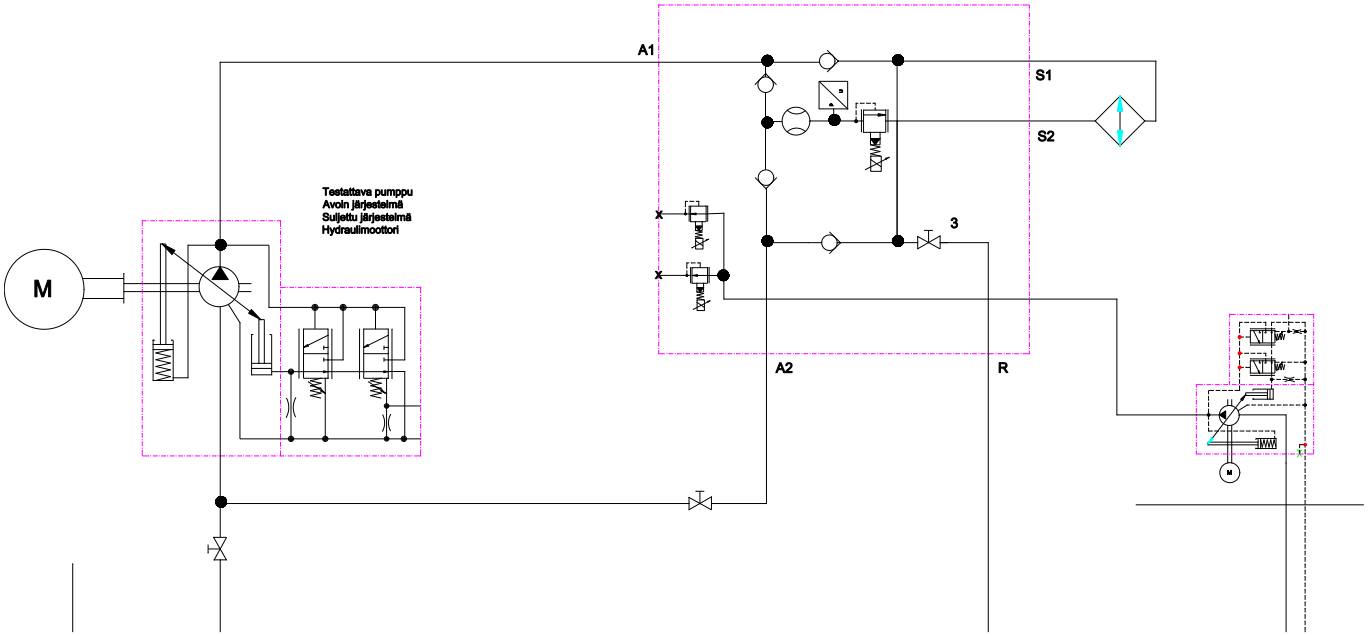
BOSCH REXROTH HYDRAULIC BENCH CONCEPT DESIGN

1. Concept

Updated version of the current bench with 315 kW active power?. Open and closed circuit pumps and hydraulic motors are tested in the same base. Electrical motor operates the hydraulic motor, which is functioning as a pump and pressure relief valve as a load.



Pros

- Testing method stays the same for pumps
- Simple
- All the pumps and motors are connected to the same base
- Cheap

Cons

- All the power is converted in to heat

Improvements

- To control the exhaust air from the cooling system to outside when the indoor temperature gets too high
- Cooling power is increased to correspond to 315 kW power

