PROPORTIONAL TECHNOLOGY WITH ELECTRONICS ON BOARD

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ABSTRACT

The continuously increasing economic requirements made it necessary to develop new parts for the proportional valve technology. Because of decreasing delivery times, caused by economic interests, the pressure of time results in shorter service units. So the time for replacement, mounting, connecting and configuration of valves and in particular this case of proportional valves is decreasing to a critical minimum. That made it necessary to consider about single items which can be improved. The result is a new proportional valve technique with electronic on board, which has been desired by our industrial clients.
A second issue is, that during the last few years it can be noticed, that the required system pressure is getting higher. That leads to higher flow rates. To avoid wear problems, the use of new materials for water-hydraulic systems and valves is indispensable. In case of that Tiefenbach Wasserhydraulik GmbH makes permanently tests with new materials. Hereby it is very important to bring the improvement of the material into a good ratio with the workability. This article should show our experiences with the different materials.

KEYWORDS: Material, Electronic on board, proportional valves

1 PROPORTIONAL TECHNOLOGY WITH ELECTRONICS ON BOARD

1.1 Motivation

To use proportional control technique in water-hydraulics it has been so far necessary to use a proportional control valve with a separate control card. The circumstances in many companies are problematic because of long distances between the valve and the be-

longing control card. In cooperation with our customer Thyssen Krupp Hoesch Hohenlimburg, with whom Tiefenbach Wasserhydraulik is in a good relationship, we have tried to find a solution, which can shorten the distances and the necessary time for installation. In this company the valves are used at a hot rolling mill. To improve the quality of the strip steel the different rollers of the reversing stands are getting a minimal bend, which is pressure controlled by using the proportional valves. Furthermore it could be noticed that the between proportional valve and control card to be transferred signal has been influences by interference sources. So the maximal length of the connection between control card and valve has to be shortened to a critical minimum.

Figure 1: Hot rolling mill TyssenKrupp Hoesch Hohenlimburg

By using the classical proportional technique the inlet and outlet valve as well as the measuring unit are to be connected with the control card.

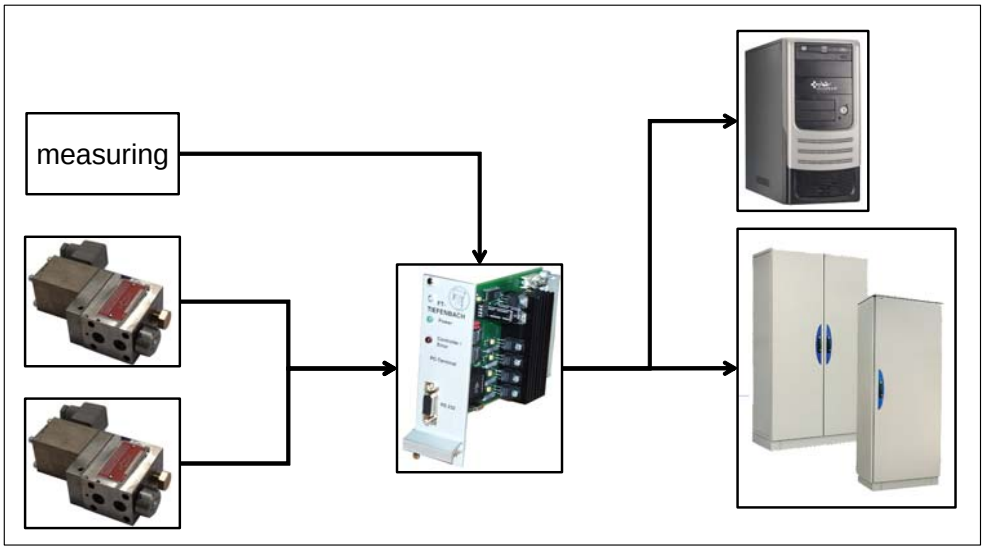

Figure 2: Classic proportional technique

The following items have been the requirements for the new proportional technique

- Monitoring ability
- Abandonment of an external control card
- Good maintenance features
- Easy installation
- Contactless configuration

1.2 The proportional technique with electronics on board

The necessary control card is integrated in the solenoid of the proportional valve.

