Hydraulics for HVAC Control Loops

Heating and Cooling Distributor with Integrated Energy Measurement

Hydraulic systems in today´s heating, ventilation and air conditioning systems make wide use of sensors and actuators. However, considerable simplifications in distributor design are possible, offering potential for cost reduction.

Picture: W. Baelz & Sohn

1 Hydropilot heating and cooling distributor with ejector modules.

The use of ejectors for controlling the performance of heating or cooling systems in different consumer circuits has been tried and tested over many years. In particular, the low return temperatures of this control method have raised much interest amongst heating technology experts.

The differential pressure generated by a pump at the distributor 1 or the network differential pressure generated by a main pump can be used to circulate the water by means of ejector pumps 2 and for temperature control with the help of return flow admixture 4 from the respective consumer circuits in the entire building. Consequently, no additional circulation pumps are required in the overall system. In addition, the efficiency of this technology increases, the higher the number of control circuits.

Energy measurement using ejector stroke position

Apart from controlling consumer loads, the energy measurement of each control circuit must be considered when planning a system involving energy efficiency and energy monitoring. This can be done either with calibrated heat meters or very cost-effectively using the stroke position of the ejector, provided that a calibrated energy measurement is not required by law or by the owner/operator. With a known differential pressure, the stroke position of the ejector represents a defined volume flow via the respective ejector nozzle opening. Whilst the differential pressure at the distributor usually varies, the volume flow data permits a precise calculation of the energy in each control loop. The temperatures required for calculating the amount of energy are continuously monitored in any case.

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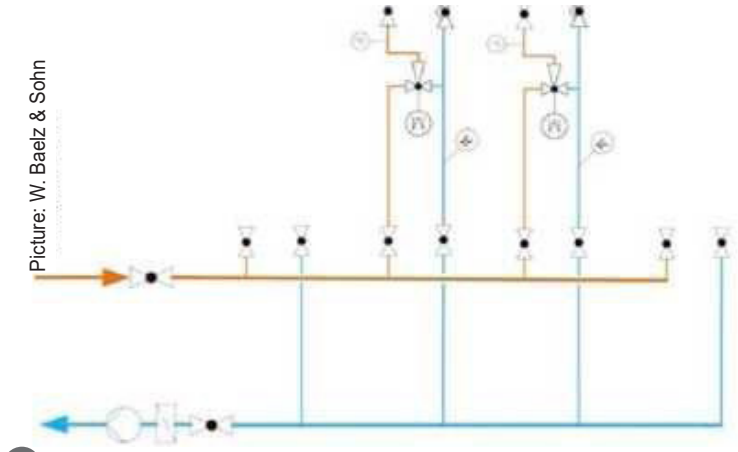
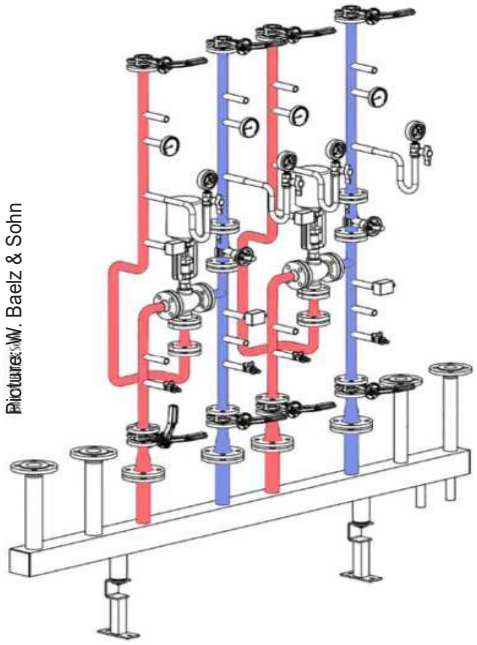
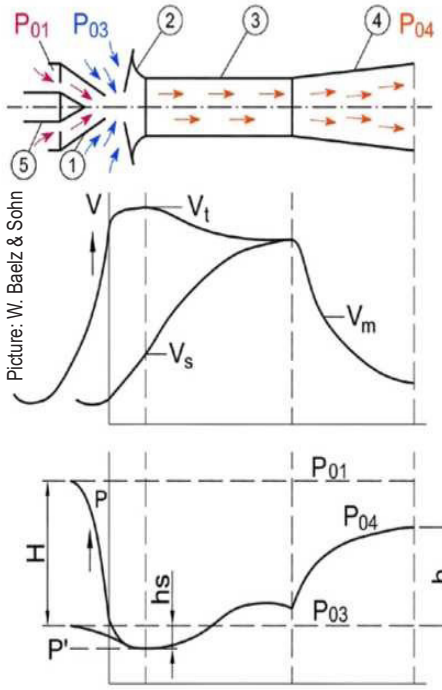