System management

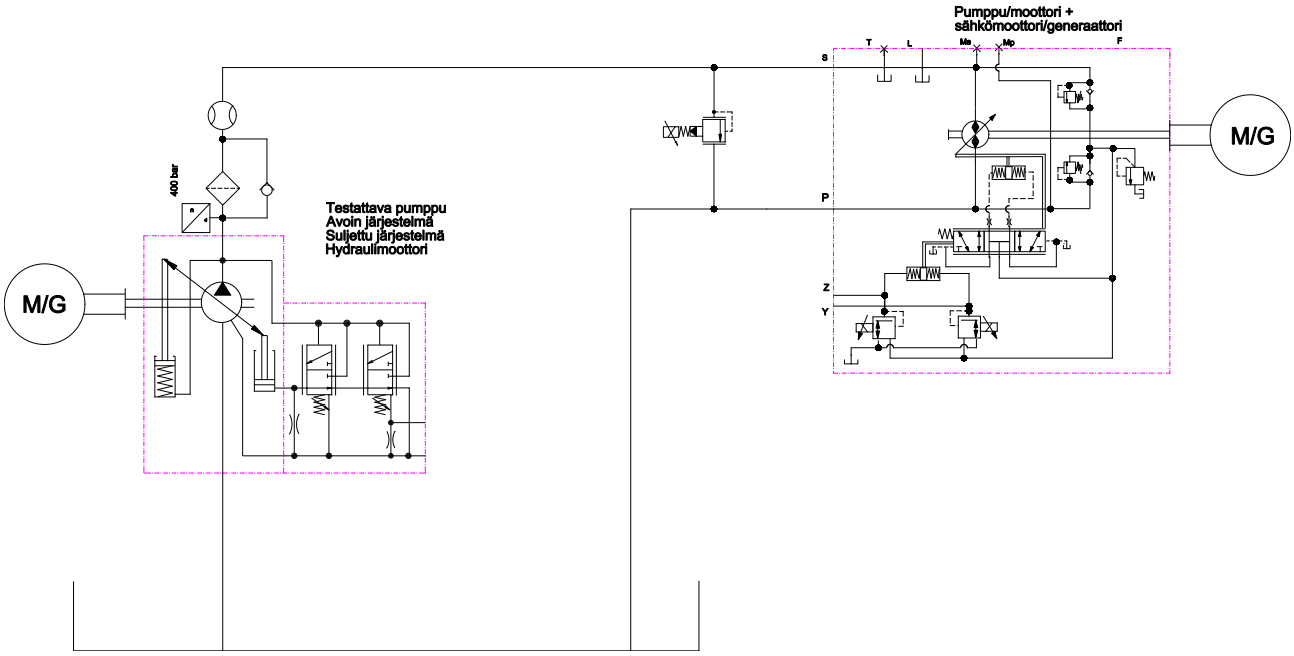
- Adjusting the desired value of the pressure restricting valve

Motor is assumed to be able to be tested like a pump!

2. Concept

A hydraulic pump/motor is used as a load for the pump/ motor being tested. The load causing pump/motor rotates an electric motor/generator.

The electric power gained from the generator is fed back to the power grid through a regenerative drive.



Pros:

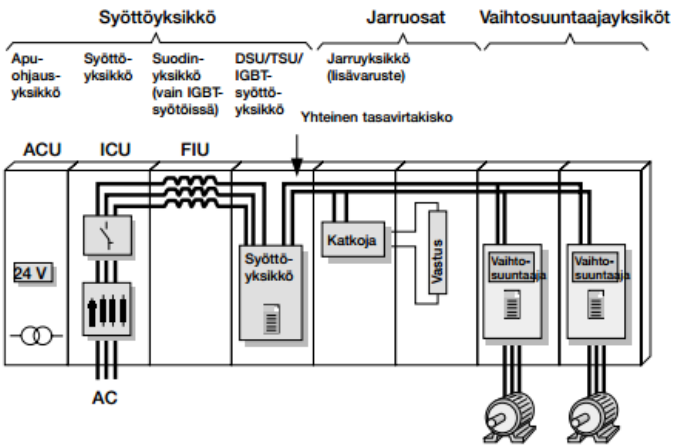
- Allows testing of open and closed circuit pumps and hydraulic motors in the same base.
- Both electric motors can function as a generator, allowing the test power to be fed back in to the grid in all situations.
- Smaller power losses.
- Requires less cooling.
- Works with open and closed circuit pumps. When testing a hydraulic motor the auxiliary pump/motor (right) functions as a pump and is rotated by the electric motor (right). The tested pump is attached to the same base (left) as a pump would be and its electric motor functions as a generator.

Cons:

- Expensive, two electric motor/generators (2*315kW) are needed.
- Large power need.

