Valves for Autoclave Processes

Engineered Solutions for the Mining & Minerals Industry

MOGAS®
SEVERE SERVICE BALL VALVES

Continued research and development programs, solid proven designs and innovative coatings—along with superior service and valve management partnerships—have given MOGAS a distinct reputation as a leader in this field.

Global Experience

Autoclave Valve Solutions

The majority of all autoclaves worldwide use MOGAS severe service ball valves.

Pressure leaching and oxidation are two of the most demanding extraction methods in the mining industry and require **dependable, time-tested severe service valves and coatings**. Whether leaching with acid injection or oxygen, the valves used in these plants must withstand corrosive and abrasive slurries, as well as endure punishing temperatures and pressures.

For several decades, MOGAS has been the **leading provider** of severe service metal-seated ball valves in autoclave applications such as HPAL (High Pressure Acid Leach) and POx (Pressure Oxidation). **Reliable valve operation** is crucial, since these plants are often located close to the ore beds—making travel challenging, should service be required. Harsh media and tough operating conditions make a proven, **application-specific** valve design essential to the economic performance of the operation.

Delivering Value

Solutions for Challenging Environments

COATING DEVELOPMENTS

Dependable coatings are a critical part of the process due to the acidic nature involved with hydrometallurgical leaching.

Both application methodology and the composition of the coating are constantly reviewed and tested to provide superior performance.

MOGAS coatings advancements result from lab research, field data and experiences.

THE LEARNING YEARS

MOGAS quickly learns that understanding operational concerns translates to improved product development.

MOGAS patents proprietary coatings technology and application-specific seat designs.

Because of our autoclave expertise, MOGAS is recognized and trusted to repair and modify competitors' inferior valves.

1973
Louis Mogas founded MOGAS Industries, Inc.

1980
Development of HVOF applied Chromium Carbide coating

1985–1987
Advancements of HVOF applied Chromium Carbide coating

1992
Established certified coater; began research & development coating program

1993
Developed proprietary fusion Chromium Carbide coating

1997–1998
Entered autoclave industry with first POx project

1999
Established local inventory and repair services in Australia

1999
First HPAL installation

2000
Advancements of coating development targeting autoclave applications

2000
First to apply TiO_2 coating in HPAL & POx applications

2001
US patent issued to MOGAS for nano-TiO_2 (M1) coating

2002
Introduced autoclave-specific valve design

2002
Introduced application-specific tracking seat valve design

2002
Converted and upgraded competitor's valves in POx service, adding superior MOGAS features and coatings

PROVING PERFORMANCE

Continued scientific research and development, along with technical alliances, ensure MOGAS valves are never a critical path concern.

Introduction of electraulic actuation reduces overall envelope size and weight, while adding valve intelligence.

For optimal valve performance, MOGAS introduces Valve Management Program (VMP online) to collect and analyze valuable client-specific data.

2004
Awarded major POx autoclave order for valves with patented coating

2004
Signed first exclusive 3-year service & supply contract with autoclave customer

2005
Introduced first electraulic actuator into autoclave applications

2005
Awarded significant HPAL order to supply all valves with nano-TiO_2 (M5) coating

2006
Developed valve management software (VMP online)

PROVEN EXPERTISE

MOGAS commits to supporting global autoclave sites with additional service facilities worldwide.

Based on proven performance and customer needs, MOGAS introduces the Managing Operation and Repair Expenses (MORE) program.

Strategically, the MOGAS engineering, sales and service teams provide ongoing technical support by integrating data from scientific research, field reports and customer feedback.

2007
Opened MOGAS facility in Perth, Australia

2007
Developed customized coating for major customer qualification

2007
Established local coating facility in Perth, Australia

2008
Continued coating research

2009
Working with leading autoclave engineering firm, developed MOGAS rapid depressurization control valve for autoclaves

