# Explaining COR Pump Technology: Part 2

*Pumps are generally divided into two categories: hydrostatic and hydrodynamic. Hydro dynamical pumps operate on a hydrodynamic physical process in which there are pressure and energy changes in the proportional square of the speed of the rotor. Hydrostatic pumps (commonly referred to as positive displacement pumps or PD pumps) increase and decrease volume of the pump chamber during operating cycle. In order to increase efficiency, some hydrostatic pumps have adopted COR Pump Technology.*

*In part 2 of this article, different simulations are considered which illustrate the benefits of COR Pump Technology.*

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## Flow-Rate Simulation (CFD)

To define the best approach for CFD simulation of COR pumps, a review of the different methodologies used for the simulations of gerotor, external gear and crescent pumps was conducted. Studies considering the influence of leakages on the interactions between the mechanical parts on the leakages were analyzed. The COR pump system includes a sophisticated software which gives operators the ability to study the behavior of the fluid in four dimensions, and to optimize conditions with regard to a given specification. The software also generates the necessary CAD data for the design of the pump.

Goals achieved by running CDF simulations in the R&D phase of a COR pump include:

- Flow & flow ripple calculation
- Pressure field & pulsation analysis
- Volumetric loss calculation
- Viscous loss calculation
- Torque calculation
- Volumetric, mechanical & total efficiencies

CFD simulation steps in COR pump technology consist of:

- Adjustment of the geometry
- Mesh generation using special grid generator
- Setting of initial & boundary conditions (pressure, speed, etc.)
- Solving and monitoring the solution
- Results analysis
- Making design decisions

Basic study of CFD simulation on COR pump technology was done on a COR200 pump used for different applications in automotive industry such as: diesel fuel pump, ICE water injection pump and oil lubrication pump.

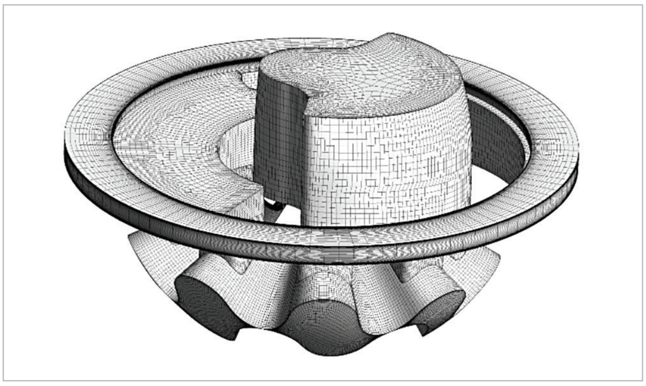


*Figure 1.*

Simulations were as follows:

- Theoretical flow @ 3000 RPM is designed for 140,6 l/h.
- Simulated flow result at 0 bar is 140,0 l/h , at 10 bar 135,7 l/h.
- Simulated from ripple at 0 bar is 8 l/h (5,8 %) and at 10 bar 9,2 l/h (7,3 bar).
- Calculation of 5 leakage paths was done with analyzation of separate contributions.
- Comparison of CDF simulation and experimental result shows lees than 5% difference.

## Experiment & Validation Results COR200

CFD simulations, physical validations and performance tests were performed on COR pump technology under different conditions. Results show stable flow at constant e-motor speed, at pressures up to 10 bar where volumetric efficiency was measured up to 90% at flow around 180 l/h up to 10 bar.

The same pump designs were tested in oil fluid at a temperature range between -20°C and 80°C to determine electrical power change (increase/decrease) caused by change of oil viscosity.

