Libralato Cycle

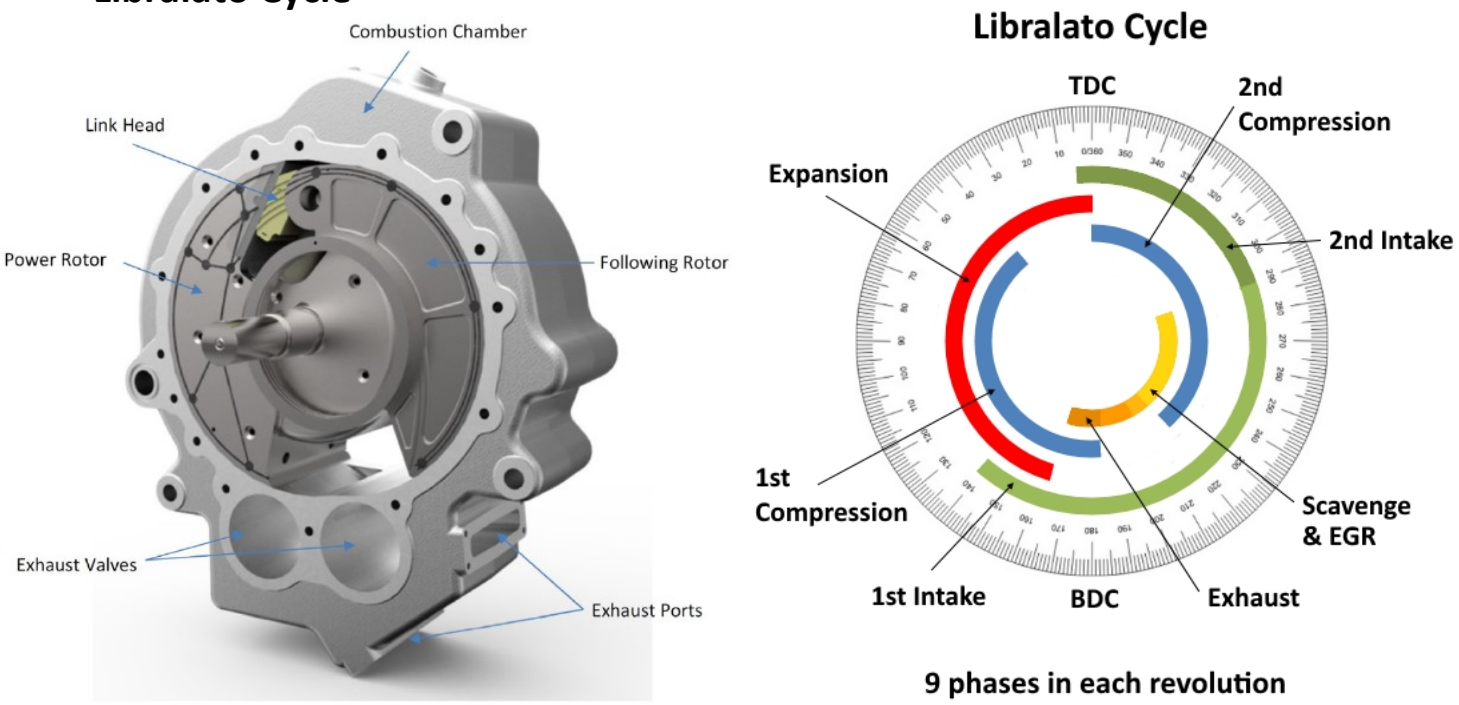

Fig 1. Libralato Engine Parts and Cycle

The Libralato engine has a revolutionary new 9-phase cycle, with all 9 phases completed in each rotation of the engine. The cycle is complex to explain and sequence due to the dynamic formation and exchange between three distinct chambers working in parallel (intake, compression and expansion). The combustion chamber is at TDC, within the water-cooled housing. Each 'cylinder' has two intake valves and two exhaust valves. Intake valve 1 is on the face of the engine close to the main shaft (cannot be seen on the illustration). Intake valve 2 uses exhaust valve 1 (on the left) but takes a different path which is separate from the exhaust path.

Rotating counter-clockwise, the Libralato 9-phase cycle is:

Phase 1: 0^{o} – 163^{o} - combustion takes place in a discrete combustion chamber at TDC; an expansion volume delivers power on the left side.

Phase 2: 40^{o} – 184^{o} - a first stage compression volume (low CR) is formed on the right side.

Phase 3: 139^{o} – 290^{o} - air enters intake valve 1 into an expanding central intake volume.

Phase 4: 163^{o} – 184^{o} - exhaust valve 1 allows the exhaust gas to exit under its own pressure.

Phase 5: 184^{o} – 210^{o} - the first stage compression volume on the right connects with the combustion chamber at the top and through this with the expansion volume on the left. The first stage compression scavenges both the combustion chamber and the expansion volume. Gas exits via exhaust valve 2.

Phase 6: 210^{o} – 222^{o} - the expansion volume connects with the compression volume allowing exhaust gas recirculation at atmospheric pressure.

Phase 7: 222^{o} – 290^{o} – scavenge of the expansion volume continues via exhaust valve 2.

Phase 8: 222^{o} – 360^{o} - a second stage compression volume (high CR) is formed on the right side and forces air and EGR into the combustion chamber, where the fuel is injected and the spark ignites the mixture.

Phase 9: 290^{o} – 5^{o} - the expansion volume merges with the intake volume and air continues to enter via intake valve 2 (more EGR).

