Valves for Chemical / Petrochemical Processes

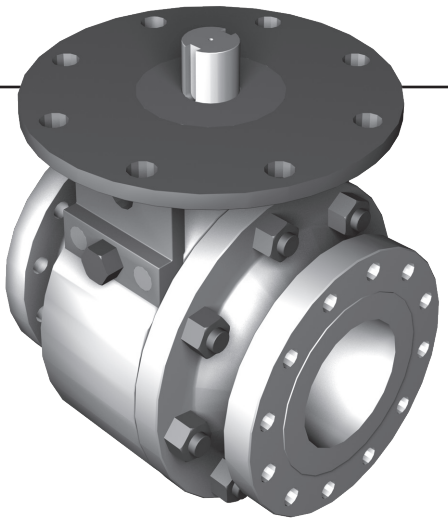
Engineered Solutions for the Chemical / Petrochemical Industry

MOGAS®

MOGAS metal-seated ball valves have proven successful in these processes and more:

…while handling these conditions and more:

- *Abrasive silica*
- *Corrosive attacks*
- *Fugitive emissions*
- *High cycling*
- *High velocity of rock hard particulates*
- *Lethal media*
- *Liquified wax*
- *Molten slurry*



Corrosive acids.
Erosive particulates.
Extreme operating conditions.
Critical safety applications.

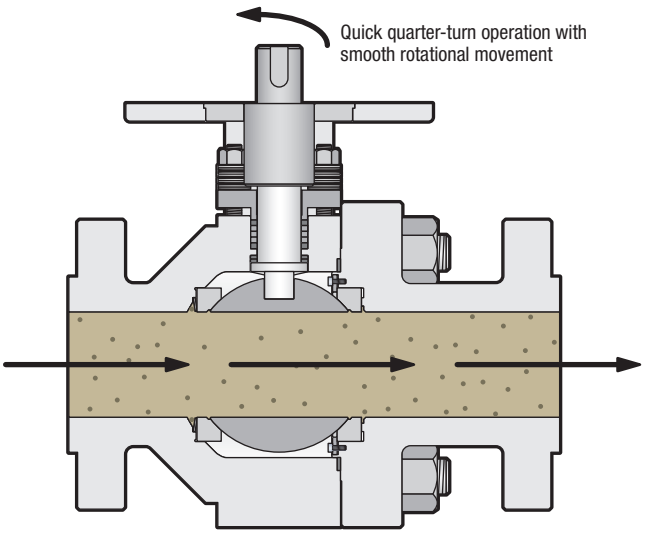
All of these severe services can be found in chemical and petrochemical processing plants worldwide. Along the many miles of piping, each plant requires dependable isolation of critical equipment and control of process flow, coupled with reliable vent and drain valves. A valve's performance ensures not only the integrity of the process and safety of plant personnel, but also the volume and rate at which the plant can produce products—thus generating revenue and enhancing profitability.

MOGAS has been involved with these types of processing plants for several decades. Each process has unique chemical characteristics where a valve's construction materials and necessary coatings must be carefully selected. A comprehensive analysis of the individual process and media—combined with years of research & development, engineering, manufacturing and service support—enables MOGAS to provide valve solutions that are ideally designed to meet your specific requirements.

Ball Valve Advantages

Compared to Gate and Globe Valves

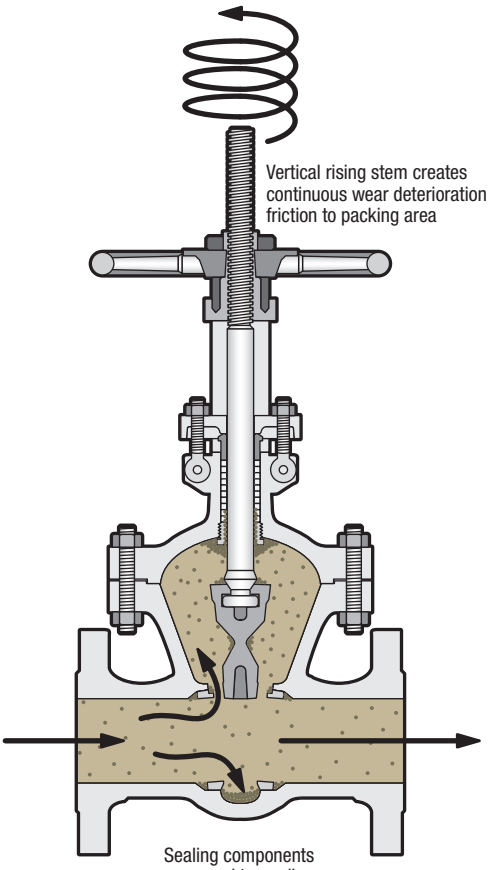
When it comes to valve types, there are distinctive differences in design, intent and purpose. Whether a valve has rotary operation or linear action is a critical part of the **longevity** and **performance** of the valve in severe services. Exposed sealing mechanisms versus protected sealing surfaces can make a big difference. Commodity valves manufactured for clean environments at ambient or low temperatures are simply not engineered to withstand the strenuous demands of extreme operating conditions.

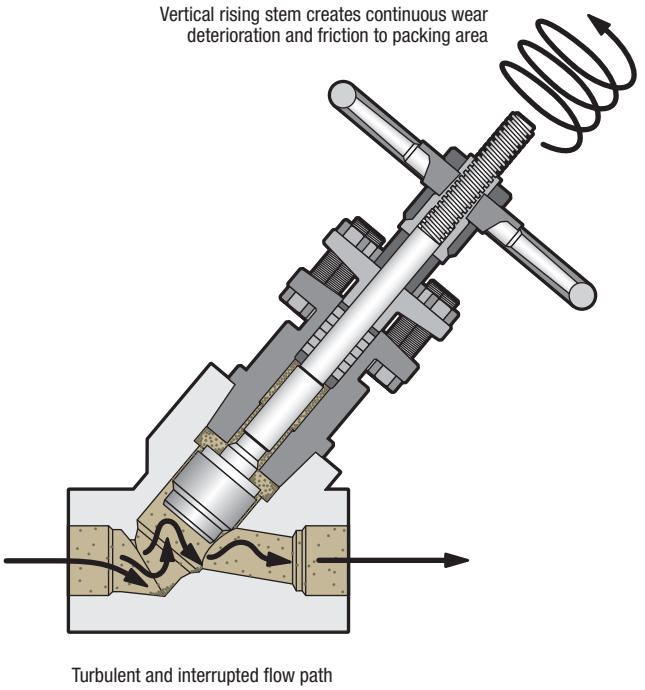


Straight-through bore path

Serious industrial processes require serious valve choices. Understanding the fundamental differences in valve types can assist with those important decisions.

Ball Valve Advantages
Recessed seats are protected from continual exposure to the process flow
Ball is wiped clean with each operation of the valve
Rotates on own axis, thus no volumetric displacement
Packing area is protected from potential media erosion, maintaining integrity of stem seal area while reducing risk of fugitive emissions
Non-rising stem design meets EPA VOC packing leakage standards for greater number of cycles
Pressure-assisted sealing





Gate Valve Disadvantages

Sealing components in the line of flow lead to potential wear and corrosion attack
Geometry of the exposed sealing surface wears and loses the ability to hold tight seal
When operated, flow path is interrupted causing volumetric displacement of the process fluid which must occur from behind the plug back into the flowstream
Multi-turn rising stems can pull destructive catalyst and pipe scale up through the interior diameter of packing area leading to possible hazardous atmospheric leaks
A sliding stem valve will not provide the length of service life or number of cycles due to the stem moving through the packing box along with the process fluid
Relies on vertical thrust by the stem to drive the sealing plug into the seat

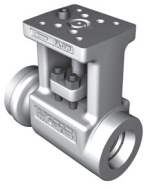
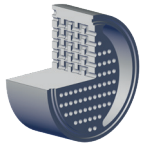
Globe Valve Disadvantages

Damage to sealing surfaces due to exposure of the seats when the valve is open
Sealing trough / rib erodes over time and can capture flow particles
When operated, flow path is interrupted causing volumetric displacement of the process fluid which must occur from behind the plug back into the flowstream
Multi-turn rising stems can pull destructive catalyst and pipe scale up through the interior diameter of packing area leading to possible hazardous atmospheric leaks
A sliding stem valve will not provide the length of service life or number of cycles due to the stem moving through the packing box along with the process fluid
Torque seated to activate seal — thermal cycling relaxes stem

Valves for Chemical Petrochemical Applications

Continuous Innovation

Valves for Chemical / Petrochemical Applications

	Key Features	Size, in (dn)	Pressure Class	Body Materials	Maximum Temp., °F (°C)
	**C-Series** Customizable Isolation Valves • engineered specifically for customer application • 2-piece or 3-piece forged body • blowout-proof stem • VORTEX PURGE™	4 to 36 (100 to 900)	150 to 4500	300 Series, Carbon Steel, Chrome Molybdenum	1500 (815)
	**T-Series** Trunnion • Metal or soft seat • Reduced operating torque • Smaller actuator requirements • Blowout-proof stem	3 to 60 (75 to 1500 dn)	150 to 2500	A105 A182-F316 A182-F51 B564 Gr N06600	400 (204)
	**ISOLATOR 2.0** Low Pressure Isolation Valves • full bore • 2-piece forged body • bi-directional • blowout-proof stem	1 to 12 (25 to 300)	150 to 600	A105, F9	800 (427)
				F316	*1000 (538) with 410 Trim
	**RSVP® / iRSVP®** Vent and Drain Valves • uni-directional sealing • forged uni-body; integrated vented body • mechanical precision stop • rigid mounting bracket	1/2 to 4 (13 to 100 dn)	150 to 4500	A105 F22 F91 F92	1100 (593)
	**G-Series** Drain and Vent Valves • in-line repairable • uni-directional • metal/graphite laminated seats • 3-piece forged body	1 to 3 (25 to 75 dn)	150 to 600	A105	800 (426)
				316SS F22	900 (482)
	**FlexStream® Technology** Rotary Control Valves • velocity control • variable characterization • high rangeability • precision modulation	1 to 42 (25 to 1066 dn)	300 to 4500	300 Series, Carbon Steel, Chrome Molybdenum	1100 (593)

*Other materials are available upon request.

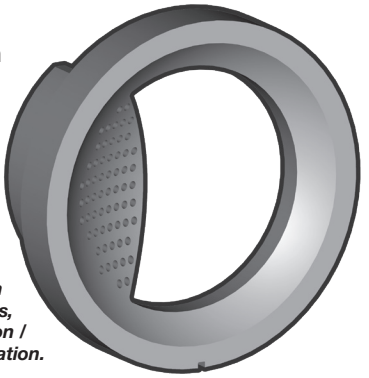
Rotary Control Technologies

Flow Control Flexibility for Demanding Environments

In the harsh environments associated with chemical / petrochemical processes, control valves are a vital part of the numerous control loops found within the plant. These important valves control gases, liquids, steam or chemical compounds by maintaining pressure, flow levels or disseminating the energy of pressure differentials to ensure the integrity of the process. They must be designed to avoid fugitive emissions and dependably handle lethal applications and often caustic media.

Pattern characterization for precision modulation

To further provide precise control at every stage of valve opening, pattern characterization varies the quantity, style, size and arrangement of passageways that fill the control area. Some passageways can be small with several stages of letdown, while other passageways progressively increase in size while reducing pressure letdown. These combinations of variable characterization allow application-specific designs that provide ideal performance and extended valve life.

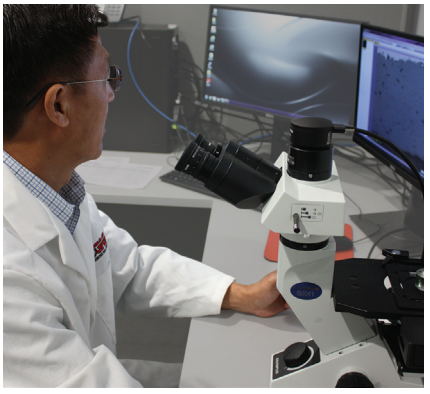


FlexStream® technology uses a varying number of passageways engineered within the bore, custom designed to suit high pressure differential applications, providing better control of velocity / noise / vibration / erosion / cavitation.

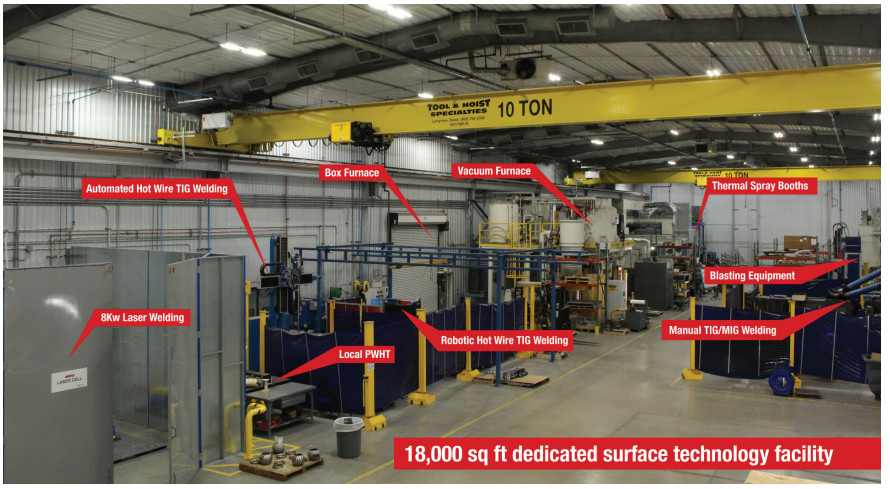
Proven Coatings

Patented Coatings Extend Product Life

Often the success of a coating depends upon proper selection of the base material and the coating, along with the method in which the coating is applied—all as a complete system. MOGAS offers a range of mechanically and metallurgically bonded coatings, applied with absolute accuracy for optimum thickness while maintaining precise design tolerances and dimensions.



MOGAS research scientists in our metallurgical test labs evaluate bond strength, porosity, structure, hardness, and wear and corrosion resistance so plants can run longer and operate at peak efficiency.



MOGAS Surface Technologies continues to invest significantly in manufacturing and innovative proprietary coatings for the harshest chemical and petrochemical process environments.

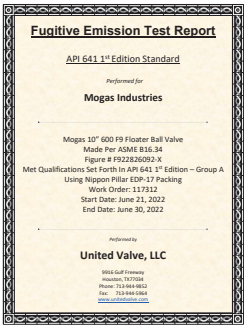
Designed for Safety

Ensuring Confidence and Reducing Risks

Fugitive Emissions Control

Most chemical and process plants must adhere to strict legislative and safety requirements (such as ISO 15848-2) regarding fugitive emissions. Under these conditions, leaks to atmosphere—no matter how small—can grow into large concerns. The monitoring and control of these emissions has become a major focus for plant operators. Whether satisfying environmental, legislative or industry guidelines of agencies such as the EPA, TA-Luft, ASME and others, all valves must meet clearly defined requirements to handle the most common valve leak areas: stems and body gaskets.

Often a small drip, or even gaseous release, can harm the equipment, environment or plant personnel. With this in mind, MOGAS has engineered stem and body gaskets to reduce the risk of unanticipated emissions. Our ball valves have two independent stem seals, as well as special body gaskets, to ensure reliable sealing. These design features are discussed in more detail below.



Fugitive Emission Test Report

API 641 1st Edition Standard

Performed for

Mogas Industries

Mogas 10" 600 F9 Floater Ball Valve
Made Per ASME B16.34
Figure # F92282609 2-X
Met Qualifications Set Forth In API 641 1st Edition – Group A
Using Nippon Pillar EDP-17 Packing
Work Order: 117312
Start Date: June 21, 2022
End Date: June 30, 2022

Performed by

United Valve, LLC

9916 Gulf Freeway
Houston, TX77034
Phone: 713-944-9852
Fax: 713-944-1964
www.unitedvalve.com

Although most customers may not require API-6D certification, they do desire API-6D standards to know that a third-party has reviewed manufacturing practices for compliance of specified requirements.

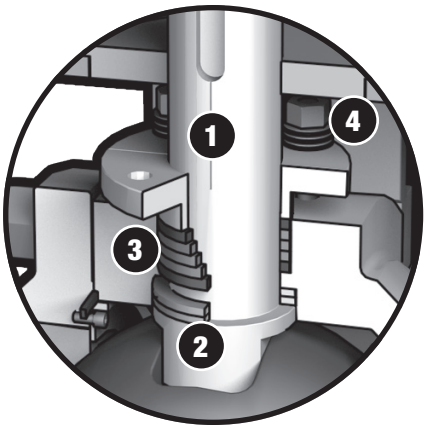
Category M for Lethal Fluids

Category M for Lethal Fluids, per ASME B31.3 code, is defined as *"a fluid service in which a single exposure to a very small quantity of toxic fluid, caused by leakage, can produce serious, irreversible harm to persons on breathing or bodily contact, even when prompt restorative measures are taken."* MOGAS metal seated ball valves have operated successfully for years in critical Category M applications such as acetic anhydride, phosgene gas and supercritical CO_2 systems.

A special requirement of this code is the **stem seal design**. MOGAS has addressed this requirement by providing independent stem seals which include:

- pressure-energized and mate-lapped stem seal bearing
- stem packing that uses two anti-extrusion rings and three application-specific packing rings
- optional lantern rings, piped to a detector
- live loading system

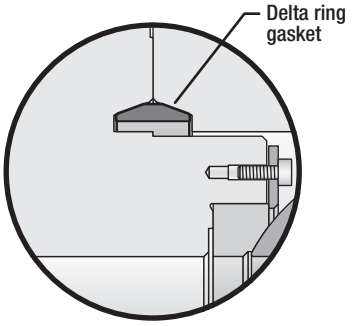
This MOGAS design meets all requirements of Category M specifications, without the use of expensive and high maintenance bellow seals—which have a limited cycle life.