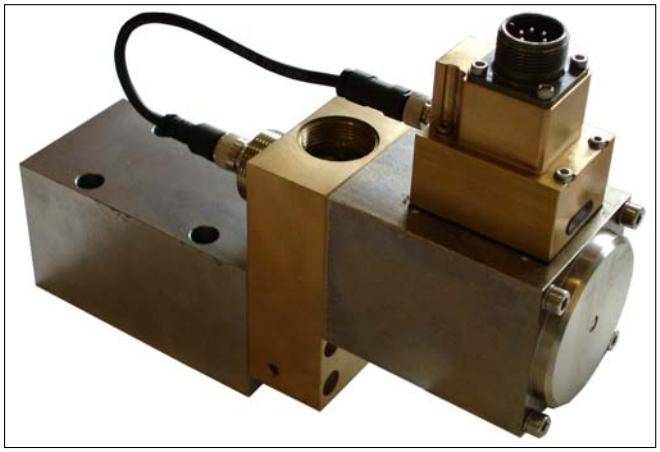

Figure 3: Proportional technique with electronics on board

The valve itself excepted the solenoid has no differences to the classic proportional valve. So the experiences of years can be transferred to the proportional valve with electronics on board.

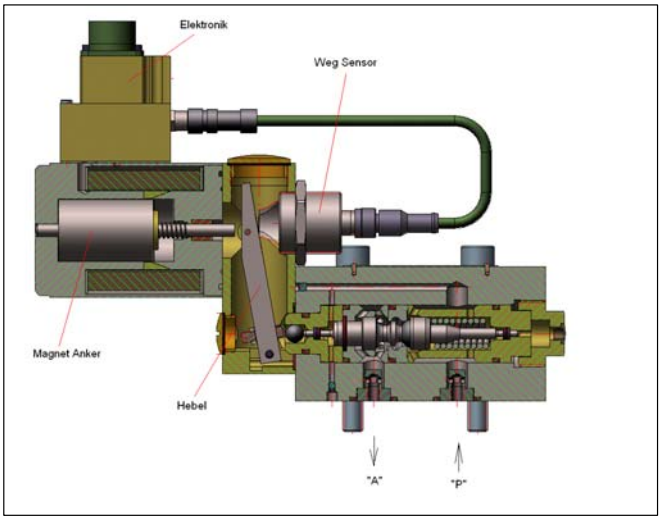

Figure 4: Sectional drawing of the proportional valve

The integration of an infrared interface makes it possible to configure the valve contactless by using a notebook. The valve with the integrated control card and the infrared interface is called “Master Valve”.

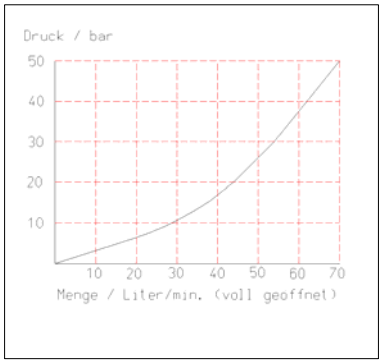

Figure 5: Pressure / flow diagram

The measuring unit is directly connected with the master-valve.
In case of a pressure control or distance control unit a second proportional valve is necessary which is designed without an infrared interface and without an integrated control card. The valve is called “slave valve” and it is connected with the master valve. The connection plan is shown in figure 6.

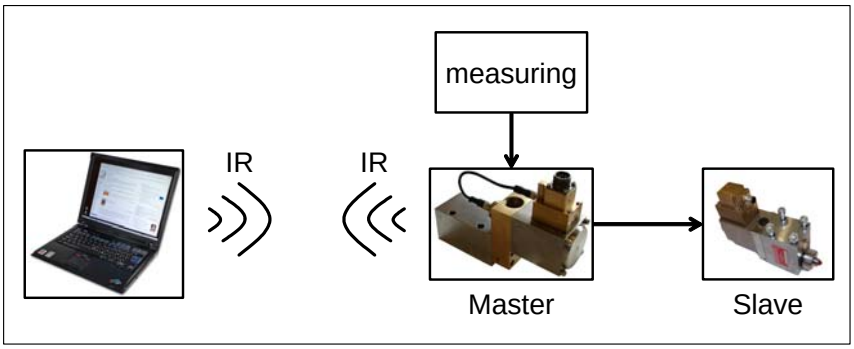

Figure 6: Proportional technique with electronics on board

The new plug makes it possible to send the actual value permanently to the control centre. The software belonging to the proportional valve realizes a valve diagnosis at runtime by using the integrated infrared interface. It is succeeded to develop a valve, which satisfies today’s requirements in monitoring features.
The error exit, integrated in the plug of the valve, sends error messages directly to the control centre. So it is realized, that malfunctions of the valve or problems with the connection can be immediately be noticed. The quantity of problems with the connections is decreasing, because of less cable.
The valves can be controlled by the voltage, which has values between 0 und 10 V or by the power with values between 0 – 20mA.

