ABB HVAC WEBINARS

Efficient pumping in HVACR

Choosing variable speed control for energy saving, continuous and cost-effective operation

Torben Silberg Poulsen – Pump Applications Business Development Manager, ABB Motion

AFFILIATED MANUFACTURER EUROVENT EUROPEAN INDUSTRY ASSOCIATION

ABB

ABB at a glance

Facts and figures

Pioneering technology

What
Offering

Products — **Systems** — **Services & software**

For whom
Customers

Buildings — **Industry** — **Transport & infrastructure**

Where
Geographies

Globally

Asia, Middle East and Africa — **Americas** — **Europe**

Revenue ~$28 bn

Countries ~100

Employees ~110,000*

Source: Annual Report 2019 published financial results
*As of July 1, 2020

Agenda

- Pump performance curves
- Variable speed pumping
- Typical control methods
- Typical pump applications
- Energy saving potential
- Digitalization for pumping applications

Note: the presentation is based on centrifugal pump type

Pump performance curves

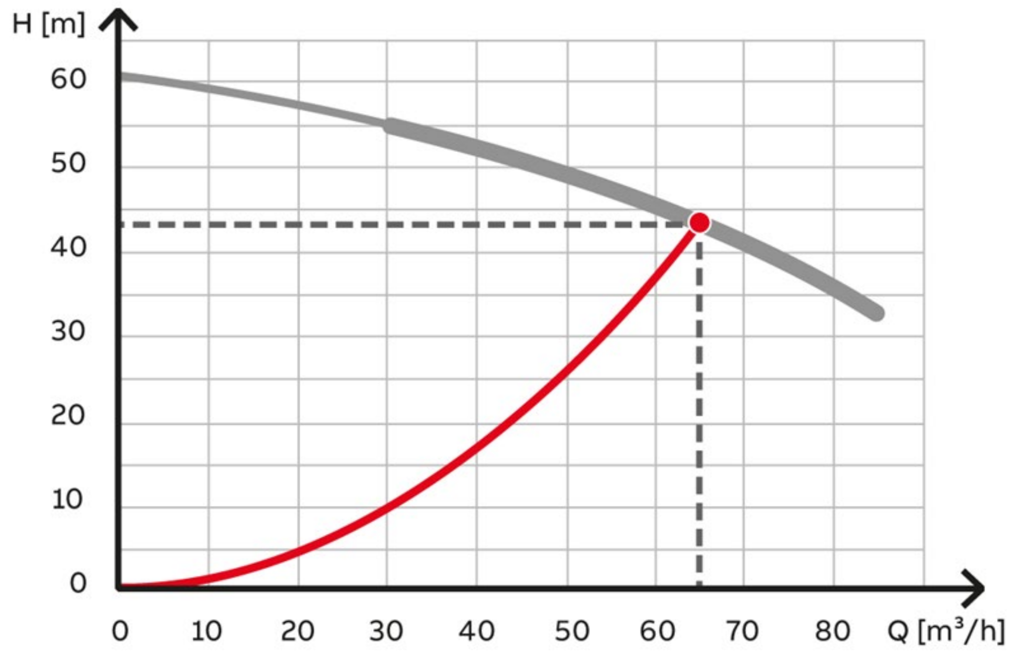
Pump performance curves

Pump performance curves shows the relationship between the pressure/head and flow the actual pump can produce

The pump performance curve is known as the QH curve, where Q indicates flow, and H is head.

For the best possible system energy efficiency high efficient pumps combined with a high efficient motors are needed. But more can be done if the demand varies over time.

By adding a variable speed drive to the pump system and use the actual demand as the speed controlling parameter even better performance can be achieved.