Things to consider:

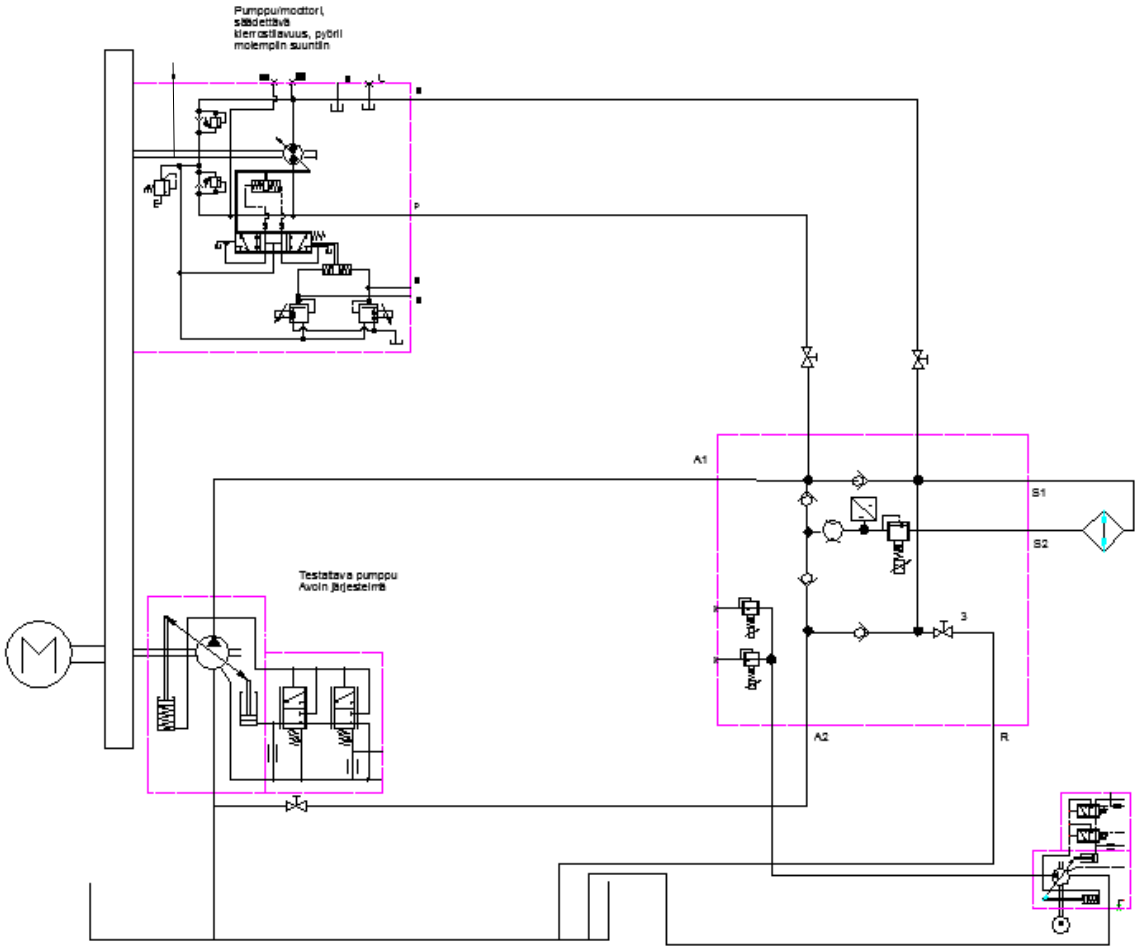
- Does it fit in the room?
- How does adjusting the pressure work in practice/ adjusting the hydraulic motor and generator combination.
- Using a shared direct current block (below), the electric power formed when braking could be possible to be utilized in powering the el. motor rotating a tested apparatus.



Kuva 3.9. Yhteisen tasavirtakiskon perusrakenne.

3. Concept

- Power is fed back to the pump through the transmission and the hydraulic motor. The hydraulic motor is operating as an auxiliary motor. The test pressure is adjusted by adjusting the displacement of the auxiliary motor or by a pressure relief proportional valve. When adjusting with proportional valve, the displacement of the auxiliary motor must be adjusted slightly smaller than the flow coming from the pump. When testing a hydraulic motor, the auxiliary motor functions as a pump.



