



# angle choke valve

versatile heavy duty valve for severe applications

# Innovate to meet



**The early days** Mokveld was founded in 1922 in Gouda, The Netherlands, as a small machine repair shop. In the mid-fifties we started making valves, this development was accelerated by the discovery of the Groningen gas field in 1959 by the Nederlandse Aardolie Maatschappij B.V. (joint venture between Shell and ExxonMobil). Mokveld started delivered the valves for the production of the billions of cubic meters of gas and over the years was challenged to respond to constant changes in safety, noise and emissions requirements. By adapting and responding efficiently to the changes of the oil & gas industry our organisation has gained an excellent reputation in the industry, which is now also applicable to other energy and water markets, such as hydrogen and CC(U)S and the hydropower and water industries.

# industry demands

## Industry challenges

Mokveld is committed to contribute to safe, reliable and sustainable development of the world's energy and water resources. Our track record of satisfied customers shows our capability for selecting control solutions, designing safety systems and managing projects successfully. The integrated choke valve systems described in this brochure will help to meet your industry and project challenges.

## Worldwide experience

Mokveld has extensive experience in designing and manufacturing valves for the oil & gas, hydrogen, cc(u)s, hydropower and water industries worldwide. The product portfolio comprises a wide range of valve products, tailor-made to application and customer specifications;

### control products

- angle choke valves
- axial choke valves
- axial control valves

### safety products

- axial on-off valves (for HIPPS)
- axial surge-relief valves
- axial check valves

In addition a full range of pneumatic and hydraulic actuators with tailored control arrangements are available for accurate control and reliable operation of your production.

## Successful innovation

Regular contact with end-users and our familiarity with a wide variety of applications provide us with all the elements required for innovation. Recent examples are: Novel trim designs, a stem-less zero emission concept, subsea control valve, CO<sub>2</sub> injection applications. Our extensive expertise in the field of material selection and flow management enhanced the choke valve technology. A significant improvement in erosion resistance is confirmed in full-scale sand erosion test of our choke valve.



### Mokveld headquarters

The headquarters and high tech production facilities, are located in Gouda, The Netherlands (area 18 000 m<sup>2</sup> or 194 000 ft<sup>2</sup>)



### Full-scale erosion testing

Confirmation of erosion resistance during testing at the DNV GL Flow centre facility.

