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Lubrication and heat dissipation in transmissions and bearings

Lubrication and heat dissipation in transmissions and bearings are critical to both the performance and the life of these systems.

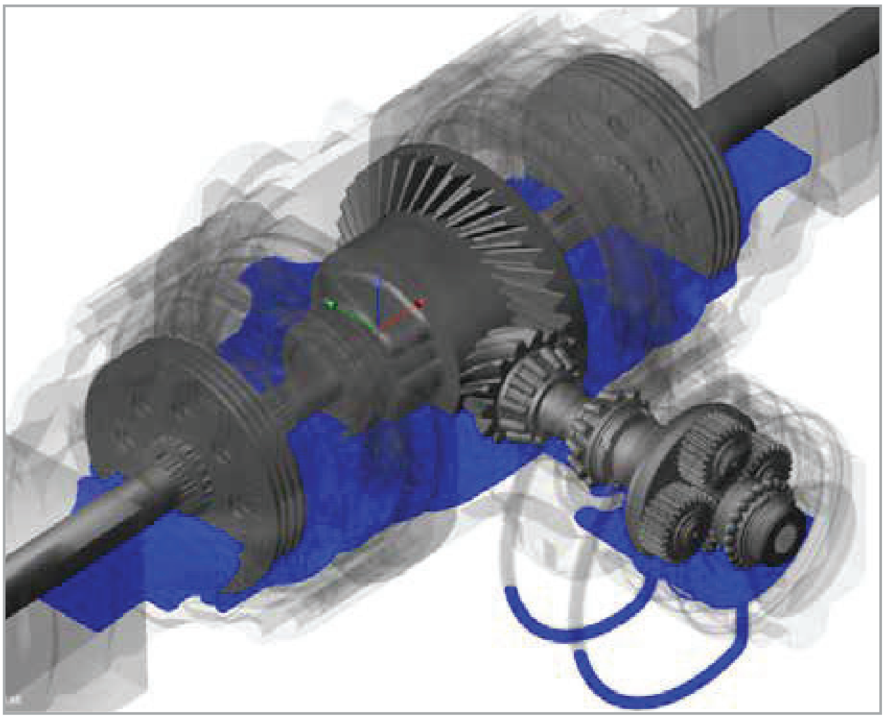
Transmission design is mainly based on the mechanical aspects of the transmission and lubrication is an aspect that is verified, and eventually corrected, based on bench testing, i.e. once the design phase has been completed and a physical prototype is available.

The use of transparent prototypes or windows in specific regions of the transmission makes it possible to visualize, at least partially, the flows and distribution of the lubricant within the transmission, and to understand whether it reaches the various components.

Similarly, by means of a physical prototype and bench tests, it is possible to verify the correct positioning of the breather ducts, which must be adequately protected in order to prevent the escape of the lubricant, and the functioning of the transmission under different operating conditions, for example by changing inclination, number of revolutions, or direction of rotation.

These are some of the issues faced daily by those who design and build transmissions of all kinds, from the automotive and industrial sectors to the aeronautical sector; from small transmissions to those for the naval and wind-power sectors.

However, waiting for an advanced stage of the project (i.e. once you have a prototype on the bench) to address the issue of lubrication can present surprises that can significantly impact both the development time of the transmission and its cost.



production of advanced engineering systems and mechatronics solutions for power transmission. The company operates in the fields of agricultural machinery, construction and forestry equipment, energy and industry.

Founded in 1970 by the Storchi family, today the company is led by the second generation. The president and CEO is Matteo Storchi.

Comer Industries has 1400 employees, exports to all 5 continents and has 7 offices in Europe, 1 in the United States, 1 in Brazil, 2 in China and 1 in India, including production plants and commercial branches it reaches 54 countries with its products and in 2020 it registered has a net turnover of 396 million euros. In March 2019, the company opened to external investors by listing on the Milan Stock Exchange’s AIM market.

Discovering that some vital components, such as bearings, are not properly lubricated, or that there are oil leaks from the vents may require design changes, which can be costly at this late stage. In addition, there are some machine operating conditions that cannot be or are difficult to test on the bench, such asdynamic braking, acceleration, or particular temperature conditions.

To address these issues and to reduce the risks, costs and development times of transmissions, more and more companies are shifting the issue of “good lubrication” from the experimental verification phase to the actual design phase.

This has come about thanks to the availability of new numerical simulation technologies that enable the use of a virtual bench to test different operating and lubrication conditions quickly, and especially before building a physical prototype.

