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PRECISION PRESSURE CONTROL

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Pore Pressure Transmission: Equilibar® BPR Increases Accuracy of Experimental Rig

Background

Pore pressure transmission (PPT) testing is used in petrochemical research to determine the effectiveness of oil drilling fluids. A PPT device simulates the pore pressure generation that occurs inside shale rocks during drilling processes and measures pore pressure changes over time. The test results help guide drilling fluid design and the selection of optimum operational conditions for improved drilling efficiency.

Adamu Ibrahim is involved in PPT testing as a doctoral student at the University of Aberdeen. He works with Dr Hossein Hamidi to research the stability of wellbores in shale formations.

Challenge

As part of Ibrahim's research into improved drilling fluids, he designed a PPT experimental rig for which he needed a wide range of pressure control to simulate various shale environments. The pressure control in the experimental design ranged from 1000 psi to 5000 psi.

Due to the low permeability of the St. Monan shale core samples involved in these experiments, flooding the test fluid through the core samples would often result in a large pressure build-up at the upstream side of the core holder. Therefore, the PPT was designed so that the test fluid flowed past the upstream face of the core. This modification led to a need to install a pressure control mechanism to maintain a constant flowing pressure over the core face. An Equilibar back pressure regulator (BPR) was recommended by Ibrahim's peers.

Upstream pressure control is an important part of the PPT design because the primary variable being monitored in the experiment is the pressure change at the downstream end. As such, any deviation in upstream pressure will have a correlated effect on the test results. In order for the results to provide meaningful information, downstream pressure measurements need to be recorded to a +/- 25psi accuracy.

Solution

Ibrahim contacted Equilibar for help choosing a pressure regulator for his pore pressure transmission experimental rig. Application engineers recommended an Equilibar U10L precision BPR in 316 stainless steel with Viton O-rings and PEEK diaphragm for its usefulness across a wide range of pressure control.

The U10L is part of the Equilibar Ultra Low flow (UL) series of back pressure regulators, which are designed to meet the demanding requirements of high-pressure core analysis and reactor applications. All Equilibar BPRs hold stable pressure across wide flow ranges and can handle liquids, gases, or multi-phase fluids.

Figure 1: Equilibar U10L

Equilibar BPR units are 1:1 dome-loaded, meaning that a pilot pressure equal to the desired setpoint must be supplied to the dome of the BPR. This pilot pressure can be supplied by a manual pressure reducing regulator (PRR) or by an electronic pressure regulator for computer automation.

The U10L BPR is designed to control pressures at a very low flow rate up to 10,000 psi, which was within the range of Ibrahim's design parameters.

Application Details

The U10L back pressure regulator was installed on the PPT test rig with a manual PRR to set the dome pressure setpoint. Ibrahim found that using nitrogen gas to set the pressure on the dome of the U10L was most effective in setting a stable pressure setpoint with no fluctuations.

Ibrahim faced a challenge regarding the source of pilot pressure in the first test phase. Initially, he had tried to use a hydraulic pump to supply the pilot pressure, but the pressure slowly dissipated over time, creating unstable pressure control.

320 Rutledge Road • Fletcher, North Carolina 28732
(828)650-6590 office • (801)504-4439 fax

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After switching to a bottle of compressed nitrogen to set the pilot pressure, the pressure control with the Equilibar U10L became extremely stable and resulted in consistent data collection.

Figures 2 and 3 show a photo and a schematic of Ibrahim's pore pressure transmission test rig.