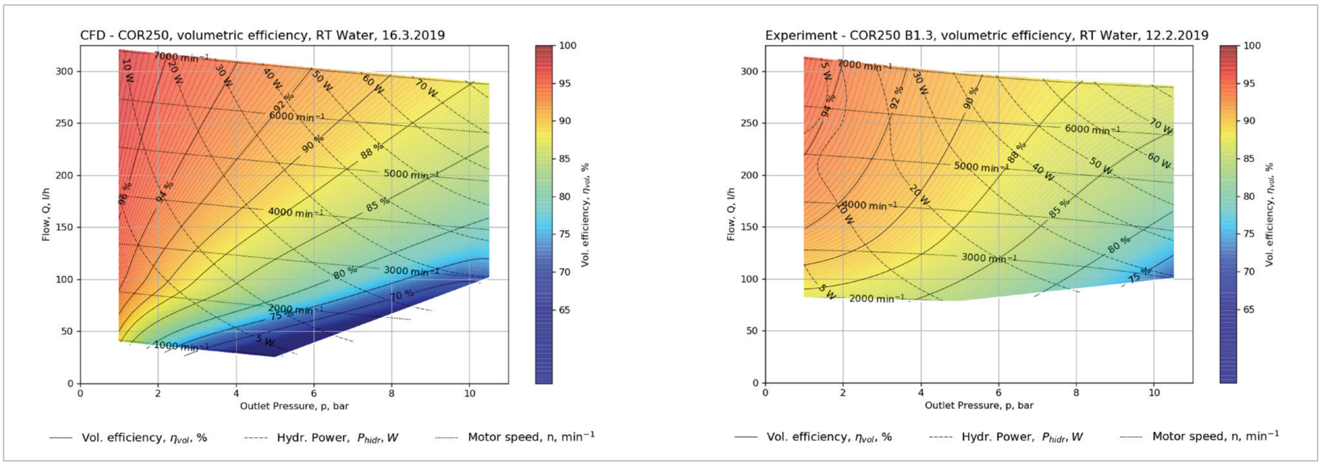



*Figure 2: Comparison of pump volumetric efficiency calculated with CDF simulation (left) and real experimental measurements (right).*

Characterization of COR200 pump at different pressures and temperatures show stable flow of liquid and different testing conditions (temperature, pressure). Performance testing was done on the COR200 pump with integrated motor in transmission oil at 50°C with a max pressure of 7 bar (flow around 200 l/h) and also tested for flows up to max 300 l/h at 2 bar of pressure.

The results found that the maximum power consumption of integrated motor/controller can be up to 230W.

Volumetric efficiency over temperature rage -20°C – 80°C is > 90 %, with overall system efficiently up to 70% was also noticed. Pressure drop over pressure range was measured in range < 1% /bar).

Durability testing was done at 60°C at constant pressure of 3 and 7 bar. Flow drop in range 3-8% was noticed over 10.000 h. 3D optical scanning of pump surface elements shows wear in range 5-20 microns and confirms that pump has self-adaptive behavior during lifetime.

Performance testing was also analyzed at pressures up to 20 bar with external e-motor in speed range between 1000 and 5500 RPM at temperatures between -10°C and 80°C. Results show that there is > 96 % volumetric efficiency at temperatures between 0°C and 30°C. Drop of volumetric efficiency < 1 % /bar was observed over tested pressure range. Required torque between 0,2 – 0,4Nm was measured to achieve pressure 5-20 bar at -10°C with approximately 50% of torque decrease at temperature 80°C. The pump's total efficiency in pressure zone 5-20 bar at temperature of oil 80°C was 60-75%.

| Pressure (bar) | Flow (l/h) | Motor Torque (Nm) | Temperature (°C) | Pump Efficiency (%) |
|---|---|---|---|---|
| 5 | 550 | 0,5 | | 45 |
| 15 | 550 | 1,1 | 30 | 65 |
| 25 | 550 | 1,75 | | 70 |
| 5 | 500 | 0,4 | | 46 |
| 15 | 500 | 1,25 | 100 | 52 |
| 25 | 400 | 1,9 | | 45 |

*Table 1: Highlights the required motor Torque at different output pressures & fluid temperatures at motor speed 3000 RPM and output flow between 400 and 550 l/h.*

## Experiment & Validation Results COR600

COR600 pump prototype was designed and produced to test pump performance up to 25 bar and flow up to 1000 l/h. Based on a series of simulations, Table 1 shows what was determined.

Motor torque was measured at different temperatures of oil (30°C and 100°C) for output pressures between 3 and 25 bars. It was also measured for liquid flows between 100 l/h up to 1000 l/h with a motor speed range of 1000 – 5000 RPM.

Volumetric efficiency of pump unit at output pressures from 5 to 25 bar measured in range 93-97% at output liquid flow between 200 and 800 l/h at oil temperature 30°C.

At 100° C, oil temperature volumetric efficiency dropped by approximately 10% due to lower liquid viscosity and consequently increased internal leakage in pump unit.

## Benefits of the COR Pump Technology

COR technology allows for the design of a gear pump with excellent overall efficiency for the range of middle pressures. The possibility of moulding parts of the COR technology from polymer also leads to cost advantages.