1 Stem
2 Stem seal bearing
3 Application-specific stem packing
4 Live loading system

Pressure Energized Gasket

Category M requires the use of *"designs that increase gasket compression as pressure increases."* MOGAS provides a pressure-energized **delta ring gasket** for all Category M severe service ball valves. This solid metal, tapered ring combines high surface loading with the strength of the seal material to provide considerable stored energy and tight sealing—even in systems where vibration or thermal cycling might weaken other sealing components, leading to potential leak paths.



Fire Tested for Dependable Performance

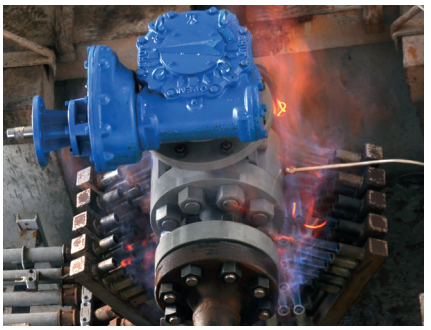
Fire in process plants can cause disastrous consequences—thus the necessity for various industry standards and specific end user requirements. The operation of valves, while in the midst of flames and extreme heat, is a significant part of any plant's safety program. MOGAS ball valves are designed to withstand the punishing effects of emergency fire situations.

Several sizes and ASME classes of MOGAS valves have been fire tested and qualified to meet these stringent requirements. Whether API spec 6FA or API 607, or particular customer fire test specifications, MOGAS works with end users to ensure all testing procedures are adamantly followed. After the burn is completed, both the operability and the performance of the valve are evaluated. When fire testing is complete, all documentation and certifications are available for review.

Safety Integrity Level (SIL) Certified

Industry experts began to address functional safety in process plants and formalize an approach for reducing risks with the development of IEC standard 61508. An emphasis on quantitative risk reduction, life-cycle considerations, general practices and equipment performance were all integral components to the evaluation. A SIL is a measure of a safety system's performance, in terms of probability of failure on demand. MOGAS C-Series severe service ball valves have been reviewed by Exida, a certification and research firm specializing in critical safety systems and related equipment, and have received a certification for certain failure rates.

Recently a 4-inch ASME 1500 Class MOGAS valve, along with a 10 inch ASME 600 Class valve, were sent overseas for a customer-specific fire test.



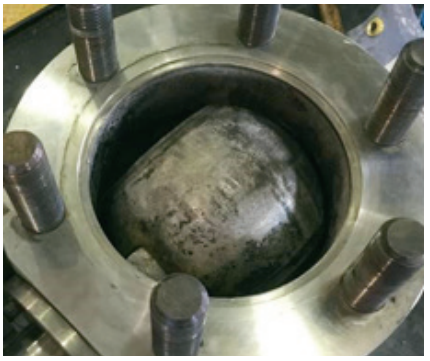
This 4-inch ASME 1500 Class ball valve was surrounded by high temperature fire for a pre-determined amount of time.

After time requirements were met, the fire was extinguished according to safety procedures.

The final step in the fire test was verifying the ability to operate the valve and documenting the valve's performance. The valve not only passed on the first attempt, but exceeded the customer's critical requirements.

Acetic Acid

MOGAS Valve Applications



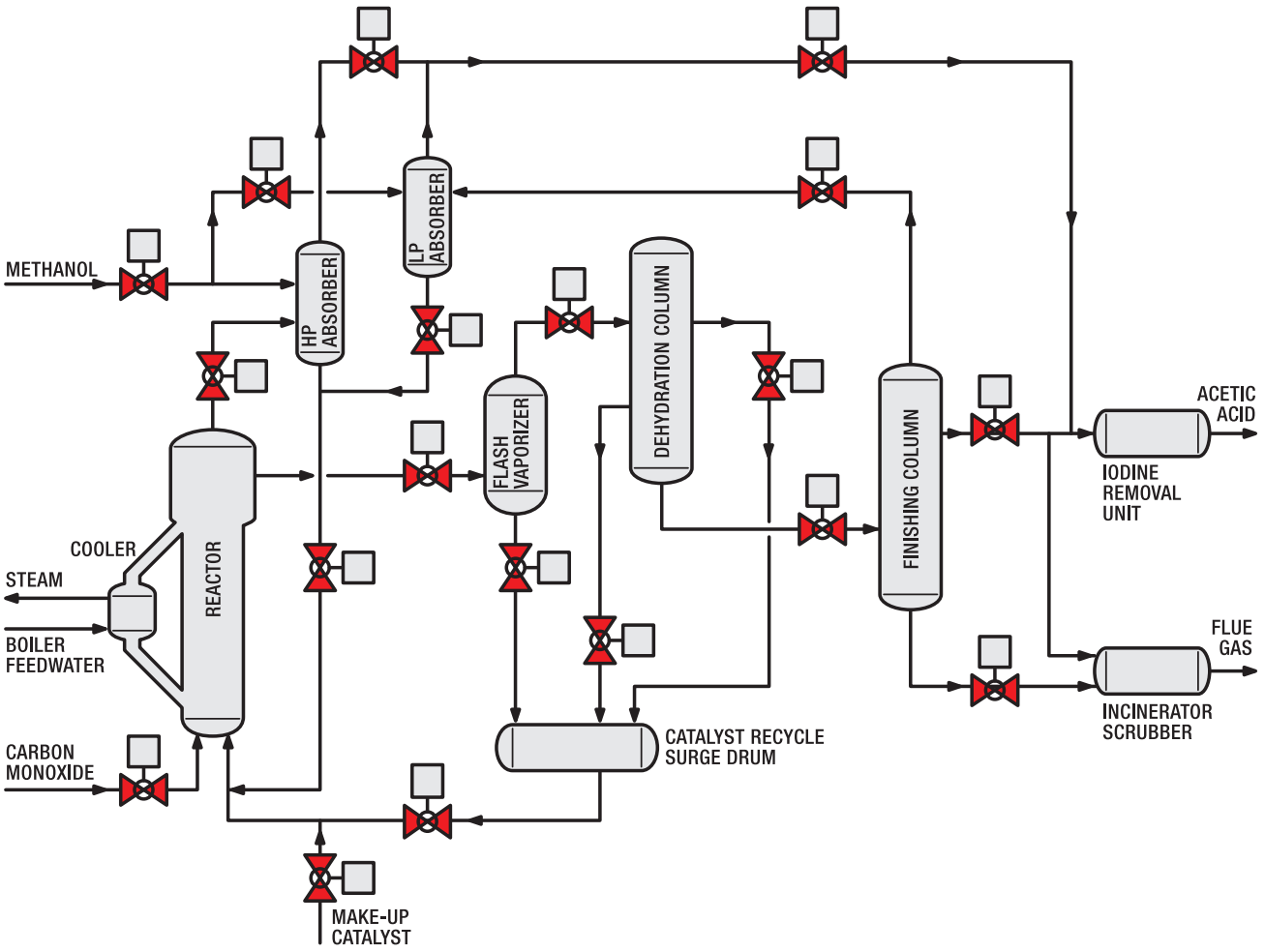
This 4-inch ASME 600 Class CA-1AS valve was repaired after 5 years in service. The ball was in good condition and only needed kiss lapping, while the seats were replaced.

MOGAS Hastelloy® valves with PEEK seats combat high corrosion and high-pressure steam in acetic acid applications.

Acetic acid, also known as ethanoic acid, or glacial acetic acid when undiluted, is used in the production of vinyl acetate monomer, commonly known as wood glue, white glue, carpenter's glue, school glue, Elmer's glue in the US, or PVA glue. A diluted solution of about 5% by volume of acetic acid produced by fermentation and oxidation of natural carbohydrates produces vinegar.

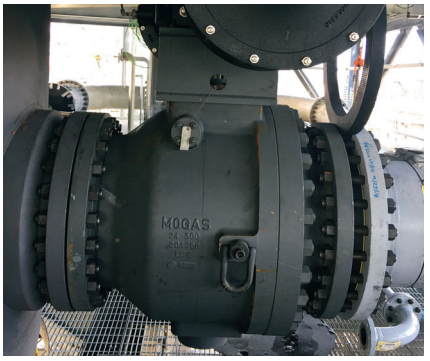
Converting acetic acid to a product involves the carbonylation of methanol using a rhodium metal iodide complex ion as catalyst, which is an expensive catalyst.

For over 30 years, MOGAS has supplied 1-inch through 4-inch ASME 600 Class Hastelloy C-Series valves with PEEK seats in this application. The larger 4-inch valves are used in the most critical service to isolate the reactors. Due to our performance in this service, MOGAS has replaced many of the competitors valves and is the preferred valve choice at a major global specialty chemical company.



1-Butene (AlphaButol®)

MOGAS Valve Applications

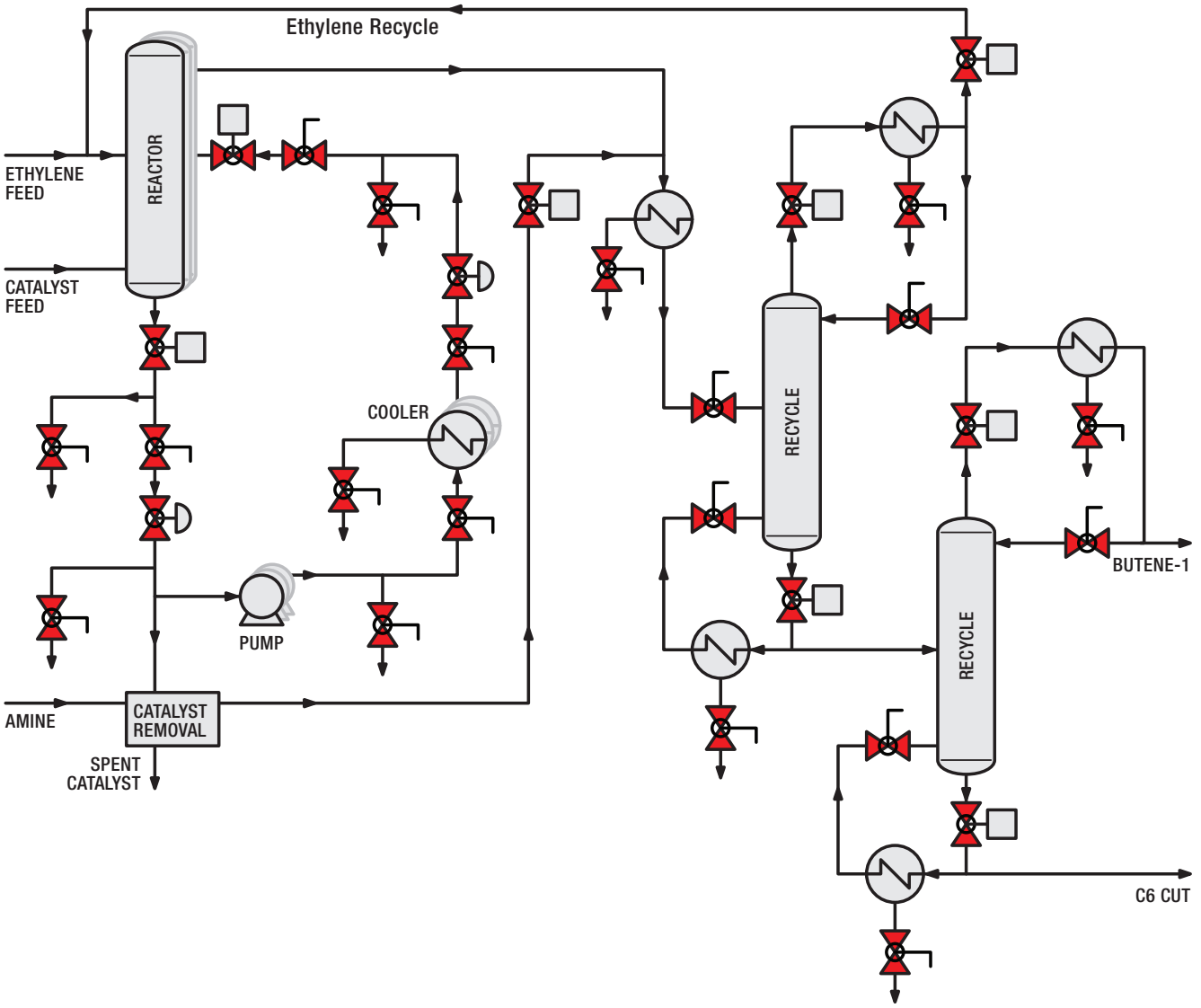


The installation of this 24-inch, ASME 300 Class T-Series trunnion was one of nearly 1800 valves for the start-up production of 1-butene.

MOGAS valves deliver repeatable and lasting isolation in the manufacturing of 1-butene.

1-Butene is an organic chemical compound, and is a highly flammable, easily condensed gas. AlphaButol is a licensed process for the production of 1-butene made by the dimerization of ethylene, which is used in Olefin conversion in the production of certain kinds of polyethylene. As 1-butene cools in production, a viscous sludge solidifies as a rubbery compound that hardens on valve internals.

MOGAS' strength lies in our technical knowledge and value we add to an often complex solution. MOGAS had worked with the AlphaButol licensor on other projects for well over 20 years. In this application, MOGAS valves offered repeatable and absolute isolation in a severe service, which also allowed periodic online cleaning of other equipment.



Ethylene

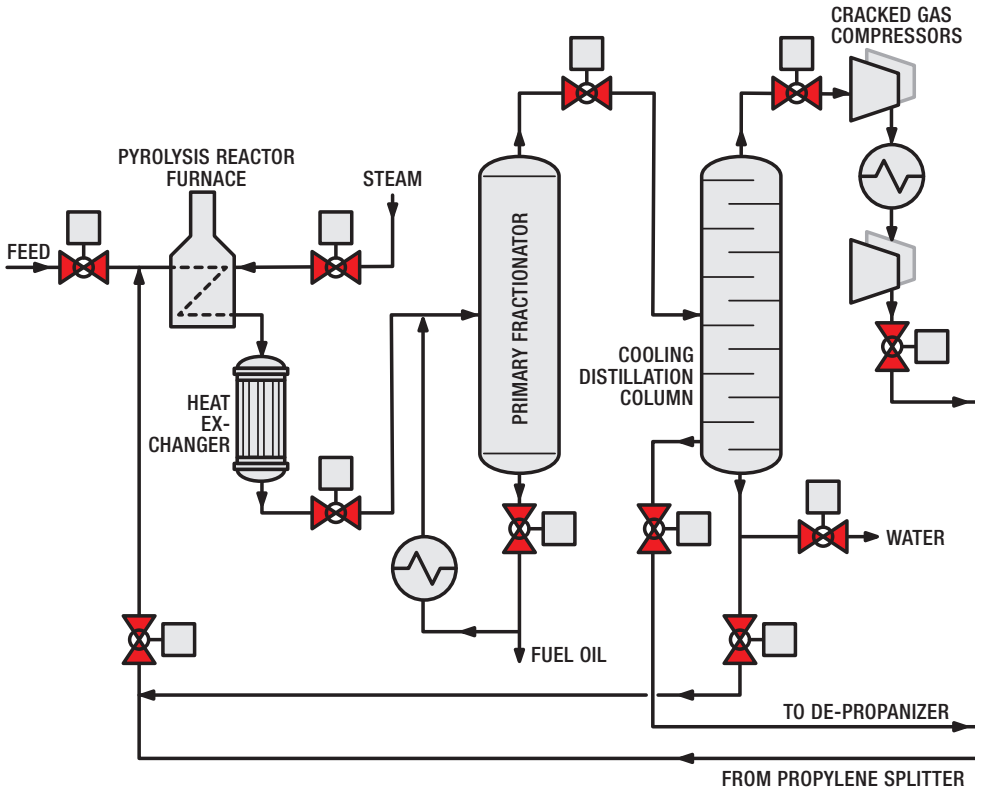
Liquid / Gas Steam Cracking

MOGAS valves handle the complications from massive cracking operations in ethylene production

A colorless flammable gas with a faint sweet and musky odor when pure, ethylene is widely used in the chemical industry. More ethylene is produced than any other organic compound, mostly to make polyethylene for plastic bags and pipes.

The ethylene production process includes four main steps: cracking, quenching, compression and processing. Reliable shut-off valves are essential to maximize ethylene quality and yield, and to minimize emissions, equipment damage and shutdowns.

The primary heat exchanger valve is the first valve in the system that sees the full range of products of the massive cracking operation that just occurred upstream, from the lightest (methane) to the heaviest (coke). Valves in this main transfer line need to absolutely isolate during the de-coking cycle, typically monthly, until a unit-wide shutdown is necessary for maintenance, cleaning and refurbishment.



