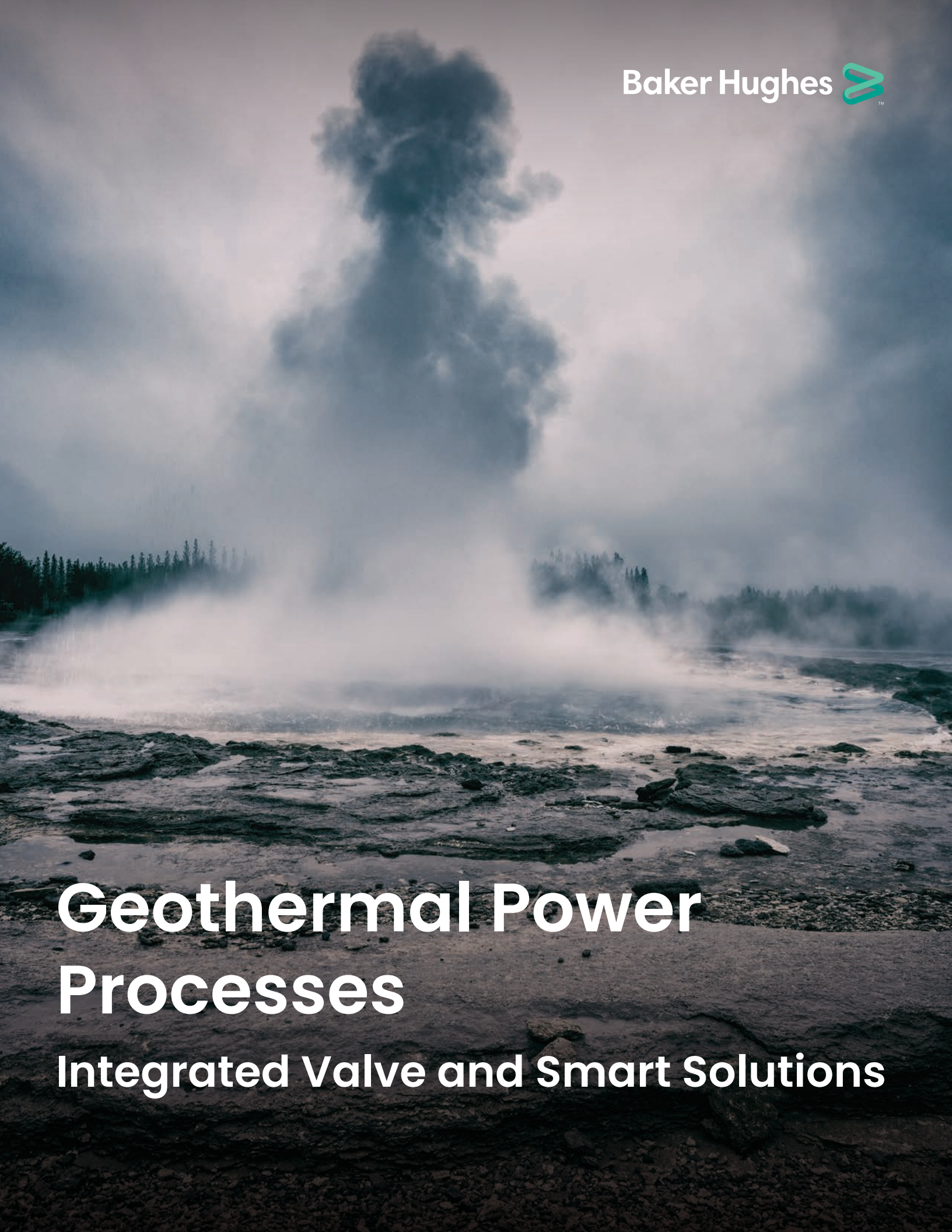


Baker Hughes

Geothermal Power Processes

Integrated Valve and Smart Solutions

Baker Hughes is looking to the future

The world is rapidly changing. In the dynamic environment of Energy Transition, it's more important than ever to innovate and provide solutions that help our customers face new challenges with confidence in their process applications.

Optimize Service

Improve Reliability

Increase Efficiency

Reduce Emissions

Geothermal power plants use heat in the form of water and steam extracted from large reservoirs below the earth's surface to ultimately generate electricity. The efficiency of this process is in part attributed to engineered control and safety relief valves. Building on a foundation of years of innovation, Masoneilan Control Valves have been designed to maximize service life while reliably controlling the media for power production.

Optimize Service

The Baker Hughes digital suite of Valve Lifecycle Management tools coupled with a global network of **Masoneilan™** Authorized Repair Centers (**MARC™**) and **Consolidated™ Green Tag™ Centers** (GTC) help you easily identify and service the valves that need it the most, making turnarounds and planned maintenance easier.

Improve Reliability

The eccentric plug design, and Stellite lining, of the Masoneilan **Camflex™** control valves provide repeatable tight shutoff and protection against corrosive brine fluids that would otherwise lead to rapid wear of other control valves in these applications.

Increase Efficiency

High capacity Camflex valves offer the maximum amount of flow of a rotary valve, while also providing the superior control and shutoff performance of a robust globe valve.

Reduce Emissions

While hot water and steam are a positive contribution to the carbon footprint in Power Generation, any leakage at these elevated temperatures can be harmful and dangerous to any personnel who are nearby the valve. The Camflex eliminates the body-to-bonnet joint, and provides options for Class A, ISO 15848-1 certification, tested to less than 50PPM, making the valve safer and more suitable for geothermal applications.

Evolving Technologies

Enhanced Geothermal Systems (EGS)

