



Power generation

# Energy efficiency assessment Improving pump system efficiency using variable-speed drives

# Typical pump system configurations

Power plants show the following typical pump system configurations. In order to focus on regular operation, the minimum flow recirculation valve is neglected.

## Control valve

Motor and pump run at a fixed speed. The flow is adjusted with the control valve position. A partly closed control valve increases the pressure between pump and control valve. According to the pump characteristic curve the pump flow falls with higher differential pressure over the pump.

– Hydraulic power of the pump =  $\Delta P_2 * F$

– Hydraulic power delivered by the system =  $\Delta P_1 * F$

– Hydraulic power loss within the system =  $(\Delta P_2 - \Delta P_1) * F$

For example, if the control valve is fully open at full load, then there is very little power loss. At part load, the losses increase rapidly.

## Hydraulic coupling

The motor runs at a fixed speed. The hydraulic coupling changes the speed of the pump. The flow is adjusted with the pump speed.

Usually centrifugal pumps show very little efficiency decrease when operated at a lower speed, since usually the process downstream of the pump requires less pressure at a lower flow rate. So the centrifugal pump stays at a good operating point.

The hydraulic coupling includes significant hydraulic friction, which can be observed as waste heat at the hydraulic oil cooler. Hydraulic friction has its lowest value at full load (5 %) and increases as the load goes down (> 20 %).

## Variable speed drives (VSDs)

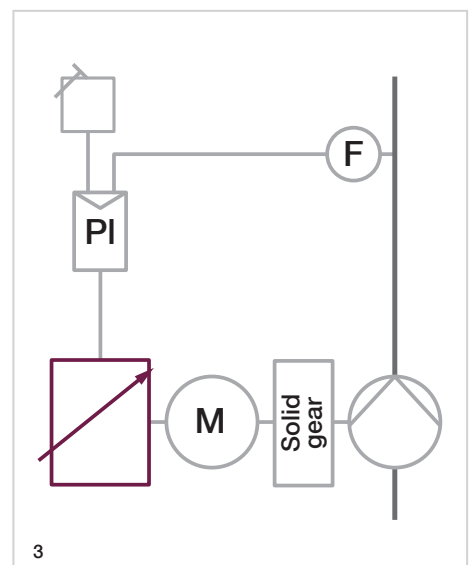
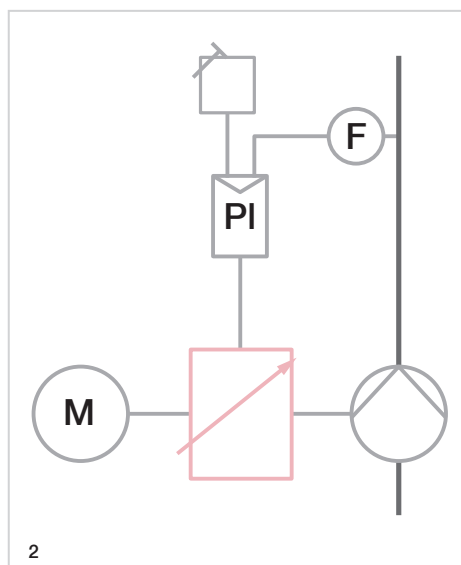
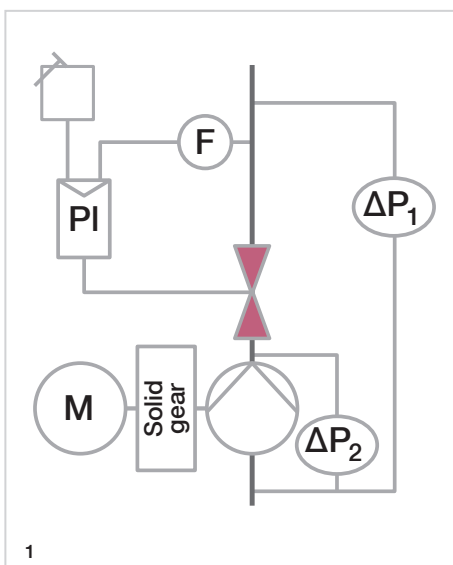
The VSD changes the speed of the motor. Motor and pump are connected directly or via the solid gearing of the pump. The flow is adjusted with the pump speed.

