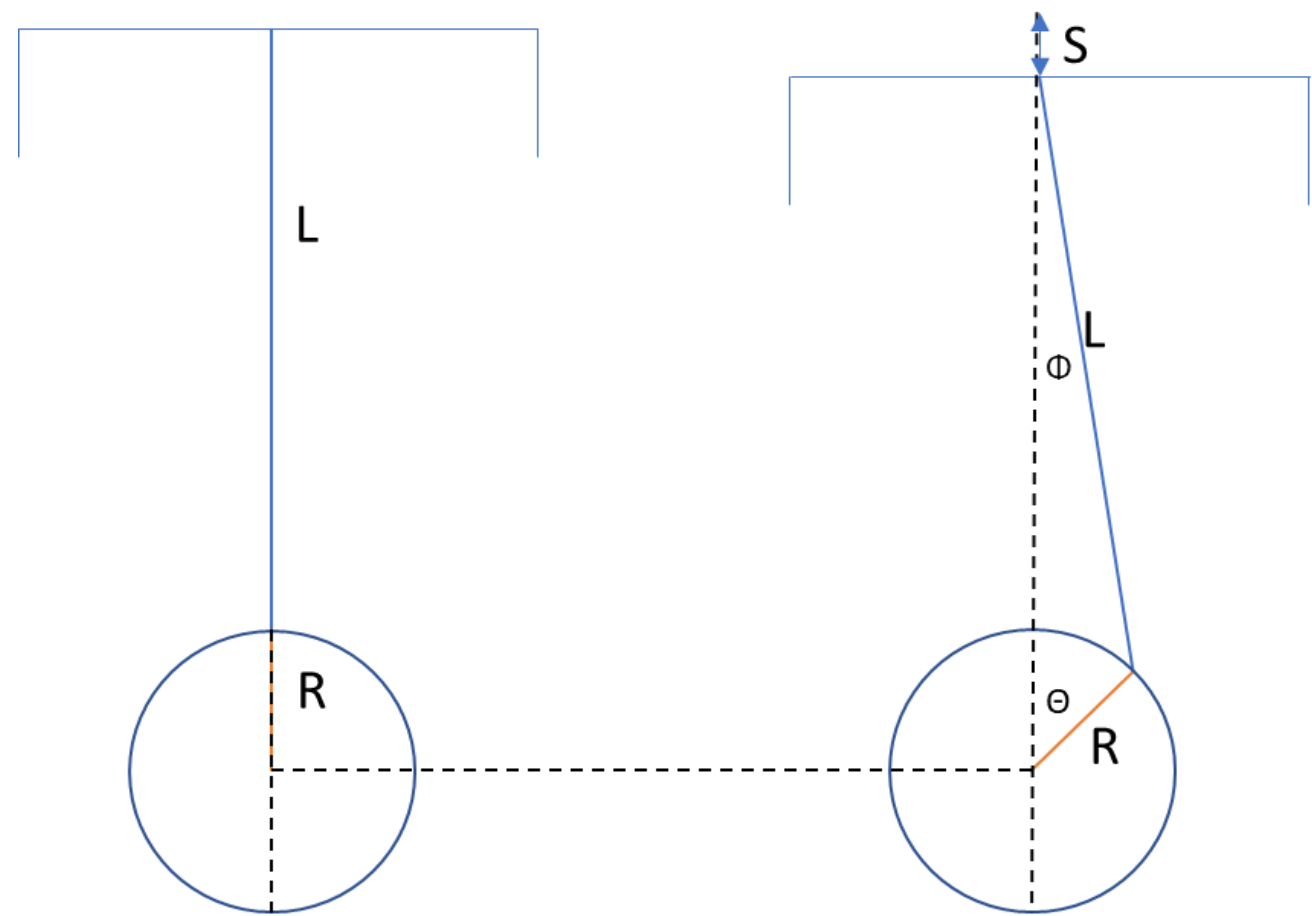
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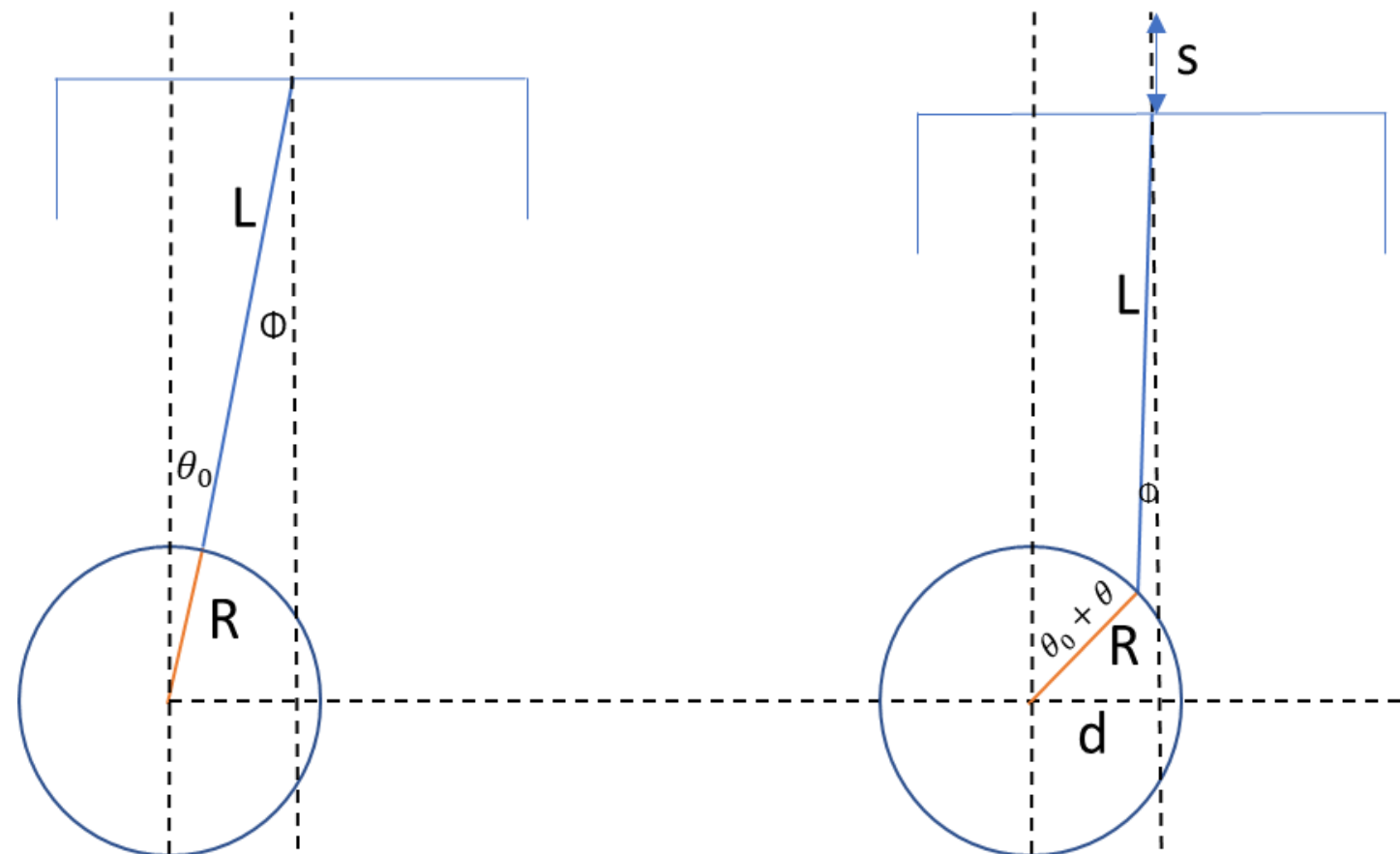
Introduction:

The role of modern engine lubrication has become a tortuous one, with the requirements made of it becoming at many times conflicting. This dissertation of this work sets out to explore the roles of a modern engine lubricant, the reasons for the paths being taken in the development of new lubrications and the engineering compromises being made to work with such styles of engine lubrication. The goal is to understand how the development of engine lubrication fits into the drive for a modern, more efficient internal combustion engine.