2009
Introduced customizable asset management plan

2009
Opened European service center

2010
Significant advancement of M5+++ coating

2011
Continued research & development for M6 coating

2011–2012
Only MOGAS was awarded all autoclave projects worldwide

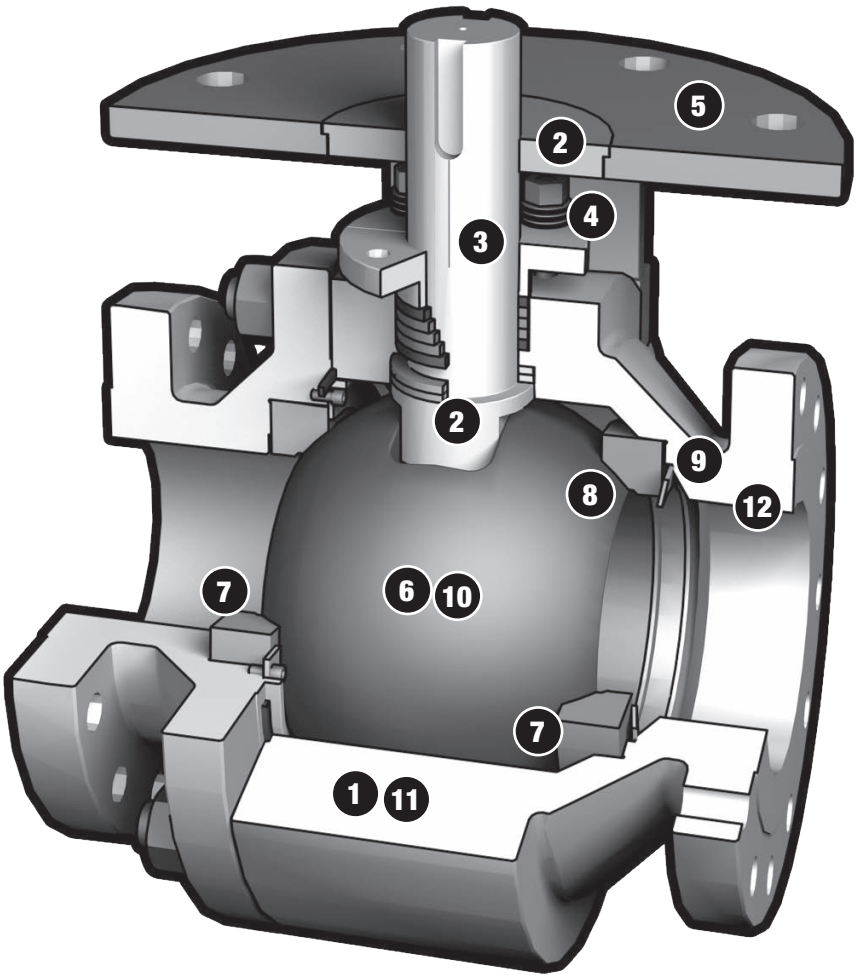
2014
M7 development

Dependable Design

Solves Isolation Challenges in Autoclave Processes

To ensure operational **efficiency** and **safety** of mineral ore processing facilities, the isolation of pumps, vessels and other equipment is critical. Exposure of isolation valves to aggressive wear in extremely corrosive environments necessitates **mechanical integrity**, **enhanced reliability** and **maximum life**. Thus, quick quarter-turn rotary isolation valves, providing **absolute shut-off** and **reliable sealing**, make MOGAS valves the perfect solution to these tough installations.

The superior design and quality of MOGAS valves reduces maintenance and eliminates valve-related downtime—providing a greater overall return on investment.



