# Oil-pump sizing

Researchers from Hinduja Tech investigate options for low friction and power consumption.

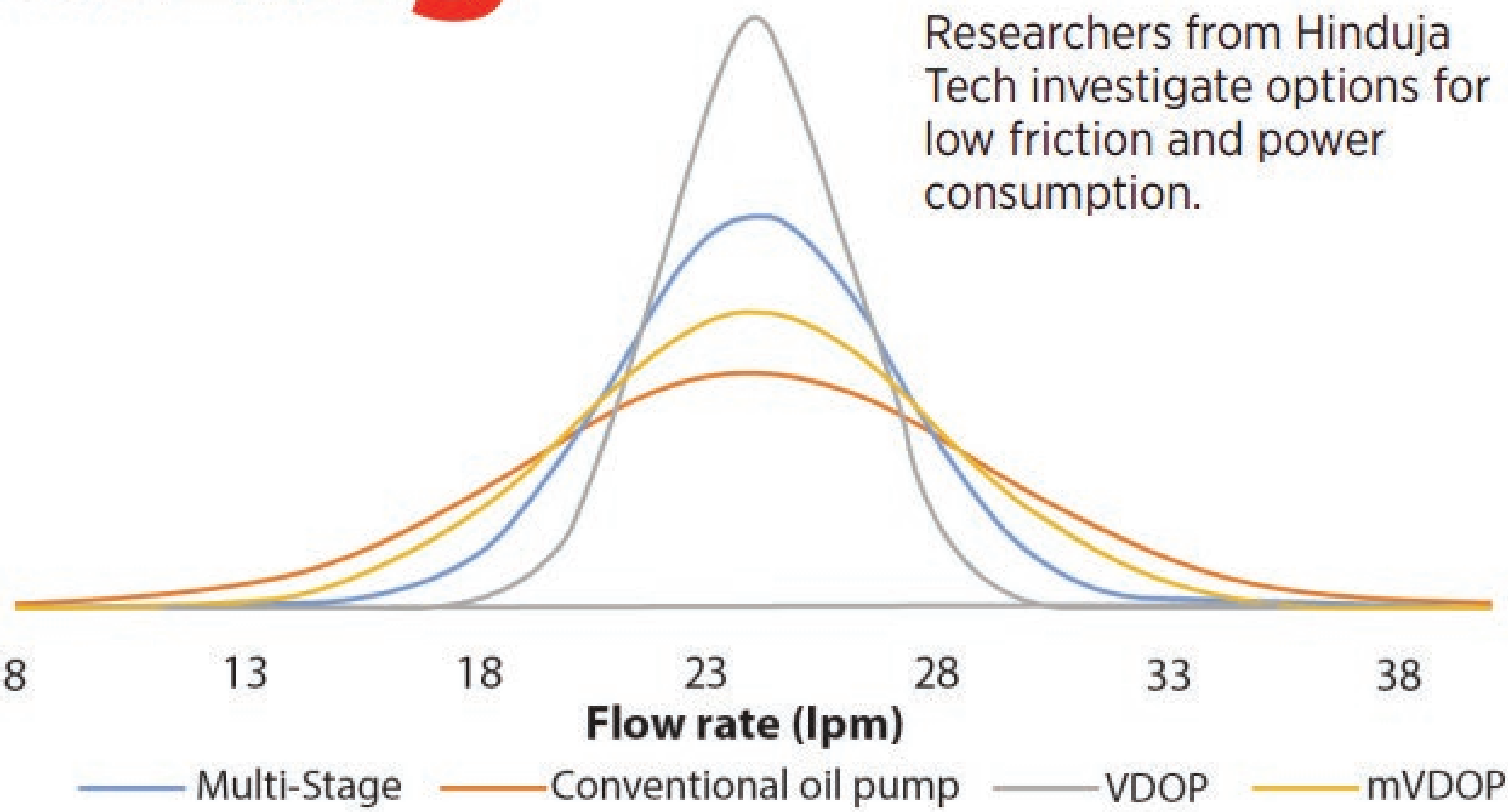


**Figure 1: Flow distribution in various oil pump types.**

Stringent emission norms are pushing OEMs to focus on making powertrains more efficient, making them look for all possible ways to reduce fuel consumption. The oil pump's contribution to accessory power loss of the engine is significant. Various OEMs have come up with different and new thought processes to counter power loss at oil pumps.

An effective lubrication system is necessary for an engine because of its tribology, hydraulic, and thermal functionality. A modern-day engine puts increased strain on lubrication systems due to additional components and higher thermal loads. The flow estimation for an oil pump is based on the flow requirement of the components in the system.

Conventional oil pumps are designed for high-temperature low-speed flow and pressure requirements. These methodologies tend to be simpler but lead to excess flow conditions at other operating points. Various technologies are implemented over the conventional oil pump design to improve overall efficiency.