Ethylene (cont'd)

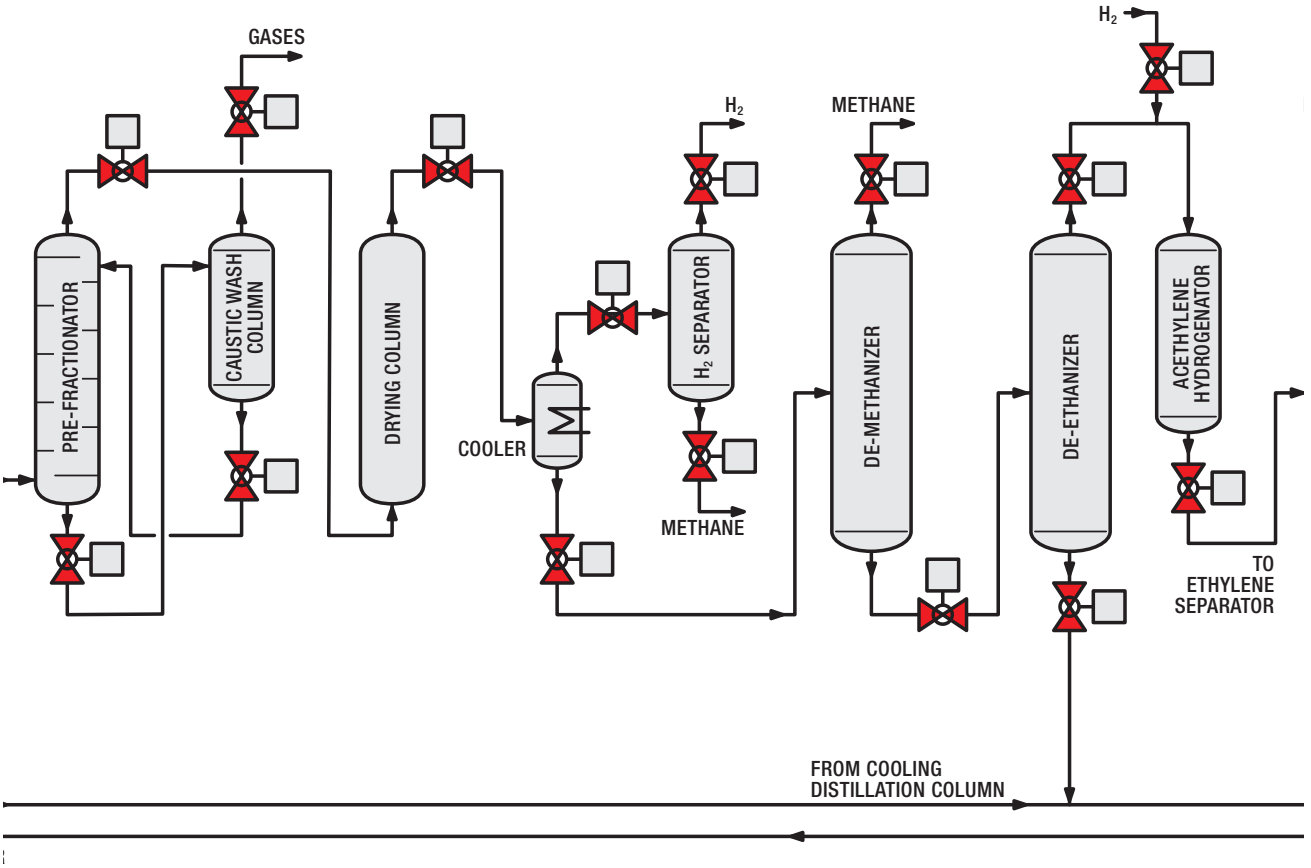
Liquid / Gas Steam Cracking

Process hazards include:

- fugitive emissions of feedstock
- toxic and corrosive gases, e.g, hydrogen sulfide corrosive materials (iron oxide, iron sulfide) that causes stress cracking
- high temperature swings from 850 to 350° F from furnace to quench towers that causes leaks and valve damage
- high pressure steam up to 1500° F
- coke buildup, where de-coking presents a fire hazard should the valve not provide reliable air-tight isolation

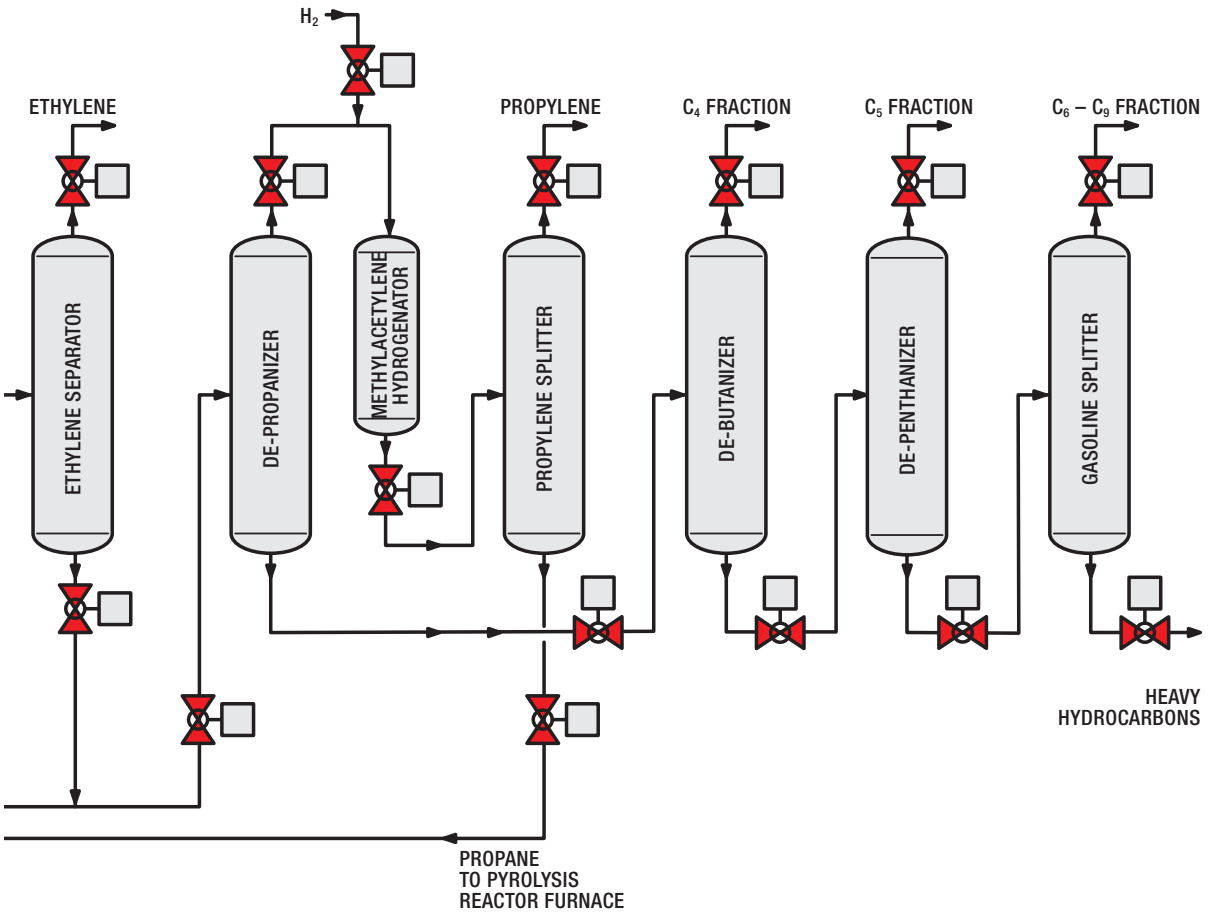
MOGAS valves protect equipment from the harsh conditions of ethylene production through design features:

- bi-directional sealing for backflow protection to restrict coke build-up and leaks into lines
- durable disc spring design is particle tolerant (vs multiple coil springs)
- wide seats and sharp leading seat edges wipe ball clean of harsh naphtha feedstock and coke build-up
- fire safe graphite packing and spiral-wound body gasket
- Class V shut-off due to risk of fire and cavitation
- process and customer-specific coatings
- high cycles
- tight shutoff



Ethylene (cont'd)

Liquid / Gas Steam Cracking



Ethylene Oxide

Major explosion at chemical plant producing ethylene oxide

MOGAS valves are designed for the conditions of ethylene oxide production.

Ethylene oxide is produced by the vapor phase oxidation of ethylene. A majority of ethylene oxide is used to make antifreeze, solvents and detergents, and in the production of polyester and plastic bottles.

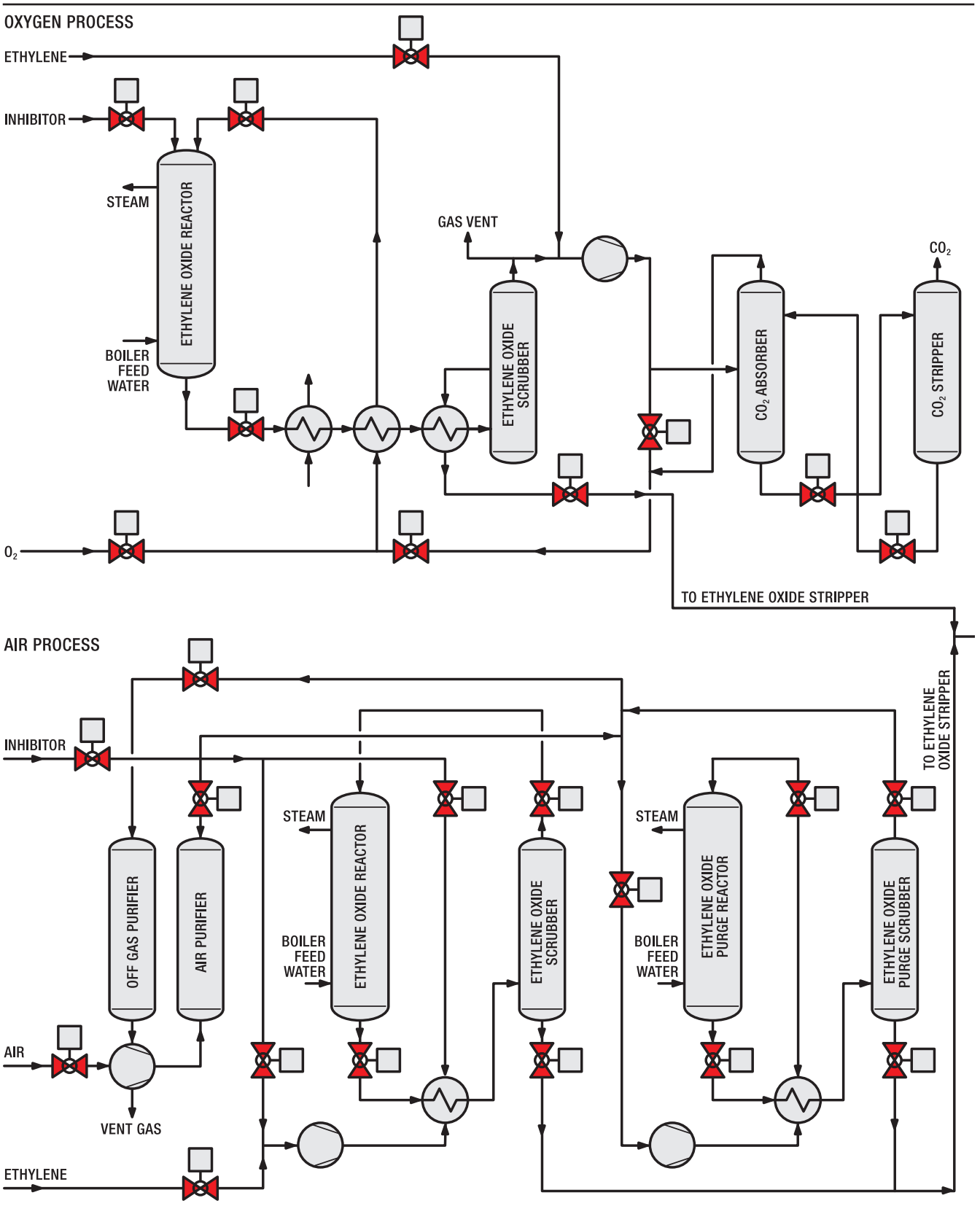
Ethylene oxide is highly explosive. With a boiling point of 51° F, it may be a gas or a liquid, depending on the temperature. As a colorless gas, it has a sweet odor, though odor is not a reliable guide to its presence.

Although there are two production processes (air and oxygen), both technologies are broadly similar and pose the same hazards. Ethylene oxide liquid or aqueous solution affect the skin and is toxic with long-term exposure. It is a carcinogenic to humans through inhalation and increases the risk of lymphoid and breast cancer.

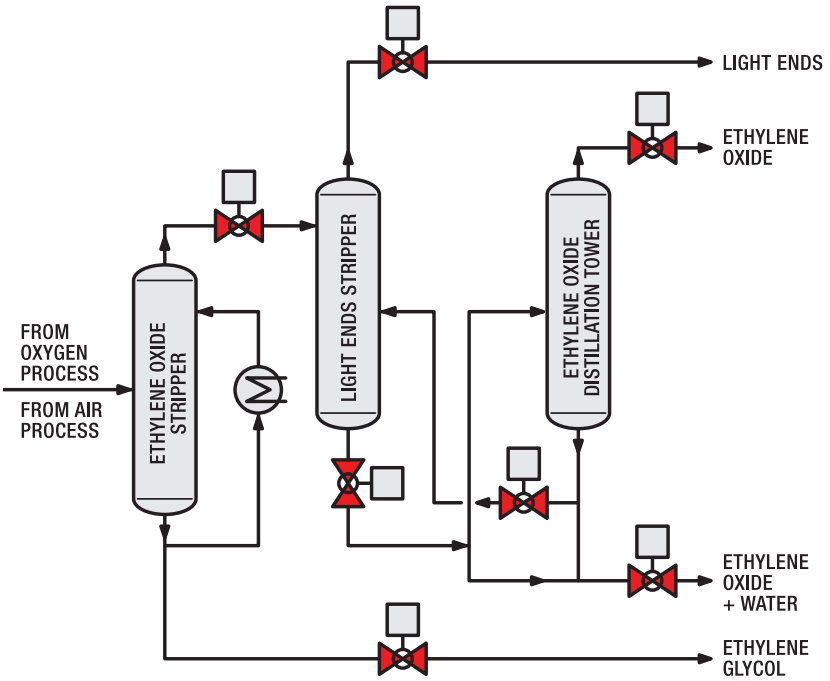
MOGAS valves are designed for the conditions of ethylene oxide production. Trapped ethylene oxide in valve cavities is the key consideration because it can polymerize and render the valve inoperative, and create an undesirable pressure build-up due to a very high coefficient of thermal expansion. In this instance, the valve needs to be vented on the upstream side, and therefore, unidirectional. Heating of a closed or isolated system containing ethylene oxide can lead to gasket failures and line or equipment rupture. Discharged ethylene oxide from relief valves should be captured and returned to its appropriate process location, or disposed of appropriately.

Controlling fugitive emissions is also an important consideration in a valve's performance. Valves must also be fire-tested.

Ethylene Oxide (cont'd)

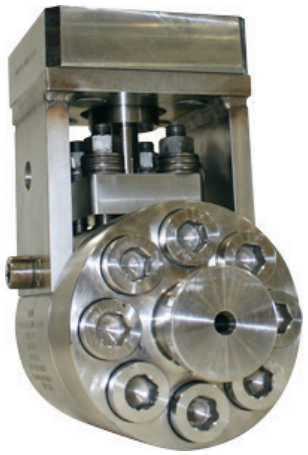


Ethylene Oxide (cont'd)



Low Density Polyethylene (LDPE)

Process Overview



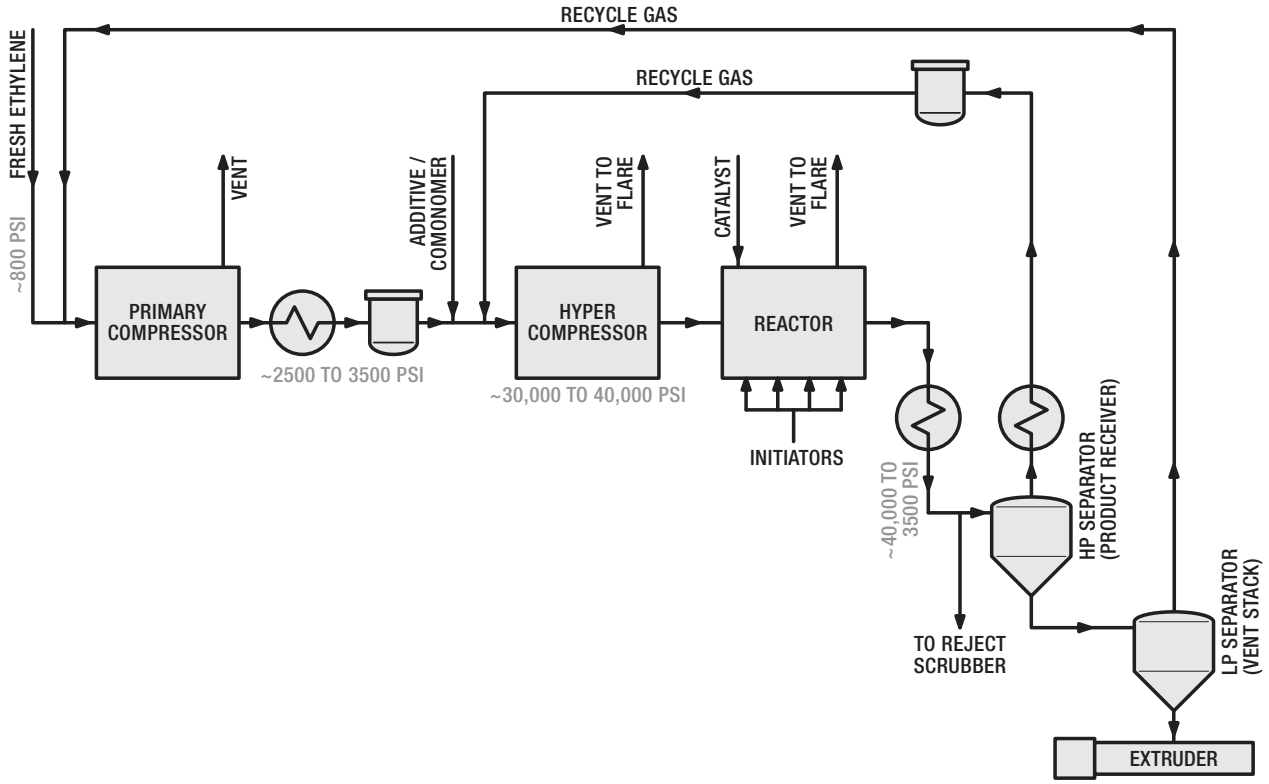
Isolating under extreme gas pressures (over 42,000 psi), this 1-inch Special Class CA-1AS was modified to dependably isolate in both high pressure and high temperature.

LDPE UltraHP valve proven to last 3 times longer

LDPE is a plastic material made from ethylene. It is soft, flexible and lightweight, so is ideal for orthotics and prosthetics, liners, tarps, water bottles, food storage containers, plastic tubing and much more.