Variable speed pumping in HVACR = energy savings

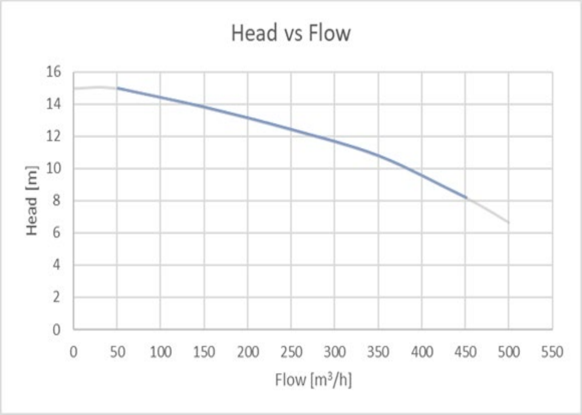
Pump performance curves

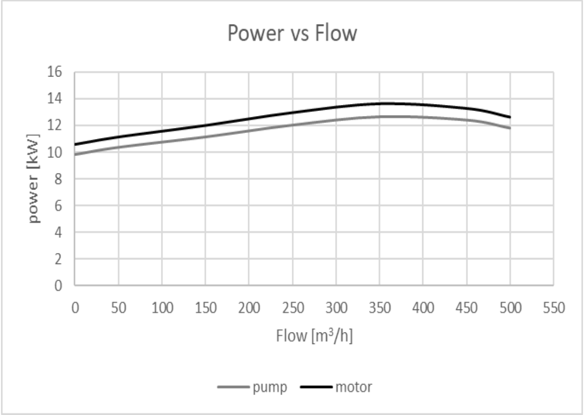
The pump performance curves show a relationship between flow (Q) and head (H). It is also known as the QH curve.

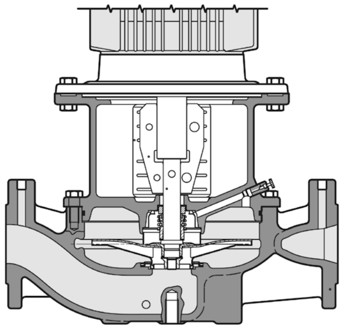
Another essential curve when it comes to efficient pumping is the power curve, showing the relationship between flow and power.

Typical two power curves are given:

- one showing the power needed by the pump (shaft power);
- one showing the input power to the motor.







Characteristics are shown for the single stage inline pump 15kW/50Hz.

Variable speed pumping

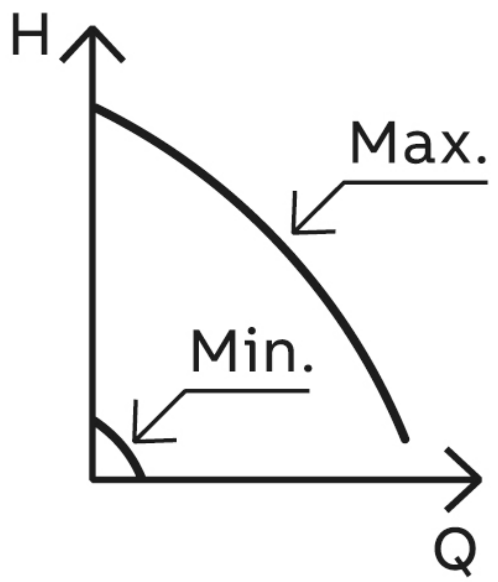
Variable speed pumping

What happens with the pump performance when a drive is added to the pump/motor combination?

The operating range of the pump changes, from a fixed speed performance to a variable speed, with a maximum and a minimum performance level defined by the maximum and the minimum speed.

The maximum speed is typically the nominal speed of the pump.

The minimum speed is defined by the pump manufacturer and depends on the pump construction.



