

HIGH PRESSURE INTENSIFIERS

Field of the Invention

The present invention relates to high pressure intensifiers.

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Background of the Invention

High pressure intensifiers (HPIs) are employed in subsea well control systems to reduce the cost of the umbilical from the control centre, which may be several hundred kilometres from the well head. Hydraulic control fluid is fed to the well control system via the umbilical at a pressure lower than that required by the control system. The lower pressure enables the umbilical walls to be thinner, making the umbilical smaller in diameter, lighter and easier to deploy, resulting in major cost reductions.

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The HPI is located at the well end of the umbilical and increases the hydraulic pressure to a level required by the well hydraulic control system. An example of an HPI is described in GB-A-2 275 969.

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Existing HPIs produce a fixed output pressure as a multiple of the input pressure, e.g. 5000 psi in and 10,000 psi out. This fixed pressure is not favoured by many well operators, because they are concerned, in particular, at the possibility of damage to the downhole safety valve (DHSV) fitted in the well fluid extraction flowline, and the major costs involved in its replacement in the event of damage. The DHSV is sensitive, in particular, to the difference in pressure between the production flowline pressure and the valve's hydraulic operating control pressure (a large difference causing the valve to slam hard when opening or closing) which is exacerbated by the fact that the production flowline pressure tends to fall over the life of the well. Well operators would consider this problem solved if the valve's hydraulic control pressure, typically derived from the output of the HPI, was adjustable, to suit changes in the production flowline pressure.

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Summary of the Invention

According to the present invention, there is provided a high pressure intensifier system comprising:

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a high pressure intensifier for receiving hydraulic fluid from an input and providing the fluid to an output at a higher pressure than at the input;

means for monitoring the pressure of hydraulic fluid provided at the output; and

control means for controlling the supply of hydraulic fluid to the input for maintaining the pressure of hydraulic fluid provided at the output at substantially a predetermined value.

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Said control means could include a valve via which the hydraulic fluid is supplied from said input and means for opening and closing the valve in dependence on the pressure of hydraulic fluid at said output as monitored by said monitoring means.

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Said control means could comprise electronic means coupled with said monitoring means for comparing the pressure of hydraulic fluid provided at said output with a predetermined value.

In a preferred embodiment, said control means includes:

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a valve via which the hydraulic fluid is supplied from said input; and

electronic means coupled with said monitoring means for comparing the pressure of hydraulic fluid provided at said output with a predetermined value, said electronic means controlling the opening and closing of said valve in dependence on the result of comparison for maintaining the pressure of hydraulic fluid provided at said output substantially at said predetermined value.

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Such electronic means could be provided in a subsea electronic module for a subsea well control system.

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The high pressure intensifier system could include means coupled with such electronic means for monitoring the pressure of hydraulic fluid at said input.

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Where a valve and electronic means are used, the system could include means coupled with such electronic means for monitoring the pressure of hydraulic fluid supplied by said valve.

Preferably, said predetermined valve is adjustable via said control means.

Brief Description of the Drawings

Fig. 1 is a schematic diagram of a preferred embodiment of the invention.

Detailed Description of Preferred Embodiment

5 Referring to Fig. 1, a hydraulic fluid input 1, typically receiving the hydraulic fluid from an umbilical, feeds a directional control valve (DCV) 2 at the input to an HPI 3. Typically, monitoring means in the form of a pressure transducer 4 is fitted at the input to the DCV 2 and monitoring means in the form of a second pressure transducer 5 is fitted at the input to HPI 3. These transducers 4 and 5 are not essential for the functioning of the system but are fitted to
10 provide confidence that the components of the system are operating correctly, bearing in mind that the equipment is on the seabed and not readily accessible and therefore monitoring for fault diagnosis is important to the well operator. The output of the HPI 3 feeds a hydraulic accumulator 6 and monitoring means in the form of a third pressure transducer 7 is fitted at the output 8 of the HPI 3, which output provides high pressure hydraulic fluid for the well control
15 system, which normally includes a DHSV. The outputs of the three pressure transducers 4, 5 and 7 are fed to an HPI electronic control unit 9, which is conveniently located in the existing well control system subsea electronic module (SEM) 10, since the SEM already communicates electronically with the control centre via the umbilical for well control. The output of the HPI electronic control unit 9 controls the DCV 2.

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The mode of operation is that hydraulic fluid is fed to the DCV input 1, which commences in the open position, allowing fluid flow to the HPI 3, which then pumps fluid to the hydraulic accumulator 6 with other feeds to the well control hydraulic devices being closed. The rising pressure at the HPI output 8 is monitored by the pressure transducer 7, which feeds pressure
25 information to the electronic control unit 9 in the SEM 10. If the pressure at the HPI output 8, is lower than that required by the well control hydraulic system and in particular the DHSV, the output of the electronic control unit 9, keeps the DCV 2 open. If the pressure sensed by the pressure transducer 7 reaches a pre-set threshold set in the electronic control unit 9, its output changes to close the DCV 2. If the pressure, sensed by the pressure sensor 7, at the HPI
30 output 8 falls, as a result of the operation of well control hydraulic devices, the electronic control unit 9 opens the DCV 2 until the required pressure at output 8 is restored to a predetermined value. Thus, the pressure at the HPI output 8 is maintained automatically and is varied as required by alteration of the pre-set pressure threshold stored in the electronic control unit 9. Typically, this pressure threshold is changed by communicated messages, through the existing

communication link from the SEM to the well control centre, via the umbilical. Thus the well operator can adjust the HPI output pressure from the control centre, typically a surface control platform.

- 5 The DCV employed is monostable in that it remains open when electrically energised and closed when the electrical supply is removed.

The present invention is not restricted to the use of a single HPI and its control means as systems using more than one HPI are possible to produce a plurality of intermediate pressures
10 as desired.

Advantages of using the Invention

The pressure of the high pressure hydraulic supply from the HPI can be varied as required, a facility not available from existing HPI systems. In particular, the output pressure from the HPI
15 can be reduced as the well ages and the production flowline pressure falls, thus maintaining the pressure differential between the hydraulic control pressure operating a DHSV and the flowline pressure, and thereby optimising the life of the DHSV.

Claims

1. A high pressure intensifier system comprising:
 - 5 a high pressure intensifier for receiving hydraulic fluid from an input and providing the fluid to an output at a higher pressure than at the input;

means for monitoring the pressure of hydraulic fluid provided at the output; and
 - 10 control means for controlling the supply of hydraulic fluid to the input for maintaining the pressure of hydraulic fluid provided at the output at substantially a predetermined value, said control means including electronic means coupled with said monitoring means for comparing the pressure of hydraulic fluid provided at said output with a predetermined value, characterised in that:
15 said electronic means is provided in a subsea electronic module for a subsea well control system.
2. A system according to claim 1, wherein said control means comprises a valve via which
20 the hydraulic fluid is supplied from said input, said electronic means controlling the opening and closing of said valve in dependence on the result of comparison for maintaining the pressure of hydraulic fluid provided at said output substantially at said predetermined value.
3. A system according to claims 1 or 2, including means coupled with said electronic
25 means for monitoring the pressure of hydraulic fluid at said input.
4. A system according to claim 2, or claim 3 as dependent on claim 2, including means coupled with said electronic means for monitoring the pressure of hydraulic fluid supplied by said valve.
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5. A system according to any preceding claim, wherein said predetermined value is adjustable via said control means.