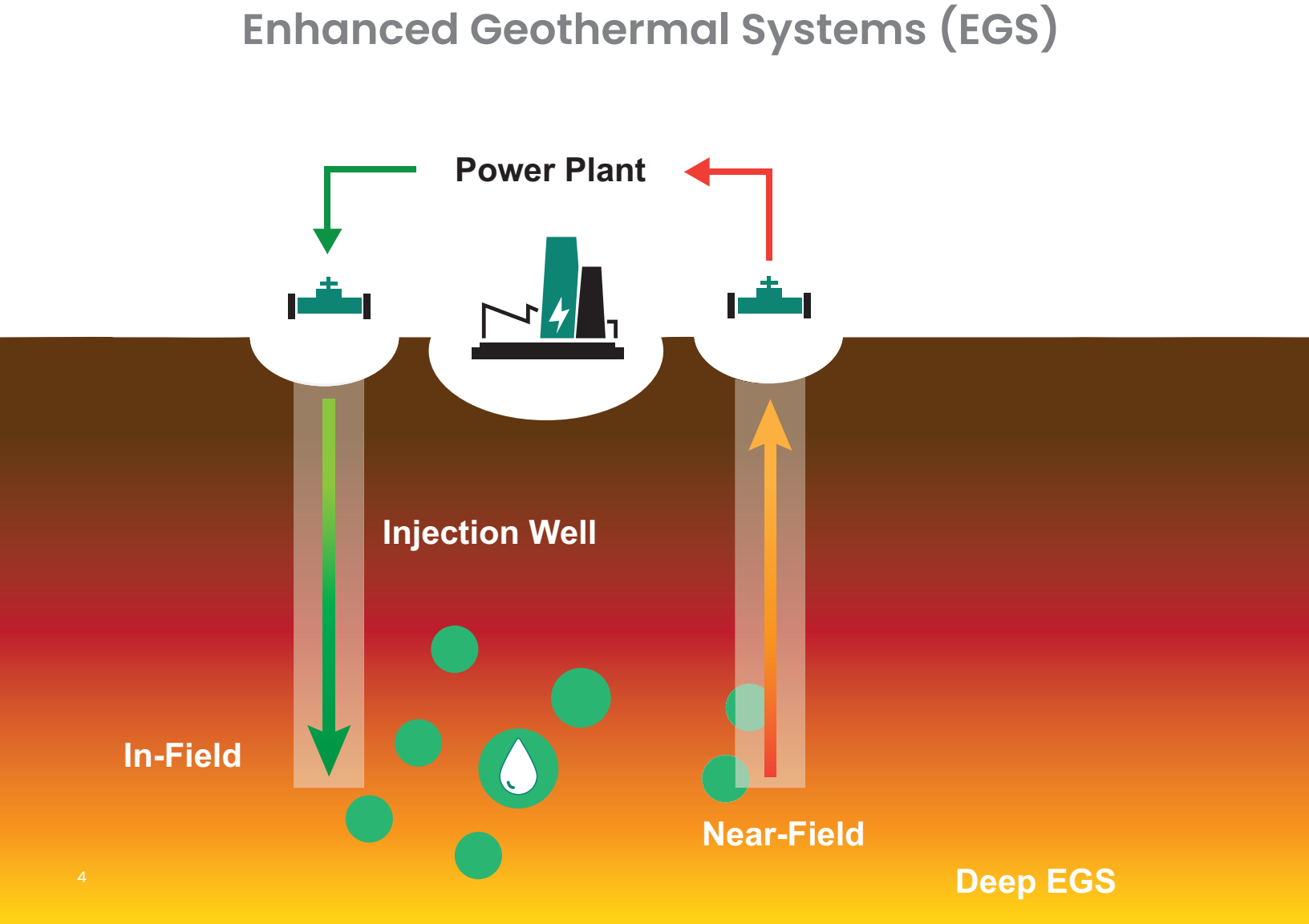
Enhanced Geothermal Systems (EGS) is a technology that utilizes a geothermal system in underground areas that are high in temperature but lack permeability and water. Fluid is pumped into the rock via a controlled environment to hydraulically shear or stimulate the rock to open up existing fractures making a man-made reservoir. The energy is then captured and brought back to the surface, used to generate power.

Advantages

- No greenhouse gases are emitted
- Production is ongoing 24/7, therefore no need for storage devices
- Expand geothermal options outside of traditional geothermal areas

Disadvantage

- Seismic activity possible from making man-made reservoirs



Advanced Geothermal Systems (AGS)

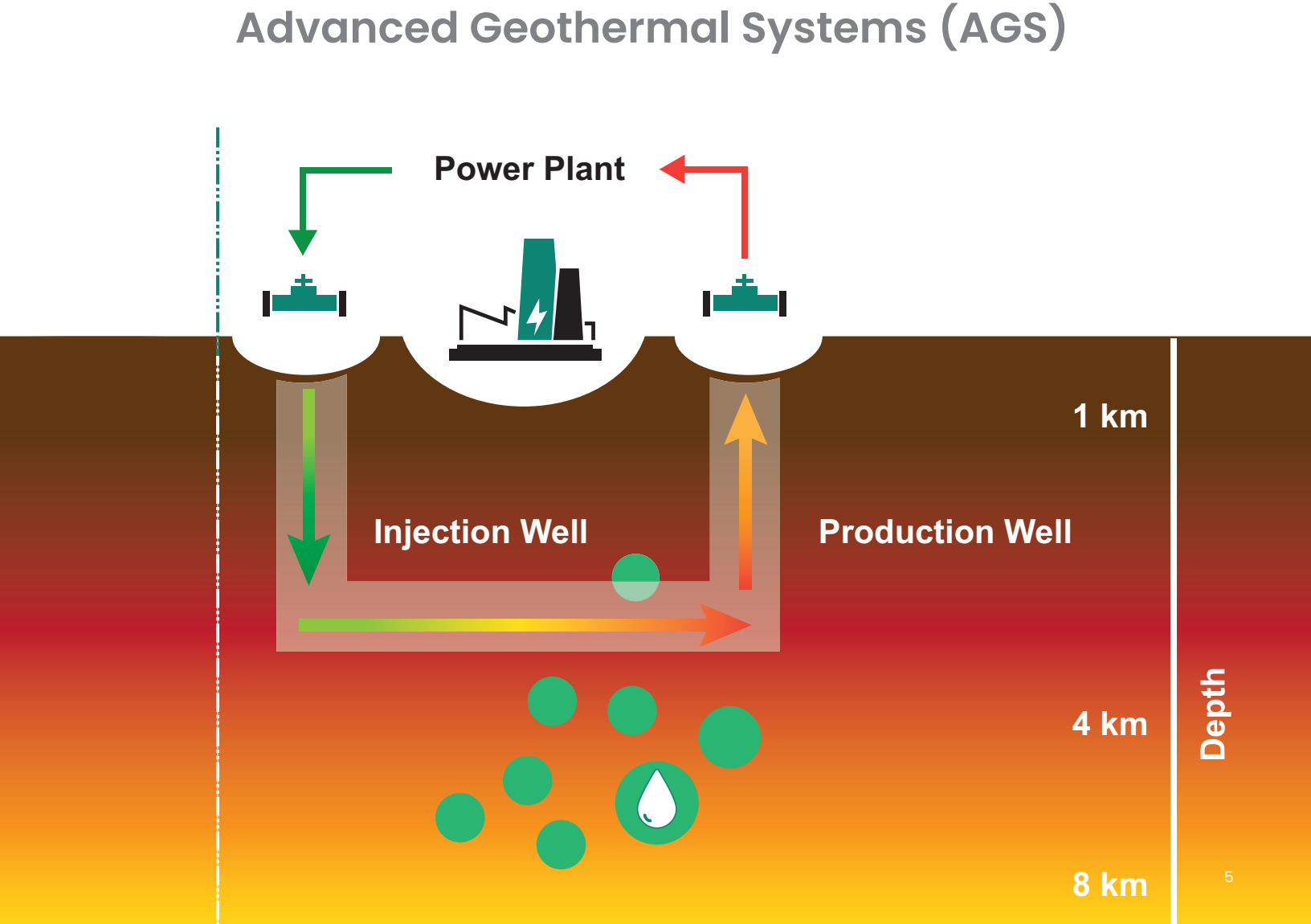
Advanced Geothermal Systems (AGS) is a technology that acts much like an indirect heat exchanger. In a closed loop, a fluid is pumped down a deep well where it conducts heat from surrounding rocks. The fluid is never exposed into the surroundings and can be optimized for heat transfer efficiency. The heated fluid is then pumped back up to the surface where the energy is then used to generate power.