Standard crankshaft geometry:

$$S = R + L - R \cos \theta - L \left(1 - \frac{R^2}{L^2} \sin^2 \theta\right)^{1/2}$$

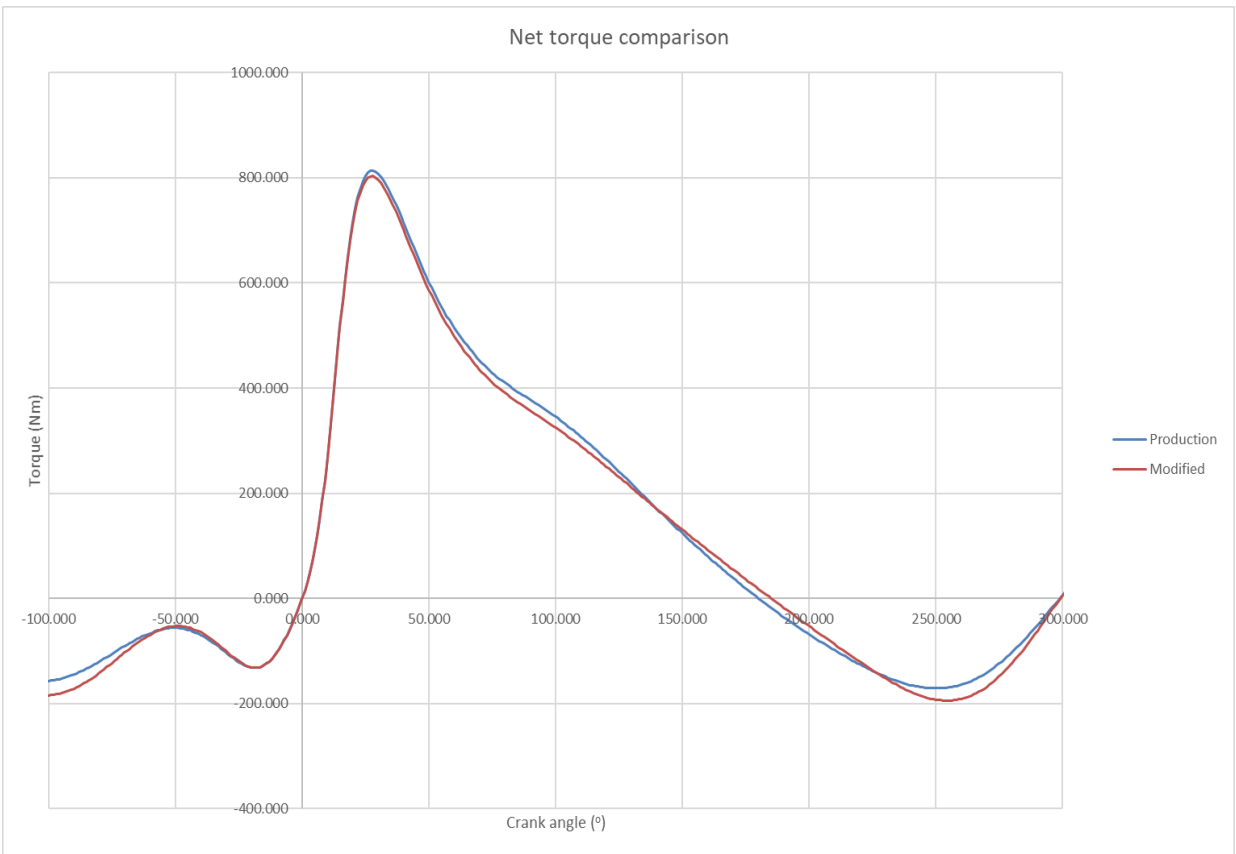