Conventional oil pumps are of external gear or gerotor design. They are either driven directly through crankshaft, gear drive, or chain systems. Conventional oil-pump flow has a high level of variations/distribution in output. Figure 1 shows various distributions in different oil pump types. These distribution outputs are caused by linearity in flow increase with respect to rise in engine speed. An increase in flow overshoots the actual demand of the system leading to increase of pressure.

## Variable displacement

A variable-displacement oil pump (VDOP), typically a solenoid actuated mechanical pump, employs a multistage pump strategy used by the OEMs and Tier 1s for power saving but are also market and cost driven. Another similar concept is a mild variable displacement oil pump. This contributes to power saving as well as counters the higher cost of VDOPs.

A variable-displacement oil pump addresses the problem of the conventional oil pump by keeping the output flow as close to system demand. VDOP lowers the variation in output by self-regulating the flow to the requirement of the system based on the feedback from the system. The feedback from the system is in pressure form. The pressure is picked up either at the outlet of the pump, in the gallery, or combination of both. The flow into the system is subsequently modified to meet the requirement. This reduces the overall system pressure and hence lowers power consumption.

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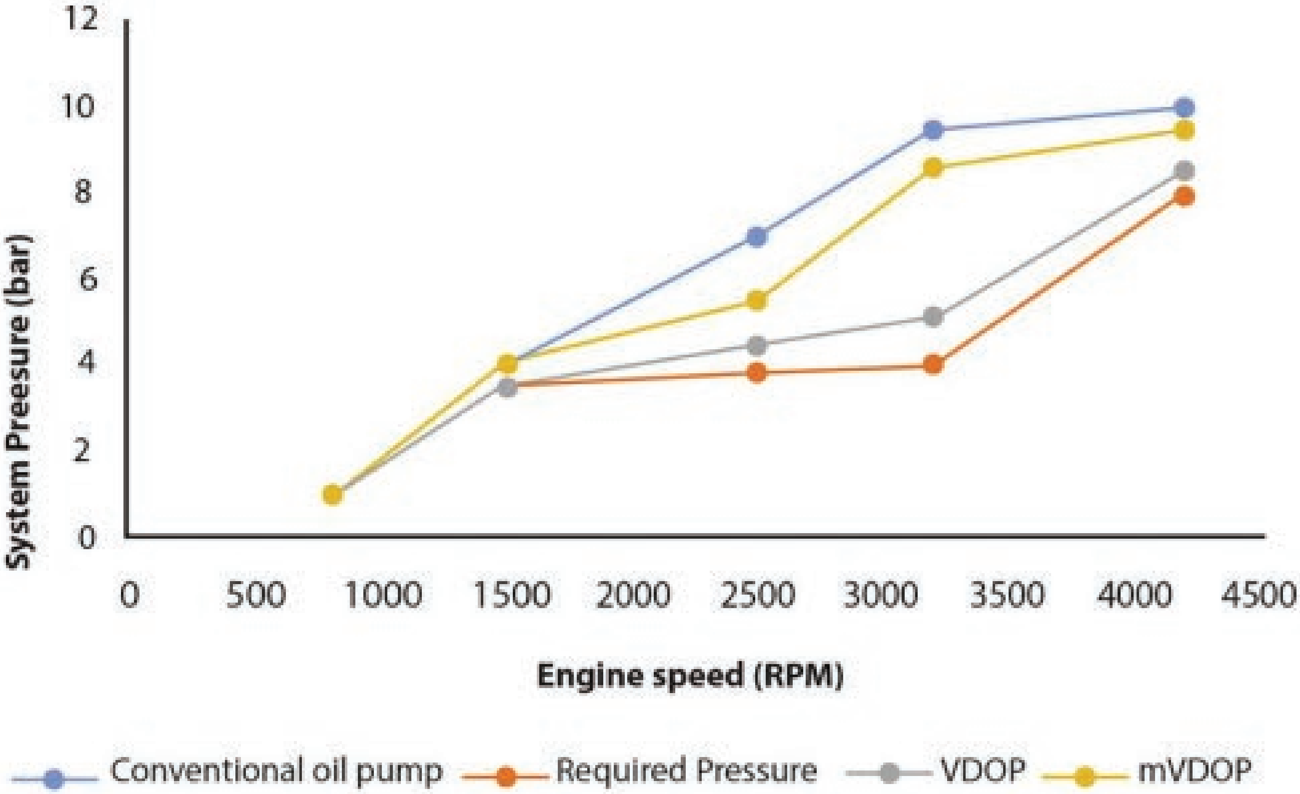