Advantages

- Low water consumption
- Limited potential for seismic occurrences
- Can be implemented in non-traditional geothermal locations
- Potential to re-purpose existing depleted oil or gas wells to geothermal wells

Disadvantage

- Deep wells dependent on drilling costs



Geothermal Processes

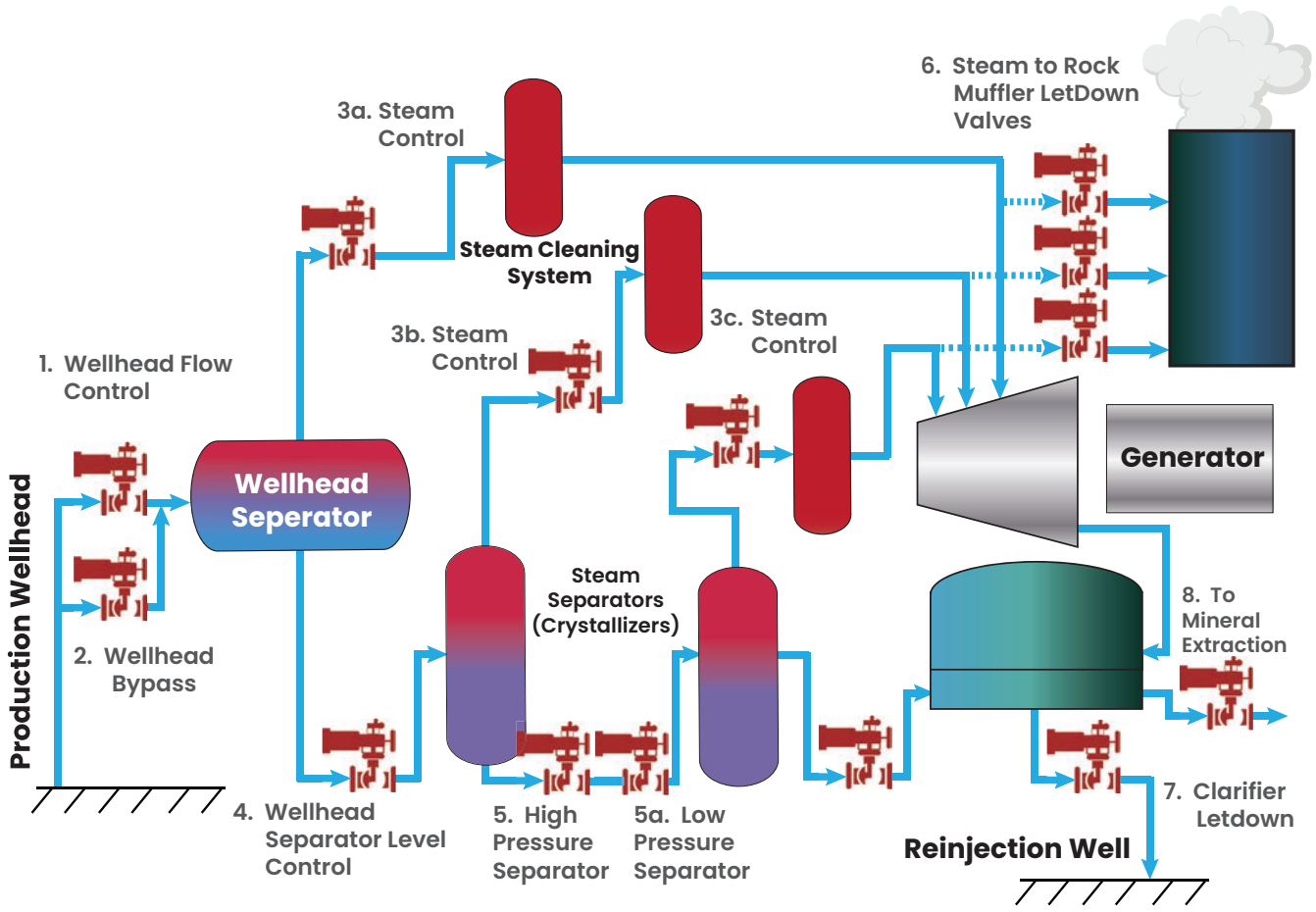
Geothermal Power Production is a sustainable way to generate power by harnessing energy from the earth via underground reservoirs of steam and hot water. While technologies to capture this energy are changing to increase efficiencies, there are two mainstream technologies that comprise the lion's share of geothermal electricity production: (a) utilizing steam (dry steam, single/double/triple flash) and (b) utilizing an organic fluid in a binary cycle to drive a generator to produce electricity. Each have advantages and are used based on regional geothermal well temperatures. Both technologies have challenges for flow control equipment, however Baker Hughes has years of experience providing superior solutions for both.

Flash Steam Geothermal Power Plant

Geothermal Flash Power Plants use hot water with dissolved salts (brine) from wells that are miles below the earth's surface. The hot brine (optimally between 300°F-600°F (150°C–315°C) is 'flashed' to steam inside flash tanks, cleaned, and dried before it is ultimately sent to a turbine to generate electricity. The left-over concentrated brine is either processed for mineral extraction or re-injected back into the well to be reheated by the earth and reused. The condensate from the steam turbine exhaust is typically reinjected back to into the well, or in some cases reheated into steam and sent to the steam turbine.