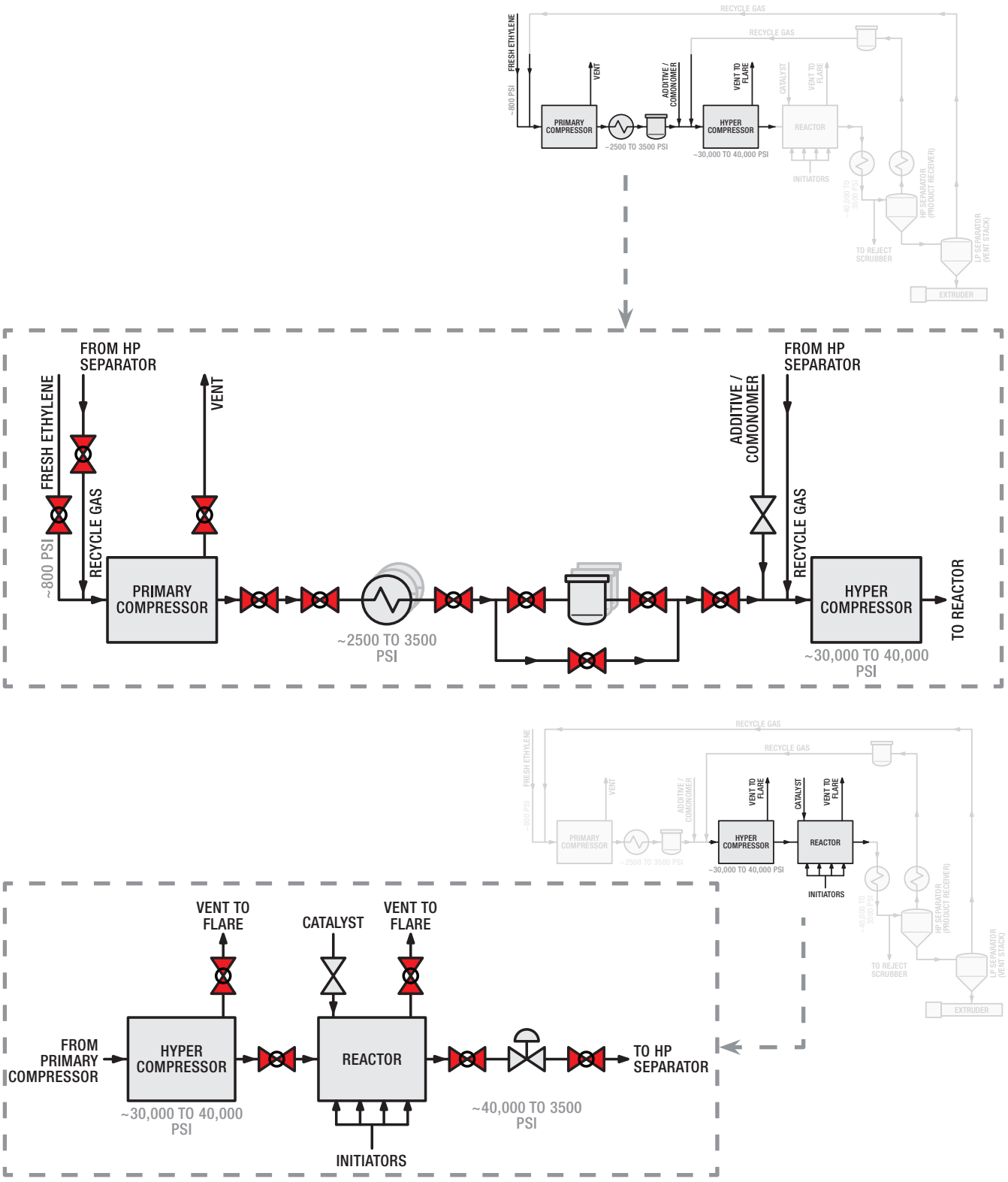
Similar to the complications of producing HDPE or LLDPE, polymerising ethylene to manufacture LDPE additionally involves extreme pressure up to 40,000 psi, and is a continual challenge and serious safety concern.

MOGAS' high pressure experts have worked closely with a large chemical company to design a dependable isolation valve for ultrahigh pressure conditions. With over four decades of severe service experience in a variety of applications, MOGAS was chosen as their "design partner" — with our valve design lasting three times longer than their previous valves. This outstanding performance helped extend the plant's overall output and minimize downtime.



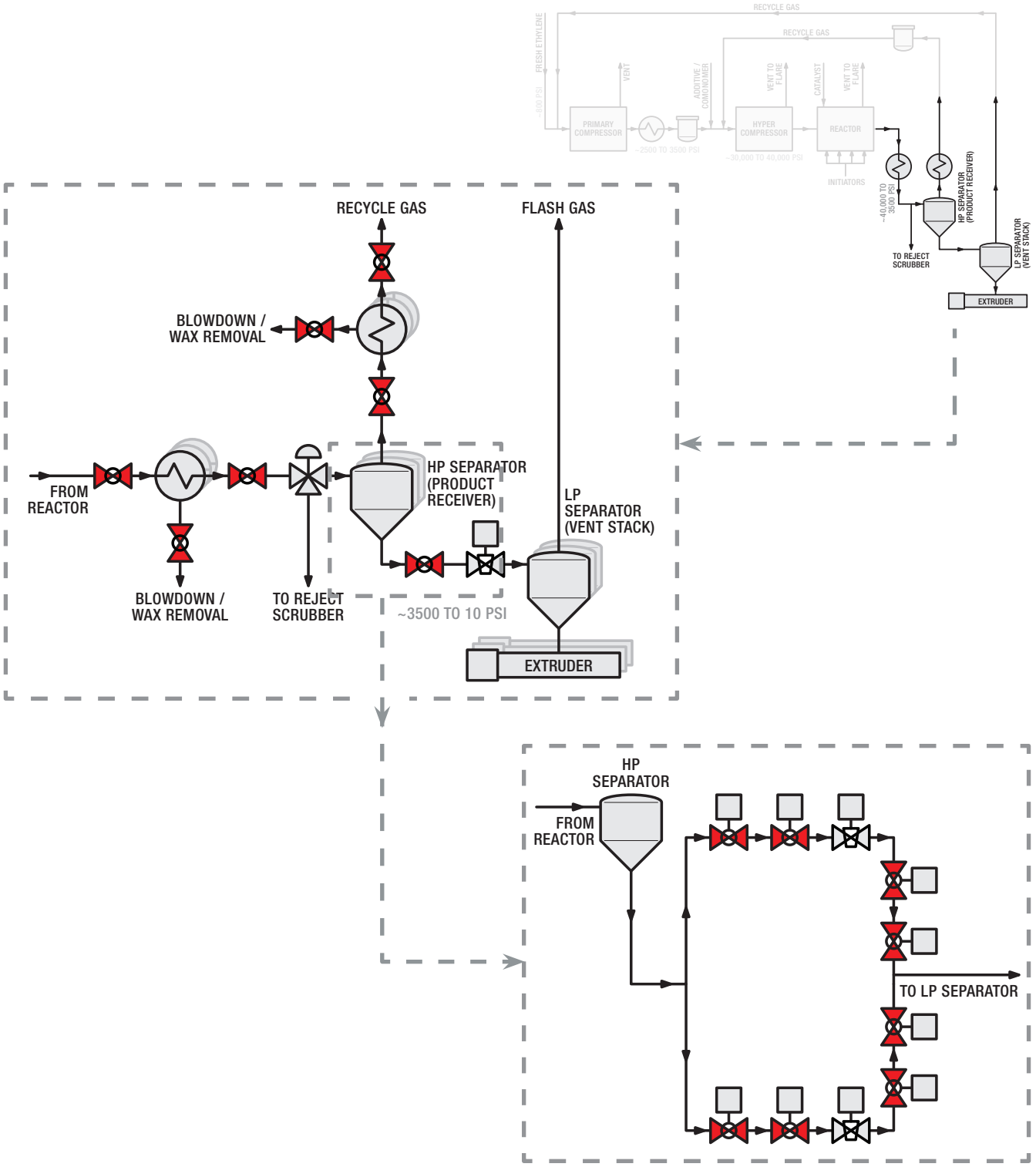
Low Density Polyethylene (LDPE)

Primary Compressor and Reactor



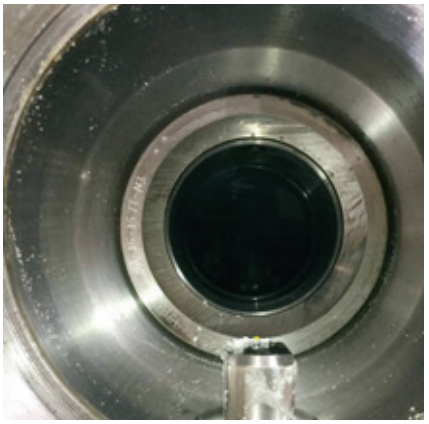
Low Density Polyethylene (LDPE)

High Pressure Separator (Product Receiver)



High Density Polyethylene (HDPE)

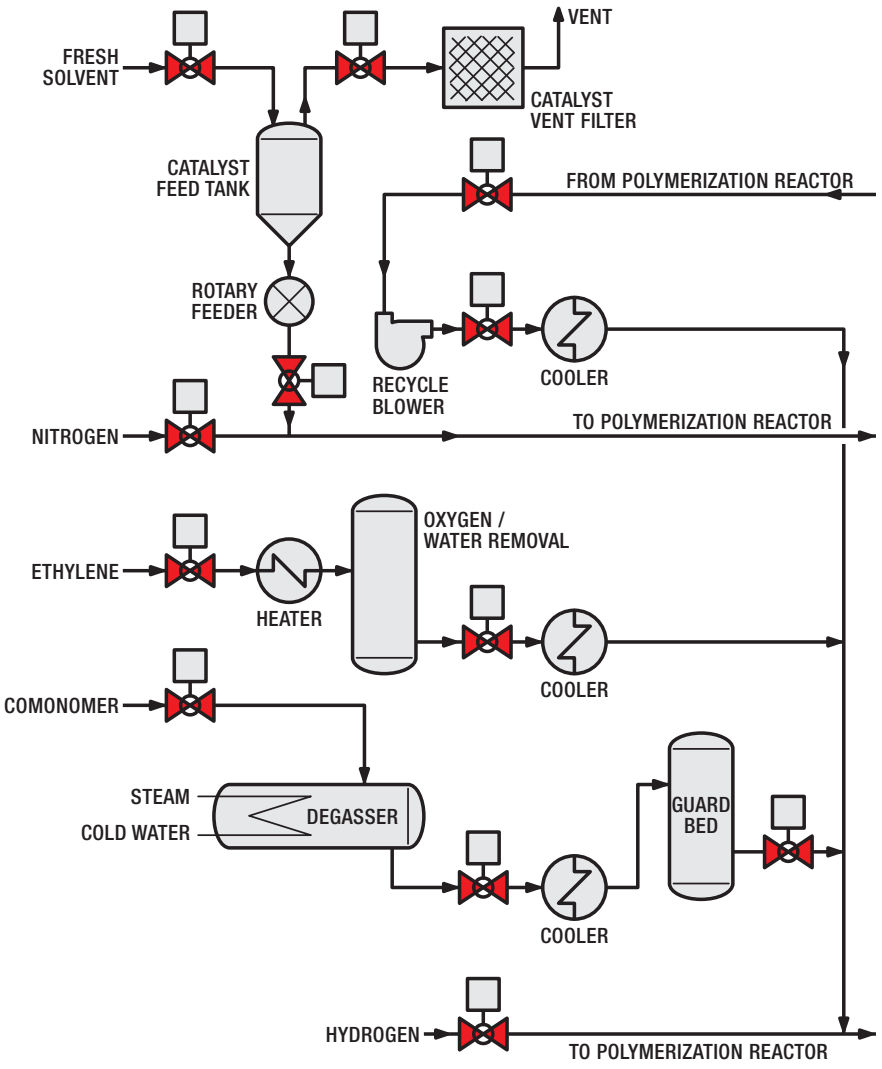
Gas Phase LLDPE / HDPE Swing Process



During operation, this CA-1AS strokes every 20 seconds and is typically operated for three months before requiring service.

Robust, dependable MOGAS valves offer many performance features for the production of HDPE and LLDPE.

HDPE (high density polyethylene) and LLDPE (linear low density polyethylene) are the products from ethane thermal cracking and fluid catalytic cracking (FCC) processes. They are one of the most versatile plastic materials manufactured because of their high strength-to-density ratio, higher temerature tolerance, and resistance to many solvents. HDPE is used in the manufacture of rope, liquid storage tanks, tables and chairs, pipes and engineered lumber, and many other products. LLDPE is used in plastic wrap, toys, containers, flexible tubings, and more.



High Density Polyethylene (HDPE) (cont'd)

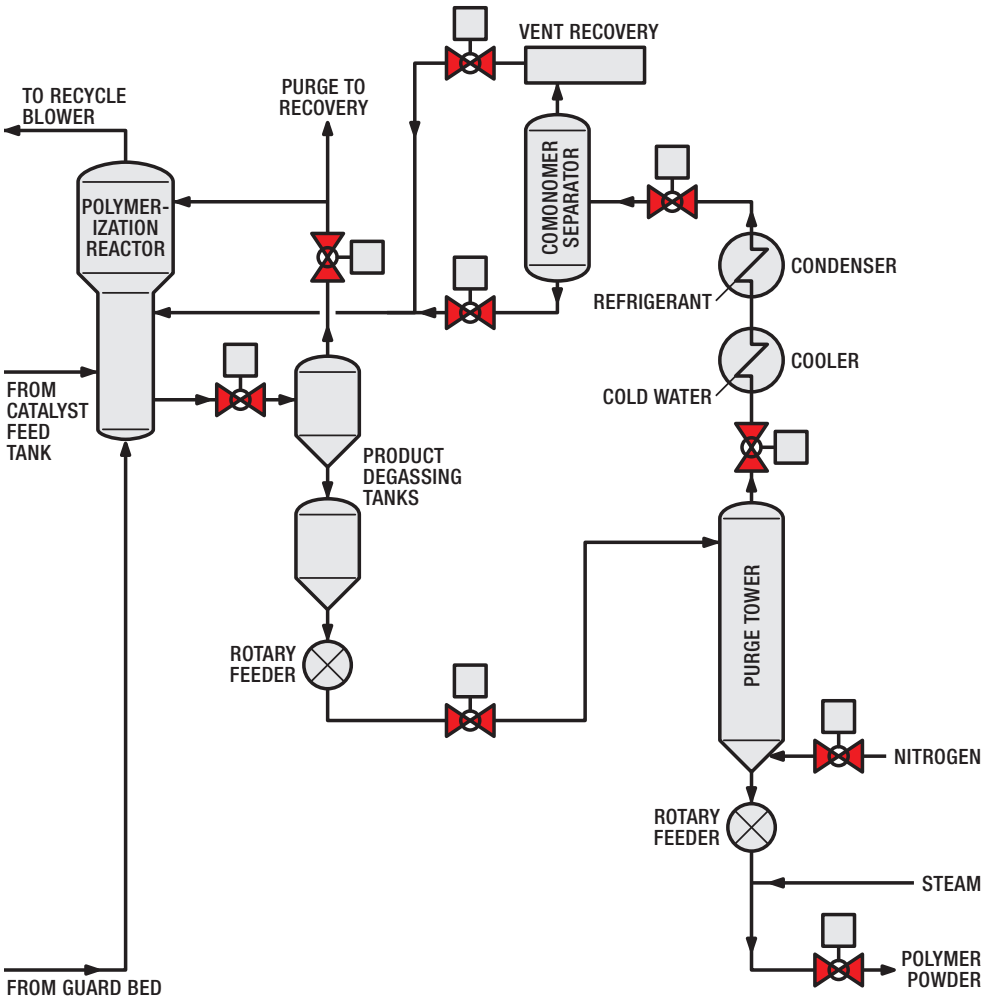
Gas Phase LLDPE / HDPE Swing Process

Valve complications during the production of HDPE or LLDPE include:

- an erosive powdery or sticky media build up
- high cycle rates typically over 150,000 cycles per year
- the continuance of polymer formation reaction inside the valve
- fugitive emissions exposure to volatile organic compounds (VOC) used as solvents—such as cyclohexane, hexane, isobutane—in certain technologies

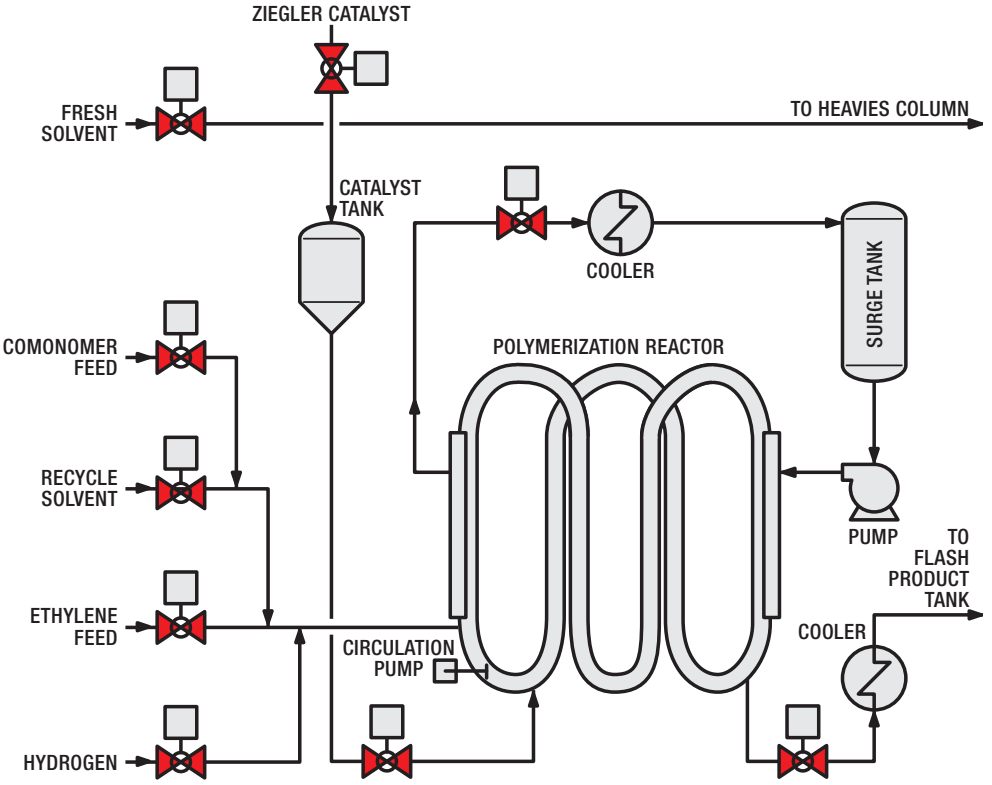
MOGAS ball valves offer many advantages over other valves:

