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Development of New Hybrid Transaxle for New MPV

Hironori Nagano [1)] Hidetomo Shiota [1)] Tomohisa Taga [1)] Hiroki Kunifuda [1)]

Yota Mizuno [1)] Tatsuo Obata [1)] Iori Matsuda [1)] Shinichiro Suenaga [1)]

1) Toyota Motor Coporation 1, Toyota-cho, Toyota, Aichi, 471-8572 Japan

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As a measure against global warming, it is required to respond to carbon neutrality worldwide. The demand for environmental performance continues to increase for automobile companies as well. On the other hand, in addition to fuel efficiency, other requirements such as driving performance and design are also increasing, and it is indispensable to develop vehicles that meet various requests. To achieve these goals, Toyota has developed a new hybrid transaxle (PA10) to be installed in the new MPV.

The PA10 has increased the allowable torque capacity while achieving a significant downsizing compared to the conventional model. In addition, high efficiency has been achieved as by reducing machine loss. In this article, detail technology is explained that made these possible.

(1) Downsizing of transaxle

By combining the utilization of MBD and AI with precise actual measurement, the shape of the tooth surface was designed to be optimal as a whole transaxle, and the gear was made into a small module. The PA10 achieved not only 5% smaller module than the conventional model P610 but also achieved a torque capacity equivalent to that of the medium-capacity model P720, and contributed to the downsizing and higher capacity of the transaxle. As for the differential, we have newly developed a compact high-strength differential gear and realized a compact differential with a physique of -8% compared to P610. The compact high-strength differential gear secures the tooth root strength by increasing the tooth thickness, while reducing the shared load by improving the meshing ratio and ensuring the tooth surface strength. As a result, we have succeeded in improving the fatigue strength by 15% compared to P610.

(2) Loss reduction including the adoption of newly developed low-viscosity oil

For PA10, Toyota developed and adopted ultra-low viscosity oil exclusively for electric vehicles for the first time. The focus on running at low oil temperature, which is characteristic of HEV vehicles. We have developed low-viscosity oil for electric vehicles at low temperature in order to reduce oil agitation loss at low temperature. The trade-off for lowering the viscosity are the decrease in reliability such as fatigue damage, seizure, and wear caused by the decrease in oil film thickness and the increase in metal contact. In the newly developed oil, the oil film thickness was ensured by adding phosphorus-based additives and calcium-based additives, and adding an oil film-forming polymer with an adsorbent group. In addition to this, by optimizing the oil discharge position of the lubricating pipe, the reliability equivalent to that of the conventional ATF adopted model was secured.

Utilizing these new technologies, the PA10 was able to achieve high capacity while achieving downsizing and significantly reduce mechanical loss. We are confident that it will be installed in a wider range of vehicles in the future and can contribute to carbon neutrality in the global market.

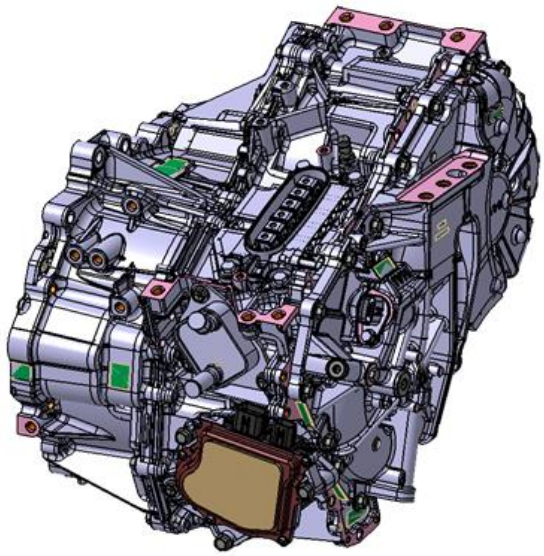

Fig. 1 New hybrid transaxle PA10