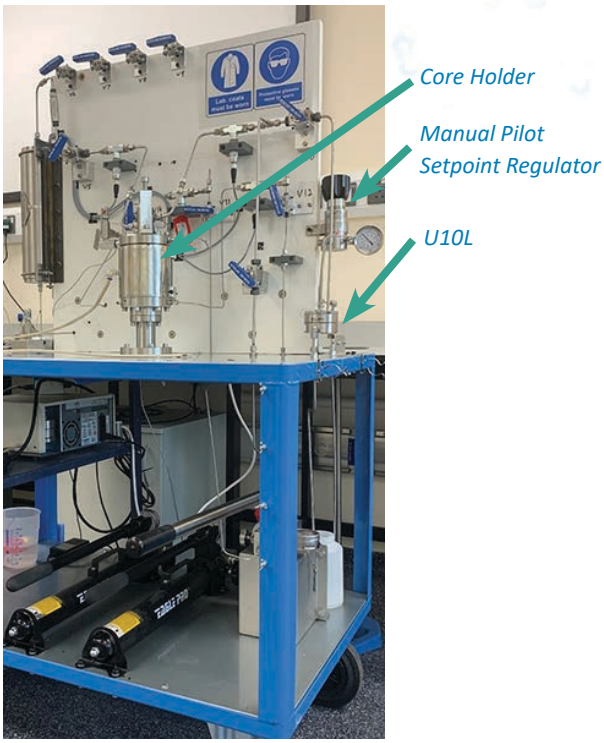

Figure 2: Photo of Ibrahim's PPT Test Rig

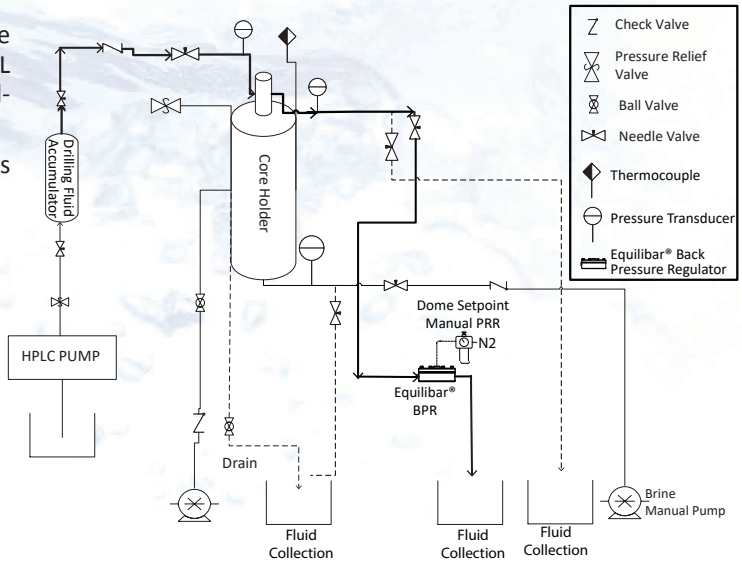

Figure 3: Schematic representation of Ibrahim's PPT test rig with an Equilibar® U10L controlling the pressure at the inlet to the core holder.

The typical PPT test is conducted over several days, collecting inlet and outlet pressure data throughout that time span. One challenge is designing a system capable of maintaining control for the duration of the experiment. The Equilibar U10L, with its dome-loaded design and sensitive diaphragm, was able to maintain constant core pressure for over a week without extra monitoring. See graph in Fig. 4 below as an example.

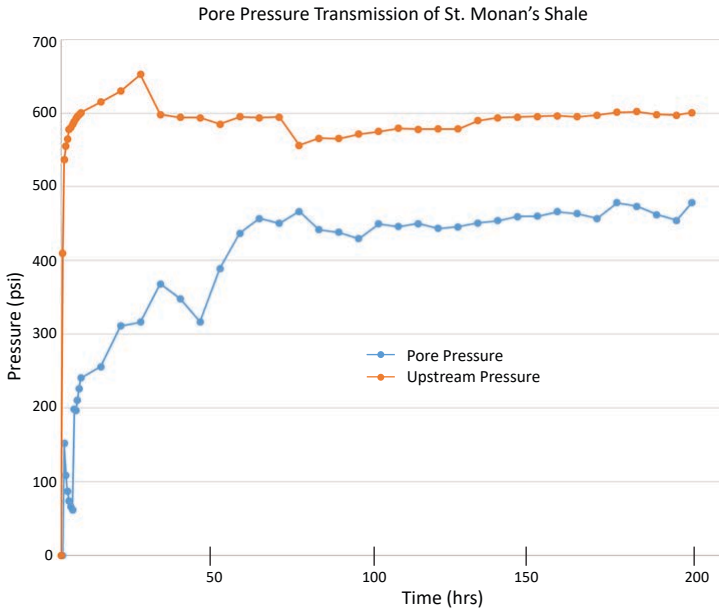

Figure 4: Graph showing consistent pressure control for the duration of the test.

> *"We are very happy with the Equilibar back pressure regulator and wouldn't hesitate to recommend it to anyone looking for a pressure control solution that's very easy to use and efficient."*
>
> - A. Ibrahim

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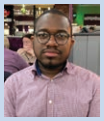
About the University of Aberdeen Petroleum and Natural Gas Engineering Research Group

The University of Aberdeen Petroleum and Natural Gas Engineering Research Group focuses on scientific advances of fundamental and applied solutions to the challenges of the oil and gas industry. With an emphasis on maximizing economic recovery from reservoirs, they carry out research in fluid flow through porous media; reservoir engineering, modelling and simulation; petroleum production; well and drilling engineering; and geomechanics and wellbore integrity.

Contact Equilibar

Equilibar is a provider of unique and innovative pressure control solutions based in Fletcher, North Carolina. Equilibar's patented pressure regulator technology is used in a wide array of processes including catalyst, petrochemical, sanitary, supercritical and other industrial applications. For more information please contact an Equilibar applications engineer at inquiry@equilibar.com or 828-650-6590.

Authors



Adamu Ibrahim is a doctoral student at the University of Aberdeen working with Dr. Hossein Hamidi to study the stability of wellbores in shale formations. His Ph.D. research focuses on the effects of multi-component fluids on wellbore stability.

Diane Jacober is a Technical Marketing Specialist at Equilibar. She has B.S and M.S degrees in engineering and has worked as a process engineer, project engineer and technical marketing specialist in several industries. Diane can be reached at dianejacober@equilibar.com or 828-650-6590.