- smooth straight-through, full bore path
- larger stem for higher torques
- sharper leading edge seats that cuts through forming polymers and wipes ball surface with each cycle
- minimal cavities between ball and body internals
- recessed seats are protected from continual exposure
- packing area is protected from potential media erosion, maintaining integrity of stem seal area while reducing risk of fugitive emissions
- non-rising stem design meets EPA VOC packing leakage standards for greater number of cycles



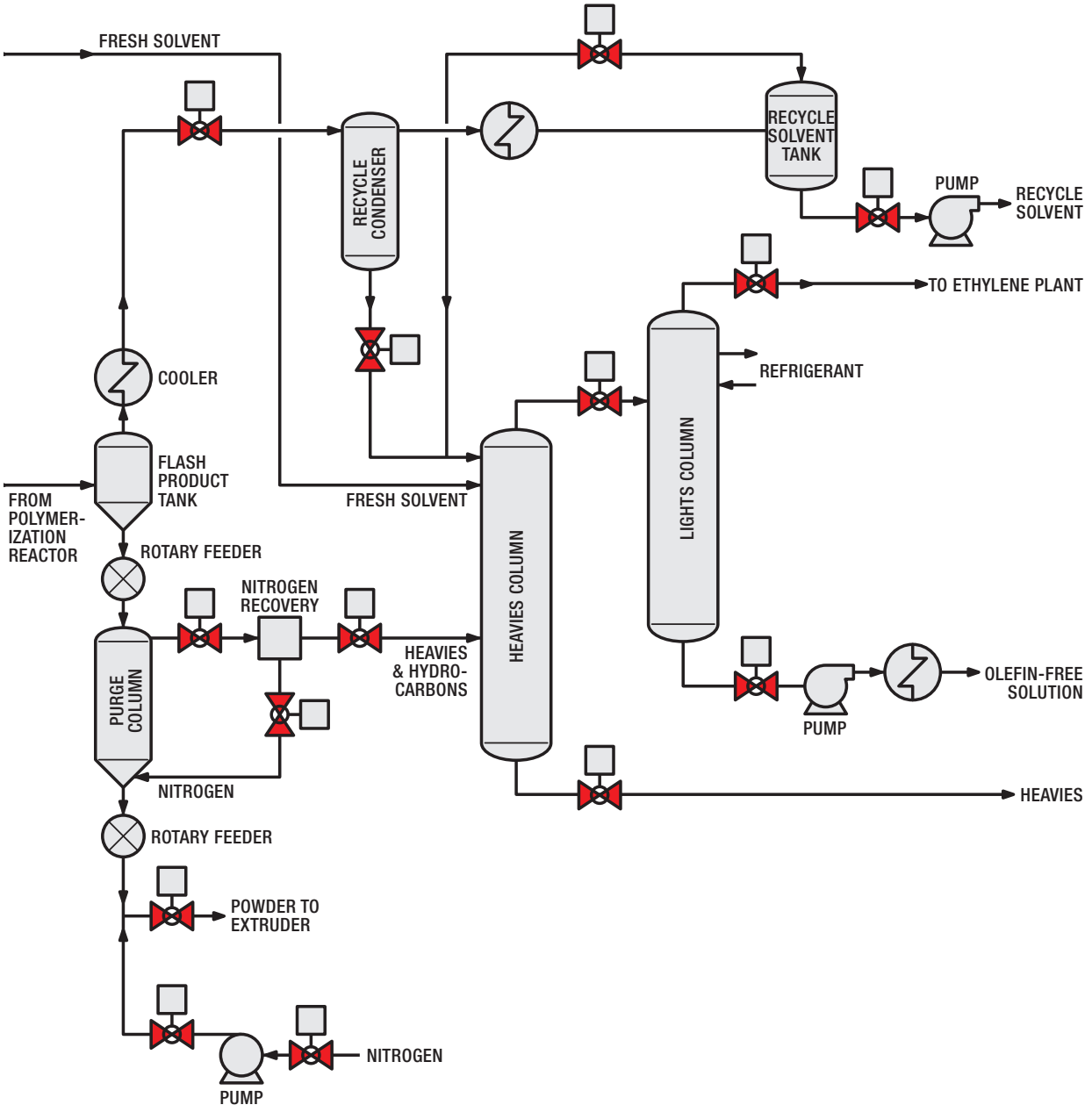
High Density Polyethylene (HDPE)

Slurry Loop Process



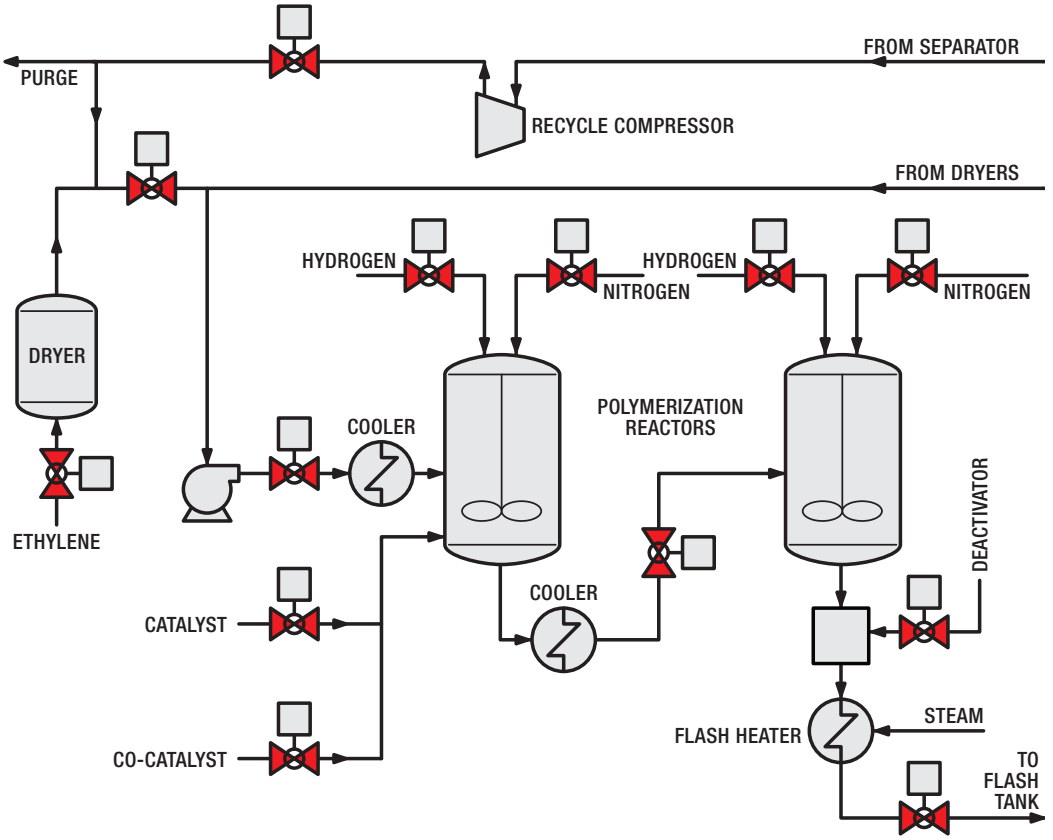
High Density Polyethylene (HDPE) (cont'd)

Slurry Loop Process



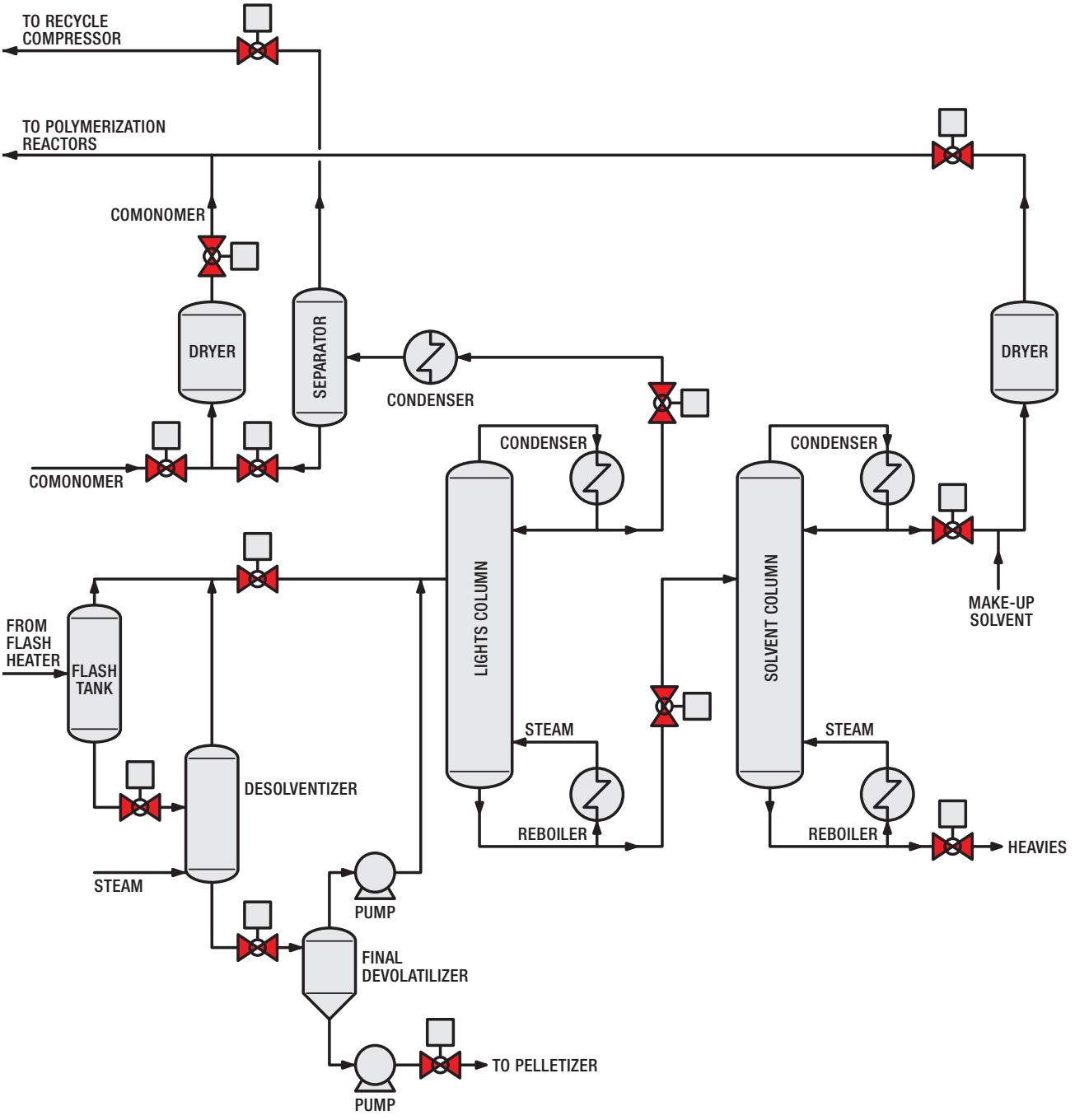
High Density Polyethylene (HDPE)

Suspension / Stirred Tank Reaction Process



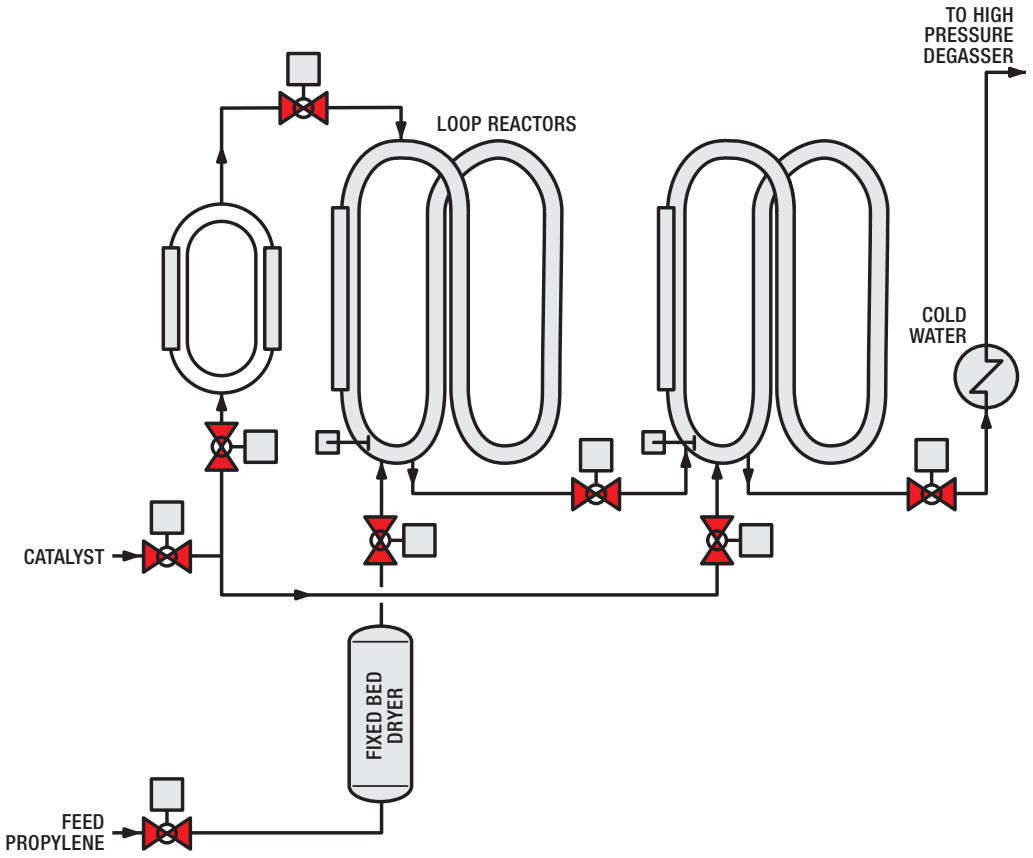
High Density Polyethylene (HDPE) (cont'd)