Variable speed pumping in HVACR = energy savings

ABB

Variable speed pumping

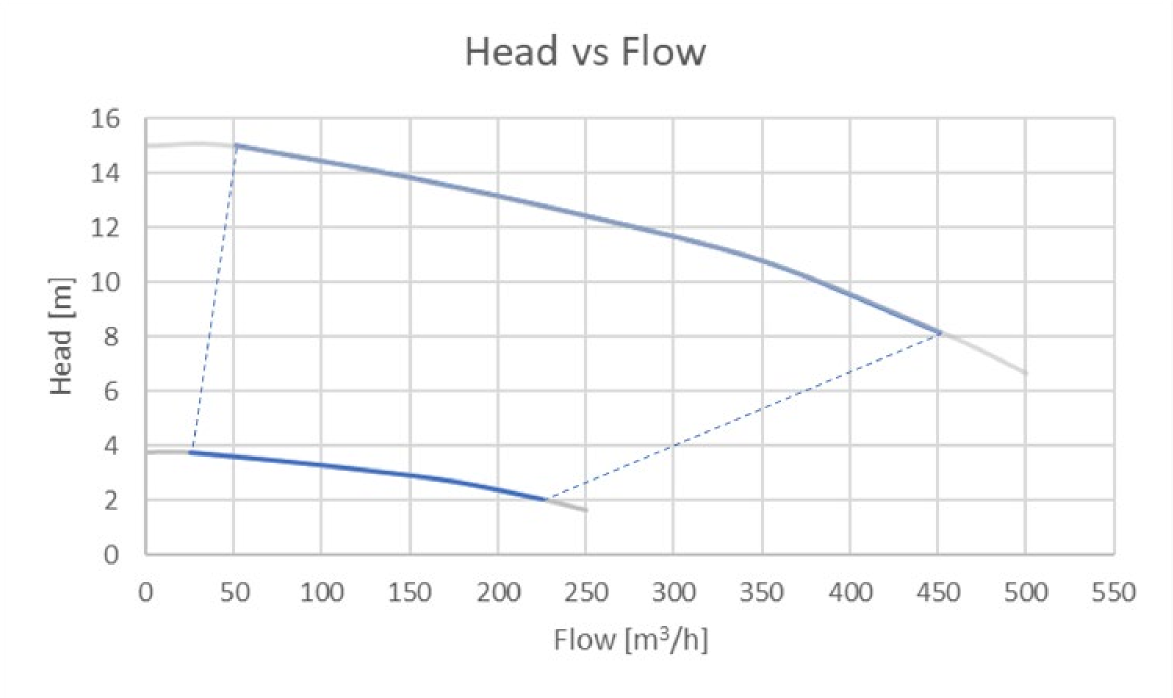
The affinity laws can be used for calculation of new performance curves of the pump.

$$\frac{Qn}{Qx} = \frac{Nn}{Nx}$$

$$\frac{Hn}{Hx} = (\frac{Nn}{Nx})^2$$

The minimum speed in our example is 25Hz or 50%.

The calculated minimum speed curve on the graph is the lower curve, and the dotted lines indicate the limits of the operating area between the maximum and minimum speed.



Typical control methods

Typical control methods

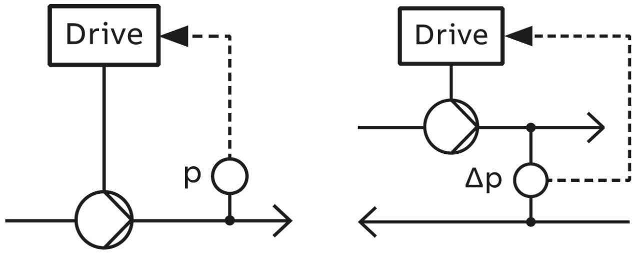
What should control the speed of the pump?

The following section will include the most typical control methods used in HVACR:

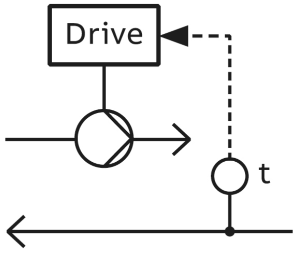
- pressure control
- differential pressure control
- temperature control
- flow control
- external control

Variable speed pumping in HVACR = energy savings

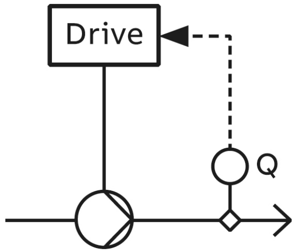
Typical control methods



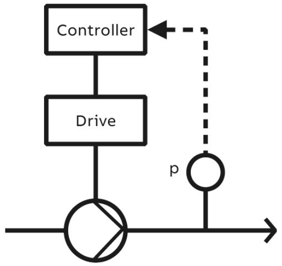
Outlet pressure or differential pressure as feedback to the drive to control the speed of the drive



Temperature as feedback to control the speed
Optional: Differential temp.