Item	Valve Features	Operational Benefits	Value to Plant Performance
1	**Forged body & end connections**	Greater wall thickness in critical areas	Valve integrity under severe conditions
		Corrosion allowance	Longer valve life
2	**Dual-guided stem design**	Eliminates lateral movement of stem	Prevents stem packing leaks
	Inner stem seal	Serves as lower stem guide and pressure-energized stem seal	Prevents solids access to packing box
		Acts as coated thrust bearing with low friction coefficient, minimizing overall valve torque	Prevents galling, binding and side-loading of stem
	Valve stem bushing	Serves as upper stem guide, securing true positioning for valve stem in packing chamber during actuation	Eliminates side-loading during actuation
			Prevents stem packing leaks
3	**Blowout-proof stem design**	Can be designed in accordance to API 6D drive train	Withstands severe service torques and maximum working pressures
		One-piece design with corrosion allowance	Ensures packing integrity is maintained
4	**Live-loaded packing**	Ensures constant packing energization	Prevents stem packing leaks
5	**Heavy-duty mounting flange**	Patent-pending design minimizes stresses and maintains precise stem alignment	Supports actuators
			Reduces overall valve cost
6	**Floating ball design**	Rotates within its own sphere	Does not displace solids
		Straight-through bore path	Sealing surfaces not exposed to media
		Locked-in downstream seat	Prevents slurry build-up behind downstream seat
			Upstream seat configuration ensures evacuation of solids during cycling
7	**Independent replaceable seats**	Field replaceable, minimizing repair times	Reduces repair costs
8	**Wide seat sealing surface**	Seats are mate-lapped to ball for 100% contact at all times	Reliable isolation
		Provides greater sealing contact area	Greater sealing integrity to withstand minor scratches or abrasions
9	**Pressure-energized sealing**	Belleville-shaped seat spring maintains constant sealing contact between ball & seats	Ensures correct position, seal and proper loads at all times
10	**Application-specific coatings**	Proprietary and patented nano-TiO_2	Reduces refurbishment costs
		Corrosion tested against H_2SO_4 acid slurry	Extends valve life, thus extending run time
		High bond strength with 10,000 psi minimum	
11	**Application-specific materials**	Erosion and corrosion resistance	Reliable endurance of critical path valves

***Note**:*
Optional inlays, liners and purge ports available as required.

Application Specific Designs

For Autoclave Processes

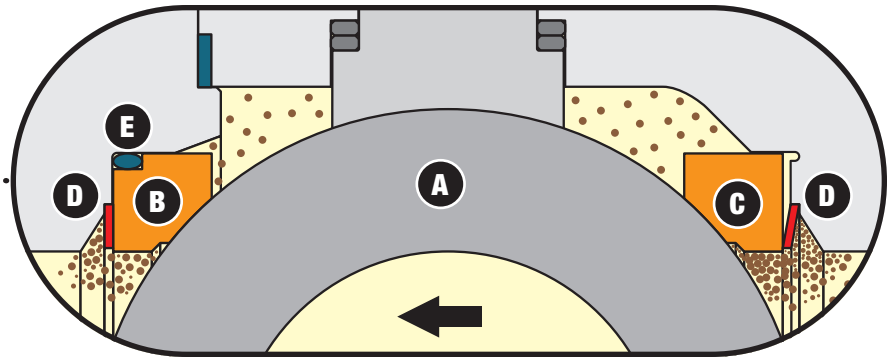
Many of our design advancements are the direct result of creating application-specific solutions to address the demanding conditions of autoclave processes.

Improve Reverse Pressure Sealing

Preventing solid particle contamination of critical sealing areas is crucial to maintaining **dependable sealing** properties in HPAL and POx processes. To address this need, MOGAS developed an application-specific **tracking seat** design to **improve reverse pressure sealing**.

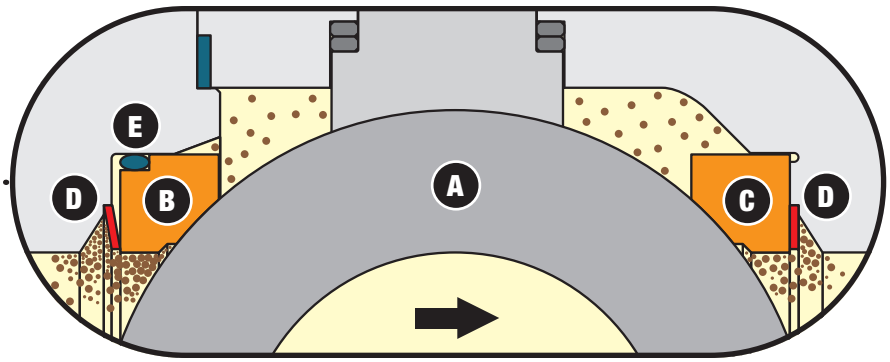
Using a proprietary elastomeric o-ring material that allows the **primary seat to track with the ball in reverse pressure sealing situations**, this design is engineered to maintain **constant contact between the ball and seats** during pressure shifts. This constant contact ensures continuous wiping action that leaves the sealing surfaces free of solids.