1.3 Configuration of the proportional valve

To be able to guarantee short maintenance units and short downtimes it is not enough to have a well developed proportional valve, it is also necessary to have intelligent software, which makes it possible to calibrate the valve and the measuring unit in

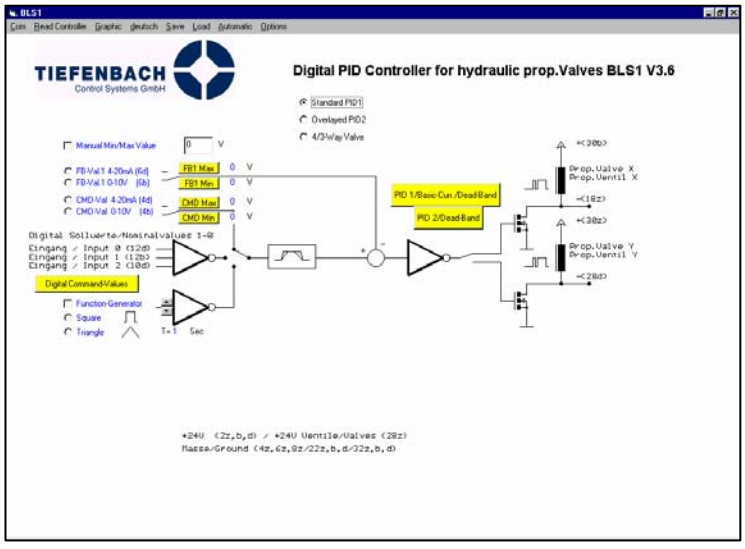

Figure 7: Control card software

a short time.

For this we are using software which makes it possible to configure the valve automatically. The basic currents X and Y and the value P, I and D, which are important for a good valve performance, will be identified. Hereby the P-value is the proportional amplification of the controller-difference, the I-value is the amplification of the integral of the controller-difference and the D-value is the amplification of the differential of the controller-difference. The identified values can be saved and in case of a valve change they can be reloaded and transferred to the valve.
By using the integrated function generator the fine tuning of the P,I and D-values can be done.

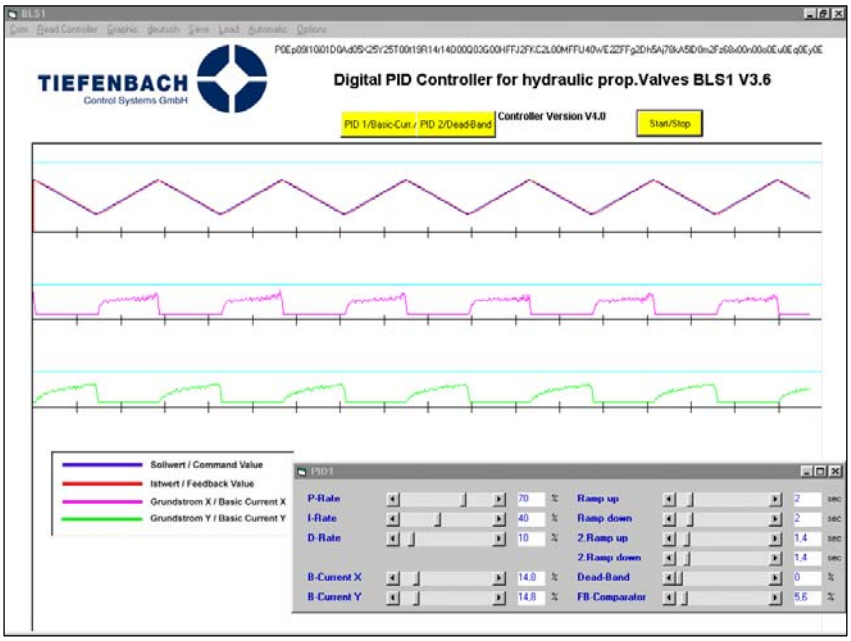

Figure 8: Function generator

1.4 Operating experiences

The application of the new proportional technology with electronics on board makes it possible to shorten the time for maintenance and the downtimes. The customers, who use this technology, have measured times for changing the valve of only a few minutes. This time includes the time for configuration as well.