Suspension / Stirred Tank Reaction Process



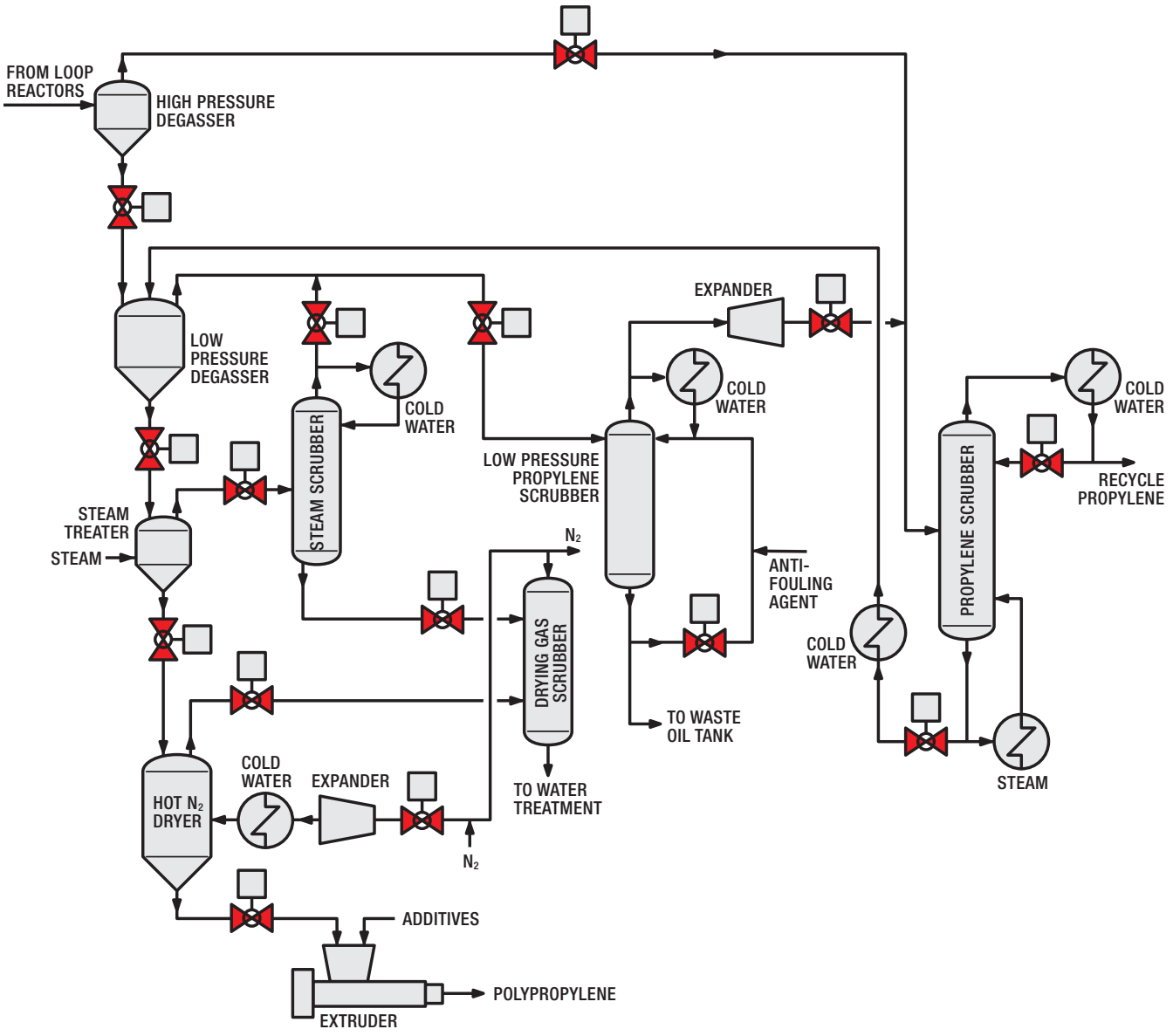
Polypropylene

Bulk Slurry – Tubular Loop Reactors – Liquid Propylene – Spheripol



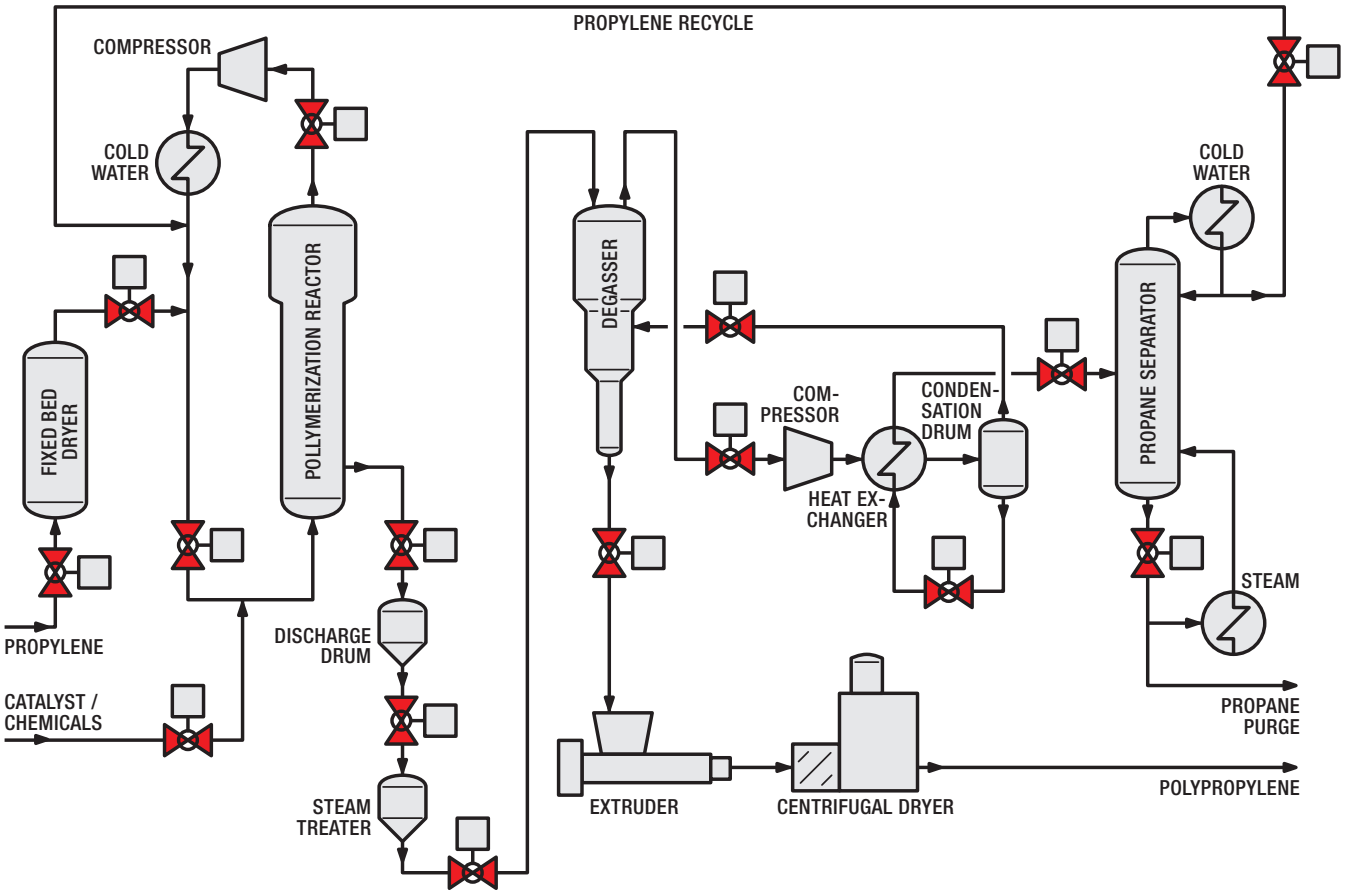
Polypropylene (cont'd)

Bulk Slurry – Tubular Loop Reactors – Liquid Propylene – Spheripol



Polypropylene

Gas Phase – Dow Unipol



Polysilicon

Twenty-five (25) CA-1AS 2-inch to 8-inch valves were chosen for this manufacturer of polycrystalline silicon materials and high-purity silicon products. Primary media was trichlorosilanes. All valves were oxygen cleaned in MOGAS' in-house cleanroom.

Polycrystalline silicon, or polysilicon, is a high purity, polycrystalline form of silicon, used as a raw material by the electronics industry and on solar cells to directly convert sunlight into electricity.

Production of polysilicon is a severe service for valves, and material selection is crucial. Extreme corrosion occurs from the beginning of the process at the fluidized bed reactor and extends throughout the plant.

Around the Chemical Vapor Deposition (CVD) reactor, temperatures are elevated up to 1650 F. There are numerous lower temperature and lower pressure processes that are difficult for other valve manufacturers to handle. This is due to the corrosive nature of chemicals produced during the manufacture of pure silicone, such as Trichlorosilane

Trichlorosilane is a colorless liquid with a sharp, choking odor. This chemical readily burns readily and rapidly vaporizes at atmospheric pressure and normal ambient temperature. Inhalation causes severe irritation of respiratory system, and as a liquid, severely burns the eyes and skin.

Other hazardous, corrosive chemicals in the manufacturer of polysilicon include:
- Silicon Tetrachloride
- Dichlorosilane
- Boron Trichloride
- Phosphate Pentachloride
- Hydrochloric Acid

Valves must absolutely isolate—and not just during the initial pressure test—but for years into polysilicon production.

Materials and Coatings

The application-specific materials and coatings of MOGAS valves provide enhanced corrosion resistance, reduce refurbishment costs, and extend valve life and run times—which means reliable endurance of critical path valves.

Stem Designs

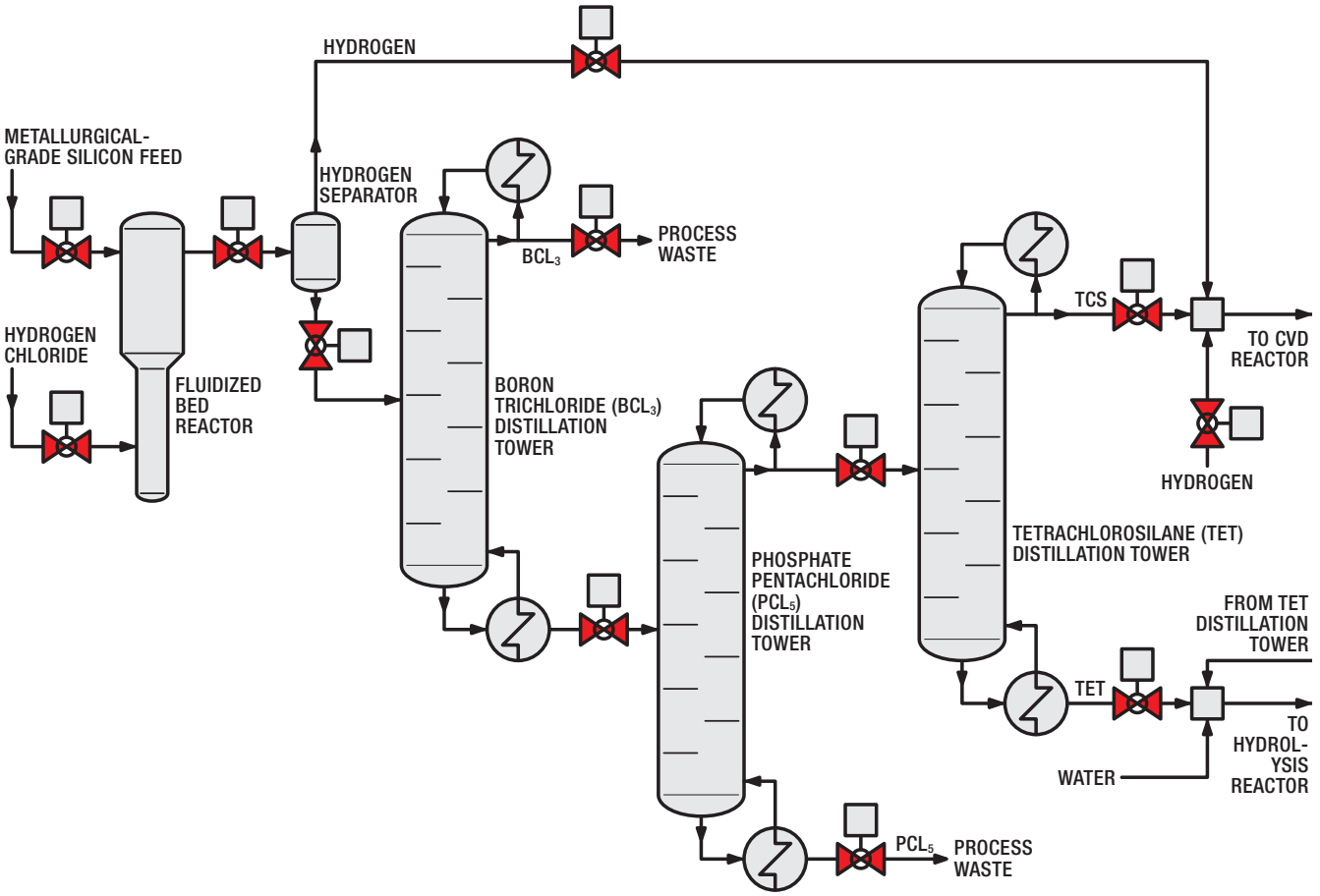
Linear rising stem valve designs have an extremely difficult time maintaining a leak-free stem seal due to high friction, shaft wear, erosion and backlash.

The MOGAS valve stem design has proven a reliable choice. It has independent stem seals which include:
- pressure-energized and mate-lapped stem seal bearing
- stem packing that uses two anti-extrusion rings and three application-specific packing rings
- optional lantern rings, piped to a detector
- live loading system

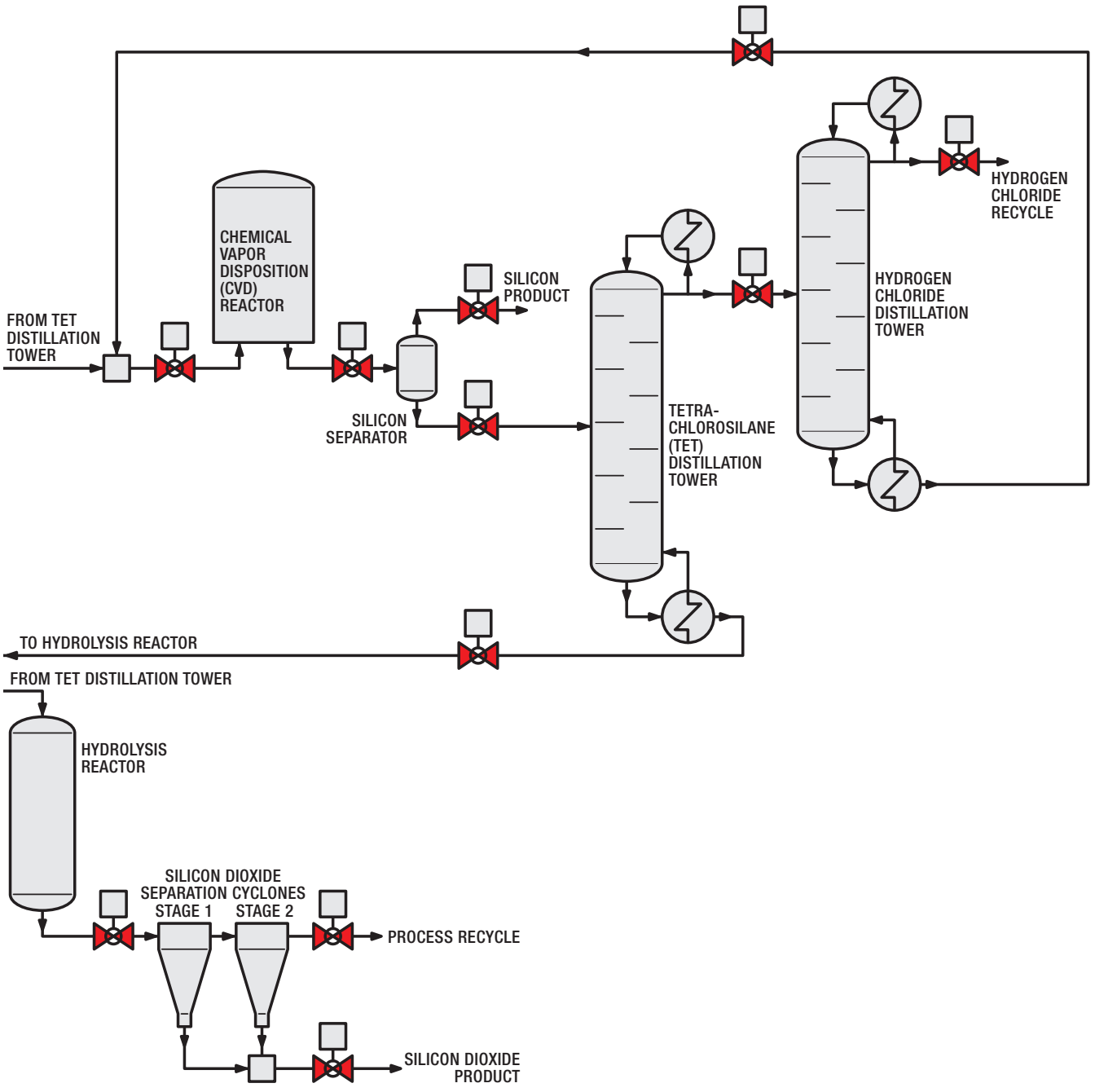
Polysilicon (cont'd)

Precision Cleaning

MOGAS' in-house cleanroom keeps impurities from corrupting the integrity of the chemical composition of the media. As part of our stringent cleaning procedures, verifiable absence is determined through the use of qualitative and quantitative inspections. Each job is fully documented to define, control and monitor processes such as material flow, cleaning details, inspection results, packaging and labeling.

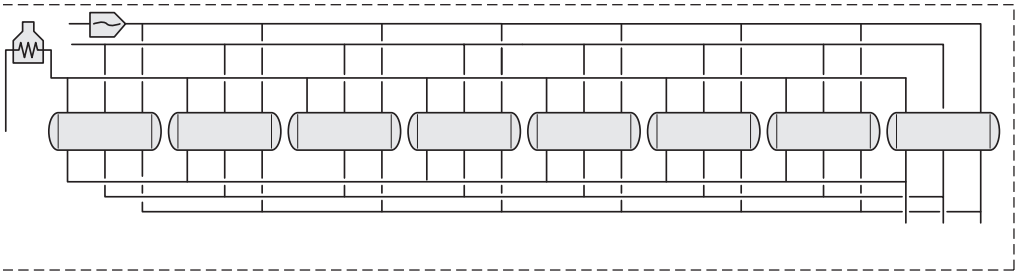


Polysilicon (cont'd)



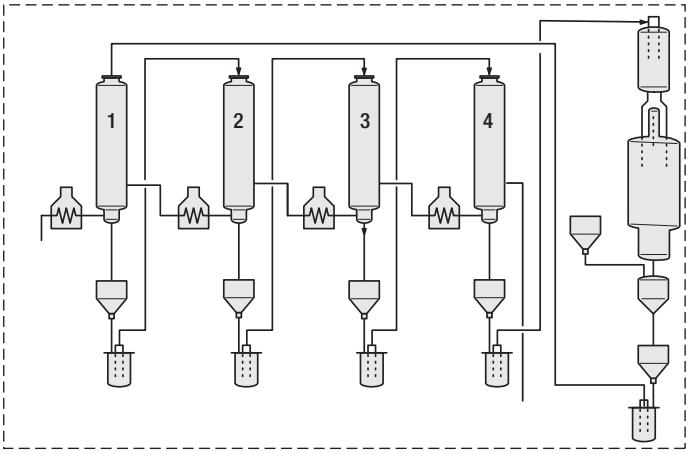
Propane Dehydrogenation (PDH)

