WEST

Application Note: AN-104

MDR-337-P

Pressure control with automatic commissioning assistant

Electronics
Hydraulics meets
meets Hydraulics
Electronics

Content

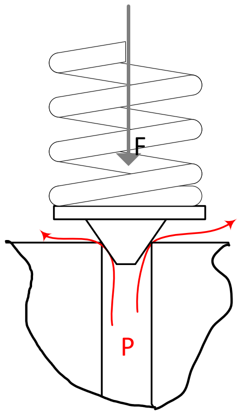
1 What does a professional expect from good pressure control?

- Precisely controlled pressure (= good stationary behaviour)
- Fast reaction to changes in the system such as fluctuations in volume flow, pressure setpoint (= good dynamic behaviour)
- Low price
- Flexibility, various valves or pumps can be used
- Little effort during commissioning
- Good service

What is the optimal solution for this?

Let us first consider the important demand for a low price:

In fluid technology, pressures can be controlled particularly cost-effectively with fixed pressure relief and pressure reducing valves, and without any electronics.



In principle, a pressure relieve valve has a very simple structure and has been an indispensable component since the beginning of industrialisation. Of course, the finesse is in the details: tendency to oscillate -> damping, influence of flow forces, tightness, etc.

The "world formula" of hydraulics applies:

$$p = F / A$$

Unfortunately there are two basic disadvantages of this simplest solution:

- No changeability of the setpoint during operation
- Limited precision, influencing factors such as the operating point, viscosity, friction and flow forces and pressure losses will negatively influence the result

If you want to do it better, the electronics come on board. But it should remain simple anyway!

So replace the constant spring force in the fixed pressure valve with the variable force of a proportional solenoid. The result is a proportional pressure valve. Because the magnetic force can be changed electronically during operation depending on the situation, the first disadvantage is eliminated.

In addition, you can also use a controller to eliminate the inaccuracies. This works on the basis of a setpoint/actual value comparison with a sensor measurement.

This may sound elaborate and complicated at first, but it is surprisingly simple.

2 Solution possibilities

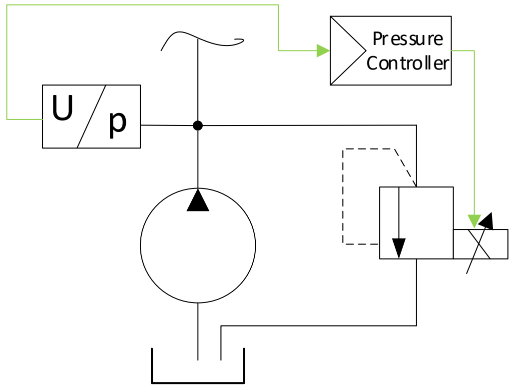
In many cases there is an electronic pressure measurement for monitoring anyway. If then the regulation and valve control are combined in a specialized, easy to adjust device, all requirements are fulfilled!

Once again a step back, a justified objection at this point:

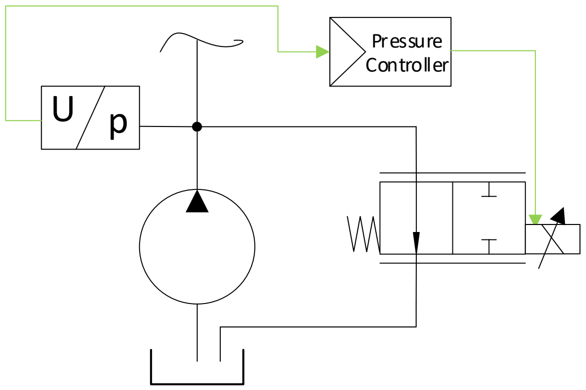
If you already use an electronic pressure control, why should you use a pressure valve in the hydraulic system instead of a directional control valve, e.g. in the bypass?

These variants are conceivable:

Variant 1:
prop. Pressure Valve



Variant 2:
Prop. Directional Valve in Bypass



Possible modifications of variant 1:

- The pressure valve determines the flow rate of a variable displacement pump
- A proportional pressure reducing valve is used instead of the relieve valve

2.1 Comparisation of variants

2.1.1 Open-loop operation

Variant 1 also works in open – loop operation, the electronic controller only makes minor corrections. Variant 2 always requires an active electronic controller for pressure control.

2.1.2 Dynamic

Demands on the dynamics of the adjustment: In the event of rapid changes in the consumer oil flow, an equally rapid compensation of the change must be achieved by the bypass. If the bypass valve closes too slowly, the pressure collapses. If the valve opens too slowly, there are pressure peaks, which is even more critical. In particular, the sudden excess of a larger quantity is a major challenge. To avoid pressure peaks, a high reaction speed is necessary. This depends on the hydraulic capacity of the system. If variant 2 is chosen, this can only be guaranteed with very fast (i.e. expensive) control or servo valves. Variant 1 has the great advantage that the reaction initially takes place only in the hydraulic-mechanical part, i.e. the pressure valve. This is optimized for fast reaction.

2.1.3 Dependence on the operating point

The pressure amplification, i.e. the change in system pressure when the valve opening changes, is not constant in variant 2. It is therefore difficult to adjust the regulator properly.

2.1.4 Behaviour on component failure:

If the pressure measurement fails, you can simply switch to open-loop operation in variant 1. Variant 2 is no longer functional, the valve must be fully opened. If the controller or the power supply fails, a system according to variant 2 is no longer functional, since no pressure can be built up. Variant 1 can also be operated with a pressure valve with a falling characteristic curve, so here you have the choice of how the error reaction should be.

2.1.5 Costs

As mentioned above, variant 2 usually requires fast and therefore expensive valves. The situation is aggravated when pilot operated valves have to be used due to large quantities. Proportional - pressure valves are also relatively inexpensive, fast and robust in pilot operated design.