Usually, centrifugal pumps show very little efficiency decrease when operated at a lower speed, since usually the process downstream of the pump requires less pressure at lower flow rate. So the centrifugal pump stays at a good operating point.

The VSD has a very high efficiency of around 98 percent over the full operation range.

As a summary of the above, pump efficiency at full load (which should be the pump's design point) is usually acceptable. The more often a plant is operated at part load, the higher will be the benefit of a VSD. Quite often the pump is oversized, so the pump system runs in part load also, even when the plant runs at full load.

1 Control valve | 2 Hydraulic coupling | 3 Variable speed drives (VSD)

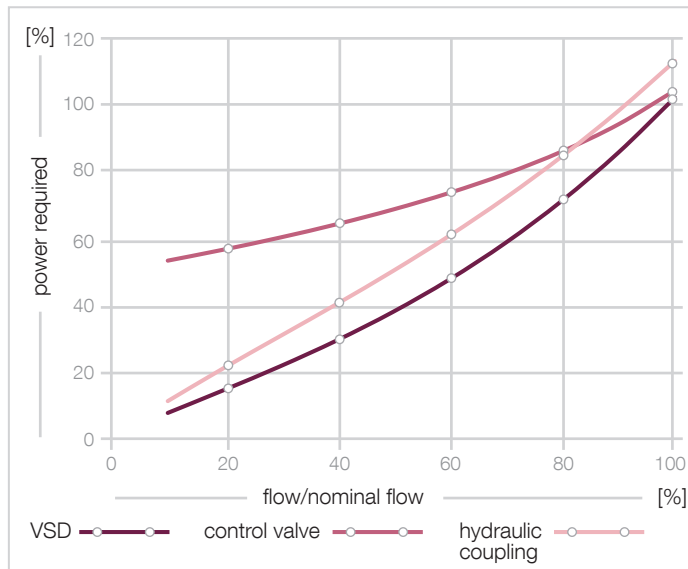


# Improving pump system efficiency using variable-speed drives

A small reduction in speed can make a big reduction in the energy consumption. A pump or a fan running at half speed may consume as little as one-eighth of the energy compared to one running at full speed.

**By employing VSDs on centrifugal pumps, instead of throttling or damping, the energy bill can be reduced by as much as 50 percent.**

Consequently, electric variable speed drives also help to reduce NO<sub>x</sub> and CO<sub>2</sub> emissions.



Savings potential for a typical feedwater pump system

Besides the electrical savings with VSDs customers achieve further benefits. Small flow variations can be corrected more rapidly by a VSD than by other control forms, which improves process control performance. Soft starting and reduction in speed reduces pump wear, particularly in bearings and seals. This results in reduced maintenance costs.

## Typical fields of implementation in power plants:

- Feedwater pumps
- Condensate pumps
- Boiler recirculation pumps
- Cooling water pumps
- District heating water pumps

## Typical fields of implementation in drinking water transmission and distribution plants:

- Water pumps

## References

### Grosskraftwerk Mannheim (GKM), Germany

ABB supplied medium-voltage drives for the refurbishment of the 280 MW boiler of block 6 at GKM's coal-fired power plant in Mannheim, Germany. Two out of three boiler feed-water pumps of 5.8 MW were retrofitted with variable-speed drives, replacing the hydraulic couplings which had a poor efficiency. The replacement resulted in estimated energy savings of 12 GWh per year and a reduction of CO<sub>2</sub> emissions by about 10,000 tons per year.

### Mälarenergi Västerås, Sweden

ABB supplied medium voltage drive systems to Mälarenergi, a city-owned electric power and district heating provider based in Västerås, Sweden. An energy audit, conducted by ABB, had revealed a huge energy saving potential by upgrading the district heating pumps with variable-speed drives. Four resistors and slip-ring motors were replaced with variable-speed drive systems, each rated at 1,765 kW. The heat losses caused by the flow control method were reduced considerably, and the production of electrical energy was increased by 35 GWh per year.

1 Grosskraftwerk Mannheim (GKM), Germany | 2 Mälarenergi Västerås, Sweden



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