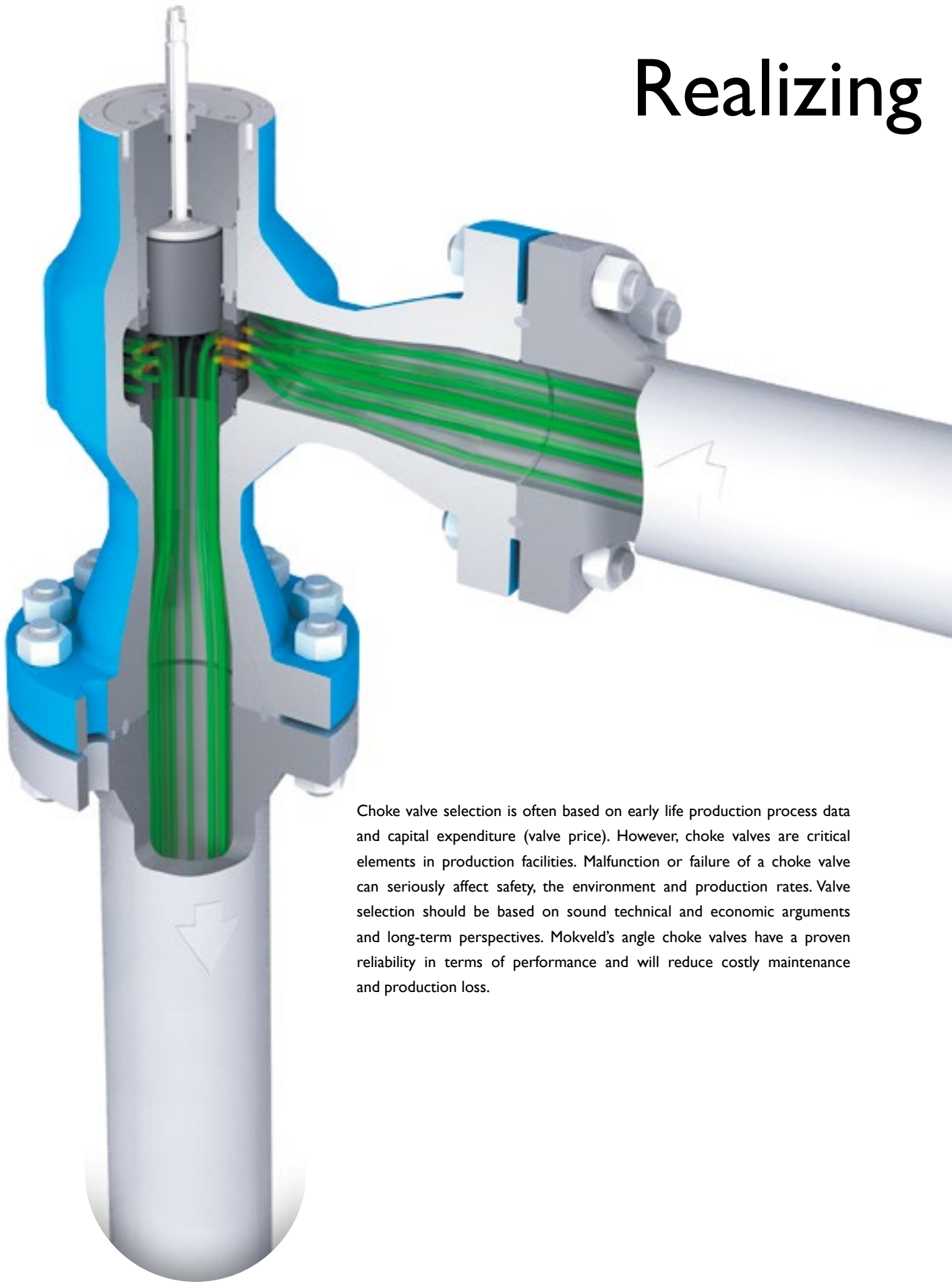


### Fire-safe testing

Upon request choke valves can be supplied with fire-safe certification. This illustrates Mokveld's intense focus on safety.



# Realizing



Choke valve selection is often based on early life production process data and capital expenditure (valve price). However, choke valves are critical elements in production facilities. Malfunction or failure of a choke valve can seriously affect safety, the environment and production rates. Valve selection should be based on sound technical and economic arguments and long-term perspectives. Mokveld's angle choke valves have a proven reliability in terms of performance and will reduce costly maintenance and production loss.

# long-term benefits

## World-class valves based on new technology

### Step changes in valve design

In the 1970's Mokveld was challenged to produce an angle choke valve, and pioneered piston-in-cage control valve technology for angle chokes. The 'cage-guided-piston' choke proved a major improvement in durability and controllability compared to the conventional 'needle-in-seat' choke design. In the 1980's some 'external sleeve' chokes were produced and field tested. This product was discontinued while the cage-guided-piston principle offered far better results. In the early 2000's a new step change was added to reduce life cycle cost. The latest development makes our chokes valves fully suitable for supercritical CO<sub>2</sub> applications as found in Carbon Capture (Utilisation) and Storage (CCUS) applications.

### The newest generation

Based on a growing expertise of materials and flow patterns, introducing tools as Finite Element Analyses (FEA) and Computational Fluid Dynamics (CFD), and working in close cooperation with customers and third party organisations, the Total Velocity Management® (TVM) concept was introduced. Full-scale sand erosion tests confirmed a factor 4 erosion reduction compared to conventional designs.

Over a period of 50 years Mokveld's angle choke valve experience exceeds 100.000 cumulative years of operational time in severe duty applications. We are proud to be recognized as the worldwide leading supplier of choke valves. And proud to be able to apply this experience in Carbon Storage applications.



**4 1/16" / API 5000 Angle Choke Valve**

Application : Hydro Carbon Production

Challenge : High H<sub>2</sub>S content

Location : Harweel (Oman, 2006)



**3" / API 15 000 Angle Choke Valve**

Application : Hydro Carbon Production

Challenge : Low noise and erosion resistance

Location : Dina (China 2008)



**8" / ASME 1500 Angle Choke Valve**

Application : Water Injection Dump

Challenge : Avoid cavitation

Location : Sirri (Iran, 2004)



# Total Velocity Management<sup>®</sup>

## Availability

Improved flow management avoids vibration and reduces erosion by a factor 4. This significantly maximizes production availability.