Flow as feedback to control the speed



External signal to control the speed

The drive will be able to use most common control signals to control the speed including bus communication

Typical pump applications

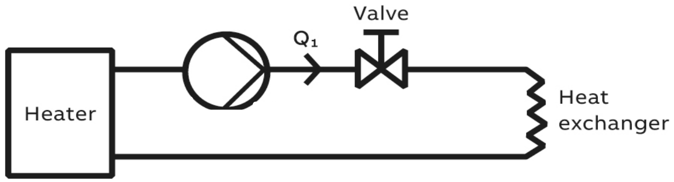
Typical pump applications

This section is about the most typical application in HVACR

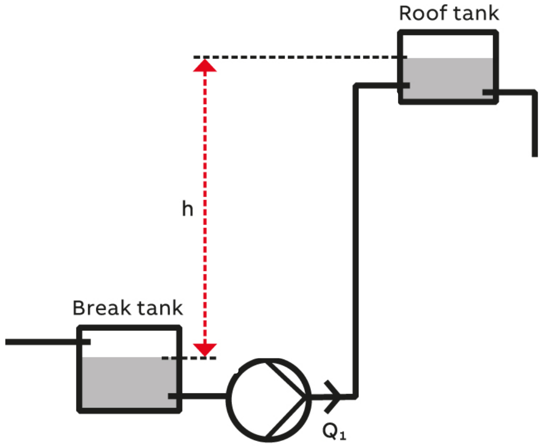
- liquid circulation (hot or cold)
- water distribution
- single pump vs multi-pump applications

Variable speed pumping in HVACR = energy savings

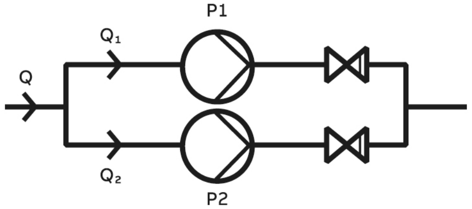
Typical pump applications



Circulation of liquid
(hot or cold)



Water distribution
(Static lift)

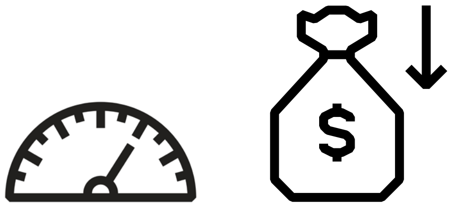


Multi-pump
- Duty assist
- Duty standby

Energy saving potential

Energy saving potential

- Most systems have variable loads, and pump sizing is not always perfect.
- Drive lets the pump adapt to the needs and unlocks energy saving potential.
- When the speed of a pump decreases, both head and flow decreases. This means that the power required by the pump decreases, releasing the energy saving potential.
- Even a small reduction in speed gives large energy savings



Variable speed pumping in HVACR = energy savings

Energy saving potential

The affinity laws tells us the relationship between flow and power.

$$\frac{Pn}{Px} = \left(\frac{Nn}{Nx}\right)^3$$

A system curve is added, based on reaching the pumps best efficiency point at full speed (400m³/h and 9.6m).

