WEEK OF AUGUST 30, 1999
US$5.00
PennWell

OIL&GAS JOURNAL

INTERNATIONAL PETROLEUM NEWS AND TECHNOLOGY

www.ogjonline.com

OFFSHORE NORTHERN EUROPE PAGE 51

Multistage Choke Valve Design Dramatically Increases Operating Life On Severe-Service Wells In Brent Field

Paul A. Smirl *CCI Rancho Santa Margarita, Calif.**

Shell U.K. Ltd. initially brought its Brent Charlie (C) platform in the North Sea into service in 1976, and recently it has been operating in a transitional stage as the reservoir changes from crude oil to natural gas production.

As is universally experienced in such transitional operations, choke-valve control became unreliable. In these 7$\frac{1}{16}$-in., API 5000-rated choke valves, the mixed liquid flow rate can range to as high as 4,895 cu m/day, while the maximum gas flow rate is 1.582 million cu m/day.

Trim and body damage as well as downstream piping damage increased to unacceptable levels. This was due to the erosive effects of increased sand content in the produced water and unpredictable flow velocities in a multiphase fluid.

The consequences of this erosive damage were particularly severe in certain wells in the Brent field.

In the Brent C valves, rapid erosive trim failure led to loss of pressure-reduction control and function, as well as resulting in trim damage that produced internal jetting. This failure would even compromise critical pressure boundaries within the choke valves themselves and the downstream piping through erosive damage.

In fact, single-stage, choke-valve life experienced on Brent C had been as low as 5 days before repair or replacement was required. The use of harder materials of construction alone to resist the rapid trim erosion and consequential failure produced little measurable benefit, especially in the high-velocity cage, plug-throttling areas of these single-stage valves, where they exert their pressure reducing and control functions.

As valve trim eroded, control was compromised and continued operation required closer and closer plug-to-seat operation. This, in turn, accelerated the plug-seat erosion regardless of the hardness of the materials used.

Another contributing factor on Brent C was increased vibration (and related high noise levels) due to the eroded valve trim, which actually caused the trim to come apart in some cases.

So it was this vicious circle that plagued choke valve operations on

**Assisted by Jack Haughey, senior instrument engineer, Shell U.K. Ltd., Aberdeen, and Graham Birnie, deputy asset manager, Brent field, Shell U.K. Ltd., Aberdeen.)*

Fig. 1

CHOKE VALVE UPGRADES

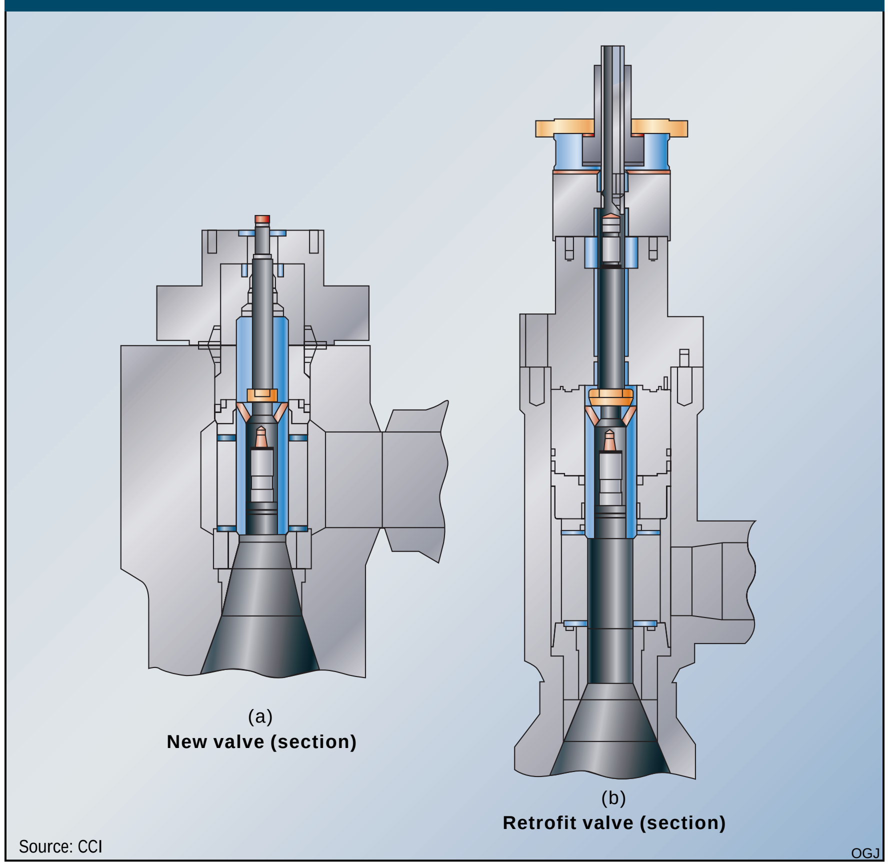
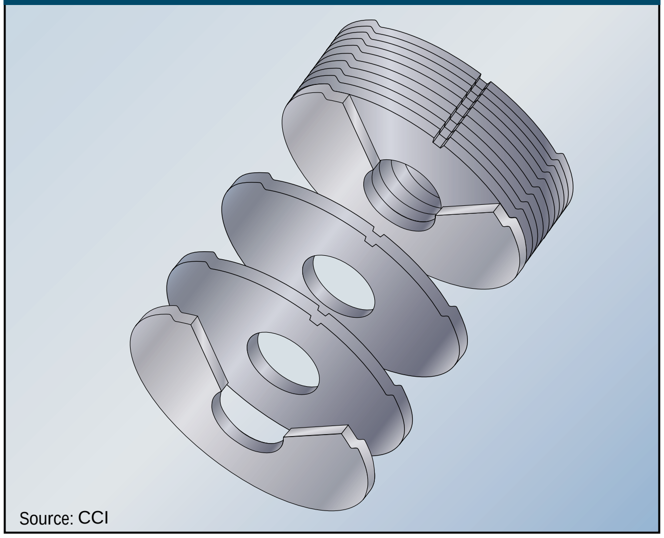