## Operational benefits

## Accurate control

Static and dynamic forces on the control element (piston) are minimized. Accurate control - also at minimum opening - is achieved.

## High turndown

High capacity and accurate control features make the valve appropriate for both start-up and well depletion production scenarios.

## Safety benefits

## FloSafe<sup>®</sup> bean

The choke can be supplied with a FloSafe<sup>®</sup> bean to provide ultimate protection against relief system overload.

## Safety bonnet

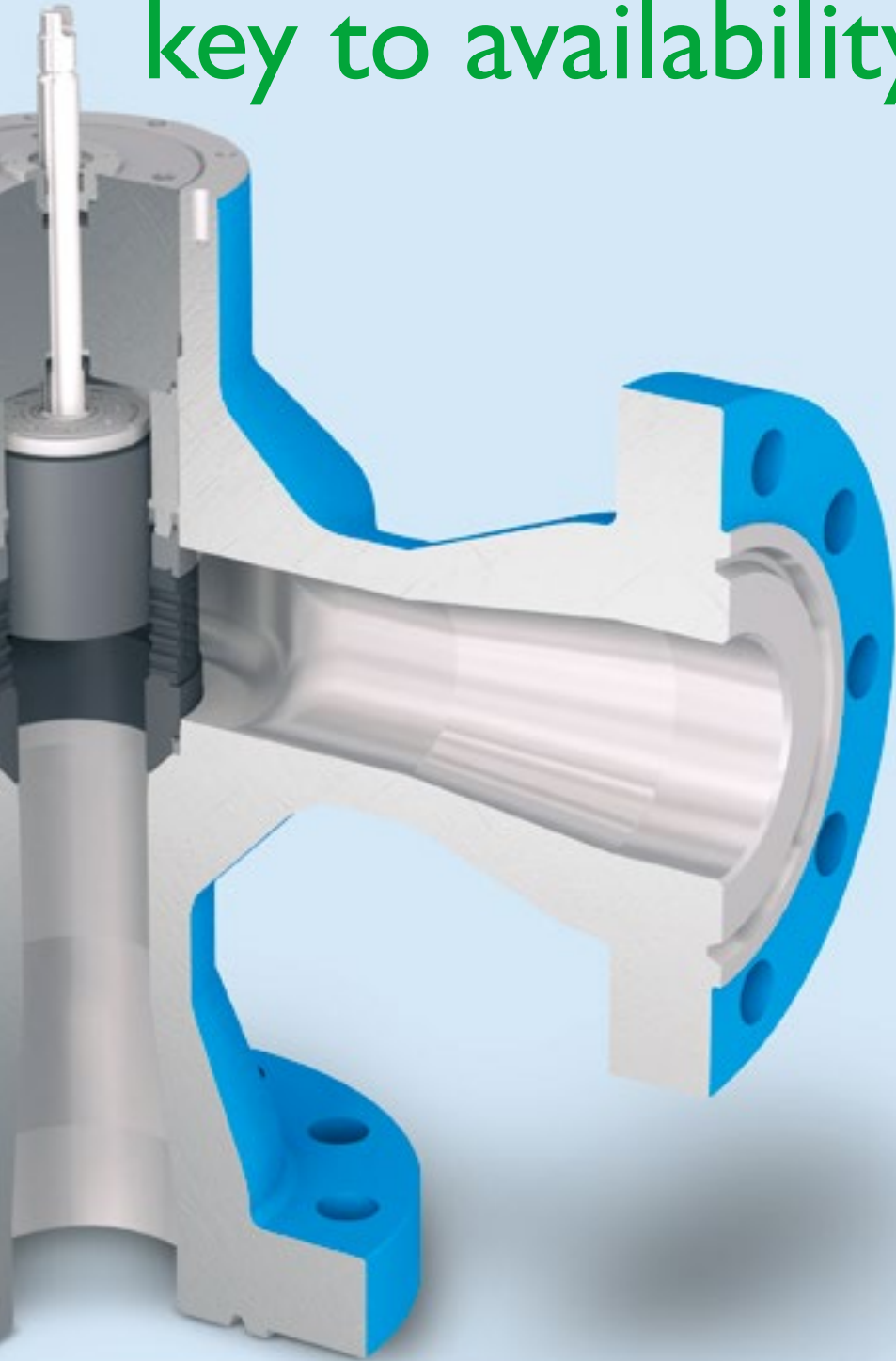
The threaded bonnet prevents the well-known 'trapped pressure risk' during disassembly, associated with bolted bonnet chokes.