Tracking Seat Design



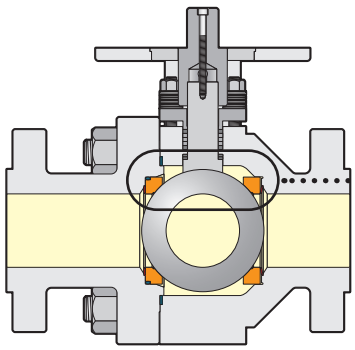
Normal Pressure

During normal pressure, the ball shifts toward the primary sealing seat (normally oriented downstream). The seat springs behind each seat apply the needed force to maintain constant contact with the ball. In addition, the primary sealing seat employs an o-ring to provide a secure seal between the seat and body.



Reverse Pressure

During reverse pressure, the ball shifts toward the secondary seat. Again, the seat springs behind each seat apply the needed force to maintain constant contact with the ball, while the o-ring provides a secure seal between the seat and body. The reverse seat ring creates a secondary seal against landing area.



Tracking Seat Valve Design

- **A** Ball (in closed position)
- **B** Primary Sealing Seat
- **C** Secondary Seat
- **D** Belleville Spring
- **E** O-ring Seal

Rotary Control Technology

for Controlled Rapid Autoclave Blowdown

Control Technologies

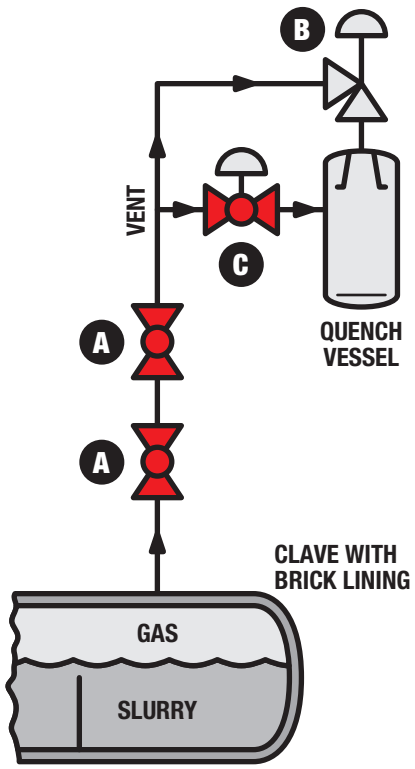
Traditionally, brick-lined autoclaves in both HPAL and POx leaching processes have a requirement to be **depressurized** or "blown down" due to process upsets, emergency situations, or to allow access for essential maintenance, equipment replacement or failure. Typical control valves are **limited** by rangeability and capacity—therefore, it takes **longer** to completely depressurize the autoclave, negatively impacting the profitability and efficiency of the plant.

Unlike linear control valves, the FlexStream rotary control technology can **significantly reduce** blowdown times for the autoclave, while still limiting the rate of temperature drop to **protect the brick lining** from thermal shock. Using a torturous path technology combined with a typical hydraulic diameter opening, FlexStream technology provides **multi-stage letdown** with an unprecedented **rangeability in excess of 300:1**.

By using rotary control technology, blowdown times can be **significantly reduced**, resulting in a substantial **positive impact** on run times and costs.

The Velocity Control (VC) trim consists of a number of engineered passageways, creating a torturous path made of right angle turns. The principle operation of the torturous path is to control the pressure drop at each right angle turn, limiting the velocity. With less velocity, there is reduced erosion and vibration.

Example of Rapid Depressurization Valve



A **Isolation Valve**

B **Control Valve**

C **Rapid Depressurization Valve**

During rapid blowdown of the clave, the vent line is used to **reduce pressure and temperature** to a point of safety.

When the clave temperature is above 140 C (284 F), the brick lining can only withstand a drop in temperature of 10 C / hour (18 F / hour).

Typical control valves (B) can only drop temperature approximately 5 C / hour (9 F / hour). Adding a valve (C) with FlexStream rotary control technology, using **multi-stage letdown**, could improve the rate of temperature drop to 10 C / hour (18 F / hour).

Once the clave temperature falls below 140 C (284 F), depressurization can progress quickly. This is where the **advantage** of using FlexStream technology becomes even more evident. The larger hydraulic opening can then be used to depressurize as quickly as possible, during a **much shorter timeframe**.

In a typical shutdown, as much as 12 hours could be saved, which results in **additional run times** and **increased revenue**.