Due to the chemical resistance, the COR technology can be adapted for use in various media (liquids and gases). The unique shape of the trochoidal gears is also beneficial for the durability properties. The pump has a self-tightening property, which means that very little performance is lost during the lifetime.

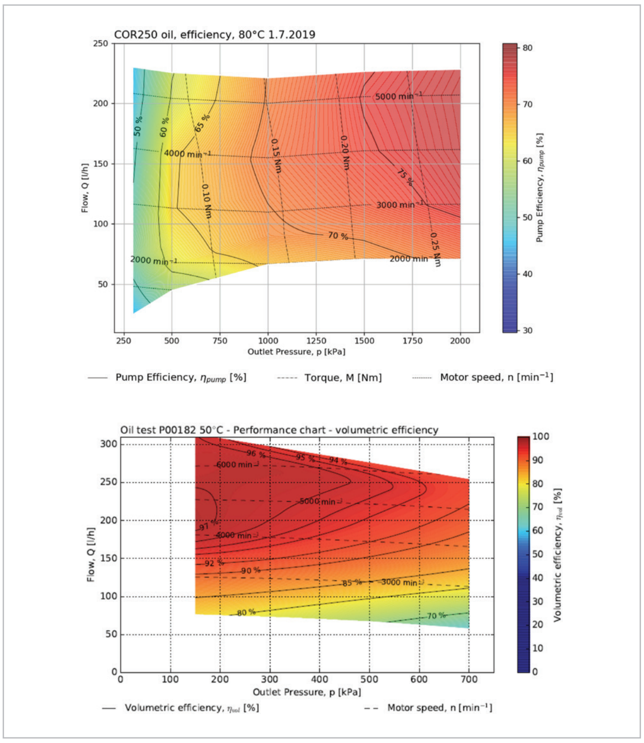



*Figure 3: Comparison of pump overall efficiency in oil at 80°C (up to 20 bar) – top and volumetric efficiency in oil at 50°C (up to 7 bar) – bottom.*

The main advantages of COR technology are:

1. Cost advantages, due to the small number of parts, and production is done in plastic injection moulding;
2. Low wear, due to the hydraulic balancing of the rotors;
3. Particle resistance;
4. Self-priming;
5. Pumping fluids and gas (2-phase is possible);
6. Simple assembly/disassembly;
7. High reliability (due to the small number of components);
8. High ratio between liquid displacement/pump size.

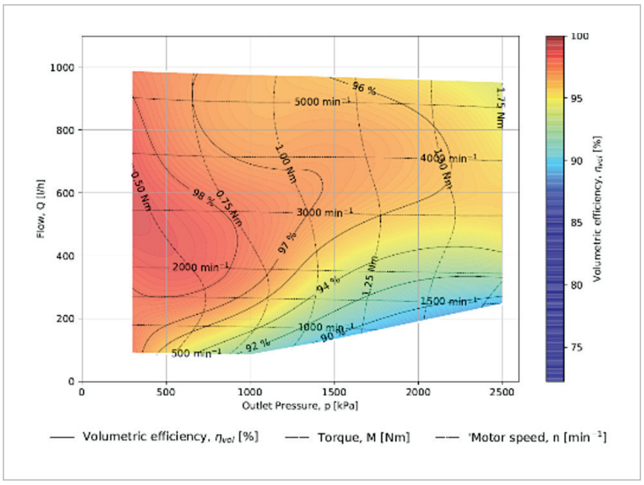
COR pumps are suited for, but not limited to, mobile mobile and stationary applications using various drives (mechanical, electrical dry or wet running motors, others) for example:

### *Pumps*

- Oil Pumps (automotive, industrial, residential)
- Mechanically controlled oil pump (automotive)
- Fuel (diesel and gasoline) pumps (automotive, industrial)
- Circulator pumps for water (automotive, industrial, residential)
- Circulator pumps is solar application for water/glycol (industrial, residential)
- Pressure booster pumps for water
- Carbonator pumps for aqueous suspensions
- Chemical pumps for various liquids
- Transfer pumps for various liquids (portable or stationary).

### *Compressors*

- Small compressors (automotive, industrial, residential)
- Compressor for fuel cells
- Compressor for refrigerant liquids.
- Heat pumps




**Be sure to read Part 1 of this dynamic technical article in the June 2020 issue of *Pump Engineer Magazine.***

## About the Authors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