## Fire-safe

To provide additional protection for assets and operators, all choke valves can be supplied with fire-safe certification.



# key to availability



**Significant  
cost savings**

## **Reliability**

Total Velocity Management® reduces your total cost of ownership and minimizes unplanned process downtime.

## **Easy maintenance**

The angle transmission allows maintenance without removal of the actuator and instrumentation. The angle transmission also improves flexibility in installation layout.

## **Compact**

As a result of the low actuation force requirement, small actuators can be used; combined with a compact valve body design this minimizes the installation's footprint.

# Increased reliability and

## Mokveld's Total Velocity Management® concept

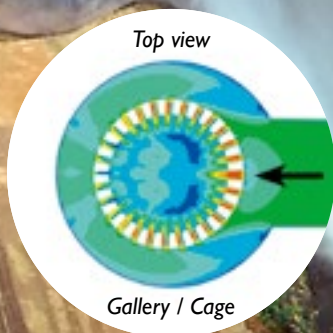
Local high fluid velocities due to preferential flow paths are the prime source of noise, erosion, vibration and malfunction resulting from unbalanced forces. Prevention is better than a cure. Mokveld's Total Velocity Management® concept is an intelligent valve design that carefully manages fluid velocity in all areas of the valve (trim and body) by smart engineering of the relevant valve parts. Source treatment by Total Velocity Management® is key to reliability.

## Improved flow path design

The basic rules to minimize erosion in valves are:

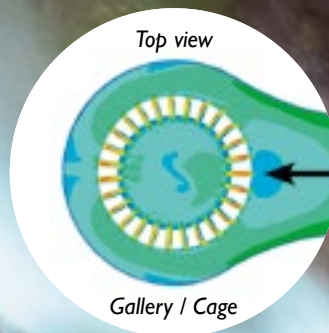
- minimize the velocity of the medium
- minimize abrupt changes in flow direction
- select erosion resistant materials

Although any angle type choke valve is inherently more susceptible to erosion than an axial type, Mokveld redesigned the entire flow path to minimize this adverse effect. Clever engineering of the flow and velocity patterns in the gallery, trim and outlet area can reduce erosion significantly. As a result of many years of research, testing and 3D CFD studies, we managed to eliminate turbulent flow in the gallery area, evenly distribute the flow through the cage (full surround flow path) and to reduce velocity through the bean. This ensures reliable valve performance as vibration and unbalanced forces are avoided and erosion is reduced by a factor 4. With a minimum of turbulence and change in the fluid velocity, the energy conversion in the valve body itself is limited. The pressure drop is mainly over the trim, which has been specifically designed to withstand high erosional velocities. Our standard design includes a cage, piston and bean of solid high-quality Tungsten Carbide with the grade selected depending on the service.



### Conventional choke valve

Preferential flow through cage facing leads to unbalanced trim forces and excessive erosion of valve body and trim parts.



### TVM choke valve

The Total Velocity Management® concept reduces choke erosion by factor 4. This results in increased production availability.



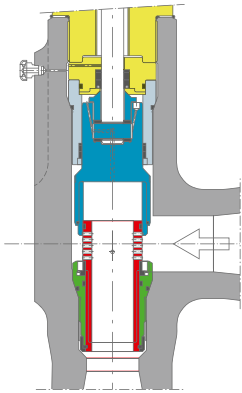
### TVM choke valve

The angled shape of a choke valve causes an abrupt change in flow direction. TVM eliminates erosion damage caused by preferential flow.

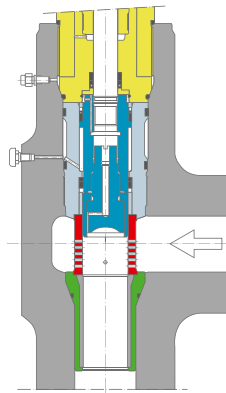


# reduced operational costs

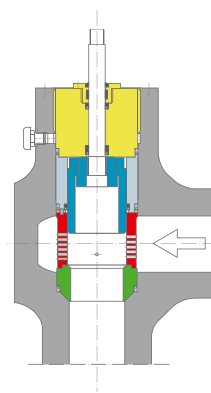
## Historic development of Mokveld choke valves