High Pressure Acid Leaching (HPAL)

Punishing Conditions for Severe Service Valves

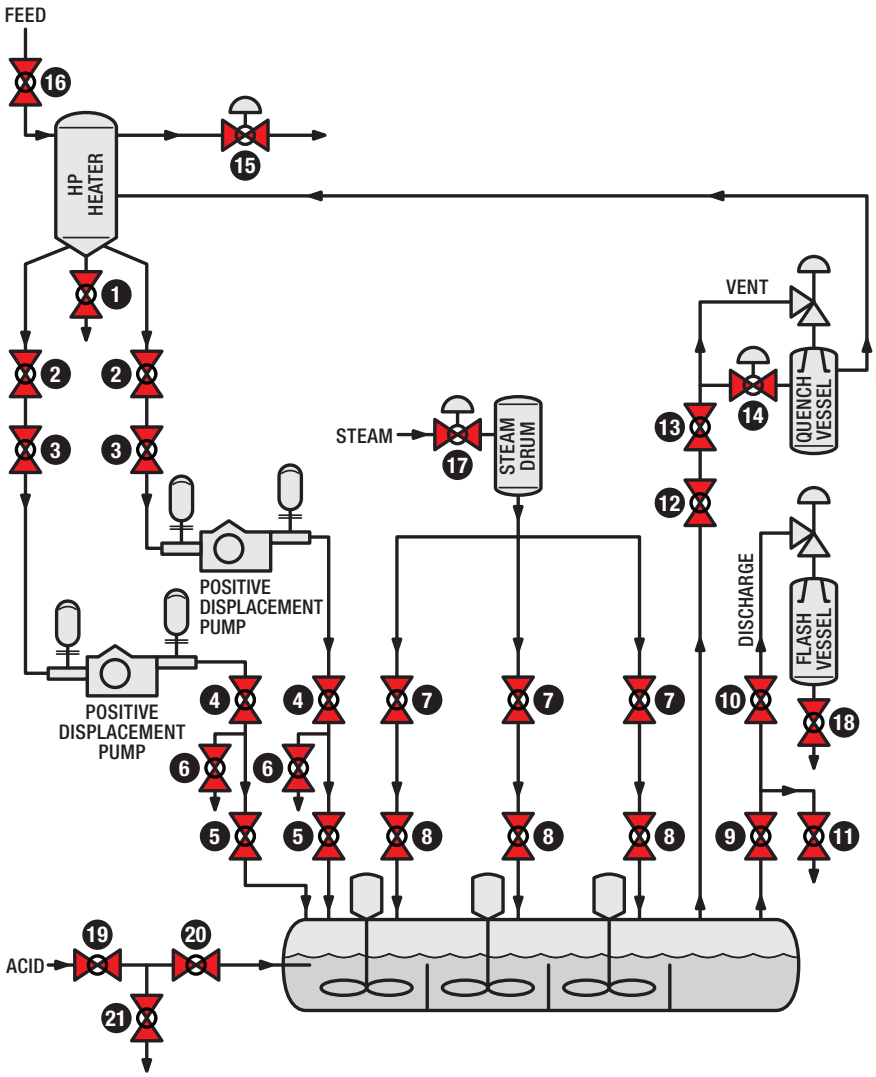
MOGAS field service technicians on-site during start-up of both autoclave plant and slurry transport pipeline at this remote location.

10-inch 600 class MOGAS valves with electraulic actuators installed at a nickel HPAL operation.

Multiple MOGAS valves were chosen with confidence to handle the punishing discharge system, one of the toughest applications in the operation.

High Pressure Acid Leaching (HPAL) was developed to extract mineral from concentrate nickel laterite ores by injecting an acid lixiviant and high pressure steam into slurry feed in an autoclave vessel. The high operating pressures and temperatures, combined with the acidic slurry, create a **highly corrosive and erosive environment**. These conditions can deteriorate the integrity and sealing abilities of inferior valves used in these applications.

MOGAS **application-specific** valve designs, **material selections**, and **proprietary coatings** have been **proven** effective for autoclave processes. Displaying twice the **wear resistance** and significantly greater **fracture toughness** than others, our proprietary coatings are verified to be **resistant to corrosion** in both autoclave vapor and slurry environments.