Fig. 2

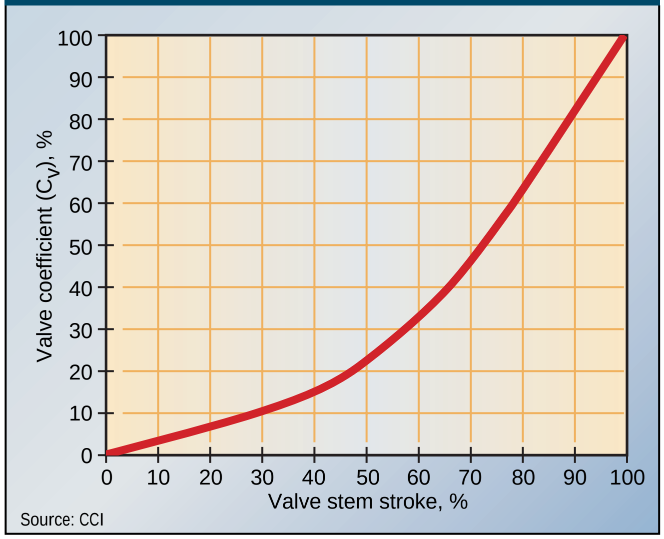
MULTI-STAGE VALVE TRIM



Source: CCI

Fig. 3

VALVE COEFFICIENT VS. STEM STROKE



Source: CCI

Brent C, causing extremely high maintenance costs and severely shortened choke-valve operating life.

Control valve design solution

In addition to the use of especially hard materials such as tungsten carbide, particularly in the choke trim of replacement valves, the key to the currently much-longer choke-valve life experienced within Brent field is a radically different design approach.

Multistage fluid velocity control was introduced as a means of curtailing the high fluid velocities produced by single-stage control in severe-service wells. As a result, internal fluid velocities were cut by at least 75% compared with single stage plug-seat, ported-cage, or drilled-hole valve designs. This drastically reduced the damaging erosive effect of the sand and helped preserve the valves' required control functions.

In all of these identically rated valves, the body sizes vary. In the larger choke valve-body sizes, where available internal control volume permitted, new multistage trim was retrofitted into existing valve bodies at a considerable savings of time and money. In the smaller body size, where this retrofitting approach was not feasible, the valves were totally replaced. Figure 1a is a cross-sectional view of a new, multistage trim valve, and Fig. 1b shows the same trim design as applied to retrofitted trim in its original valve body.

Using silver alloy-braised, multistage tungsten carbide trim, valve operating life was initially extended from as low as 5 days to up to 3 months. As a further improvement, the fused tungsten carbide multistage trim now in use has extended valve life to 1 year and perhaps even better.

Multistage velocity control

To limit fluid velocity throughout the valve trim and drastically reduce the erosive effects of the sand, a multistage valve trim design was used, in the form of a stack of disks.

Each disk provided a tortuous path flow pattern for the fluid by means of a series of right-angle turns in each disk (Fig. 2). In addition, the longer valve stem stroke increased rangeability and enhanced controllability, so that flow set points could be maintained and changes in operating conditions could be accommodated over time.

This valve trim was also "characterized." This meant that the tortuous paths in discrete groups of individual disks in the disk stack were individually designed. Hence, the flow per disk in one group was higher or lower than in a disk in another group.

The benefit of choke-valve characterization lies in the ability to maintain a larger distance between the plug and the seat at low fluid flows. Pressure reduction was therefore the same as that achieved within the tortuous path, multistage disks as opposed to the previous throttling process through a small plug-seat annular clearance.