Fig 2. Libralato Engine Key Features and Benefits

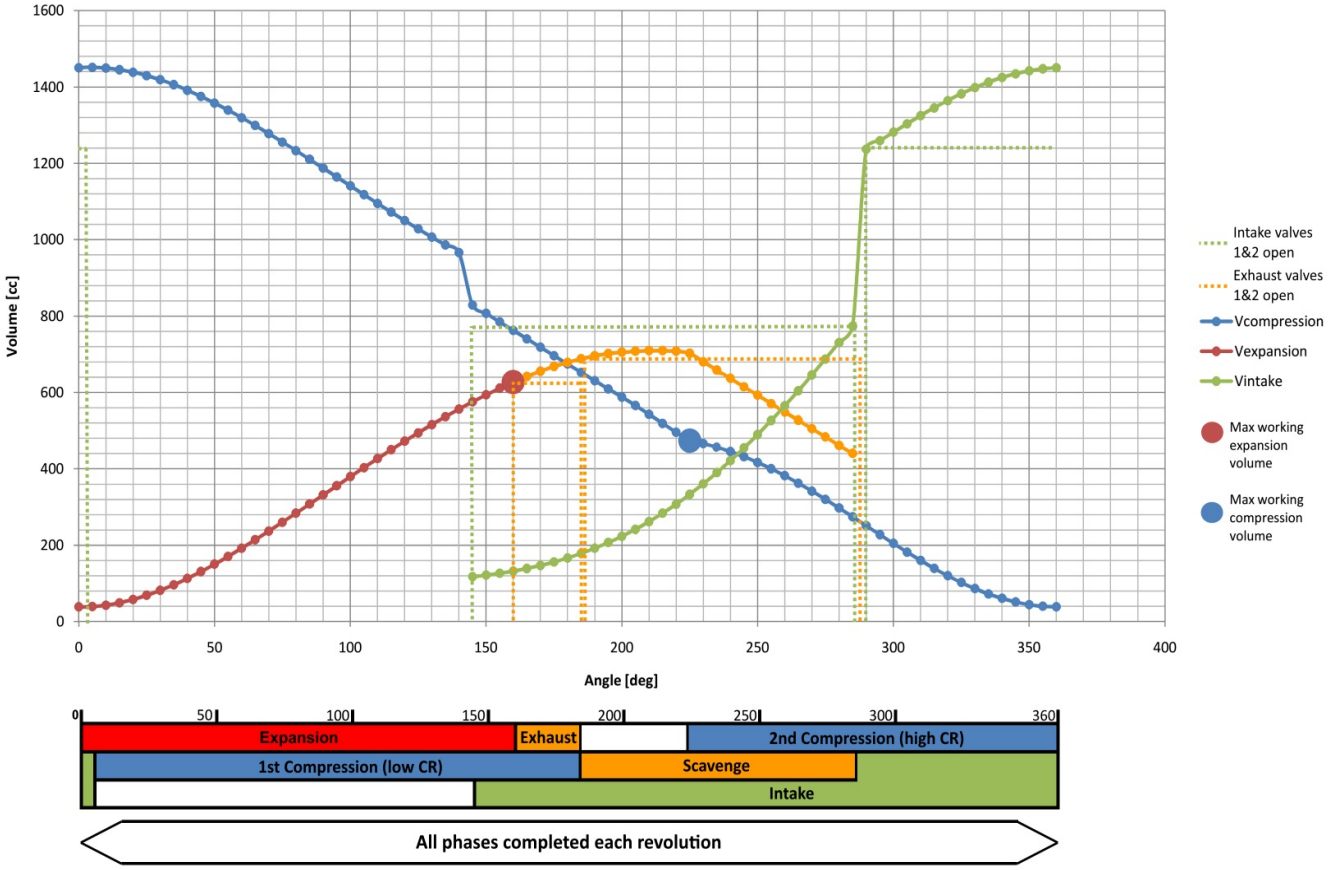

Fig 3. Libralato Engine Cycle and Chamber Volumes

Amongst other things, Fig 3. shows that there is a very high rate of air flow through the engine. For a one 'cylinder' 25kW engine, the maximum intake volume is 1,448cc compared to the maximum working compression volume of 474cc and the maximum working expansion volume of 627cc. In addition to the water cooling, this excess air provides several advantageous cooling functions: it scavenges and cools the combustion chamber, allowing a higher compression ratio and higher thermal efficiency whilst avoiding engine knock; it scavenges and cools the expansion chamber, helping to balance the temperature difference between the two sides of the engine; and it cools both rotors, prolonging engine life. The engine's architecture is well suited to direct injection, accurately controlling and directing the quantity of fuel used in each cycle with no air throttling and consequently reducing pumping losses. Since the combustion chamber is separate but dynamically linked to the compression and expansion volumes, it can be shaped to a near hemispherical form for optimum combustion flame propagation.

The expansion ratio (16.26:1) is greater than the compression ratio (12.28:1), which allows more complete conversion of the pressure of the expansion stroke into useful work. The effect is similar to the Miller cycle, but is not compromised by fuel-air 'blow-back', which works against the charging in any boosted engine. Since the power rotor is directly connected to the shaft, the transfer of torque is immediate and significantly more effective than a connecting rod-crankshaft arrangement. The surface area of the rotor face expands as it rotates, due to the sliding action of the rotors. This helps to maximize the work extracted as the pressure drops and maintains relatively high torque. Since the post expansion-exhaust volume connects with the 2nd compression volume at atmospheric pressure and subsequently merges with the intake volume, the engine mechanism itself provide an element of exhaust gas re-circulation, one of the most effective means of reducing NOx emissions. The engine's dual exhaust port arrangement allows for use of a standard catalytic converter without expensive after treatment.