Autoclave – HPAL

Valve Number	Valve Description
1	HP Heater Drain
2	HP Heater Isolation
3	Slurry Pump Suction Isolation
4	Slurry Feed Pump Isolation – Secondary
5	Slurry Feed Pump Isolation – Primary
6	Slurry Feed Pump Drain
7	Steam Isolation – Secondary
8	Steam Isolation – Primary
9	Discharge Isolation – Primary
10	Discharge Isolation – Secondary
11	Discharge Line Drain
12	Vent Isolation – Primary
13	Vent Isolation – Secondary
14	Rapid Depressurization
15	Heater Pressure Control
16	Heater Feed Isolation
17	Steam Supply Control
18	Flash Vessel Drain
19	Acid Feed Isolation – Secondary
20	Acid Feed Isolation – Primary
21	Acid Line Drain

Pressure Oxidation (POx)

Reliable Isolation Under Pressure

Large Asian mining complex maintains operational reliability in its autoclave utilizing MOGAS severe service ball valves. MOGAS' patented coating is a critical component to dependability of valve performance.

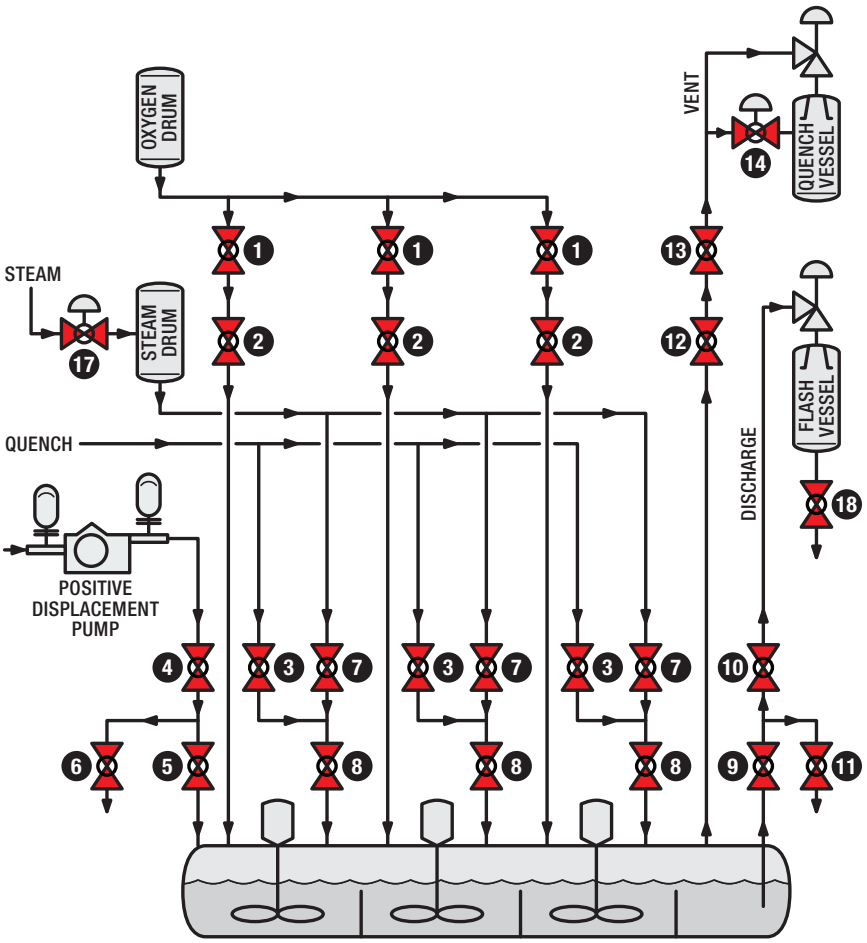
This 6-inch 900 class vent valve has been in operation since 1999.

This 10-inch 300 class discharge valve has been designed with purge ports per the customer's request.

The Pressure Oxidized (POx) autoclave circuit is a hydrometallurgical process that recovers minerals from sulphide ores by injecting oxygen into slurry in an autoclave vessel. Operating at high pressures and temperatures, the exothermic POx process generates **heat** and **acid**. This creates an **oxygen rich** environment where components require **exotic materials**, such as super duplex and Ti-niobium, to prevent flash ignition.