Challenges

- High temperatures and pressures
- Flashing
- Highly corrosive hot brine fluid
- Erosive media containing entrained particles
- Flow induced vibration
- Binding

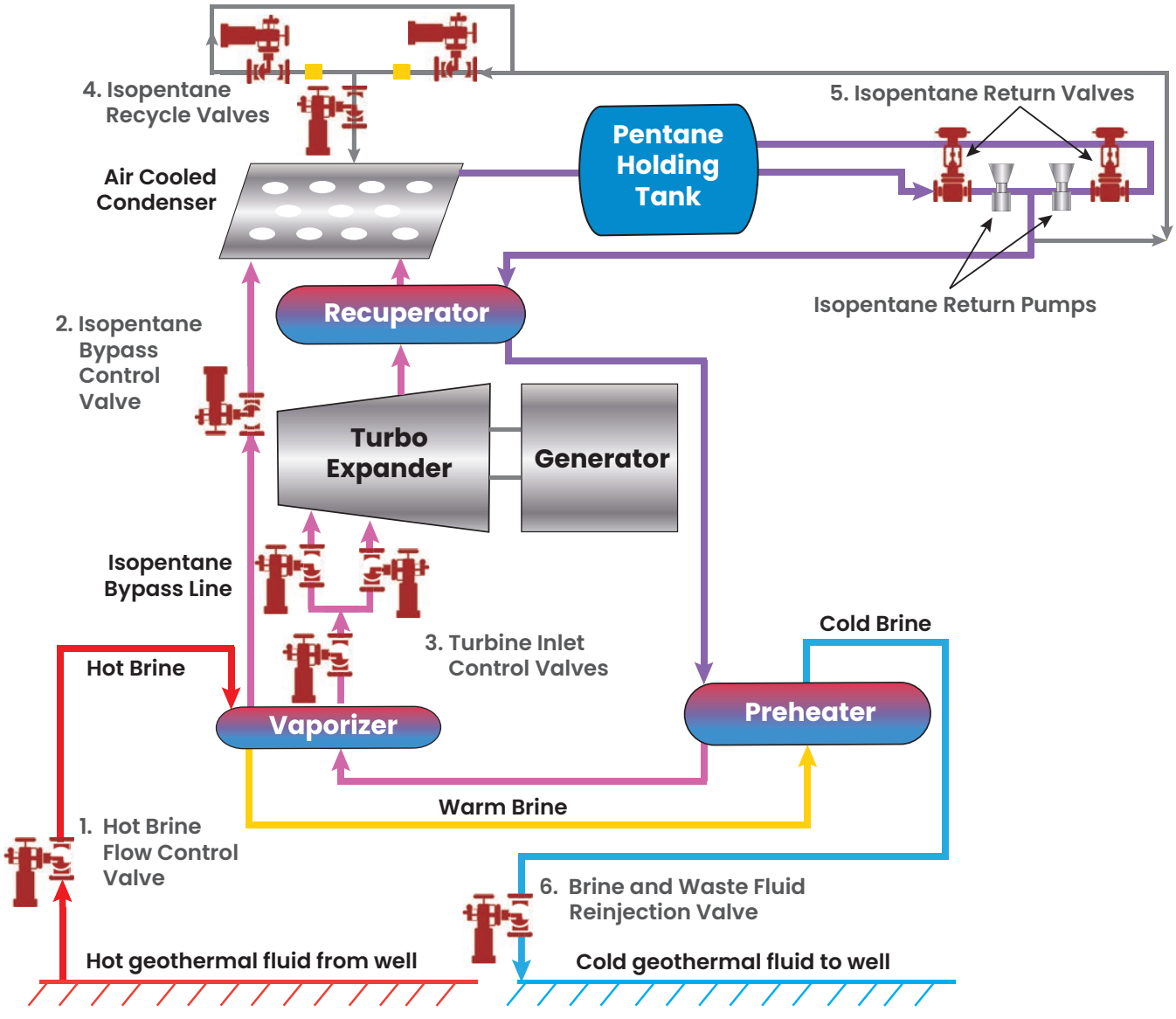


Binary Geothermal Power Plant

As the name Binary suggests, two cycles are involved in a Binary Power Plant. The first cycle consists of bringing liquid geothermal brine up to the surface from a production well (optimal temperatures are between 225°F-360°F (107°C-180°C)) and fed into a heat exchanger or evaporator. The hot brine is used to transfer heat to a secondary fluid (such as isopentane) that has a lower boiling point. When the pressurized secondary fluid heats up, it changes from a liquid phase to a gas phase and is then passed through a turboexpander coupled with a generator to produce electricity. After the turboexpander, the secondary fluid is cooled back into its liquid form through a condenser, and once again recirculated through the same process. The liquid brine is injected back into the well, or in some cases reheated into steam and sent to a steam turbine for higher efficiency power generation.

Challenges

- Highly corrosive hot brine fluid
- Erosive media containing entrained particles
- Flow control of the secondary fluid into the turboexpander
- Packing leaks



Geothermal Applications

Geothermal Flash Applications

Critical Applications	Service Challenges	Product Scope
1. Wellhead Flow Control	Severe erosive, corrosive, flashing, binding	Geothermal Camflex 10" to 16", Cl 300 to 600
2. Wellhead Bypass	Severe erosive, corrosive, flashing, binding	Geothermal Camflex 10" to 16", Cl 300 to 600
3. Steam Control	Noise, vibration, high temperature, binding	33000 Series 12" to 32", Camflex Cl 150 to 600
4. Wellhead Separator Level Control	Severe erosive, corrosive, flashing, binding	Camflex 8" to 12", Cl 150 to 300
5. HP/LP Separator Level Control	High temperature, vibration, binding	Camflex 6" to 12", Cl 150 to 300
6. Steam to Rock Muffler Valves	Vibration, noise, leak tightness, binding	Camflex 10" to 16", Cl 300
7. Clarifier Let Down	Erosive, corrosive, binding	Camflex 2" to 12", Cl 150
8. To Mineral Extraction	Erosive, corrosive, binding	Camflex 2" to 12", Cl 150

Geothermal Binary Applications

Critical Applications	Service Challenges	Product Scope
1. Hot Brine Flow Control	Severe erosive, corrosive, flashing	Geo-Camflex or Slurry Trim Camflex (depending on the quality of brine)
2. Isopentane Bypass	Corrosive	Camflex, Cl 150 to 300
3. Turbine Inlet	High temperature, vibration	Camflex, Cl 150 to 300
4. Isopentane Recycle	Corrosive	Camflex, 21000 Series, Cl 150 to 300
5. Isopentane Return	Corrosive	Camflex, 21000 Series, Cl 150 to 300
6. Brine and Waste Fluid Reinjection	Erosive, corrosive	Camflex, 21000 Series, Cl 150 to 300