A clutch is added, which is used to disable the auxiliary motor/pump, when the tested pump/motor is burdened by a pressure relief valve. At the same time the flow is halted to the auxiliary pump/motor.

It should be noted that in this version, the flow going to the auxiliary hydraulic motor goes through pipeline P and returns from pipeline S. Another thing of note is that in this setup the auxiliary motor cannot be used as a pump (it's possible to achieve though...). This means that hydraulic motor is tested like a pump, with the auxiliary motor as the load.

Pros:

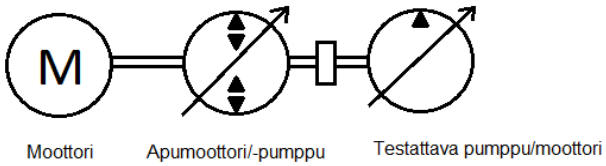
- Smaller need for power. The reversible power is estimated to be between 50-70% of the test power, then a 160 kW electrical motor is enough to provide 315 kW test power.
- Smaller losses, estimated to be 30-50% of the test power. Additional loss from the gear is estimated to be 10%
- The test pump/motor is always connected to the same base
- Physically similar to the current system
- 600 kW or possibly even 900 kW test power can be achieved with 315 kW active power

Cons:

- Method has never been tried before
- Reversible power is based on estimations
- Tested pump/hydraulic motor has the same revolution speed compared to the auxiliary motor/pump. The danger of cavitation exists.
- To prevent cavitation, the displacement of the auxiliary motor/pump must be actively adjusted.
- The auxiliary motor/pump has to be able to operate as a pump and motor in spite of the direction of rotation.
- The large displacement of the auxiliary motor may cause adjusting problems while testing small pumps.
- The displacement of the auxiliary motor increases when the maximal test power is utilized.
- The maximum pressure may rise to extremely high due to the large amount of torque and power. This has to be noticed in restricting of pressure.

Notifications

- While testing the open circuit pump, the auxiliary motor may lose its adjusting pressure.
- A counter pressure, that's as high as minimum adjusting pressure, is probably needed back to the outlet pipeline.
- In rudimentary hydraulic map haven't been considered purging and supply pump.
- When selecting and measuring the transmission, a possibility for even triple the amount of test power and torque has to be considered.
- The transmission isn't needed if the auxiliary motor/pump can be connected to the same shaft with electric motor and testing apparatus according to the picture below. An extra loss from the transmission (approximately 10%) is disposed. In this case the auxiliary motor has to have a shaft that goes through the motor. When measuring the shaft, between the auxiliary motor and testing apparatus, a possibility for increased amount of power and torque has to be considered.



Moottori	*= Electric motor*
Apumoottori/-pumppu	*= Auxiliary motor / pump*
Testattava pumppu/moottori	*=Testing Apparatus*

Adjusting

There are two ways to adjust the test pressure:

1. By adjusting the desired value of the proportional pressure restricting valve.

    - A control circuit is needed, that holds the displacement of the auxiliary motor a bit smaller than the displacement of the tested pump.
    - Can be based on the measured yield the pump (measured with a liquid flow meter) considering the volumetric efficiency of the auxiliary motor.
    - Also works in an open control circuit but quick changes in rotational speed have to be restricted.

2. By adjusting the displacement of the auxiliary motor.

    - Displacement of the auxiliary motor is adjusted based on the desired test pressure.
    - Closed pressure control circuit
    - Risk of cavitation, especially with low test pressures. Anti-cavitation valves are required.
    - Maximizes the return power.

Price Comparison

	Concept 1	Concept 2	Concept 3	Concept 3 no transm.	Concept 3 reduced power
Electric motor 315 kW	18000	36000	18000	18000	9000
Drive 315 kW	17500		17500	17500	8750
Regenerative Drive		52500			
Transmission			5000		
Cooling	5000	1500	2000	2000	2000
Additional adjusting			1000	1000	1000
Pump/motor 355 cm2	10000	10000	10000	12000	12000
	50500	100000	53500	50500	32750
Relative Price Comparison	100	198	106	100	65