2 Hydropilot with main pump



3 Baelz manufactures the Hydropilot heating and cooling distributor to customer specifications and delivers it ready for operation without the need of a service technician



4 Legend:
1 Propulsion nozzle
2 Throat nozzle
3 Mixing tube
4 Diffuser
5 Plug
V, Vt, Vs, Vm: Speeds (propulsion, suction, mixing flows)
P: Pressure
H: Differential pressure at inlet of ejector pump = P01 - P03
h: Differential pressure at outlet of ejector pump = P04 - P03;
P01: Pressure in primary circuit
P03: System return flor pressure
P04: System feed pressure
P´: Pressure behind nozzle
hs: Differential pressure between P03 and P´

4 shows the schematic design of a controllable ejector. The propulsion flow with idle pressure P_{01} is accelerated in the convergent propulsion nozzle (1) and reaches its maximum speed V_t upon entering the mixing tube (3), i.e. at the end of the throat nozzle (2).

Due to its high speed, the propulsion flow draws the suction flow with it by means of the turbulent shearing stress. The suction flow with idle pressure P_{03} is accelerated in the throat nozzle, from where it eters the mixing tube at a speed of V_s. Both flows are combined in the mixing tube, whereby momentum, kinetic energy and thermal energy are exchanged. The resulting mixed flow at the end of the mixing tube has a velocity of V_m which is lower than V_t and higher than V_s. In the diffuser (4), the flow is slowed to the required velocity.

The pressure drops in the propulsion and throat nozzles are approximately in accordance with Bernoulli´s equation and reach their lowest value at the entry to the mixing tube - the joint pressure P´. Due to the momentum exchange mentioned above, the pressure increases in the mixing tube and is then further raised due to the reduction in velocity in the widening section of the diffusor.

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Lower investment costs
The more homogenously the hydraulics of the overall system are designed, the lower the necessary differential pressure of the main pump. Reference [1] describes the hydraulic circuit, the performance characteristics and the control behaviour of ejectors. the advantage of this plant design is only the simpler hydraulics and the associated simpler hydraulic balancing, but also the reduced investment costs.
Ejectors are nothing more than longlasting control valves, so that investments for control valves can simply be replaced by investments in ejectors. Consequently and depending on the number of control circuits, the elimination of circulation pumps and auxiliary components results in a considerable potential for savings.

Not only the circulation pumps, but also the associated data points for DDC and BACS as well as the control system in the control cabinet are no longer needed. The cost savings by use of the stroke position of the ejector for thermal energy metering have already been mentioned. Moreover, check valves to prevent flow misdirection in the pipework [2] are omitted, because, with ejectors, mutual interference of circulation pumps in a hydraulic system is a thing of the past.

Ready-to-run system
Baelz manufactures the Hydropilot heating & cooling distributor fully assembled and wired 1 to customer specifications and delivers it ready for operation without the need of a service technician.
Amongst others, the German Federal Funding for Efficient Buildings (BEG) promotes heating modernisation including the peripheral measures, the optimisation of existing heating systems and the use of optimised technology.
In all these fields, the hydropilot can provide considerable support in achieving these aims and meeting the technical requirements of the BEG.

COMPACT INFORMATION

The Hydropilot heating and cooling distributor with ejector modules greatly simplifies the design of a distributor for controlling the performance of heating or cooling systems.
For example, there is no need for individual circulation pumps in the control loops with the associated costs for data points and control. Additionally, flow misdirection is no longer possible, so check valves to prevent it are rendered unnecessary.
Moreover, the stroke position of the ejector can be used to provide information on energy flow in every control loop at hardly any extra cost (provided no calibrated measurement is required)


Picture: W. Baelz & Sohn

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References

[1] Regelungs- und Steuerungstechnik in der Versorgungstechnik. Berlin: VDE Verlag, Arbeitskreis der Professoren für Regelungstechnik in der Versorgungstechnik (publisher), 7th issue 2014
[2]Gebauer, M.: Vereinfachung des hydraulischen Abgleichs. Offenbach am Main: VDE Verlag, Euroheat & Power, December 2010

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