From field analysis, MOGAS has learned that the importance of **material selection** can also affect the geometry of a valve during thermal expansion—potentially jeopardizing its sealing integrity. Exotic materials, coating types and application methods require **extensive knowledge** of metallurgical properties and a full understanding of the POx process when oxidizing metals such as gold, copper or uranium.

Building on years of global experience, MOGAS engineers provide **application-specific** valve solutions and **superior** coatings to address safety concerns while **maximizing the profitability** of the plant.



Autoclave – POx

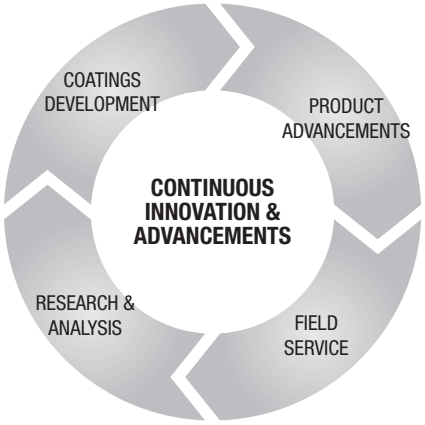
Valve Number	Valve Description
1	Oxygen Isolation – Secondary
2	Oxygen Isolation – Primary
3	Quench Isolation
4	Slurry Feed Pump Isolation – Secondary
5	Slurry Feed Pump Isolation – Primary
6	Slurry Feed Pump Drain
7	Steam Isolation – Secondary
8	Steam Isolation – Primary
9	Discharge Isolation – Primary
10	Discharge Isolation – Secondary
11	Discharge Line Drain
12	Vent Isolation – Primary
13	Vent Isolation – Secondary
14	Rapid Depressurization
15	—
16	—
17	Steam Supply Control
18	Flash Vessel Drain

Total Cost of Ownership

Determining Economic Value of Investments

Total Cost of Ownership (TCO) analysis often shows there can be a large difference between the **price** of something and its **long term costs**. Several analytical methods can be used to justify the purchase of capital equipment—such as critical valves—but it really comes down to getting the **expected performance** you purchased.

The potentially diminished performance of a valve can cause a significant reduction in the plant's ability to generate revenue. When evaluating a financial investment, all aspects of **operating** and **maintaining** severe service valves should be just as important as the initial purchase price. To protect such economic considerations, original valve manufacturers need to validate their commitment to a specific market through continuous **innovation** and **advancements**, always seeking to **extend** the life of the valve.



Key Components to TCO

MOGAS integrates many activities into their daily business to help focus on providing the best metal-seated ball valve available in the world. Teams are dedicated to research and analysis, coatings development, and product advancements, along with asset management and field service agreements. Without these important capabilities to back up the purchase of a valve, ownership is similar to buying a car without any tires or a set of keys for the ignition. You bought it, but it is really not functional.

Discovering All the Numbers

When planning a severe service valve purchase, here are some important numbers to consider:

Purchase price (including actuation)	$ _____
Spare parts / replacement valve(s)	$ _____
Cost if critical path valve fails	$ _____
Inventory costs to stock / insurance costs	$ _____
Downtime / lost availability of clave	$ _____
Service / removal & installation costs	$ _____
Value of plant / personnel safety	$ _____

This is just a partial list, but it emphasizes the importance of **total cost of ownership**, and understanding the true return on investment or the avoidance of outrageous loss of revenue due to downtime. The following pages explain in more detail a few of the ways in which MOGAS provides much more than just a metal-seated ball valve.

OEM Advantages

The Service Provider Difference

Initial cheap “fixes” to your repairs and spare parts are not worth any potential long term risks that may be controlling the operations of your plant—which directly equates to your profitability.

This table provides some distinct differences and advantages between Original Equipment Manufacturers (OEM) and Replicators (Non-OEM).