**Figure 2: System pressure various engine speed.**

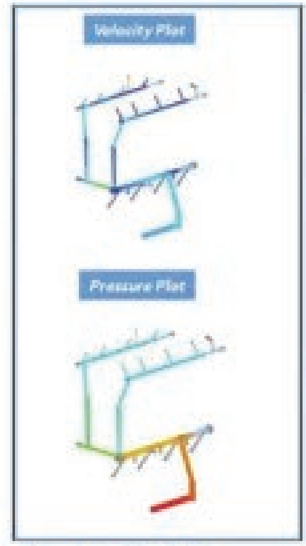



**Figure 3: A CFD analysis of the oil passage.**

The flow regulation can also be achieved through the set pressure of the oil pump relief valve. The oil pump concept implemented is a two-stage oil pump called mild-VDOP (mVDOP). The two-stage setting of relief valve brings out a two-mode operation of the pump. The first stage takes care of the pressure surge during cold-start and high-speed operations. The second stage controls the flow during the cruise range of the engine. During the cruise condition, engine operation is stabilized. Conventional oil pumps have flow regulation set at a region beyond cruise region, leading to higher displacement from the pump into the system. Using mVDOP, the second stage of the oil pump relieves excess flow and lowers the system pressure. Thus, an advantage of power saving is achieved.

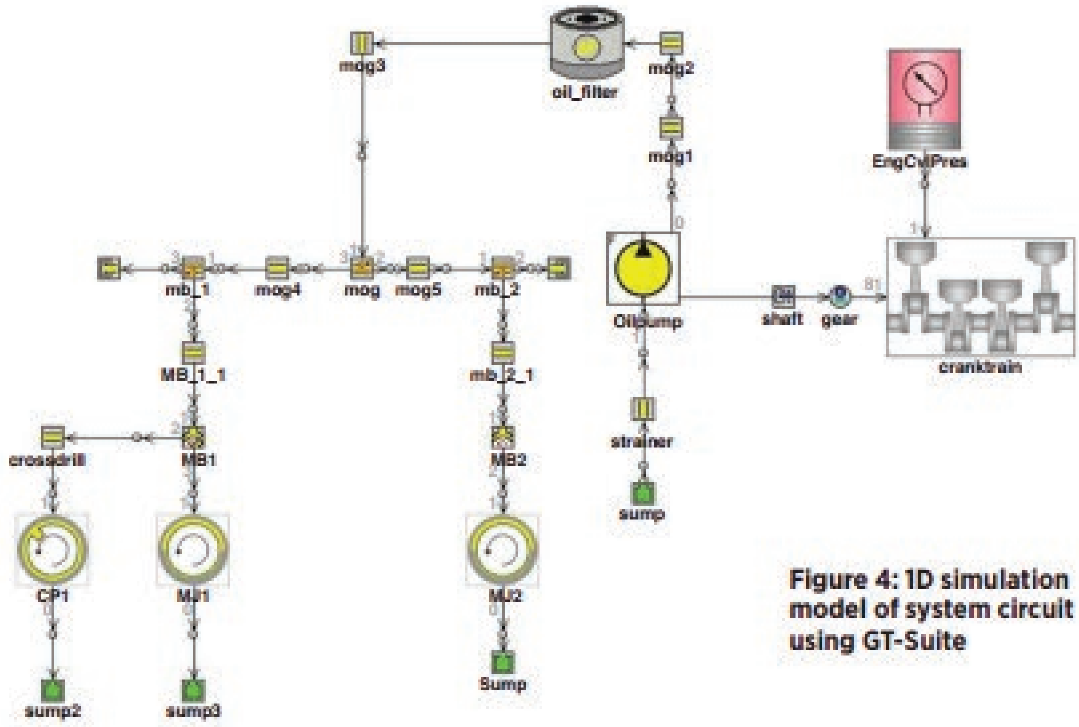
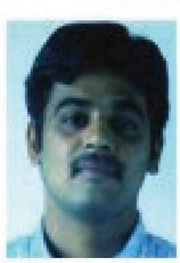



**Figure 4: 1D simulation model of system circuit using GT-Suite**

## Case study

The operating condition of every component was evaluated in an mVDOP trial to define an overall system's definition. The pressure of the system was estimated based on the orifice diameters of the flow passages, pressure drop across filter, and other components of the system. Components considered in the system were oil filter, oil cooler, piston-cooling nozzle, HLA, and vacuum pump. The flow rates for these components were specified by the manufacturer.

The pressure of the system was verified through CFD. Based on the results, orifice diameters were optimized for nominal restrictions. A 1D simulation model for the system was carried out through GT-Suite. The data were verified for a newly developed 1.0-L three-cylinder diesel engine. Thus, a concept of power saving oil pump was conceptualized, implemented, and validated, and the mVDOP was found to give an efficiency benefit of 3-4%. ■



**Mr. R. Madhusudhan, System Engineer, Powertrain, and Mr. Meenakshi Sundaram, GM, Powertrain, both of Hinduja Tech Ltd., Chennai, wrote this article for *Mobility Engineering*.**