Miscellaneous Applications

Plant	Function	Product Scope
On/Off	Manual	21000 Series 1.5” to 2”, Cl 150
HP/LP Demister	Control	Camflex 1” to 8”, Cl 150 to 600
HP/LP Scrubber	Control	Camflex 1” to 4”, Cl 150 to 600
Cooling Tower Blow Down	Control	Camflex 1” to 3”, Cl 150
Steam to Cake Dryer	Control	Camflex 1” to 3”, Cl 150
Purge	Control	Camflex 1” to 3”, Cl 150
Hotwell Condensate	Control	Camflex 1” to 6”, Cl 150
Dilution Water Heater	Control	Camflex 1” to 6”, Cl 150
Gas pressure to cooling tower	Control	Camflex 1” to 3”, Cl 150
Brine Steam Wash	Control	Camflex 1” to 2”, Cl 300
Heat exchanger flow	Control	33000 Series
Rock box muffler block	On/Off	33000 Series
Brine Block	On/Off	33000 Series
Steam Control	Control	33000 Series
Isobutane Bloc	On/Off	39004 Series
Turbine Trip	On/Off	39004 Series
Cooling Water	Control	39004 Series

Flow Control Solutions for Geothermal Applications

PROBLEM

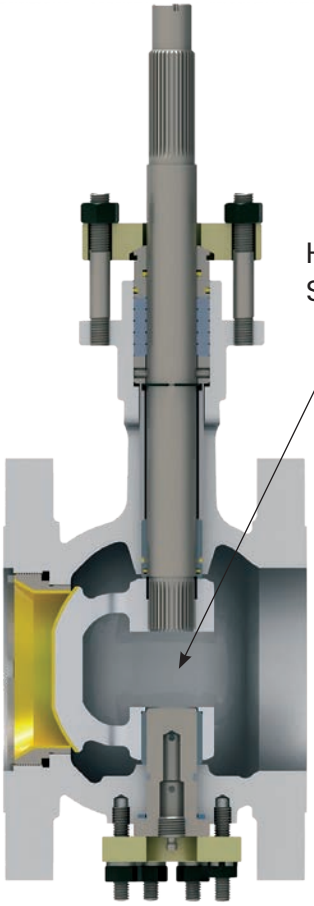
- Erosion
- Corrosion
- Entrained Solids
- Flashing
- Vibration
- Noise
- Binding

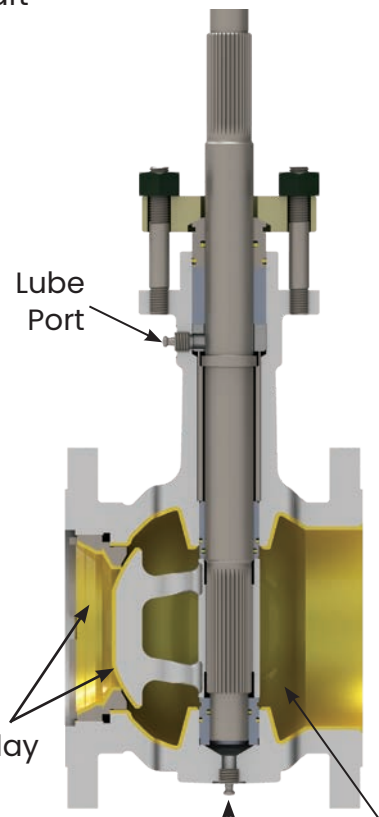
PROCESS

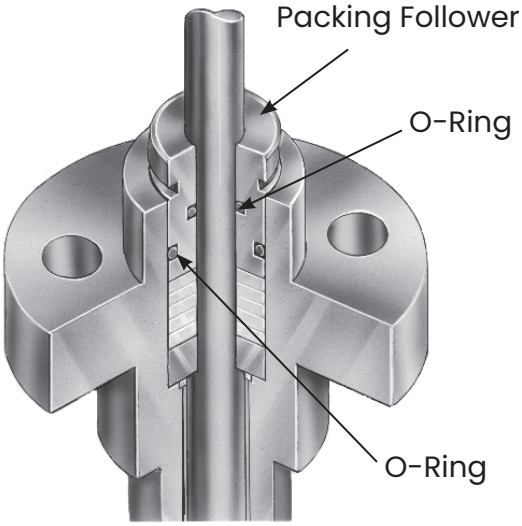
- Geothermal Well Site (Extraction)
- Power Plant
- Reinjection into Well

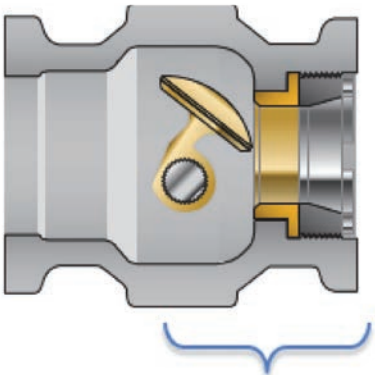
APPLICATIONS

- Wellhead Flow Control/Manual Bypass
- HP/LP Steam Level Control
- Steam Separators for Crystallizers
- Steam to Rock Muffler Letdown
- Clarifier Let down









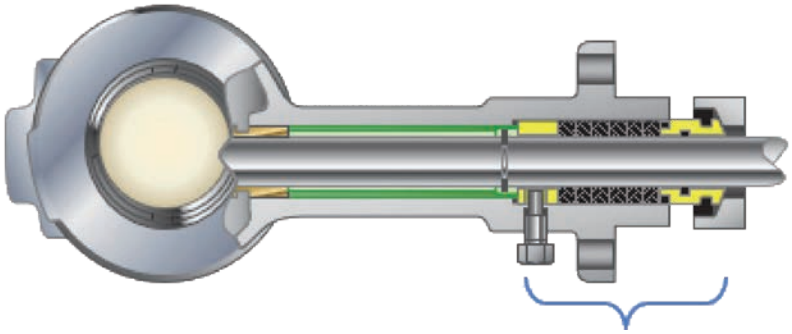
SOLUTION: Masoneilan Camflex 35002 Series

The Masoneilan Camflex is the original rotary control valve and a universal answer to a wide range of flow control applications. Specifically in geothermal applications that can range from challenging to benign, the straight through geometry with eccentric plug provides superior control and consistent shut off, while the extended bonnet allows for elevated temperatures using TFE packing for lower friction.

For applications with increased severity, there are features that can be added to maximize valve performance and lengthen the life of the valve. Customizing the valve allows flexibility to choose what is needed without having to accept options that are not required.

