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Hydraulic power in the SCF pilot scale systems from concept to realization.

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Almost all pilot supercritical fluid (SCF) systems use such modules as high pressure pump, back pressure regulator (BPR) and valves. All of the above are designed to work under high pressure of hundreds of atmospheres. There is a number of challenges that are common to high pressure pumps and BPRs.

We would like to focus on high pressure pumps first. In case of the most common medium is carbon dioxide (CO2), a gas under room temperature and atmosphere pressure.

Compressing CO2 to high pressure and maintaining high flow rates is challenging. When medium is compressed its temperature rises which causes cavitation. Standard crankshaft mechanism of a piston causes pulsating pattern of the flow rate; and in addition to this, may result in cavitation at lower flow rates.

With regards to a BPR there are engineering challenges if one needs to reduce length of piping between regulator and separation vessel.

Most of these difficulties can be overcome by using hydraulics to power high pressure pump and valves in the BPR. Unprecedented power density of hydraulics opens doors to designing relatively inexpensive but extremely reliable units for SCF pilot systems. Our team designed, built and tested two hydraulic high pressure cryogenic pumps; paired with electro-hydraulic powered BPRs.

In the first case the pump had been tested as a part of continuous close loop CO2 rig. We did not observe evidence of cavitation at input pressure range of 25-50 bar and subcooling of 1-10 K. We did not observe pulsation either at flow rate range of 1-3 litre/min at target pressure of 200 bar.

In the second case both pump and BPR were used in a supercritical fluid extraction (SFE) pilot. The system had been designed to be used with propane or CO2 as extracting medium. As in the first case we sis not observe cavitation, nor pulsating of the pump at flow rate range of 1-3 litre/min at target pressure of 250 bar.

Our new electrohydraulic BPRs exhibited quick response and consistency in controlling the pressure in the system both in automatic and manual modes. We completely eliminated piping between the BPR and a separator which helps to avoid unwanted dry ice formation.