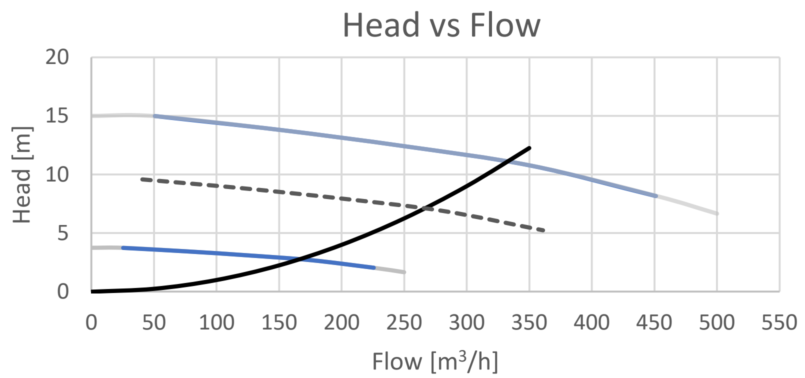
As an example we are reducing the speed from 50Hz to 40Hz.

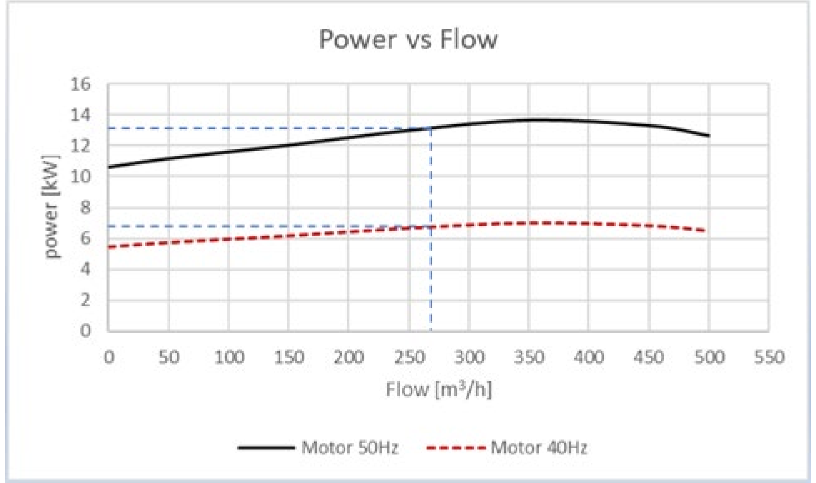
We have to calculate a new QH curve at 40Hz and a power curve at 40Hz.

We can see that the power consumption has dropped from 13kW at full speed to 6.8kW at 40Hz.

This is a reduction of 47%.

Using the time/load profile of the application makes it possible to calculate the energy savings.