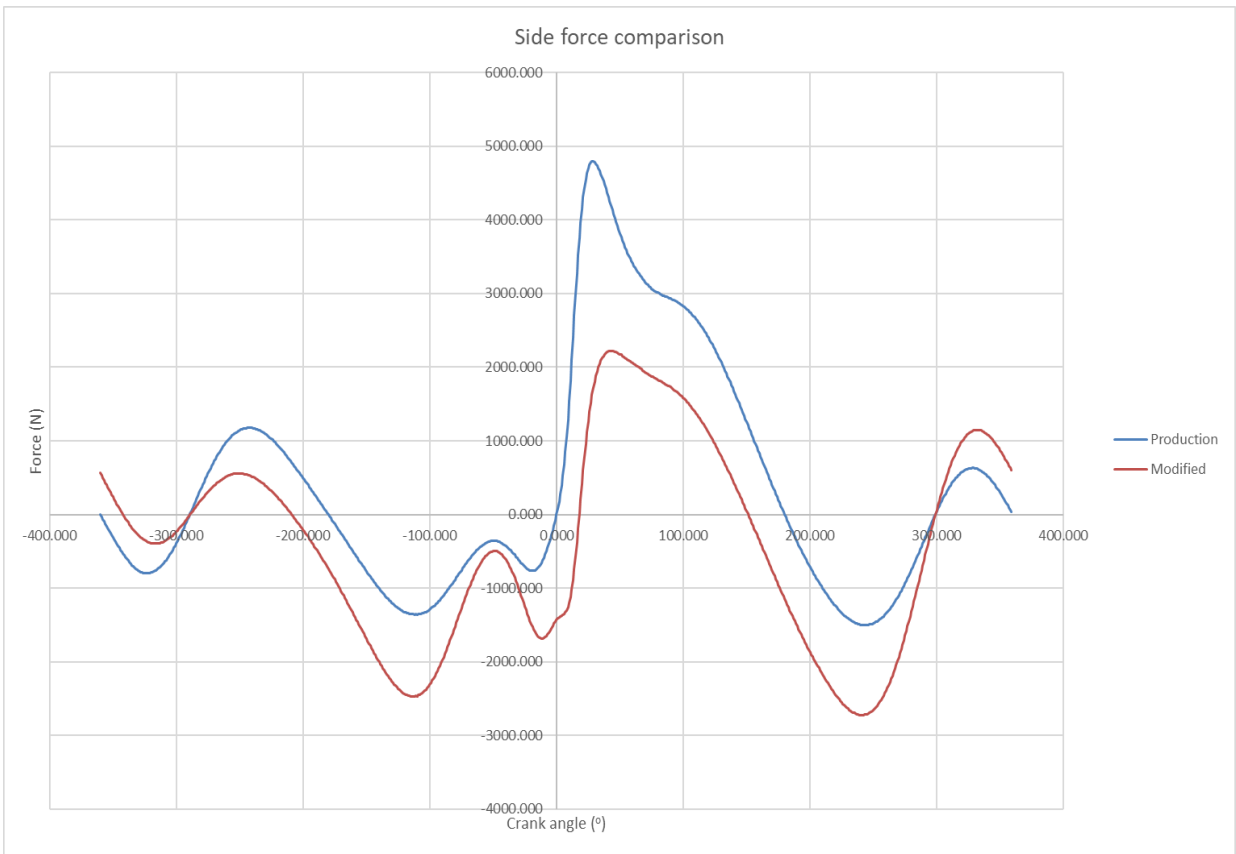


Offset crankshaft geometry:

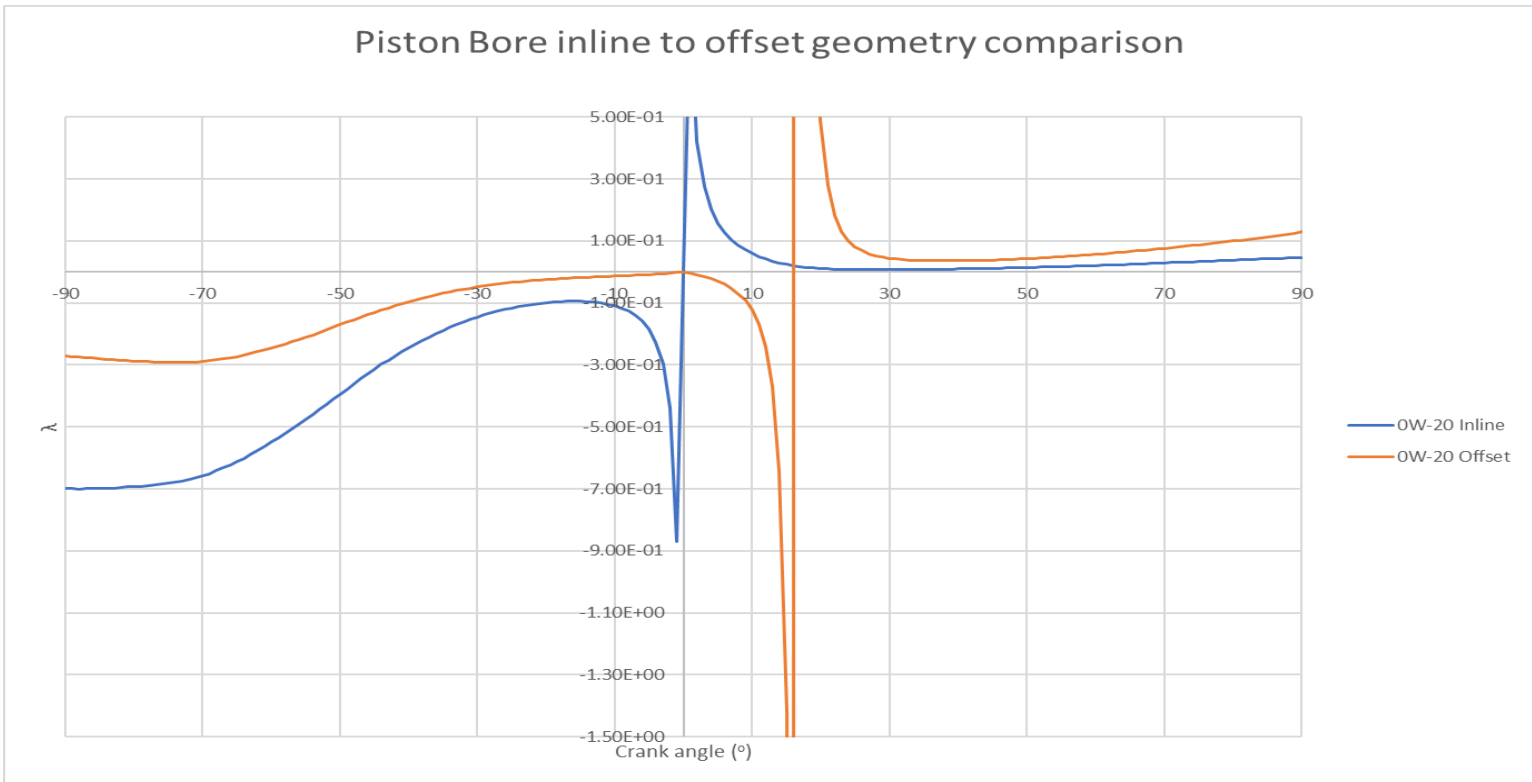
$$S = (L + R) \cos \theta_0 - R \cos(\theta + \theta_0) - L \cos \left[\sin^{-1} \left(\frac{R \sin(\theta + \theta_0) - d}{L} \right) \right]$$

The difference in relative piston motion can be seen in the two functions of “S”

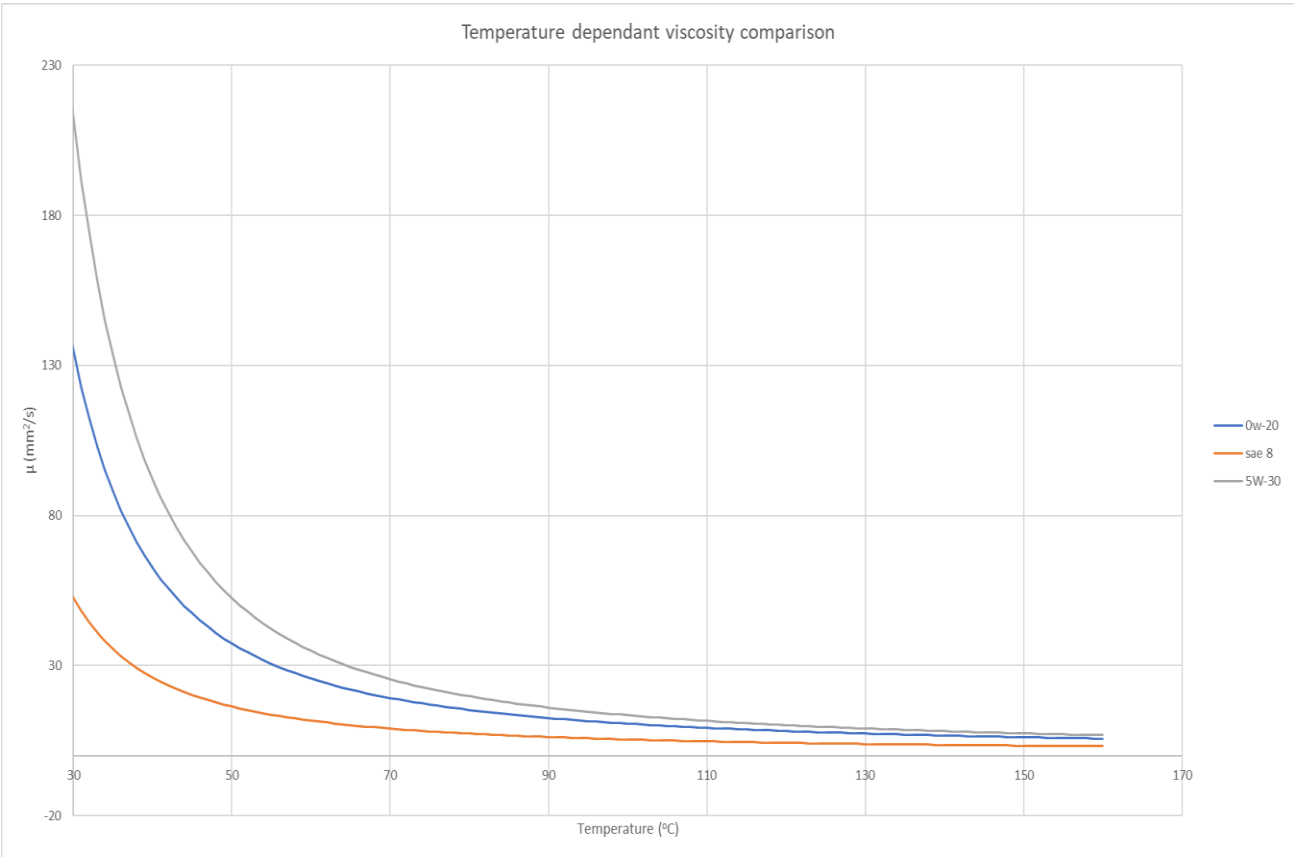
The model was created for an offset crankshaft design, one in which the bore and stroke characteristics were retained.