Camflex Table

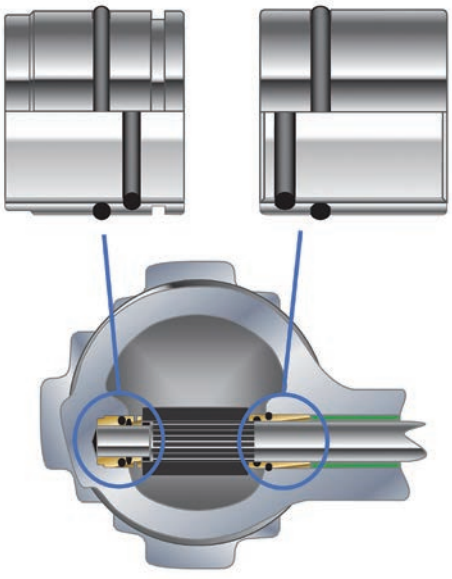
Feature	Benefit
O-ring/Guide Bushing	Keeps particles out of the guiding area and prevents stem binding
Lube Port	Keep guiding area clear of contaminants
Stellite Body Overlay	Protects body from erosive and corrosive damage
Stellite Overlay Trim Components	Protects trim from erosive and corrosive damage
Reduced C_V Option	Customize Flow for better control
High Capacity Design	Provides higher C_V for more capacity
Fugitive Emission Packing	Reduce packing leaks



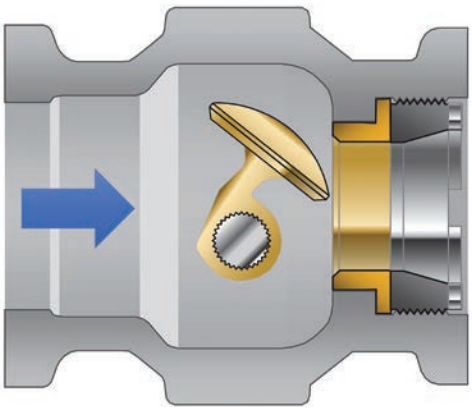
Fugitive Emission Packing

Slurry Package Seal Rings

Prevents build up in bushings



Large, Trash Tolerant Flow Passages



Flow Control Solutions for Geothermal Applications

PROBLEM

- Cavitation
- Noise

PROCESS

- Steam Turbine Auxiliary System Valves

APPLICATIONS

- Condensate Systems
- Gland Seal Systems
- Drain Systems
- Vacuum Breaker Systems

SOLUTION: Masoneilan 21000 and 41005 Series Valves

The Masoneilan 21000 Series and 41005 Series reciprocating valves can be ordered in carbon steel and stainless steel.

To reduce or eliminate low pressure steam, noise or cavitation, there are several options for optimal trim to extend the life expectancy of the valve and reduce down time.

21000 Series Globe Valve

41005 Series Control Valve

PROBLEM

- High-Capacity
- High Temperatures
- Maintain Shut off

PROCESS

- Water Transport
- Heat Transfer
- Auxiliary Steam

APPLICATIONS

- Isobutane Block
- Turbine Trip
- Cooling Water

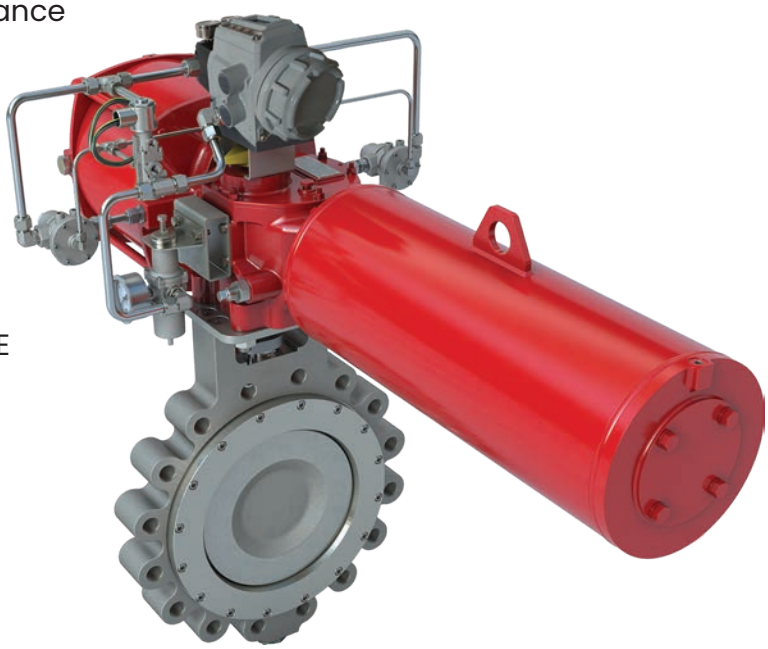
SOLUTION: Masoneilan 39004 Series with Scotch Yoke Actuator

The 39004 Series High Performance Butterfly Valve (HPBV) is a heavy-duty, double offset valve designed for bi-directional zero leakage performance, providing quality, value and reliability.

- Designed for high pressure and high temperature applications
- Bi-directional zero leakage shutoff rate across full pressure range
- Designed for dead-end service at full rated pressure
- Double offset geometry reduces seat wear and extends valve service life
- Easy field maintenance, seat replacement only requires removing a few bolts
- Adjustable and field replaceable stem packing
- Fugitive emission packing available

The Scotch Yoke actuator features modular designs to handle a wide range of applications, converting linear motion into rotary motion.

- Compact, modular design for ease of maintenance
- High Torque to weight ratio
- Easy field configuration
- Premium epoxy/polyurethane coating
- Optional Seacorr® coating for harsh environments
- Wide range of modules
- Replaceable self-lubricating metal backed PTFE bearings for enhanced service life
- Wide range of accessories to mount



Flow Control Solutions for Geothermal Applications

PROBLEM

- High-Capacity
- High Temperatures
- Maintain Shut Off

PROCESS

- Steam Systems
- Heat Transfer
- Brine Transport

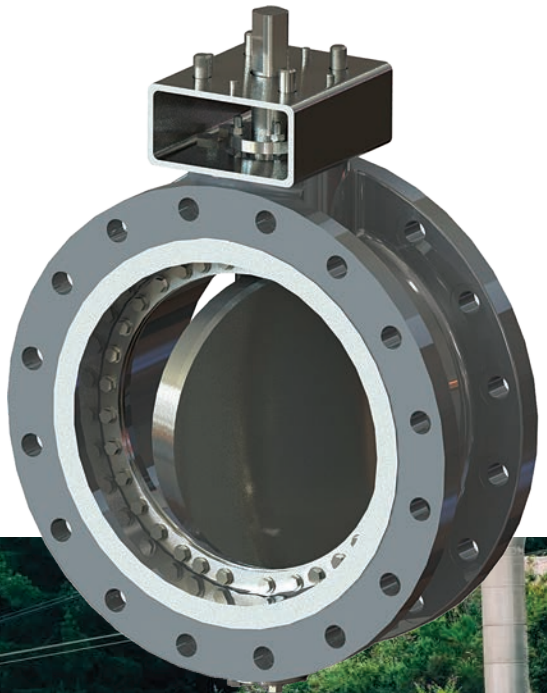
APPLICATIONS

- Condensate Systems
- Rock Box Muffler Block
- Brine Block
- Steam Control
- Heat Exchanger Flow Control

SOLUTION: Masoneilan 33000 Series Triple Offset Butterfly Valve

The 33000 Series provides a high performance, triple offset butterfly design that enables bi-directional and isolation tight shutoff under a wide range of pressures and temperatures for both control and on/off applications.