2<sup>nd</sup> Mokveld generation  
External sleeve choke valve



4<sup>th</sup> Mokveld generation  
Cage-guided-piston choke valve



TVM angle choke valve.  
sCO<sub>2</sub> ready

## Our cage-guided-piston design - your preferred choice

To improve erosion resistance reputable choke suppliers use solid Tungsten Carbide for the throttling parts. Because of the brittleness of this material, the cage needs to be firmly secured in the valve body. For reliability reasons Mokveld selected the cage-guided-piston design for its choke valve designs. The advantage of this design is that the cage can be firmly secured in the valve body and the piston can be guided over the full length of the stroke. This results in minimum sensitivity of the cage and piston to:

- flow-induced side loads
- vibration-induced fatigue and
- impact by particles

In addition, the flow area around the cage (the gallery area) is wide, which results in low velocities effectively reducing erosion of the cage and choke body.

## High rangeability

At the start of field developments high wellhead pressures with aggressive fluids and entrained sand and other solid particles are often found. High differential pressure, with both low and high flows shall be handled, whereas at the well depletion stage minimal differential pressure occurs while keeping the flow as high as possible. Mokveld's high rangeability cage-guided-piston choke can handle these extremes without the need to replace the trims. Mokveld's extensive sizing capabilities to propose the best solution for your application includes (supercritical) CO<sub>2</sub>.



# Setting the tone

## Safety first

Choke valves operate with dangerous fluids under high pressure and often even containing toxic components. The safety for personnel, the installation and the environment is an inherent part of the design of our choke valve.

### Safety bonnet

According to API 6A / ISO 10423 (§ 14.15.2.) chokes shall be designed to vent trapped pressure prior to releasing the body-to-bonnet connector. The Mokveld safety bonnet is an intrinsically safe solution which offers a high level of security compared to the conventional bolted bonnet design.

When maintenance is required with a bolted bonnet choke, the engineer can easily forget to open the relief and vent trapped pressure. After removal of a few bolts the remaining bolts may not be strong enough to contain the pressure behind the bonnet; the bolts will break and the bonnet is ejected with dangerous force potentially causing fatal injuries.

The Mokveld safety bonnet is screwed into the choke body by means of self-locking thread making it virtually impossible to unscrew the bonnet under pressure. To further increase safety a vent is installed relieving the pressure in case the bonnet would be unscrewed under pressure where the remaining thread is more than sufficient to contain the full rated pressure to prevent accidents.

### Low emission and fire safe

The high-integrity valve body is an integral casting or forging, without any welds or bolted parts and no leak paths to the atmosphere other than the bonnet/stem assembly. The excellent sealing system ensures compliance with all international standards for fugitive emission. Optionally the choke can be supplied with leak detection of the dynamic stem seal. For certified fire-safe execution, a redundant stem seal is provided.



#### **Mokveld safety bonnet**

*The bonnet is screwed into the body by means of self-locking thread. Any residual pressure will automatically be vented at 15% opening.*

# for safety and control

## FloSafe® bean

There are three material properties that are critical to the longevity of the trim: resistance against erosion, corrosion and impact. The Tungsten Carbide grade used in Mokveld choke valve trims proves to be among the top performers with regard to these aspects, and will therefore give outstanding performance.

Sometimes, a choke valve is considered as a safety device to prevent overload of the relief system. In that case it is of paramount importance that the valve capacity does not exceed predefined limits under any circumstances. Although unlikely, the worst scenario would be a collapse of the trim upon impact of parts. One solution that Mokveld offers, is to improve the impact resistance by adding a fortifying steel outer cage. This, however, is not an ultimately safe solution as the steel fortification cage is subject to erosion which will reduce its functionality over time. The optimum solution is to separate the choke valve's control and safety function. Following an evaluation of your process conditions Mokveld choke valves can be equipped with a FloSafe® bean to provide ultimate protection against relief system overload. The custommade FloSafe® bean is capacity balanced with the cage and the available flaring capacity. During normal operation the bean does not influence the choke control characteristic, but in case of cage collapse the FloSafe® bean will limit the flow rate to an acceptable flaring rate.

