# Hydraulic System vs. Electric Motor

By: Ryan Harker

Minimum Requirements

- 0-1900 RPM minimum, 4,000 RPM stretch goal
- 24,900 in-lb (2,814 N-m) continuous torque
- 560 KW Continuous power
- Minimum possible weight

Electrical Engine Option

- Magnix's Magni500 Motor
- 24,900 in-lb (2,814 N-m) continuous torque
- 1900 RPM Base speed
- 2600 RPM Max speed
- 560 KW continuous power
- **297 lbs (135 kg)**
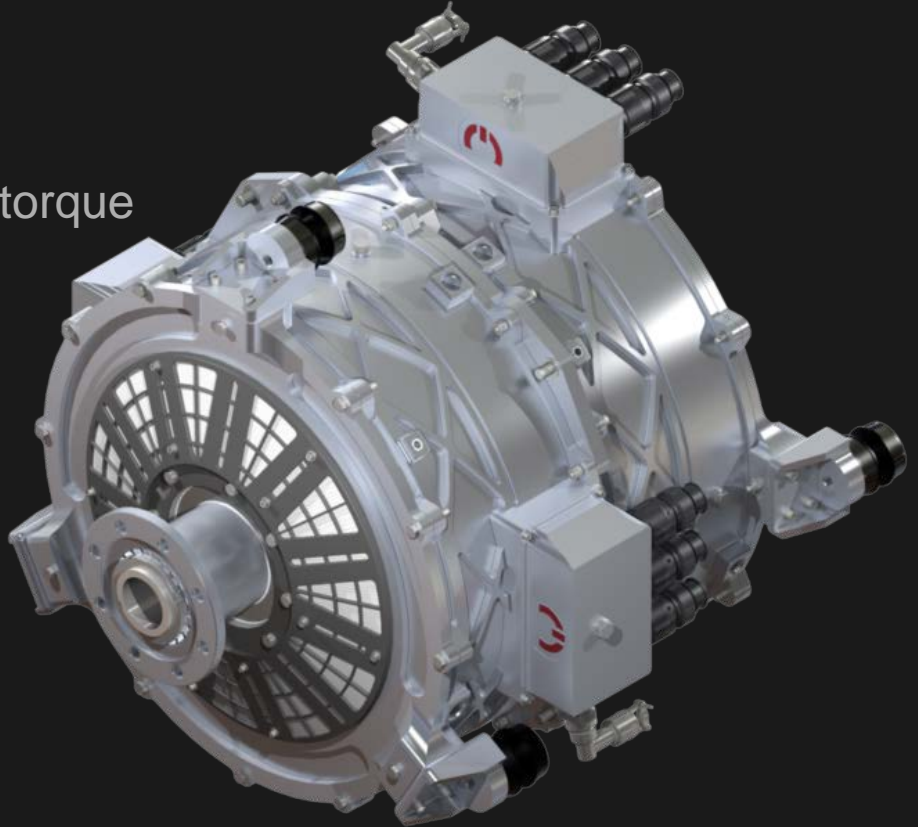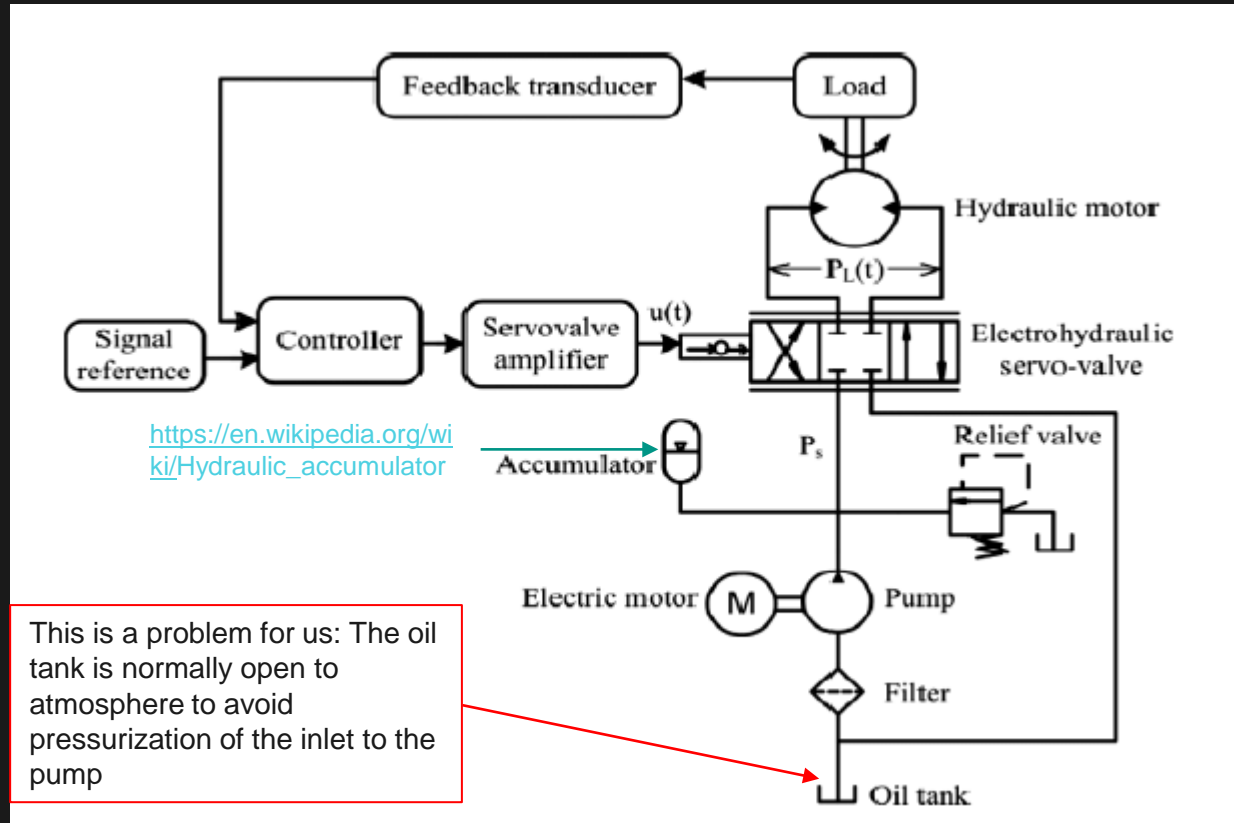
magniDrive - 100