Fig. 3 shows the percentage stem stroke vs. percentage valve coefficient (C_V) profile for these characterized disk stacks. Note that at about 10% of full flow, the plug has lifted from its seat by about 30% of its full travel, which reduces the fluid velocity through the annular plus-to-seat clearance.

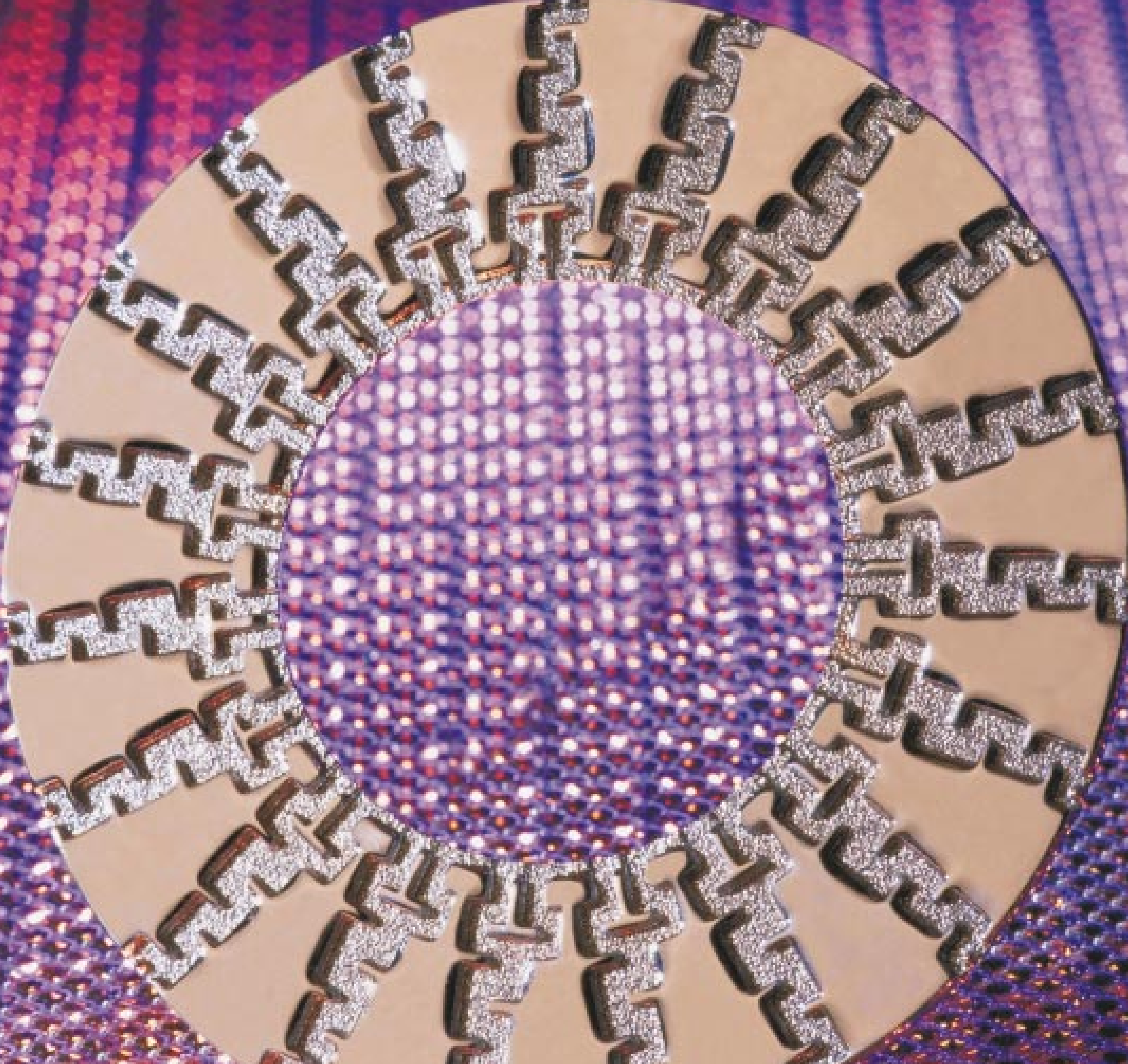
Service life successes to date with the choke valves within the Brent field certainly indicate that multistage velocity control combined with highly erosion-resistant materials are the keys to acceptable service life and reduced maintenance costs in severe-service choke valves. ▪

THE AUTHOR

Paul Smirl is manager of advanced products at CCI. He has served more than 13 years in the process control industry and has 10 years of experience with severe-service control valves. He attended Texas Tech University, Lubbock.

Smirl

We Solve Control Valve Problems



CCI World Headquarters

Telephone: (949) 858-1877 • Fax: (949) 858-1878

22591 Avenida Empresa • Rancho Santa Margarita • California, 92688 USA

Sales & Service Locations Throughout The World

www.ccivalve.com