## Custom designed trim

Standard and custom designed trims can be selected for various applications. The all-round RQX trim is most commonly used. This single-stage, multi-hole trim offers accurate control and high noise abatement. The holes are of a sufficiently large size to avoid clogging at normal production applications. The RQX trim is suitable for a wide operating envelope, which diminishes the need for replacement at a later stage. For more extreme conditions, including (s)CCS, a selection of multi-stage, labyrinth-style cages is available offering very high noise abatement and/or high anti-cavitation coefficients. It should be noted, however, that in a normal production environment labyrinth-style cages work as a strainer and may cause the choke to clog. During dirty well clean-up service a RCU large hole trim can be installed. At well depletion stage a RDS cage will almost eliminate pressure loss over the choke.

All trims can be provided with reduced capacity and linear or equal% control characteristics. Together with the long valve stroke this is the optimum recipe for accurate control of your process.



### Selection of single-stage trim

*The all-round RQX trim is suitable for high to low pressure drops offering high capacity and considerable noise abatement.*



### Selection of multi-stage trims

*Multi-stage trims are designed for high noise abatement or to avoid cavitation at high pressure gas, two-phase or liquid applications.*

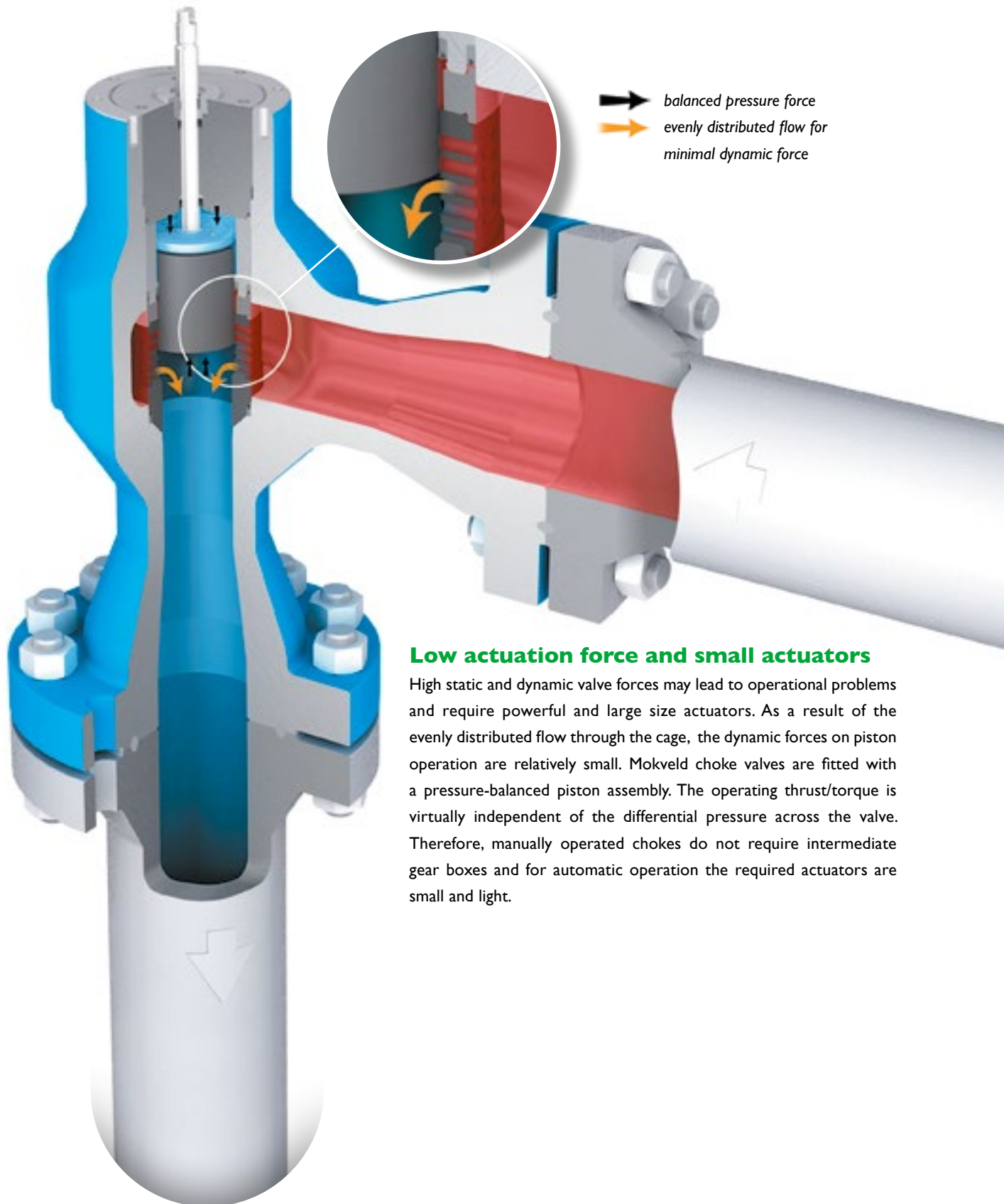


### Ultimate safety choke

*This choke has a FloSafe® bean to provide ultimate protection against system overload and can be provided with a steel fortification cage.*