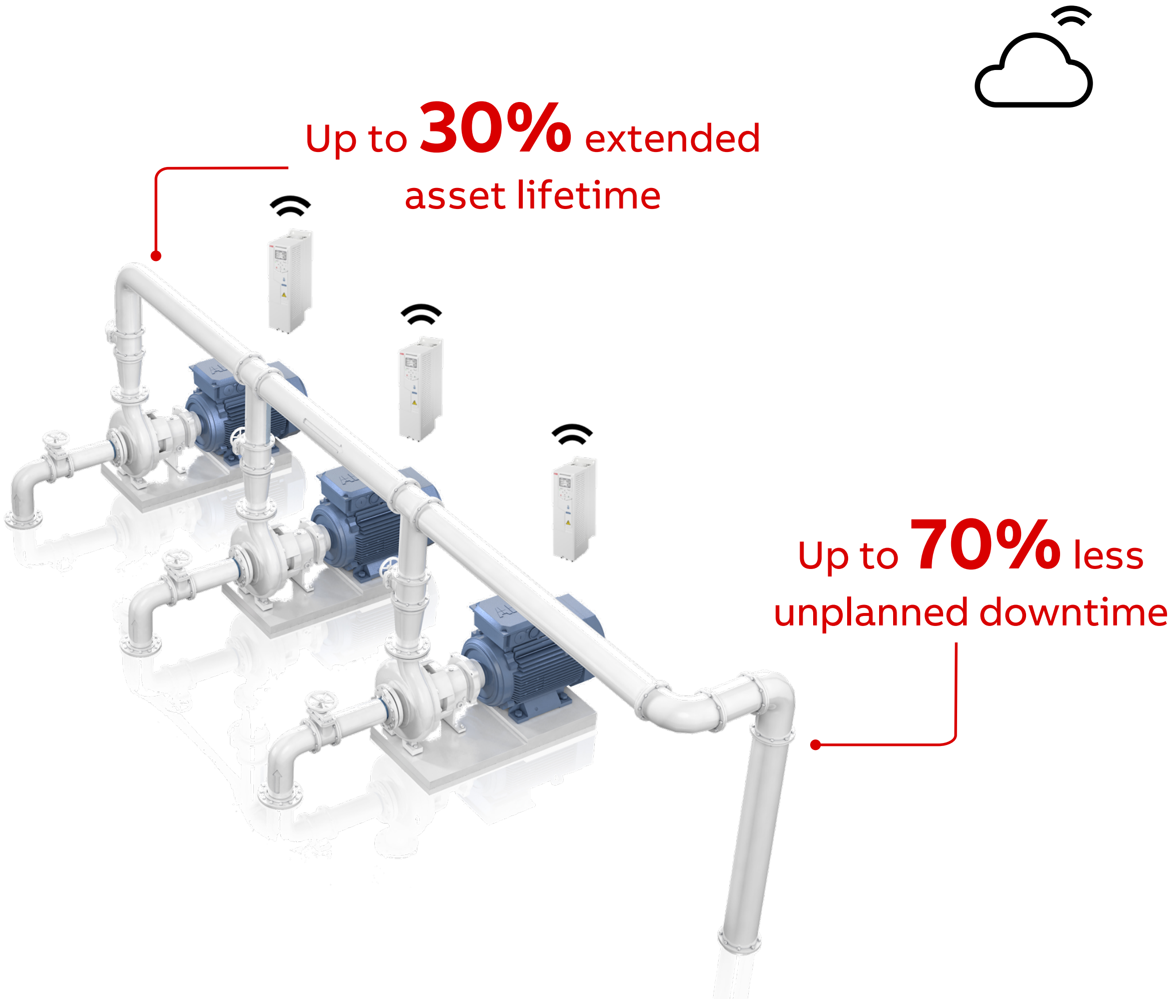
Digitalization for pumping applications

Digitalization for pumping applications

Adding a drive to the pumps in HVACR does not only save energy it is also a perfect platform for digitalization of the pumping applications.

The option of having a feedback from the pump system and the performance data a drive can provide makes it a perfect component in the digitalization process.

By adding an additional ABB Ability™ Smart Sensor for motors, even the motor becomes an integrated part of the digitalized pump system.



ABB

Digitalization for pumping systems

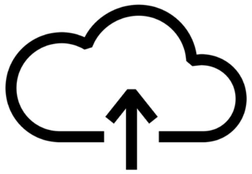
The drive can be connected to the building control system and provide valuable data or to a cloud service through the ABB Ability™ platform.

Typical drive data could be:

- actual speed
- actual power consumption
- drive status
- temperature of the drive cooling surface
- control status
- sensorless flow estimation

And from the ABB Ability™ Smart Sensor for motors:

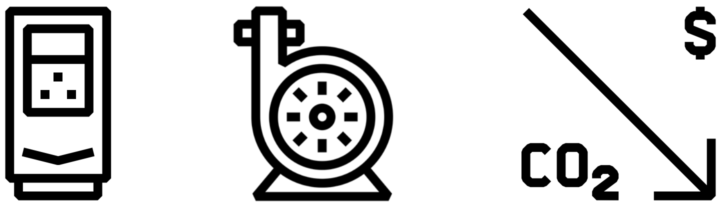
- temperature of the motor
- vibration



Summary

- Most systems have variable loads, and pump sizing is not always perfect to the specific application. Adding a drive and let the demand control the speed of the pump unlocks the energy saving potential
  - In our example 47% reduction in power with a speed change of 20%
  - The pump performance curves, the affinity laws and the load time profile of the application makes it possible to estimate potential savings

- The digitalization of pumping system with the introduction of the drive and the ABB Ability™ Smart Sensor for motors can reduce unplanned downtime and longer expected asset lifetime due to timely service



Variable speed pumping in HVACR = energy savings