The magniDrive - 100 is a multi-application, high-performance power electronics solution including both the inverter and motor controller functions. It is designed as bi-directional, capable of both DC/AC operation for propulsion and AC/DC operation for generation. It is suitable for HVDC networks of up to 800 VDC. Designed for unpressurized operation, the magniDrive combines high thermal performance, EMI immunity and lightning protection for metallic and composite structures. The magniDrive-100 can support both analog throttle inputs (for use in retrofits for example) as well as Fly-By-Wire controls (for newly designed aircraft).

Output power	170 kw
magniDrive Weight	12 kg / 26 lbs 4X = 48 kg / 104 lbs
Interfaces	CAN x4, RS485, PT1000, pressure sensors
Voltage (HVDC)	400 - 800 V

Block diagram of a hydraulic motor system

The electric motor (only) system diagram would have a motor driver/power conditioner and similar feedback instrumentation.

https://en.wikipedia.org/wiki/Hydraulic_accumulator

This is a problem for us: The oil tank is normally open to atmosphere to avoid pressurization of the inlet to the pump

Hydraulic Motor Option - Hydraulic Motor

- Eaton ME Series Piston Motor

Producing:

- 142,796 in-lb Torque (16,133.8 N-m)
- (about 5.7X more torque than we need)
- 1,000 RPM
- **271.17 lb (123 kg)**

Perfect for applications such as directional drilling machinery, top head drives, marine winches and more, Eaton ME Series motors feature a double swash plate design and multiple opposed pistons. The low-speed, high-torque design of the ME Series results in smooth operation all while reducing torque ripple for optimal power output.

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I found one in our torque range,
https://www.eaton.com/us/en-us/skuPage.134ME00019C.specifications.html

PRODUCT NAME
Eaton Dowmax ME Series Axial Piston Motor
CATALOG NUMBER
134ME00019C
MODEL CODE
ME MOTOR ME750BKE DWG
PRODUCT LENGTH/DEPTH
22.12 in
PRODUCT HEIGHT
11.69 in
PRODUCT WIDTH
11.88 in
PRODUCT WEIGHT
271.16 lb

PRODUCT SPECIFICATIONS
SPECIAL FEATURES
None
TYPE
Axial
MAXIMUM DISPLACEMENT
750 cm³/rev
TORQUE
3280 Nm
MOUNTING TYPE
Flange
BRAKE RELEASE PRESSURE
174 Psi
PRESSURE RATING
3988 Psi

Specs do not say what its maximum speed is.

Hydraulic Motor Option - Pump

- Eaton Hydraulic Piston Pump
- Used piston type pump because it tends deliver higher pressures with little added
- **55.1 lbs (25 kg)**

Loader backhoes, Vibratory cable plows, Mining machinery, Dump truck lifts, Agric
equipment, Container handling, all terrain and truck cranes, Vibratory cable plows, Mining machinery and tunnel boring equipment, Utility boom, off road dump and refuse trucks, Material handling trucks and rough terrain fork lifts, Concrete and asphalt pavers, Feller/bunchers, forwarders and log loaders, Crawler dozers, Articulate haulers, Mini excavators

Hydraulic Motor Option - Gearbox

- The hydraulic motor shown puts out more torque than we need, so we could sacrifice torque to gain speed.
- 5:1 Gearbox
- Speed **increaser**, not reducer
- https://www.rjlink.com/speed-increasers/
- These are heavy

Hydraulic Motor Option - Filter

- Sealed Fitting
- Heavy Duty
- Motor needs 1.43x10^6 cm^3/min of oil
- 8x filters needed
- Each filter weighing 15.2lb(6.89 kg)
- **121.6lb(55.12 kg)**

Final Thoughts

- The hydraulic pump (without pump motor) and hydraulic motor only weight is 447.9 lbs (203.12 kg) No plumbing, reservoir, accumulators, speed increaser, etc.
    - We don't know how much power the pump motor needs or the total system efficiency
- The Magni motor weighs 297 lbs (135 kg) and its drivers weigh 104 lbs (48 kg), for a total of 401 lbs (183 kg) (>93% efficiency)
- The Magni500 Motor is still the best option
    - Not only does it save on weight and money but it saves a lot on complexity of the system as a whole.