# Small actuators for reliable



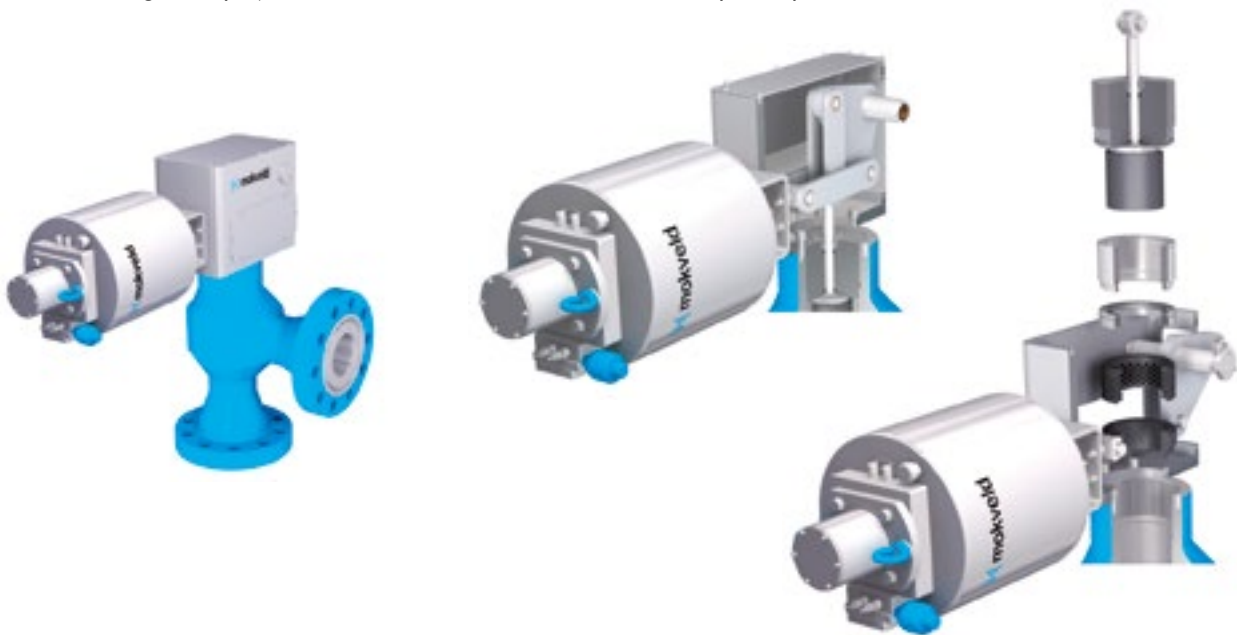
## **Low actuation force and small actuators**

High static and dynamic valve forces may lead to operational problems and require powerful and large size actuators. As a result of the evenly distributed flow through the cage, the dynamic forces on piston operation are relatively small. Mokveld choke valves are fitted with a pressure-balanced piston assembly. The operating thrust/torque is virtually independent of the differential pressure across the valve. Therefore, manually operated chokes do not require intermediate gear boxes and for automatic operation the required actuators are small and light.

# and accurate control

## Integrated actuator and control systems

A full range of matching Mokveld pneumatic and hydraulic actuators with tailored control arrangements is available for accurate control and reliable operation of your production. Electric and electro-hydraulic actuation is also available. Depending on functional requirements, a variety of control arrangements can be engineered. All our choke valve products are fully integrated, operational systems. Each component is carefully selected and then tested during the various stages of a project to ensure balanced and trouble free start-up and operation.



## Easy maintenance accessibility

The total number of individual parts and the weight/size of internals are far less compared to other choke valve designs. This ensures easier access and easier disassembly and assembly of the valves. To minimize lost production time due to actuator disconnection and removal, Mokveld offers angle transmission. Removal of the cover plates and levers provides full access for removal of the choke bonnet and internals. The angle transmission will also offer more flexibility in installation lay-out.