Models of this type complement and complete experimentation and, if used in the preliminary stages of the design, allow the project to be directed correctly and prevent lubrication or overheating problems.

One of the companies that has adopted these numerical simulation methods is Comer Industries.

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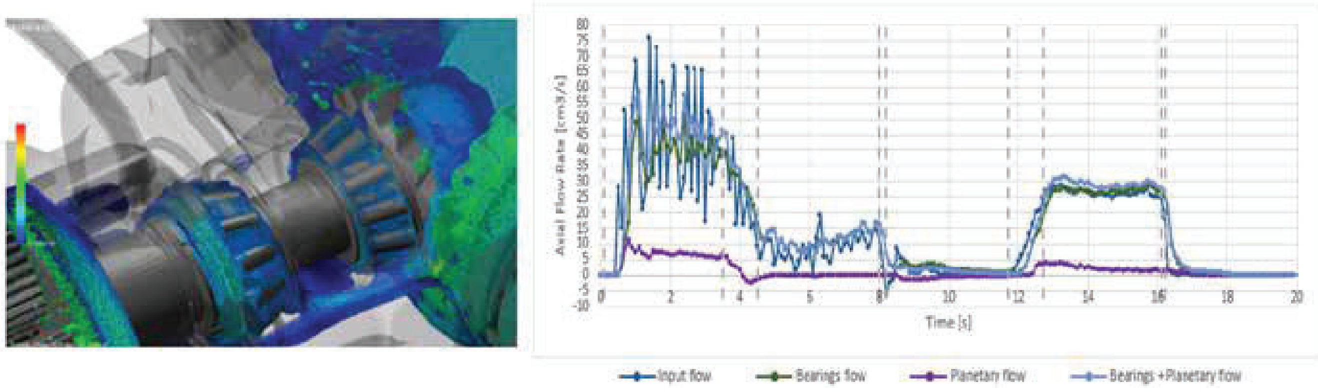
Comer Industries is one of most important suppliers of the most relevant world players in the construction of agricultural, industrial and renewable energy machinery. The mechanical components made by Comer Industries represent crucial elements for the correct functioning of combine harvesters, tractors, plows, mowers, round balers, excavators, bulldozers and wind generators.

The market on which Comer Industries works is perfectly globalized and competition has imposed the ability to ensure customers products and assistance services with unique standards of excellence in every part of the world.
One of Comer Industries’ numerical simulations for lubrication concerned predicting the path of the oil in an axle with an integrated planetary gear system input stage for a compactor.

During its operations, the compactor frequently travels uphill and downhill. The lubrication of the planetary gears is critical in these phases and must be guaranteed, as must the correct exchange of oil between the planetary gears and the axle to avoid dangerous increases in temperature.

Since the planetary gear system and the axle communicate via two oil passages, the analysis aimed to optimize the geometry of these two passages by recreating a meaningful operating condition in a single simulation consisting consecutively of a horizontal machine path phase, an uphill, a downhill, and a horizontal phase to return to the starting point.



All internal components of the axle and planetary gear system were included in the model along with two variants of the housing: the first with the existing oil passage geometry and the second with some proposed optimized oil passages. Finally, the oil was modeled at its working temperature properties: the model consisted of about six million particles.

The results obtained were very interesting and made it possible to evaluate:

- the oil redistribution between the two oil passages both qualitatively and quantitatively in terms of oil flow rates
- how this redistribution changes in the various phases - horizontal, uphill and downhill
- how the previous stage of the path affects the next stages, and how the oil behaves during transitions

It was found that, with the same oil quantity, the geometry of the current passages does not allow the oil to reach the planetary gears in all the configurations, thereby the oil exchange between the two environments is insufficient.

On the other hand, by enlarging and shaping the passages differently, it was possible to guarantee a greater flow of oil to the planetary gears and to ensure an adequate exchange of oil between the axle and the planetary gears that can avoid temperature raise.

This analysis was validated experimentally with some specific tests on a test bench: a high correspondence was obtained during the same work cycle (with the same inclinations) when comparing the simulated dynamic oil level with the experimental one.

This made it possible to implement the modifications to the oil passages without carrying out multiple experimental iterations which, since they affect the casting models, would have resulted in excessive time and costs related to potentially numerous remakes of equipment and components. In addition, there was no need to increase the oil level, so efficiency could be preserved.

About Comer Industries

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