- Low friction, zero leakage with patented seal
- Full capacity C_V with conical sealing technology
- Options for fugitive emission certified packing (consult factory for details)



Geothermal Overpressure Protection

Safety relief valves (SRVs) are critical components in geothermal systems, as they help to maintain safe operating conditions by preventing excessive pressure build up. While SRVs play an important role in maintaining safe operating conditions in geothermal systems, there are also a number of challenges to be considered in selecting the right valve.

PROBLEM

- Blocked Discharges
- High Pressures
- High Temperatures
- Flashing
- Corrosive Fluids
- Valve Chatter

PROCESS

- Steam
- Water
- Two-Phase

APPLICATIONS

- Production Wellhead Protection
- Pipeline Protection

SOLUTION: Consolidated 1900 DM and 19000 Series SRVs

The Consolidated 1900/1900DM and 19000 Series spring-loaded design safety relief valves are specifically engineered to provide superior performance in high pressure, high temperature and corrosive service applications, such as those found in geothermal systems.

The Consolidated 1900DM Series safety relief valve is designed to provide reliable and stable operation for gas, liquid, and two-phase fluids. These valves meet agency certification requirements for multiple media per ASME B and PVC Code Case 2787, validating valve performance on any service without changes to set pressure or part modifications.

The 19000 Series offers enhanced capacity and blowdown performance on many media types. In most cases, it does not require parts changes to accommodate different media.

1900/1900DM Series Safety Relief Valve

19000 Series Thermal Relief Valve

Consolidated SRVs combine safety, stability, and reliability for any Geothermal application.

Masoneilan SVI Digital Control Valve Positioner

Control and monitor your critical valve assets with the proven reliability of the **SVI™** platform and new Valve Diagnostics.

SVI3 Digital Valve Positioner

The SVI is a user-friendly digital valve positioner for pneumatic control valves. Utilizing advanced control and diagnostic algorithms, along with field proven, non-contact position sensing technology, the SVI delivers accurate, responsive, and reliable positioning performance.

Continuous Health Monitoring

Improve plant efficiency and process uptime with continuously calculated diagnostics which monitor the health of the valve and process.

Plan turnarounds and prioritize repair events via data driven decisions utilizing one year of on-device diagnostic storage.

Simple, Modular Platform

Automated, self-calibration routines and universal mounting system provide effortless setup and commissioning across any linear or rotary control valve.

Performance and Reliability

Built upon 20+ years of field proven technologies with billions of operating hours, the SVI is trusted on the most critical applications.

Ready to Serve, Anywhere!

Designed with corrosion resistant materials, and universally certified to global hazardous area standards. Ready to serve with explosion proof rating for the presence of mining.

SVI Benefits

Robust Metal Enclosures

The SVI3 is available in Chromated, Copper Free, Epoxy painted aluminum or 316L stainless steel, both designed to stand up to the most challenging mining environments. IP66 and NEMA/TYPE 4X enclosures keep the elements out and protect internal components.

Electronics Ready to Serve

Encapsulated and conformally coated electronics protect against humid and corrosive environments. SVI's unique positive pressurization inside the enclosure maintains a constant purge of clean-dry instrument air to prevent moisture build up inside the enclosure.

Non-Contact Valve Position Feedback

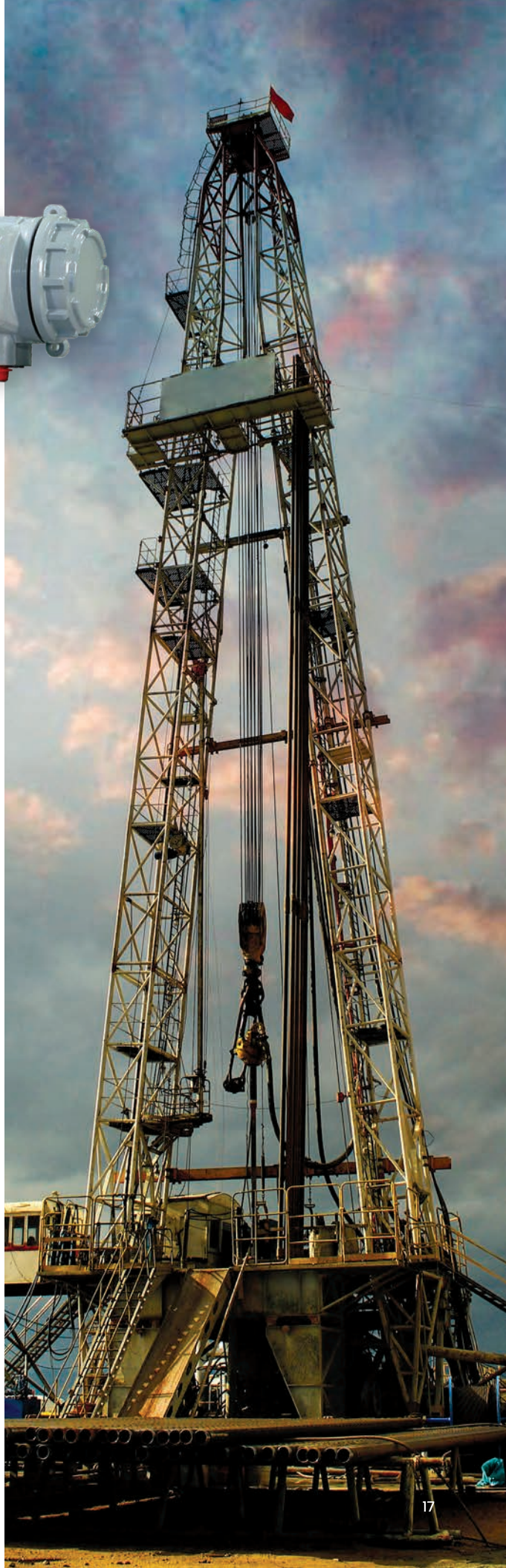
Fully sealed from the environment, protected from weather, and shielded from magnetic influences, the SVI's non-contact sensing system has been field proven for over 20+ years with billions of operating hours and is built to withstand harsh mining environments.