### **Hand wheel actuation**

*The torque to operate our chokes is very low. Small hand wheels are also sufficient to operate the choke at full pressure differentials.*

### **Mokveld stepping actuator**

*Very accurate control with repeatable positioning is obtained by means of the pneumatic or hydraulic stepping actuator.*

### **Mokveld linear piston actuator**

*For a relatively quick response to process changes, the choke can be operated with pneumatic or hydraulic piston actuators.*



# Comprehensive scope

## Valve range

Our range of choke valve designs covers the ASME and API ratings that are commonly applied in the oil & gas industry, up to API 15 000 (1035 bar design pressure) with related temperature ratings. For the -100 °C to 200 °C (-148 °F to 390 °F) temperature range we offer special sealing solutions. The choke valves can be supplied with a variety of inlet and outlet connections such as flanges and clamp connectors and sizes up to and including 12" in the ASME ratings and 13 5/8" in the API ratings.

Choke valve nom. body size mm(")	Pressure rating					
	PN 150 ANSI 900	PN 250 ANSI 1500	PN 420 ANSI 2500	PN 345 ANSI 5000	PN 690 ANSI 10 000	PN 1035 API 15 000
125 (5")						
250 (10")						

Larger sizes and higher pressures (incl. API 15 000) on request. The complete table with valve sizes and ratings can be downloaded from [www.mokveld.com](http://www.mokveld.com)

## Extensive material selection

Mokveld choke valves are tailored towards the changing needs of the oil & gas market. We take into account that the medium will frequently contain free water, chlorides, CO<sub>2</sub>, H<sub>2</sub>S, and other corrosive compounds. Therefore valves are available in a wide range of body materials, varying from plain carbon steel to nickel-based materials. For the valve internals, matching material selections are available, sometimes engineered to order. To avoid problems related to explosive decompression the standard seal selection is non-elastomeric HP lipseals.

We design our valves with limited material and energy consumption, good reparability and the ability to extend service life. We are committed to a high level of circularity, using intelligent designs to make our valves last longer than average. This allows our valves to retain their value for as long as possible and requires less material to manufacture and maintain.

## Quality and health, safety and environment

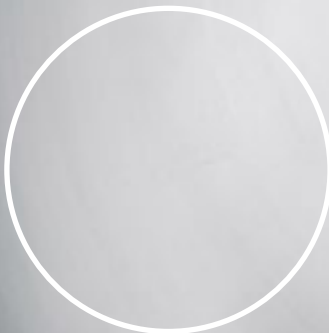
At Mokveld we consider quality and health, safety and environment prime objectives for the successful completion of any project. An integrated QHSE management system focuses on continuous improvement. We aim to build customer trust and confidence through a quality of products and service that meets customers' requirements and expectations. In-house valve test facilities are available for hydrostatic and gas body and seat tests under ambient or cryogenic temperatures.

All our products are designed and built to the required international standards and certified by recognized authorities such as the API, PED or IECEx. We are familiar with a variety of standards specific to particular countries, users and projects.

Our commitment to reducing our environmental impact and providing a safe and healthy workplace is underpinned by third party certification to ISO14001 and ISO45001. Our values affirm that sustainability is not limited to GreenHouse Gas, but encompasses all environmental, social and governance (ESG) issues.

Mokveld's Quality, Health, Safety and Environment system and product specific certifications are kept up to date. A copy of our QHSE manual is available on request. A list of certificates can be found at [mokveld.com/certificates](http://mokveld.com/certificates).

# at top quality



# global network - supported locally



## Mokveld Offices

- 1 **Mokveld Valves BV**
- 2 Mokveld USA Inc
- 3 Mokveld UK Ltd
- 4 Mokveld Norge AS
- 5 Mokveld Central Europe GmbH
- 6 Mokveld Marketing JV
- 7 Mokveld Valves BV, Middle East
- 8 Mokveld Valves BV, Asia Pacific
- 9 Mokveld Valves BV, China
- 10 Mokveld Valves BV, Algeria
- 11 Mokveld Valves BV, Brazil

## Adresses

### Gouda, The Netherlands

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Cirencester, United Kingdom  
Stavanger, Norway  
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Dubai, United Arab Emirates  
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Beijing, China  
Alger, Algeria  
Rio de Janeiro, Brazil

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