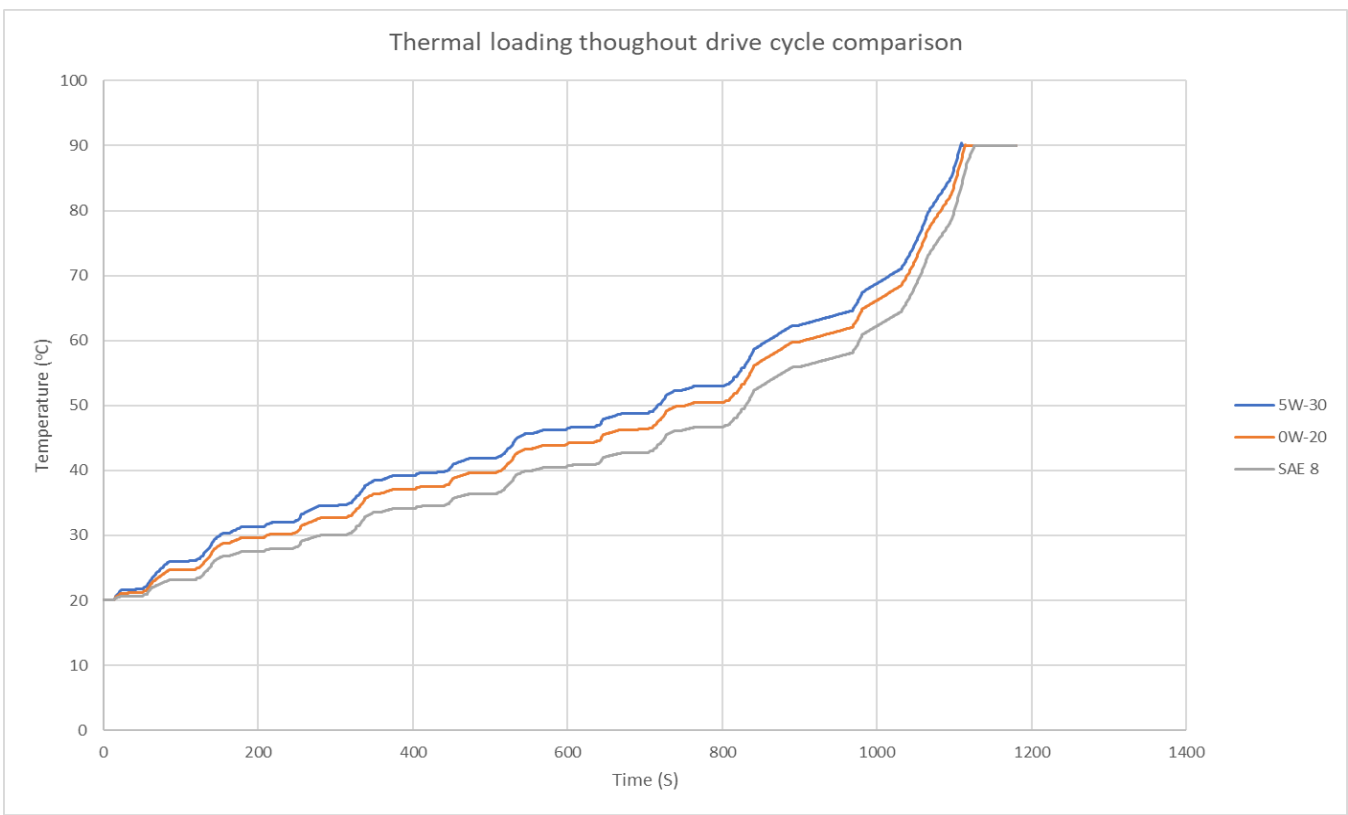
Offsetting the crankshaft reduces side loading on the thrust side of the bore under firing, to reduce friction and wear. However, yields less mechanical Work.



