Control Valve Design & Sizing – an efficient tool to reduce energy consumption
ARCA Facts

- Internationally operating manufacturer of control valves
- 100% family owned
- Two factories in Germany, with more than 200 employees
- Products are 100% “Made in Germany”
Control valves

Control valve with actuator and digital positioner
Steam Conditioning valves & solutions

Single-nozzle desuperheater

Multi-nozzle desuperheater

PRDS
Applications

▪ Thermal power plants: coal, gas, biomass, geothermal, solar-thermal, waste incineration
▪ Oil and gas industry
▪ Food and beverage industry
▪ Chemical, pharmaceutical industry
▪ Steel plants
▪ Marine business
References

- Energy
- Oil and gas
- Chemical, pharma, biotech
- Food, beverage, sugar
- Steel, paper
- Marine & Offshore
Jänschwalde is the biggest Power Station in Germany and one of many examples in which ARCA Valves have been installed.
ARCA is Main Valve Vendor of BASF in EUROPE
Delivery of 1,200 ECOTROL®-Valves
Our Mission...

...is to provide the best and most efficient solution for your control application.
Energy efficiency in industry:

Energy Loss in Control Valves – General Considerations
In the field of automation, control valves are among the largest energy consumers of a plant.

But, control valves are as essential for a production process as the brakes of a car for safe driving.
Energy efficiency in industry:

Saving energy when actuating a Control Valve...
Besides the energy converted by control process itself, the valve actuator needs energy to actuate the control valve.

Often pneumatic actuators are used, which are operated by the plants compressed air supply.

The consumption of compressed air should be reduced to save energy.
Air consumption of pneumatic actuators

ARCA actuators safe energy!

ARCA minimizes the “dead volume”, due to different shelves for the air and the spring chamber.

The use of ARCA actuators permanently safes energy and money!
Energy consumption of positioners

All pneumatic systems have a loss of instrument air, even when the valve is not moving, dependent on the pneumatic amplifier inside the positioner.

With the unique binary-triggered I/P output, the ARCAPRO® 827 positioner provides the lowest “steady state” air consumption in the market with only 26 std l/h.

Compared with 110 std l/h (typical other brand), every single ARCAPRO® 827 saves around 650 m³ of compressed air per year, which is more than 40 US$ of energy cost!
Energy required to actuate the Control Valve

The energy required for one full stroke is:

\[ W = F \cdot s = A \cdot \Delta p \cdot s \]

The energy to close a valve with 200 mm seat diameter and 100 mm stroke against 60 bar pressure is:

\[ W = 0.0314 \, m^2 \cdot 6 \cdot 10^6 \frac{N}{m^2} \cdot 0.1m = 18.84 \, kWs \]
Energy required to actuate the Control Valve

The energy required for one full stroke is:

\[ W = F \cdot s = A \cdot \Delta p \cdot s \]

The energy to close a valve with 200 mm seat diameter and 100 mm stroke against 60 bar pressure is:

\[ W = 0.0314 \, m^2 \cdot 6 \cdot 10^6 \, N/m^2 \cdot 0.1m = 18.84 \, kWs \]

With pressure balancing, it is only:

\[ W = 0.000707 \, m^2 \cdot 6 \cdot 10^6 \, N/m^2 \cdot 0.1m = 0.424 \, kWs \]
Case Study: Optimising Steam Conditioning in Power Generation
Steam Conditioning valves & solutions

Single-nozzle desuperheater

Multi-nozzle desuperheater

PRDS
Multi-nozzle desuperheaters save energy:

ARCA uses quarter-turn/one-piece-design technology of Borsig, which was one of the best and most famous German steam technology companies.

By management-buy-out, it is now ARCA-Group technology.

The ARCA design is extremely reliable especially in installations with frequent start-ups, e.g. in gas power plants.
Multi-nozzle desuperheaters save energy:

For a static nozzle, the water pressure must be 30 bar higher than the steam pressure, to get a rangeability of 3:1. For a multi-nozzle desuperheater, it only has to be 10 bar higher than the steam pressure. For a steam pressure of 22 bar and a water flow of 40 t/h, the power required for the cooling water pump is

- for static injection nozzles: 82 kW
- for a multi-nozzle desuperheater: 45 kW
- for a PRDS with Venturi nozzle: 28 kW
In a combined **Pressure Reducing and De-superheating Station (PRDS)**, a fraction of the high pressure steam can be used to atomize the cooling water in a 2-phase nozzle, using the Venturi effect.

Then, the water pressure can be equal or even less than the downstream steam pressure, reducing the power required for the water pump to only **28 kW**.
1. The main steam flow passes the reducing stages and leaves the valve.
2. The cooling water goes into the 2-phase nozzle.
3. A fraction of the steam is separated upstream and led to the swirling chamber of the 2-phase nozzle. The Venturi-effect maintains a high velocity and a very low pressure at this point, providing perfect atomizing of the water.
Energy saving per year, compared to static nozzles, for steam at 22 bar and a water flow of 40 t/h:

- with multi-nozzle desuperheater: 324 000 kWh
- with Venturi 2-phase nozzle: 473 000 kWh

This is BIG!!!
These were some examples how ARCA can help to improve the energy efficiency in your production processes
We are open
...for any questions
...and challenges
...and inquires