CASEGUARD™

2.2

Rig-less, low cost remedy for Sustained Casing Pressure (SCP).

Simple solution, easy to apply, field proven and safe.

CHEMIX
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Sustained Casing Pressure (SCP)

Oil- and gas-producing wells are nested collections of pipe, cement, seals and valves forming multiple barriers between the production stream and external environment. The annuli enclosed by these barriers form a series of sealed pressure vessels. Sufficient barrier integrity must be maintained over the lifetime of the well to ensure that the pressures in the annuli are kept within safe limits and no flow path is created for high pressure formation fluids or gases through the annuli to external environment via casing head or shoe.

Well barrier failure

Unfortunately the integrity of wellbores tends to deteriorate with time and some will develop Sustained Casing Pressure (SCP), a condition which is defined as any measurable annular pressure that rebuilds after being bled as a result of the failure of a well barrier component.

The barrier components that most commonly fail and cause SCP are:

- Production tubing or packers
- Casing tubulars or couplings
- Cement sheaths behind the casing

SCP is a pervasive problem for the oil industry. For instance, a study conducted by the US Minerals Management Service found that the problem of leaking wells in the Gulf of Mexico is massive, with 11,498 casing strings in 8,122 wells exhibiting sustained casing pressure (1).
Cement failure and gas migration

The most common cause of SCP in the outer casing strings (i.e. the B, C and D annuli) is the ingress of gas from high pressure formations through cracks and channels in the cement sheaths behind the casing. These gas flow channels can develop during the primary cementing operation or are created over time by mechanical shocks and temperature/pressure fluctuations in the well after the cement has set.

Safety risk

Any breach of a well barrier is a serious matter that may eventually lead to the uncontrolled escape of formation fluids and gases threatening loss of life and environmental distress.

Well integrity is threatened when the casing pressure in an annulus approaches the Maximum Allowable Annulus Surface Pressure (MAASP).

It is important to recognise that well integrity may be compromised at pressures much lower than the MAASP if:

- The formation fluids and gases leaking into the annuli are corrosive and degrade the competence of other well barriers.
- The barriers are already compromised or weakened by other corrosive agencies
The blowout of Total’s Elgin G4 well in the UK North Sea is a good example of what can happen if SCP is allowed to build in a well containing barrier components weakened by corrosion. In this incident the A and B annuli of the G4 well became pressurised with gas leaking in through the production liner and cement, eventually leading to the rupture of a weakened C-110 casing coupling in the 10 ¾” production casing some 8 years later [2,3].

The casing coupling that failed had been compromised by stress corrosion cracking caused by an interaction between pipe dope and the annular fluid (calcium bromide brine) [4]. The 51-day blowout from the wellhead D annulus that ensued in Elgin G4 is reported to have reduced the UK’s gas output by 7% and is seen by some as one of the causes of UK’s double-dip recession in 2012 [5].

Elgin G4 wellhead assembly showing high pressure gas blasting out of 4 ports
Rig-less mitigation of SCP

The conventional remedy for SCP in B and C annuli of the outer casing strings is to perform a cement squeeze using a workover rig. A workover solution of this kind will cost $ millions, not even including the loss of production revenues for the duration of the workover.

An alternative and cheaper rig-less method for managing SCP involves the gradual replacement of the annular fluid and gas cap in the annulus with a heavy fluid. This “bleed-and-lube” method requires the frequent extraction of small volumes of annular fluids and gases via the wellhead casing valves, and their replacement by an equivalent volume of heavy fluid injected through the same valve. By gradually increasing the hydrostatic head pressure exerted by the annular fluid in this way the rate of gas ingress into the annulus through channels in failed cement can be slowed or stopped.

Specification for heavy bleed-and-lube fluid

The special functionalities required in a heavy bleed-and-lube fluid make for a very demanding product specification:

- Solids-free, clear, low-viscosity fluid – for ease of injection and maximum penetration into the micro gas channels in the cement
- Highest density possible – to maximise the hydrostatic impact of the injected fluid and minimise the number of bleed-and-lube cycles
- Compatible with annular fluids – no gelation or precipitation reactions
- Capable of buffering acid gases (CO₂ and H₂S) in the annulus
- Long-term compatibility with all metallic well components in presence of acid gases
- Long-term compatibility with elastomers and cement in the presence of acid gases

- Non-hazardous – a benign HSE profile

- Long-term chemical- and thermal-stability – i.e. no adverse transformations over time

- Flowable at sub-zero temperatures (for use in cold climates)

In effect, the specification calls for a product matching the performance and properties of the highest-quality heavy clear packer fluid.
CASEGUARD™ 2.2 is the tried and tested ideal heavy bleed-and-lube fluid

CASEGUARD™ 2.2 heavy formate brine from Chemix was identified in 2014 by a large multi-national consortium operating one of the largest gas condensate fields in the world. It is the ideal fluid for use in bleed-and-lube operations to mitigate SCP in their onshore wells.