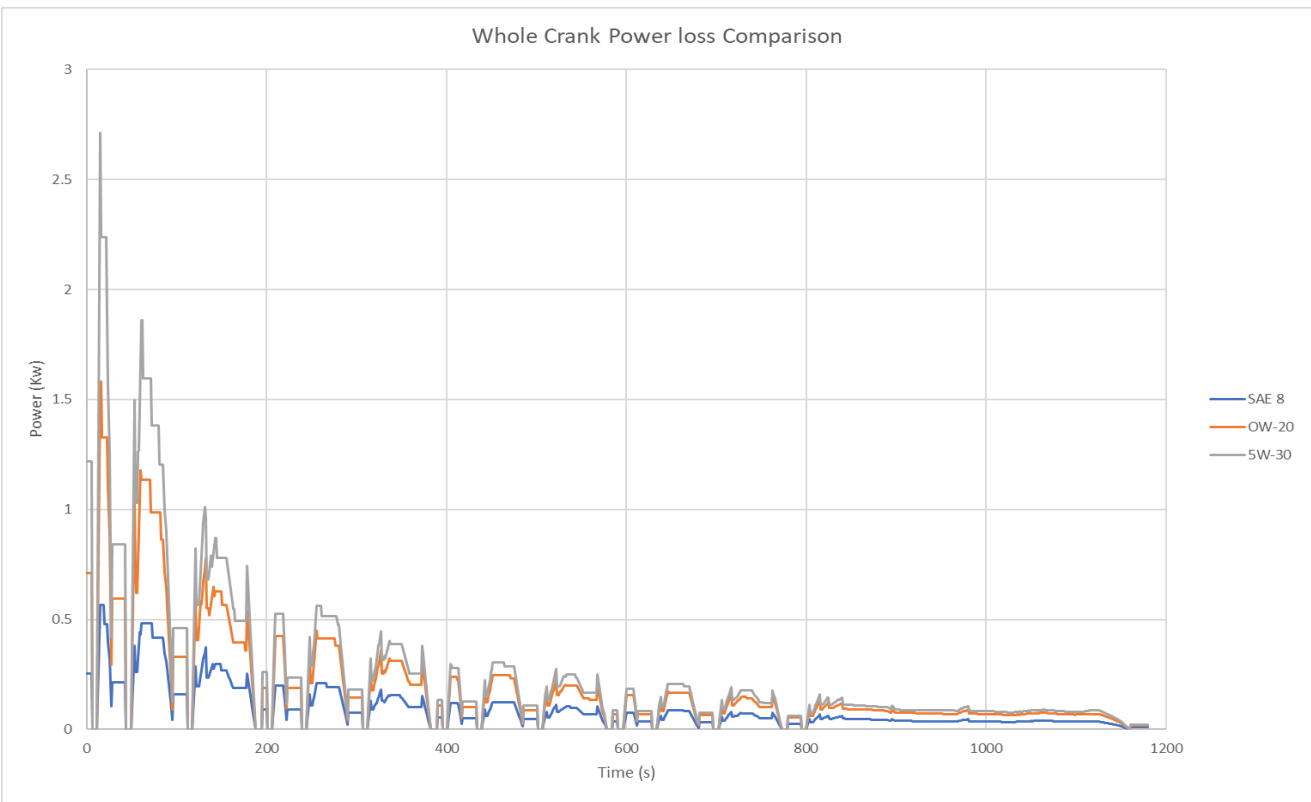
Right: The temperature viscosity dependency of the lubricant , has a large impact on the performance across it’s operating thermal range. $\mu = 10^{10AT^B - K}$
The proposed “SAE 8” ultra- low viscosity lubricant displays a much flatter visco-thermal profile, supported by polymeric viscosity modifiers.



Left: The variance in temperature over the course of the drive cycle is directly related to the viscosity. This connects the latter visco-thermal dependency. The rejected thermal energy in the drive cycle drives the temperature up and the viscosity down.



Right: The link between the viscosities and temperature culminates in the unique power losses of each of the 3 lubricants over the entire drive cycle. What was seen, is that the reductions in losses are seen at the start of the rive cycle, where the difference in viscosity is at its greatest. The “SAE 8” lubrication yielding a 5.64% reduction in energy usage over the 5W-30.



Conclusion: The need to provide a holistic view is evident in the use of ultra-low viscosity lubricants where one small aspect affects so many components . Where a small change, in lubricant property requires extreme engineering comprise to yield a positive result.