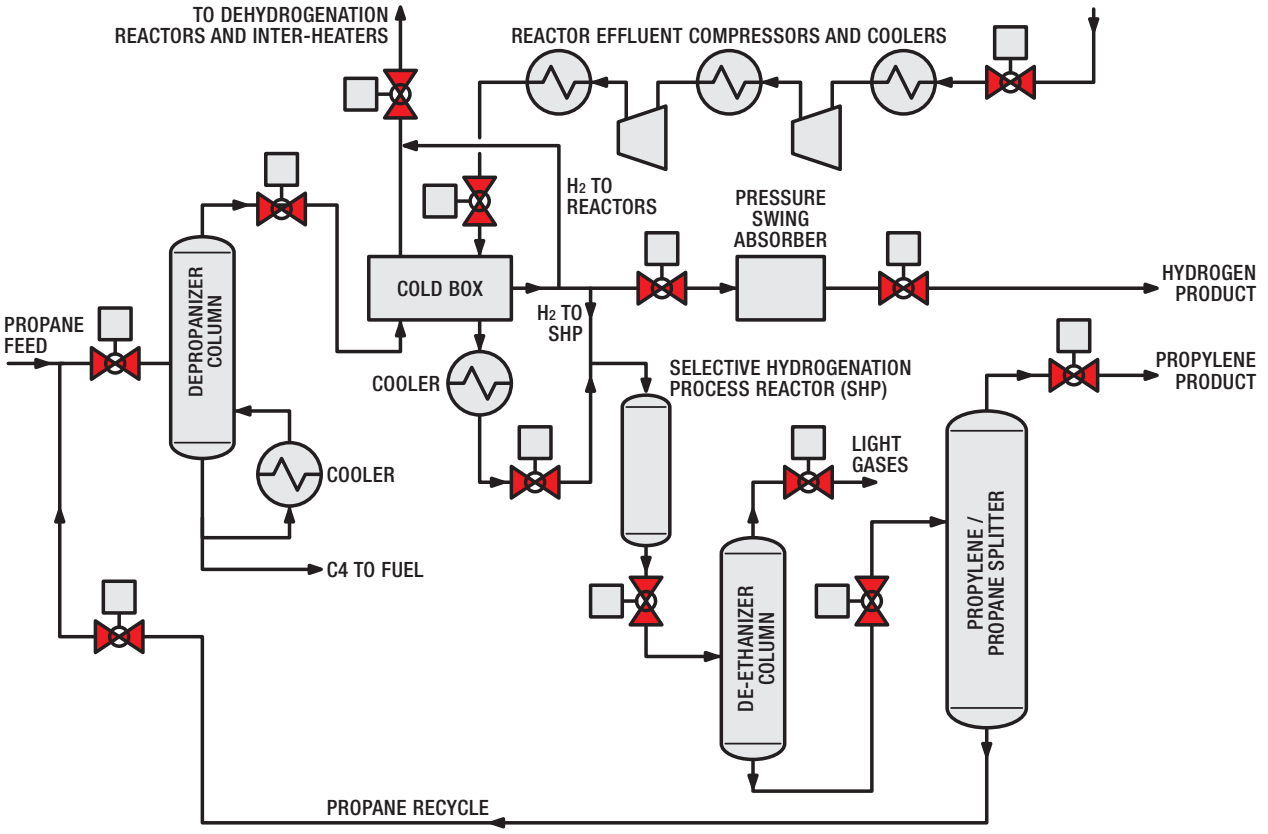
Overview



Process Option A

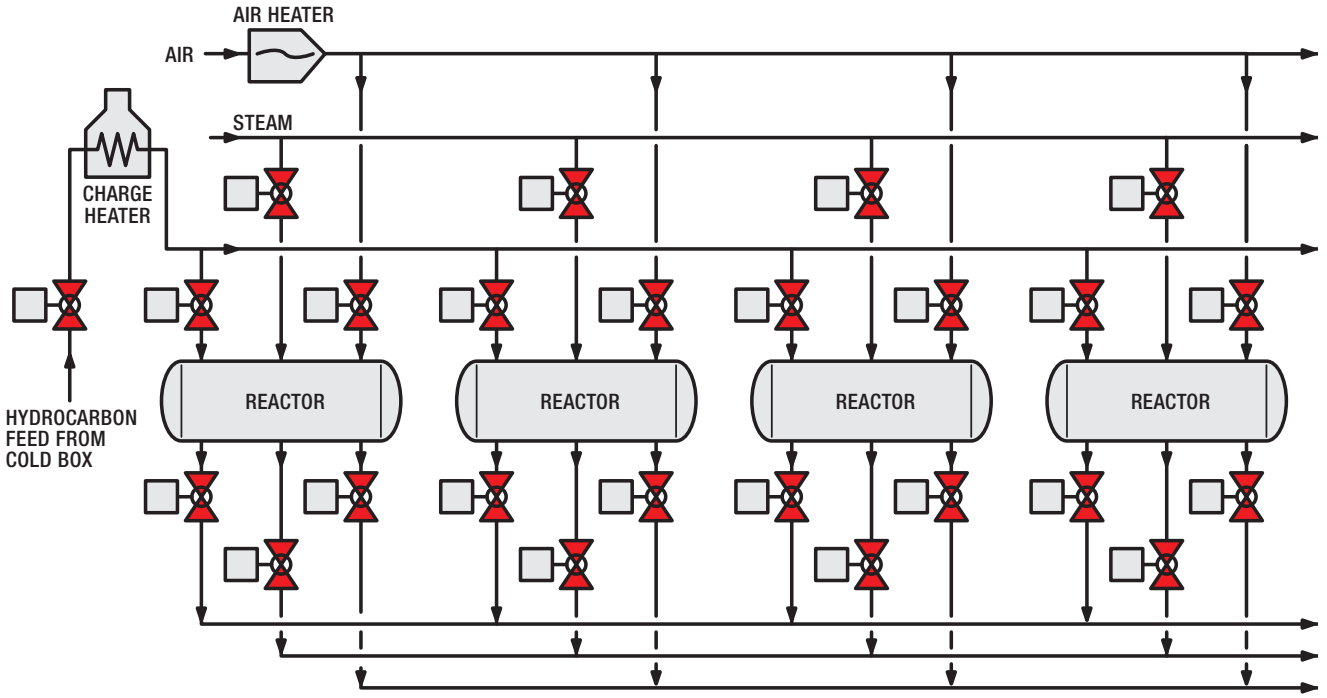
Process Option B





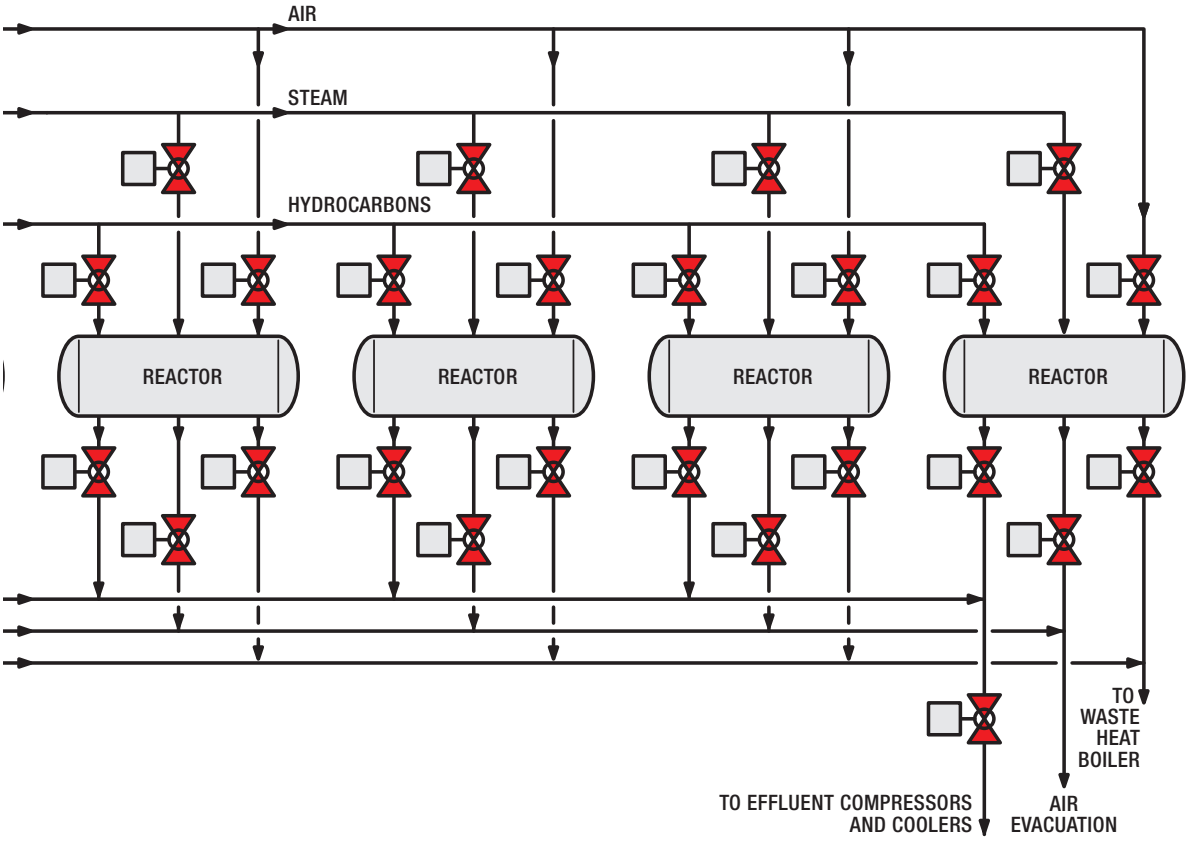
Propane Dehydrogenation (PDH)

Process Option A



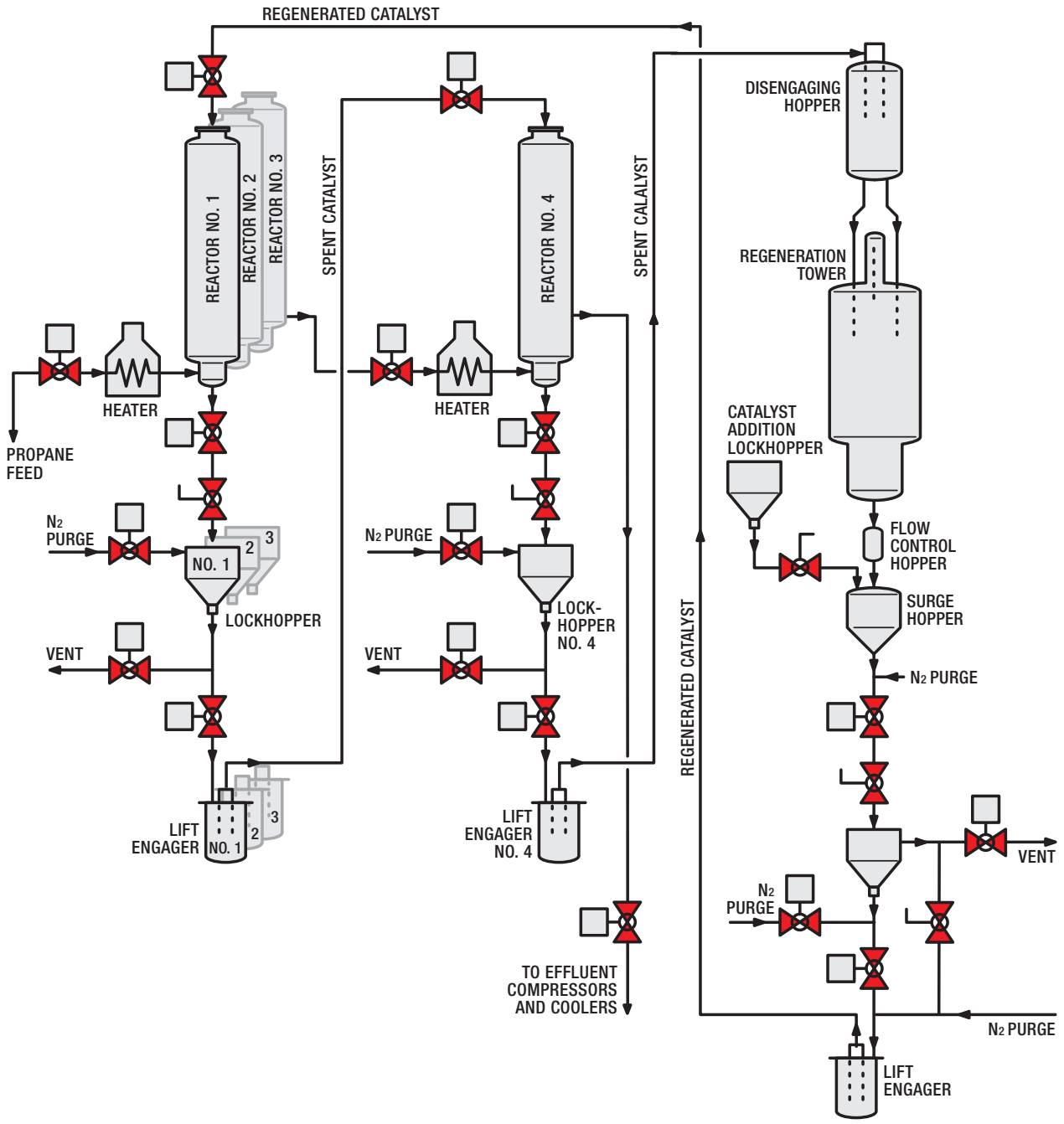
Propane Dehydrogenation (PDH) (cont'd)

Process Option A

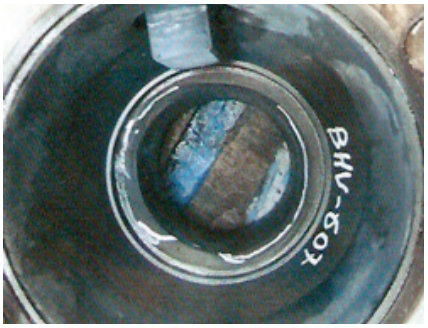


Propane Dehydrogenation (PDH)

Process Option B



Purified Terephthalic Acid (PTA)



After 9 years with no repairs or maintenance, this MOGAS 6-inch ASME 600 Class valve was moved from PTA slurry service to another application, where it is still in service today.

Rely on MOGAS valves for Purified Terephthalic Acid (PTA) process

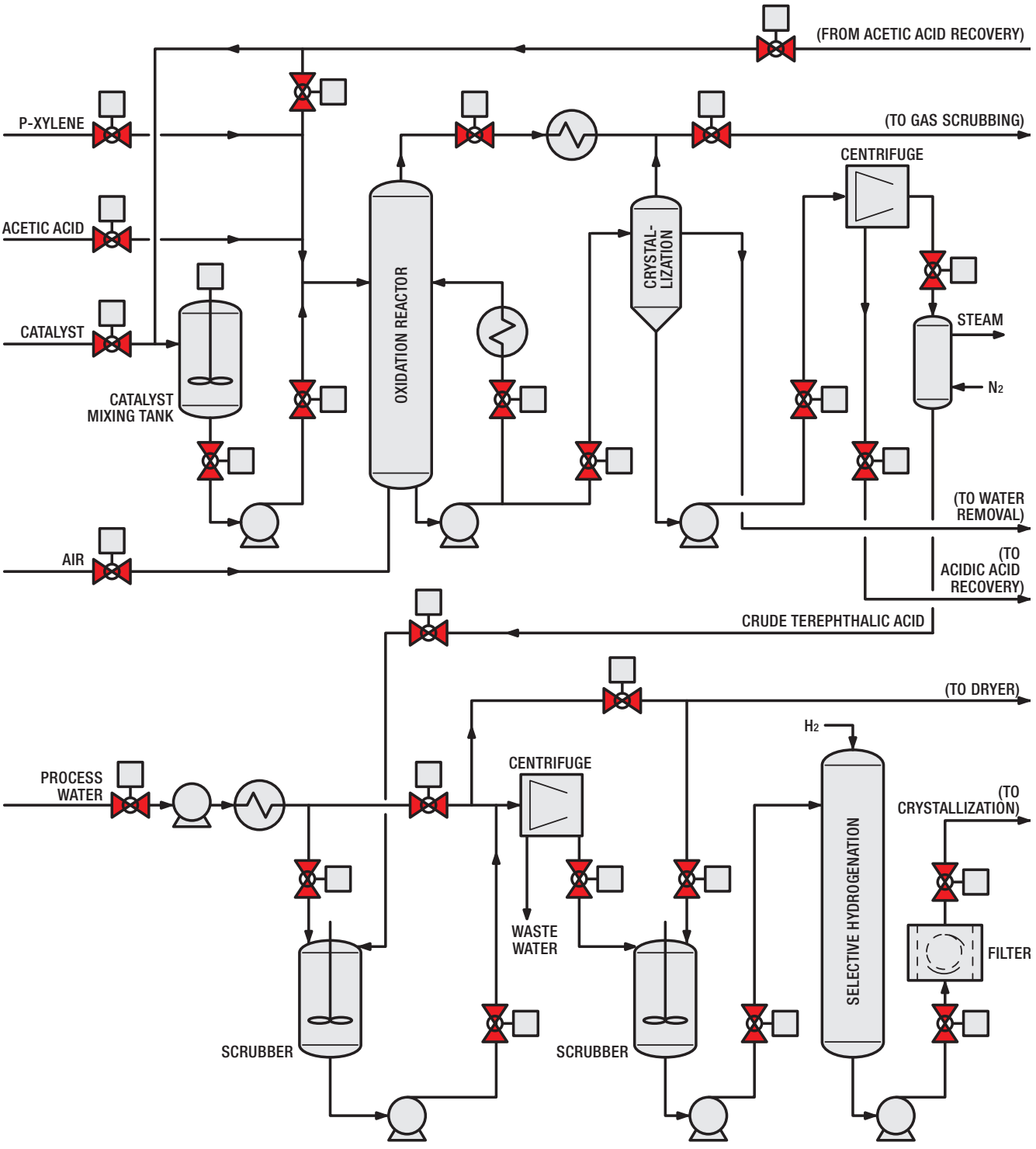
Purified Terephthalic Acid (PTA) is a white crystalline commodity powder and an important organic compound used as a precursor to thermoplastics, like PET (polyethylene terephthalate). Products from PTA include polyurethanes, powder coating resins, polyester fabrics, films, and plastic bottles.

Corrosion, slurries and crystalization are the main valve challenges in PTA production. The raw material of acetic acid and PTA are highly corrosive even after the slurry process. During crystallization, hard polymers stick to metallic surfaces, solidify on the ball and seat and cause erosion at the end flange.