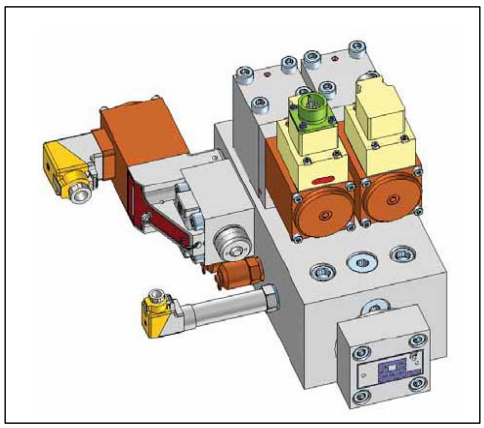

Figure 9: Control unit with new proportional technology

The reason is that we have attached importance on the fact that there are only four screws to be loosened if the customer wants to change a valve. A second reason is, that there are no distances between valve and control card. The complete control unit is centralized, which makes it easier to find possible errors. The check the connections and the valves can take place at the same location.
The modular design of Master-valve, Salve-valve, measuring unit and a 2/2 direction control valve as a shut off unit for possible valve replacements has motivated many customers to change to the new proportional technology.
Long-term tests have shown, that the lifetime of the new technology is as long as the lifetime of the classic proportional technique. At the moment we are developing a bus solution for the Master-valve, so that we will be able to use the same technology for applications with several parallel working inlet and outlet valves as we need them for proportional valves with bigger diameters.

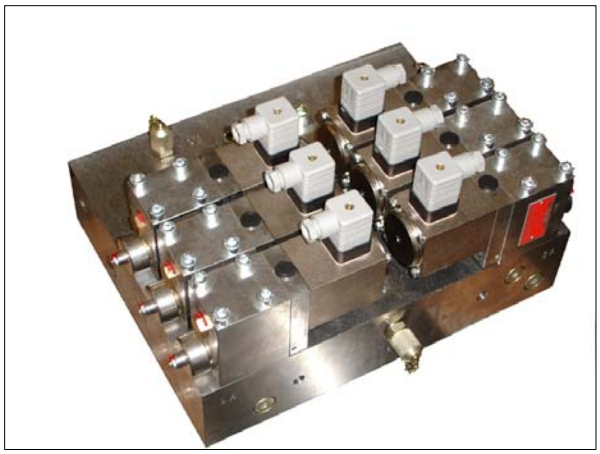

Figure 10: Pilot-control unit with classic proportional technology

In future one master-valve should control several slave valves, which can decrease the price for pilot control units.

2 MATERIALS USED FOR WATER-HYDRAULICS

In the past the most of the manifolds and valves have been manufactured out of the material 1.4104. The experiences with this material have been and still are positive. The tendency to higher pressure requirements and higher flow rates makes it necessary to think about using other materials. Nowadays many machines are running with pressures higher than 320 bars which is different to the past. The result is, that we are using the material 1.4313 in more frequent cases, if the height and the width of the manifold is lager than 400 mm.

Figure 11: Manifold

This is a stainless steel with good stiffness performance. It is in particular more resistant to erosion and damages in case of high pressures. A disadvantage is the longer machining time, which causes higher cost for the manufacturing and affects the price of the product.

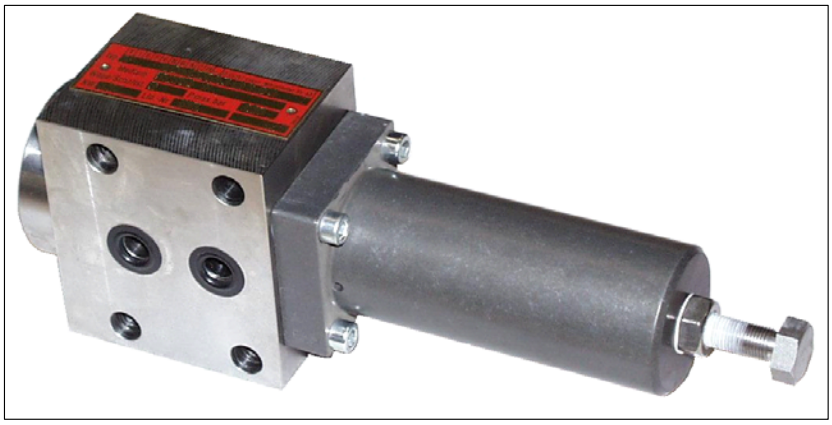

Figure 12: Pressure reduce valve

In particular pressure reduce valves are exposed to high demands. Because of the continuous overflow of some parts of the valve, usual steels are not wear resistant enough. That is the reason for proving to manufacture parts like the valve seat and the piston out of powder steel M390 PM. By using this material the produced parts will be vacuum hardened in a second step. The big advantage of this material is the good machining performance before the material will be hardened. A disadvantage is the high price of the material, so that it only makes sense to manufacture the most stressed parts of the valve out of powder steel.
If valves have to meet special requirements like very low weight or very good corrosion resistance we use the material titan.

Figure 13: Seawater valve

So especially valves for the navy or civil shipbuilding industry are made out of titan.

3 SUMMARY

It could be shown that the development of a new proportional control technology with electronics on board is important for being competitive with the oil hydraulic and for the future. The test with new materials shall make it possible to use water-hydraulics with higher pressures and higher flow rates.

4 REFRENCES

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