Heavy formate brines have a long and successful history of use as clear packer fluids and long-term well suspension fluids in extreme gas condensate wells. The consortium saw that the properties of Chemix’s CASEGUARD™ 2.2 brine met ALL of the required performance criteria for a rig-less SCP remediation treatment:

- Low viscosity clear fluid for ease of injection into annuli and penetration into micro gas channels in cement

- Heavy SG 2.20 fluid for maximum impact - so only small volumes are needed to raise hydrostatic head (pressure) of fluid column in annuli for SCP control and mitigation

- Stable, reliable well control providing the increased hydrostatic fluid head required to stop or minimize further gas ingress into the annuli from reservoir or shallower formations

- Penetrates into micro-channels in cement to take hydrostatic pressure control to the source of the gas ingress

- Compatible with annular fluids

- An effective buffer of acid gas – absorbs CO₂ and keeps H₂S in its less harmful form, bisulfide (HS⁻)

- Cost effective - a rig-less solution provided by a small injection of heavy fluid into the annulus – much cheaper than a workover with a rig
- An excellent HSE profile - safe for people and safe for the environment - no liability issues and does not require special precautions or permits

- Compatible with downhole seals and metals over long periods - proven as a long-term well suspension and packer fluid since 1996

- Compatible with acid gases - does not initiate stress corrosion cracking in casing, packers, seals or production tubulars when contaminated with H₂S or CO₂

- All-weather all-climate handling – stays as a pumpable liquid down to -30 deg C when diluted down to SG 2.0
CASEGUARD™ 2.2 is field proven

The major gas condensate field operated by the consortium has more than 400 onshore wells and some of these have had SCP in B and C annuli due to gas leakage through cement. CASEGUARD™ 2.2 heavy formate brine has been used by the consortium as a remedy for SCP in more than 20 wells in the field.

Annular pressures of up to 50 bar have been treated by bleed-and-lube with CASEGUARD™ 2.2 formate brine as the heavy fluid. Typically only 150-250 litres of CASEGUARD™ 2.2 fluid is required to treat each well over a period of 3 months. It is reported that the success rate to date has been excellent, with SCP removed or significantly reduced.

The Chemix Service

Chemix offers security of supply, consistently high-quality products and a responsive service;

- Supplying heavy CASEGUARD™ 2.2 formate brine to the oil industry is Chemix’s core business

- Chemix can deliver large volumes of CASEGUARD™ 2.2 formate brine from stock at short notice

- Chemix can deliver CASEGUARD™ 2.2 worldwide

- CASEGUARD™ 2.2 is manufactured to the strictest specifications under ISO standards and is a virgin, high-purity product. It is essential for its long-term presence in the annulus that the product has not been used in other applications previously with the consequent risk of contamination.
### CASEGUARD™ 2.2 - Technical Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tbody>
<tr>
<td><strong>Density (SG)</strong></td>
<td>≥ 2.20 (@ 16 deg C)</td>
</tr>
<tr>
<td><strong>pH</strong></td>
<td>9.0 – 11.0</td>
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<tr>
<td><strong>Turbidity</strong></td>
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<tr>
<td><strong>Total non-Cs Monovalent Cations</strong></td>
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<tr>
<td><strong>Total Divalent Cations</strong></td>
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<tr>
<td><strong>Chlorides</strong></td>
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<tr>
<td><strong>SO₄</strong></td>
<td>&lt; 150 ppm</td>
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</tbody>
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References


5. Kavanagh, M. “Total resumes Elgin-Franklin production”, Article posted on the Financial Times online , 13 March 2014 - https://www.ft.com/content/d0e5e510-8819-11e2-b011-00144feabdc0?mhq5j=e3