Universal Hazardous Area Certified

Certified to stringent global electrical safety standards, the SVI combines both flameproof and Intrinsically safe designs into 1-model, reducing inventory complexity, beneficial in remote areas.

Diagnostics

Continuously calculated online diagnostics monitor the health of the valve, positioner, and process. Plan turnarounds and prioritize repair events via data driven decisions utilizing the one year of on-device diagnostic storage.

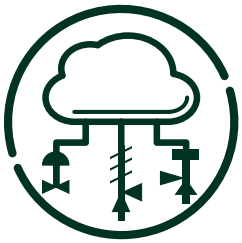


Valve Lifecycle Management Solutions

Driving Outcomes

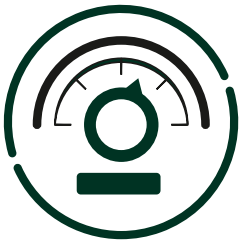
Across the many processes underway in a mining operation, with its harsh and remote environments, performance reliability and safety are non-negotiable. Efficiently planned maintenance and turnaround events reduce unnecessary time spent on examining devices that may not require immediate maintenance. Baker Hughes' Valve Lifecycle Management solutions, when installed independently or as a solutions suite, provide real-time remote diagnostic valve health monitoring, troubleshooting and valve maintenance management. Identification of the valves that require attention allows for more efficient planning for maintenance and inventory, or necessary upgrades to keep processes running reliably and productively. Baker Hughes is looking to the future to deliver solutions that enable companies to deliver on their commitments and address their toughest operational challenges.

Valve Lifecycle Management



ValvKeep™

Valve Asset Management software application to track and manage all valve assets throughout the entire lifecycle



ValvAware™

Online valve health monitoring service enabling condition-based monitoring in real process conditions without production interruption.

ValVue™3

Device Type Manager (DTM) application performs the configuration, calibration, and performance testing of your Masoneilan digital devices.

ValScope™

In-line or offline control valve diagnostics and troubleshooting device to evaluate and optimize control valve performance and loop efficiency.

EVT PRO™

In-situ pressure relief valve portable testing device to confirm valve set pressure in process and under normal operating conditions.

ValvStream™

Valve sizing and selection tool for Pressure Relief Valves and Control Valves to guide the proper selection of the right valve for the right application.

Global Support

We understand that you need a partner that understands the challenges you face and has the resources to support you from new products to maintenance cycles to changes in your process. Whether it is technical support, manufacturing, to maintenance planning we are here to support you.

Baker Hughes is committed to providing best in class products and service through manufacturing sites, Aftermarket centers and Channel Partners located throughout the world.

The Baker Hughes MARC and GTC Network consists of more than 155 facilities located in more than 30 countries worldwide.

Masoneilan Authorized Repair Centers (MARC) and Consolidated Green Tag Centers (GTC) from Baker Hughes offer you responsive and effective service through OEM-certified repairs, innovative valve diagnostics, management, and maintenance programs. Regionally stocked local modules and kits give sites the ability to assemble and test a wide range of final valve configurations from our Valv*FAST* program.

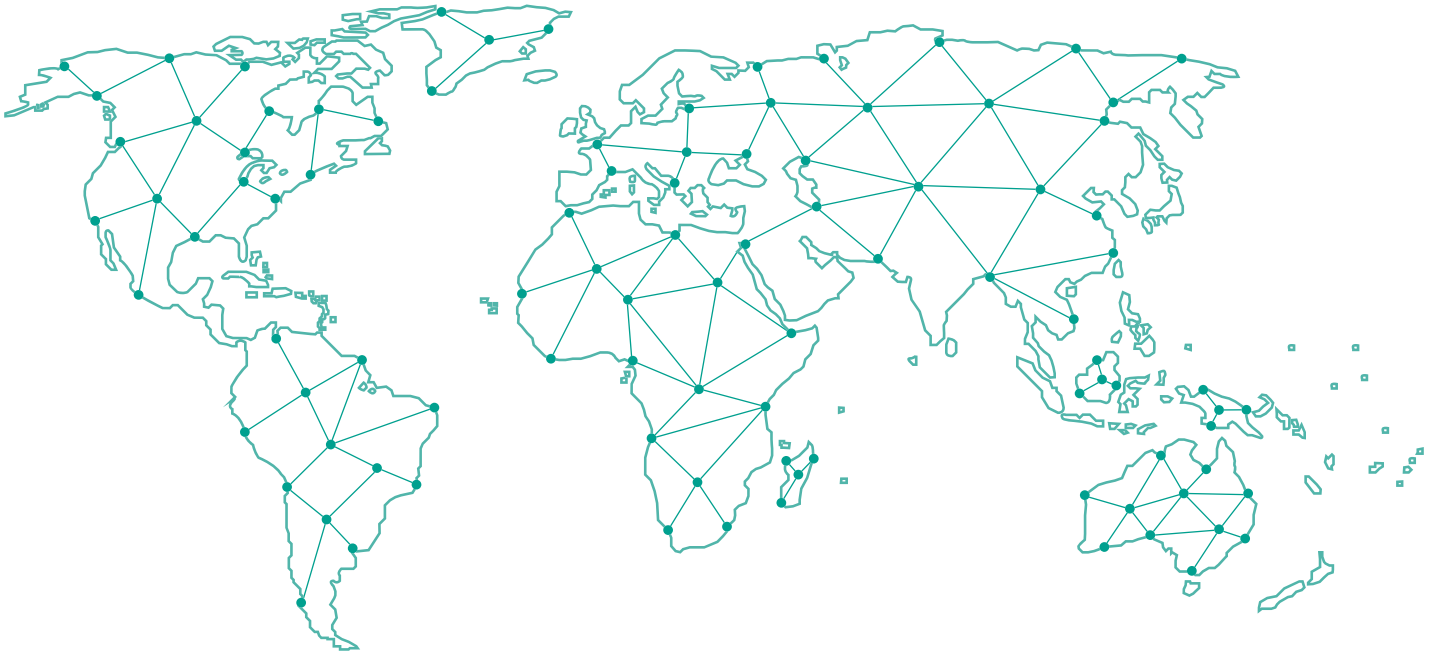
Each MARC and GTC location is staffed with highly qualified technicians who are specially trained and certified to deliver exceptional product support and technical expertise.

MARC GTC

ValvFAST

Find the nearest local Channel Partner in your area:

valves.bakerhughes.com/contact-us



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BH-Valves-Geothermal-BR-34704B-1024 10/2024

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