Original Equipment Manufacturer (OEM)	Advantage		Replicator (Non-OEM)
	OEM	Non OEM	
Fully aware of all scientific and technical nuances applied to the manufacture and performance of the valve. Very subtle changes can make big differences in valve performance.	✓		Can only attempt to reverse engineer. Unaware of design intent.
Invest heavily in the specifics of the industries they serve.	✓		Not typically involved in these types of efforts. Only there for immediate fix and revenue.
Proprietary coatings and manufacturing procedures developed over decades. Improvements are made in order to manufacture and sell the next valve, not simply the next repair.	✓		Goal is to provide momentary “reactive” procedures. Leaving problems unresolved guarantees repeat business.
Justifiable investments in the science of metallurgy to gain significant technological expertise and equipment.	✓		Many consider this a non-essential step in regards to their ability to “bring in revenue.”
Numerous “global” experiences.	✓		Application experience limited to geographic “location.”
Spend extensive resources and dollars testing coatings, designs and performance.	✓		Replicators will often try to “imitate” a proprietary coating, not fully understanding the relationships between base materials & coatings — as well as consequences to valve performance if coating is too thick or thin, etc.
Know the history of product developments, coating improvements, design changes, etc.	✓		Can only “guess” about certain changes or new developments for a particular product.

MOGAS is the only OEM that services its own valves in autoclave applications around the world.

Service

Global Capabilities

We provide exceptional service for unique locations—everyday, everywhere.

Service Excellence in Action

When you select MOGAS products, service is a big part of what comes with them. The MOGAS commitment to service means more than basic repairs. It also means timely access to our knowledgeable and experienced team of experts—anytime, anywhere in the world. And when our team becomes part of your team, you can trust that we will do everything we can to come through for you.

When you have a problem, our technical advisors get to the root of it. They will look at your entire application to accurately identify and solve the issue. Using a comprehensive approach helps you improve equipment reliability and operational efficiency, as well as reduce costs. Our core services include:

Project Support

- Installation, startup and commissioning
- Shutdown planning and implementation
- Procurement and contract management

Preventive Maintenance

- Complete system inspection
- Routine maintenance, valve repacking
- Valve asset management

Repair, Refurbish & Customization

- 24-hour emergency response
- Troubleshooting
- Valve performance analysis
- 3D finite analysis
- High pressure testing
- Online repair documentation

Asset Management Plan

Optimize Your Investment

Getting more **value** for every dollar is now more important than ever. To help **minimize your total cost of ownership** while truly benefiting from predictive maintenance, MOGAS offers the **MORE™ Asset Management Plan**—a totally customizable valve purchase and service plan. Whether you buy a few valves or several hundred valves, you can choose from a variety of options to help optimize your investment.

On-site Services
- Start-up and commissioning assistance
- Field support and troubleshooting
- Quarterly walkdowns
- Major shutdown planning

Managed Inventories
- Revolving dedicated inventory (located and managed at MOGAS facility)
- On-site inventory (for emergency use)

Walkdown Evaluations
- On-site inspection of installed valves
- Customized reports

Valve Management Program (Online)
- Initial setup, input, links to P&ID and maintenance reports
- Repair history
- Performance analysis reports
- Incident reports
- Valve repair cost
- Valve torques
- Revised bills of material
- Revised drawings
- Predictive / preventive maintenance recommendations

Certified Training
- Lunch-n-learns
- Valve installation & operation (hands-on)
- Maintenance & troubleshooting

Get **MORE**™...with **MOGAS**®

MANAGING OPERATION & REPAIR EXPENSES

- *Technical Assistance*
- *Dependable Operation*
- *Preventive Maintenance*
- *Data Collection*
- *Proactive Communications*
- *Value Pricing*

Confidence for Tomorrow

A Warranty is Not a Performance Guarantee

CONFIDENCE
PREDICTABILITY
RISK FREE DECISIONS
IMPROVED SAFETY
ENHANCED RELIABILITY
LESS DOWNTIME
ANTICIPATED BUDGETS

Only from MOGAS

Due to continuous years of research and development, coating improvements, proven manufacturing techniques and application experience, we now offer an unprecedented application-specific PERFORMANCE GUARANTEE on our metal seated isolation and control valves. Years of continual valve performance analysis, field reports and statistical service data from around the globe provide the information required to guarantee our valves for a performance time period. Now every MOGAS valve comes with a statistically driven, application-specific PERFORMANCE GUARANTEE…
plus a Lifetime Warranty on materials and workmanship.

Severe Service

The MOGAS Definition

- Extreme temperatures
- High pressures
- Abrasive particulates
- Acidic products
- Heavy solids build-up
- Critical plant safety
- Large pressure differentials
- Velocity control
- Noise control

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MOGAS®
SEVERE SERVICE BALL VALVES