2.2 Conclusion

Due to many advantages, variant 1, i.e. the use of a proportional pressure valve or a pressure-regulated pump, is generally preferred.

3 How must an electronic controller look like for the optimal function of a system?

- Input and output signals?
- Controller structure?
- Settings?
- Fault reaction?

The question of the **signal interface** is quite easy to answer:

Certainly an input for the actual pressure value is required. Since pressure regulators should work quickly, an analog interface is still the best and simplest solution. Here there are two variants, voltage signal (mostly 0-10V) or current (4-20 mA). The controller should be able to process both.

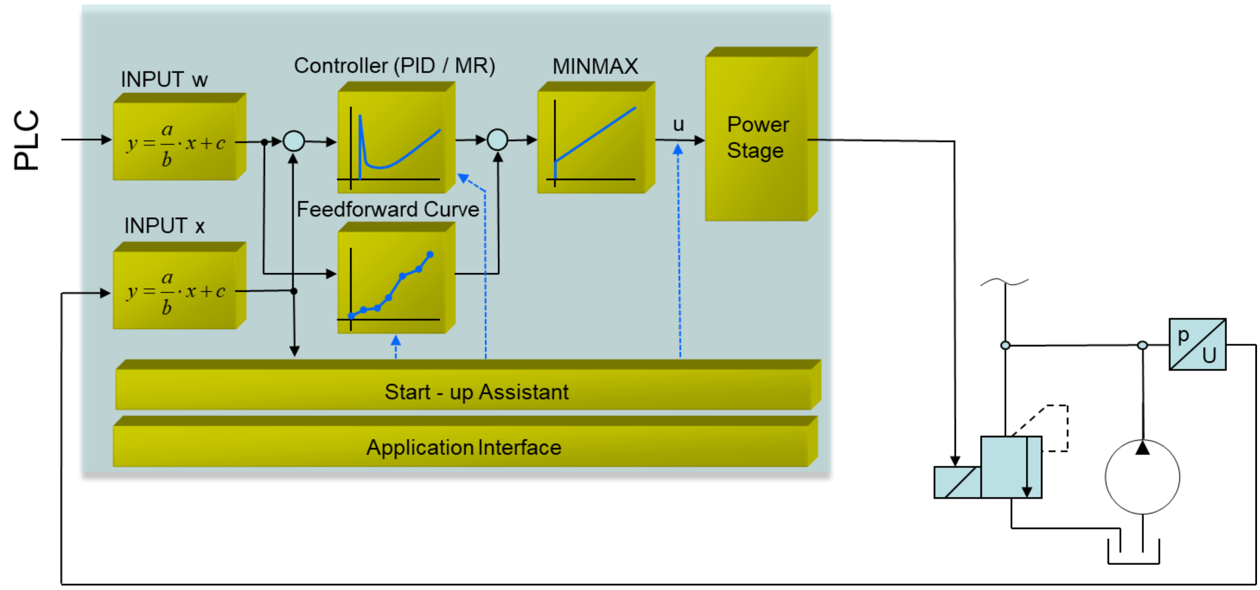
It must also be possible to supply the setpoint in these standard signal variants. If you want to control a fixed pressure, i.e. do not require a setpoint signal, there should be a simple possibility for this as well.

In addition, a general enabling of the device must be carried out via external switching signals and it must be possible to switch between active control and controlled operation. Both should be optional, i.e. the corresponding inputs can also be permanently connected to the operating voltage, so that the device is constantly activated and the controller works.

On the output side, the coil of the pressure valve is to be connected directly, therefore all common solenoid coils should be connectable to the device.

3.1 Controller structure

This picture shows the optimal internal structure of the pressure controller



The input signals are first treated with a flexible scaling function.

A very important element is the pilot control curve.
Even without an activated controller, this signal path generates an activation of the valve which already leads to a very good result. For this purpose, the setpoint signal is not passed on 1:1 to the output stage, but a curve generator is used to linearize the system. Often pressure valves do not have ideally linear characteristics. This can be compensated for by appropriate (inverse) pretreatment of the control signal.

As a result, the PID controller only has to compensate for small deviations, so its output signal can be limited - this promotes robustness and behaviour in transient situations.
Finally, the min/max function serves to scale the output signal. A previously known minimum control of the solenoid can also be specified here so that the pilot control can work with the best resolution. However, this is optional.

3.2 Automatical parameterization

The adjustment or parameterization should of course be as convenient and reproducible as possible. Here the digital method via a USB computer interface has already proven itself 10000 times. A free commissioning program with the possibility of saving data records, displaying and even recording fast real-time data values of the device is now state of the art.

But you can see from the functions and the controller structure: The device will have some setting options. Or, to put it in negative terms: A lot of work will have to be done before the function is optimally set.

But:

- How to determine the ideal pilot control curve?
- How are the controller parameters set?

The solution to this is an integrated self-adjustment function in combination with a step-by-step guide for the remaining (but very manageable) basic settings.

The commissioning assistant makes handling the device very simple - and the settings are optimally adapted to your system.

Error reaction
Ideally there are no errors or malfunctions. However, if there is a failure of an input signal, wire break or short circuit at the output to the solenoid coil or even an internal error, an appropriate reaction is important.

The user determines what is appropriate:

- Should the device be deactivated in case of an error until the user actively resets it?
- Should the controller restart automatically once the fault has been rectified?
- Which output signal should be delivered if an input is faulty?

The ideal pressure controller MDR-337-P can be adjusted here exactly according to your requirements

You can order the full technical documentation and an offer from our sales team vie e-mail: order@w-e-st.de

4 Imprint

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