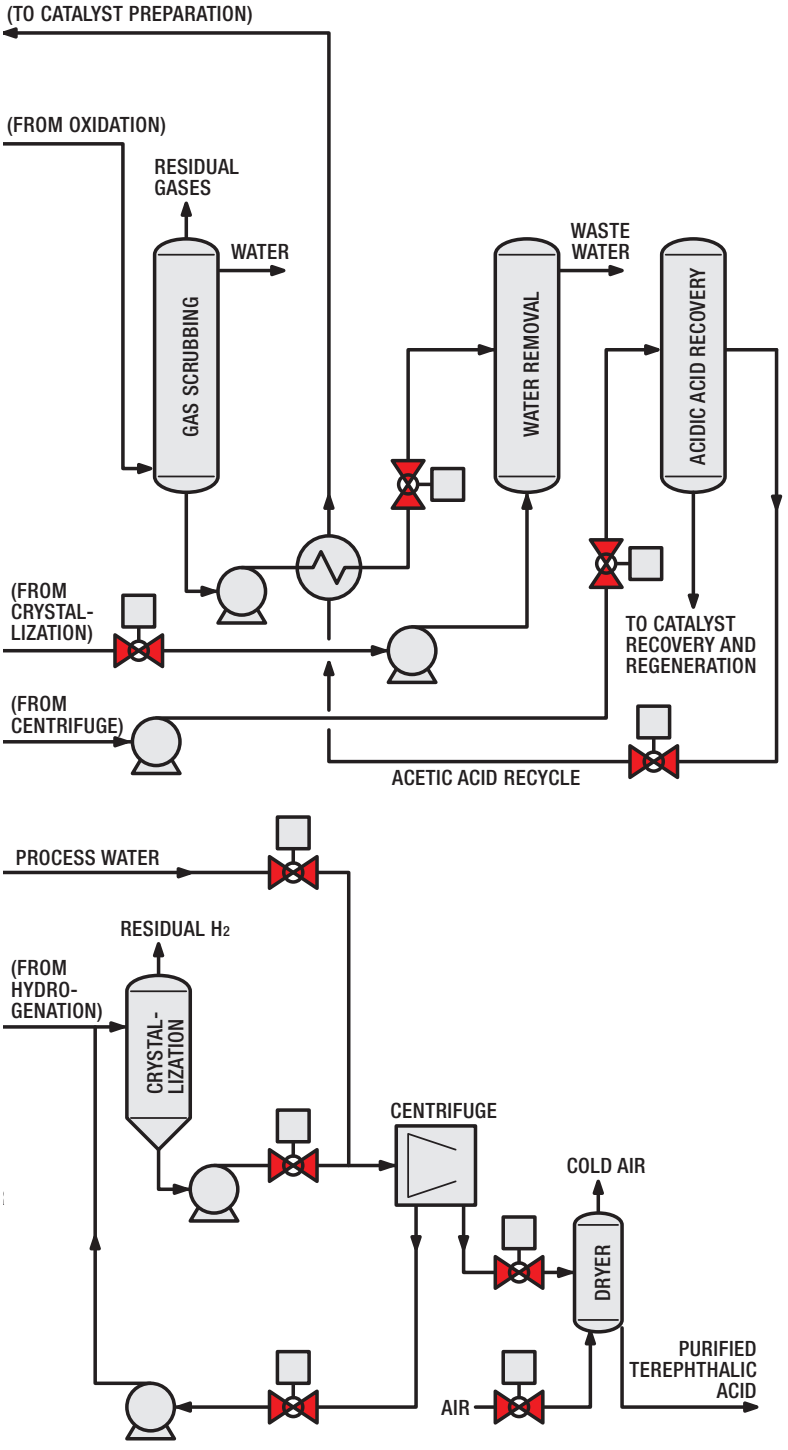
MOGAS valve designs offer:

- sharper leaning edge on seat to scrape ball surface for repeatable tight isolation
- metal seats that wipe sealing surface of ball clean during operation
- greater sealing contact area
- dual-guided stem design and live-loaded packing to prevent stem packing leaks and risk of fugitive emissions
- application-specific coatings that provide enhanced erosion and corrosion resistance

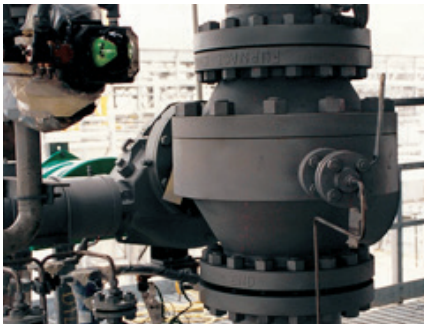
Purified Terephthalic Acid (PTA) (cont'd)



Purified Terephthalic Acid (PTA) (cont'd)



Vinyl Chloride Monomer (VCM)



This 12-inch ASME 300 Class C-Series valve has successfully isolated a VCM furnace at a major German chemical plant for 15 years before it required spare parts.

MOGAS valves are ideal for the hazardous conditions of VCM production

VCM is a colorless gas manufactured using a series of chemical reactions from ethylene dichloride (EDC). (Most EDC plants are integrated with VCM plants.) VCM is flammable at room temperature and will polymerize if exposed to air or other activating substances, so is an explosion hazard. It is a known human carcinogen in situations of overexposure, and can cause frostbite from rapidly evaporating liquid.

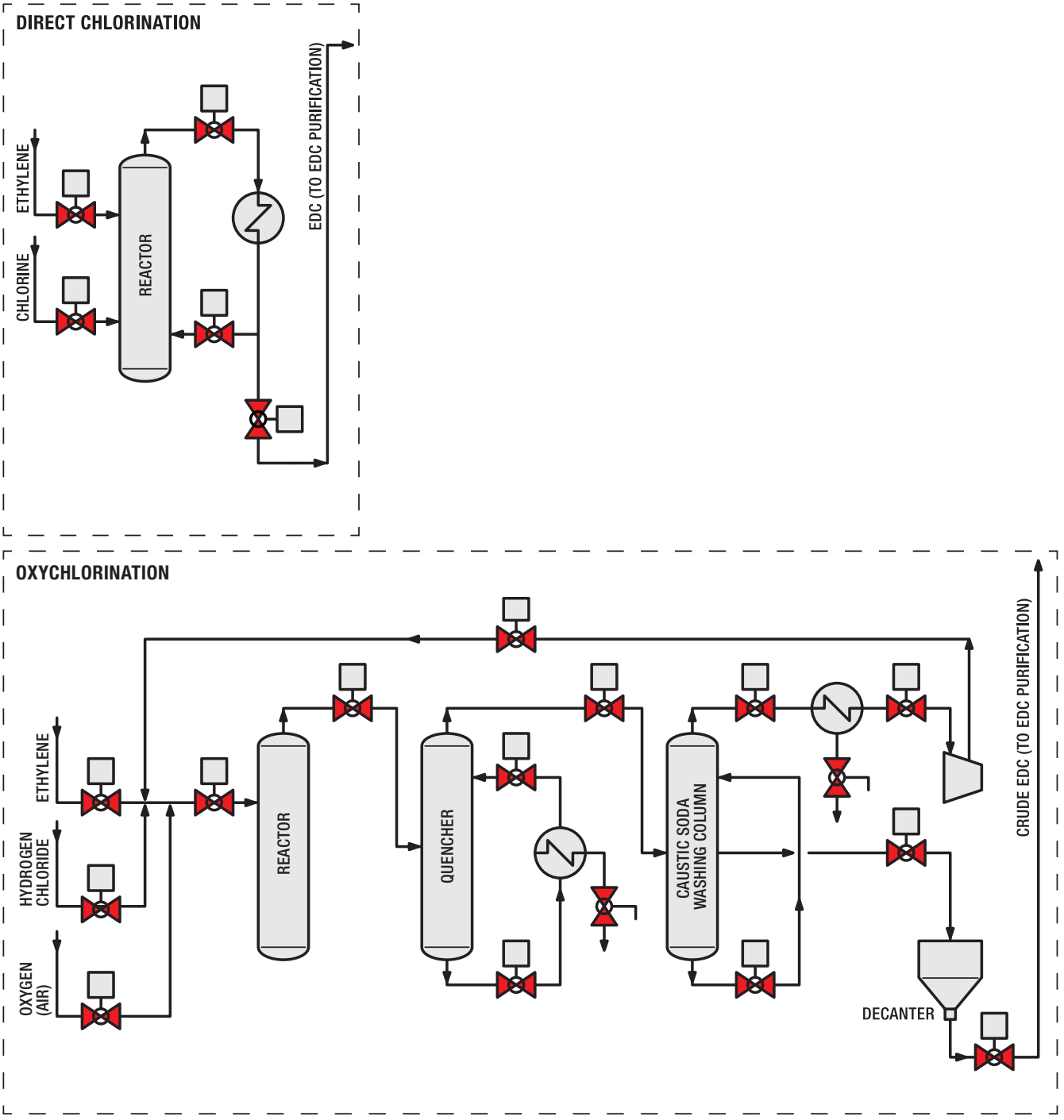
When moisture is present, VCM can corrode iron and steel. Equipment used for VCM storage or processing should be constructed of mild, carbon or stainless steel; not aluminum, copper or copper alloys.

VCM is the building block in the production of polymer polyvinyl chloride (PVC), accounting for almost the entire demand for VCM. PVC products include vinyl siding, magnetic strip cards, window frames, pipes, gloves, rain coats and shower curtains.

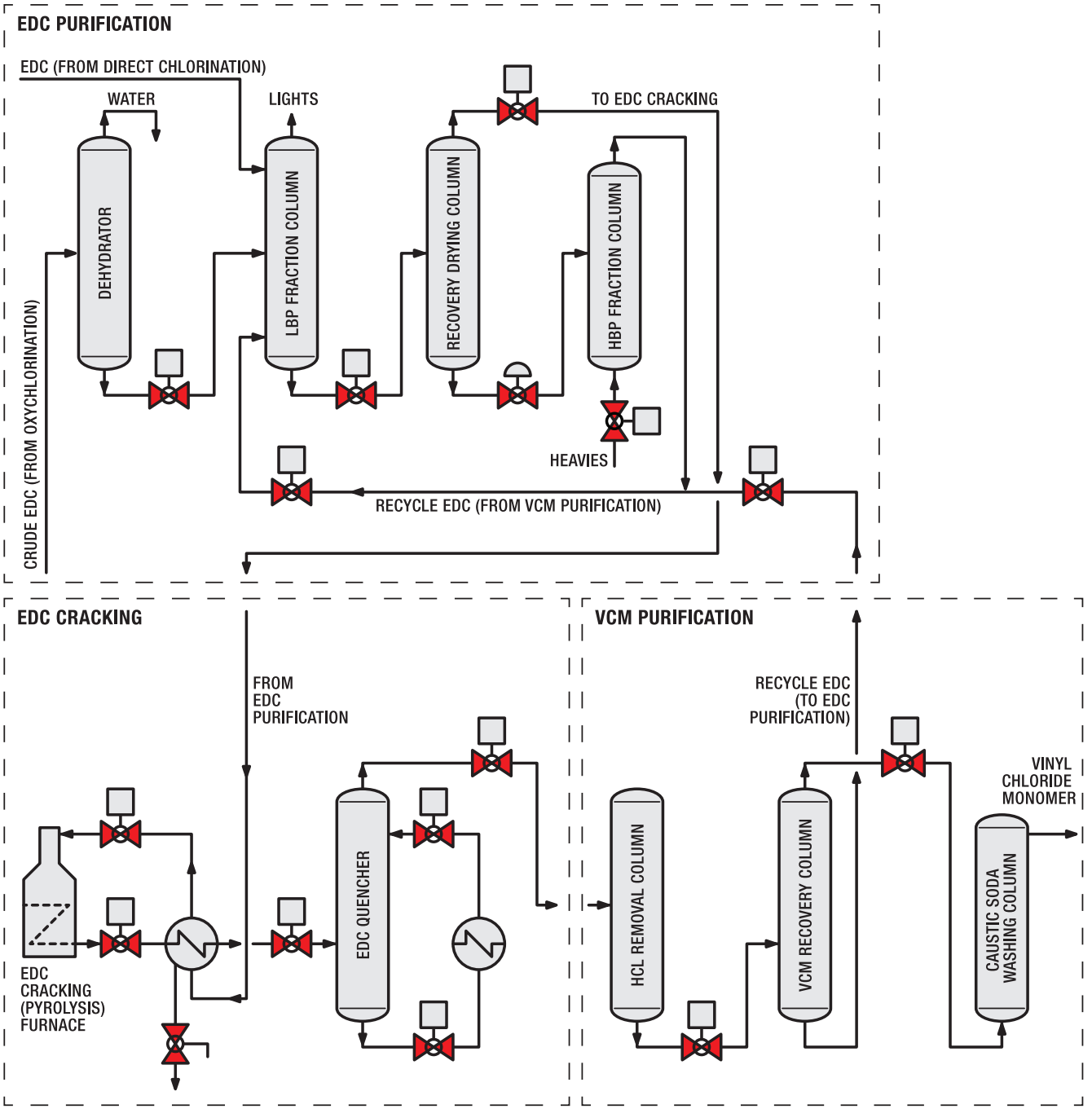
MOGAS valves perform well under the harsh conditions of VCM production. Typical valve sizes are up to 18 inch, ASME 300 Class. Though pressures are moderate (up to 450 psi), temperatures can reach up to 1000° F at the EDC furnace outlet, Features on MOGAS valves include:

- materials of construction specifically designed to be resistant to impact and corrosion
- metal seats with a sharp leading edge to wipe and clean the ball surface of the sticky polymerization reactions
- seat springs that maintain constant contact between ball and seats for pressure-energized sealing
- lapping process on ball and seat set that provides 100% sealing contact through the full transition between the open and closed position
- a wide seat sealing surface that has more contact area, while allowing for thermal expansion of trim
- a larger stem design for additional torque
- a dual-guided stem design that prevents stem packing leaks and risk of fugitive emission

Vinyl Chloride Monomer (VCM) (cont'd)



Vinyl Chloride Monomer (VCM) (cont'd)



Polystyrene

Ethylbenzene

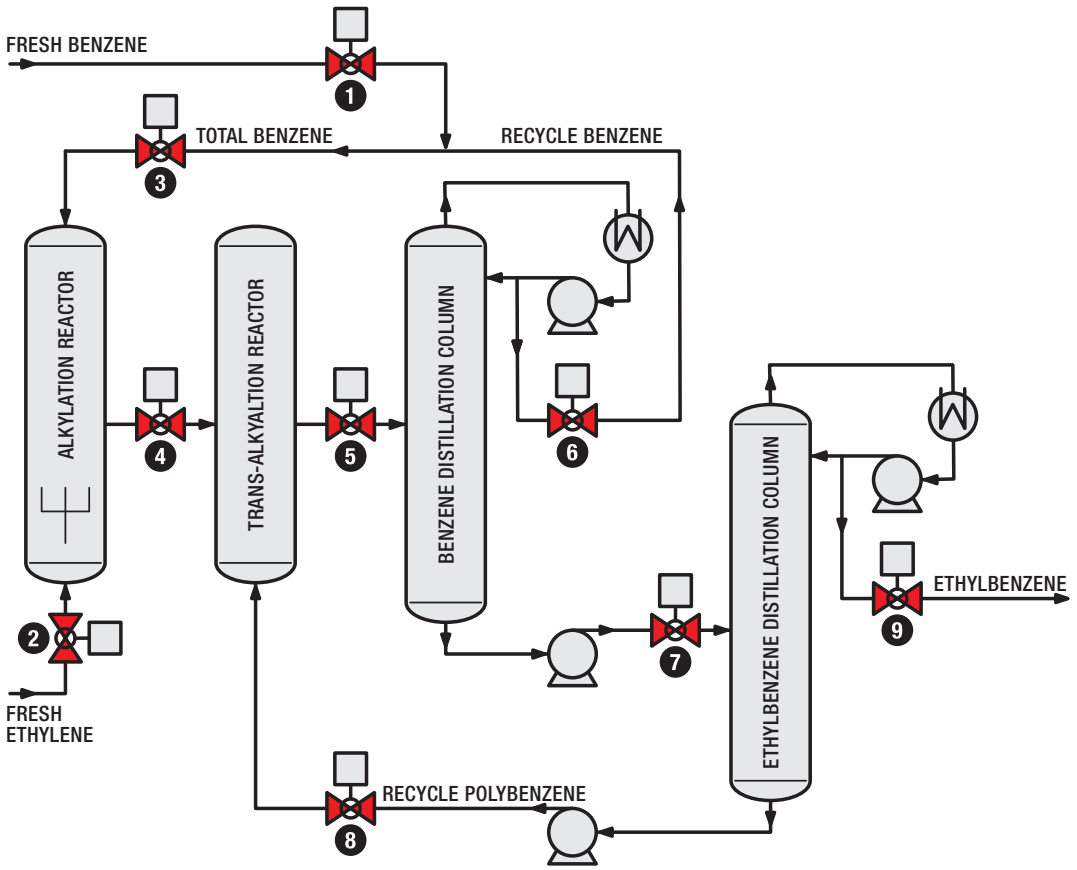
MOGAS valve design is ideal for critical chemical applications of ethylbenzene and styrene production.

Ethylbenzene is a volatile organic compound found in natural products such as coal tar and petroleum. It appears as a clear, colorless liquid with an odor similar to gasoline.

Almost all ethylbenzene is used in the production of styrene. It is also used as a solvent, in fuels and to make other chemicals.

Hazards from ethylbenzene production include:

- Short-term exposure results in respiratory effects, such as throat irritation and chest constriction, irritation of the eyes, and neurological effects such as dizziness. Limited information is available on the long-term carcinogenic effects of ethylbenzene in humans. EPA has classified ethylbenzene as a Group D, not classifiable as to human carcinogenicity.
- Ethylbenzene is a very dangerous fire hazard, and emits acrid smoke and irritating fumes. The vapour mixes well with air, and explosive mixtures are easily formed.



Polystyrene

Styrene

While in dock, this tanker explosion in 2019 was attributed to over 5,000 metric tons of a styrene monomer detonating

Robust, dependable MOGAS valves offer many performance features for the production of polystyrene.

Styrene is an organic compound, and a derivative of benzene and a precursor to polystyrene. It is a colorless oily liquid that evaporates easily and has a sweet smell.

Styrene is widely used to make plastics and rubber, which are used to manufacture a variety of products, such as insulation, pipes, automobile parts, printing cartridges, food containers and carpet backing. Most styrene produced is destined for polystyrene production.

Health hazards producing styrene include irritation of the skin, eyes, and the upper respiratory tract. Acute exposure may also result in gastrointestinal effects. Chronic exposure affects the central nervous system showing symptoms such as depression, headache, fatigue, weakness, and may cause minor effects on kidney function. It is a known carcinogen.

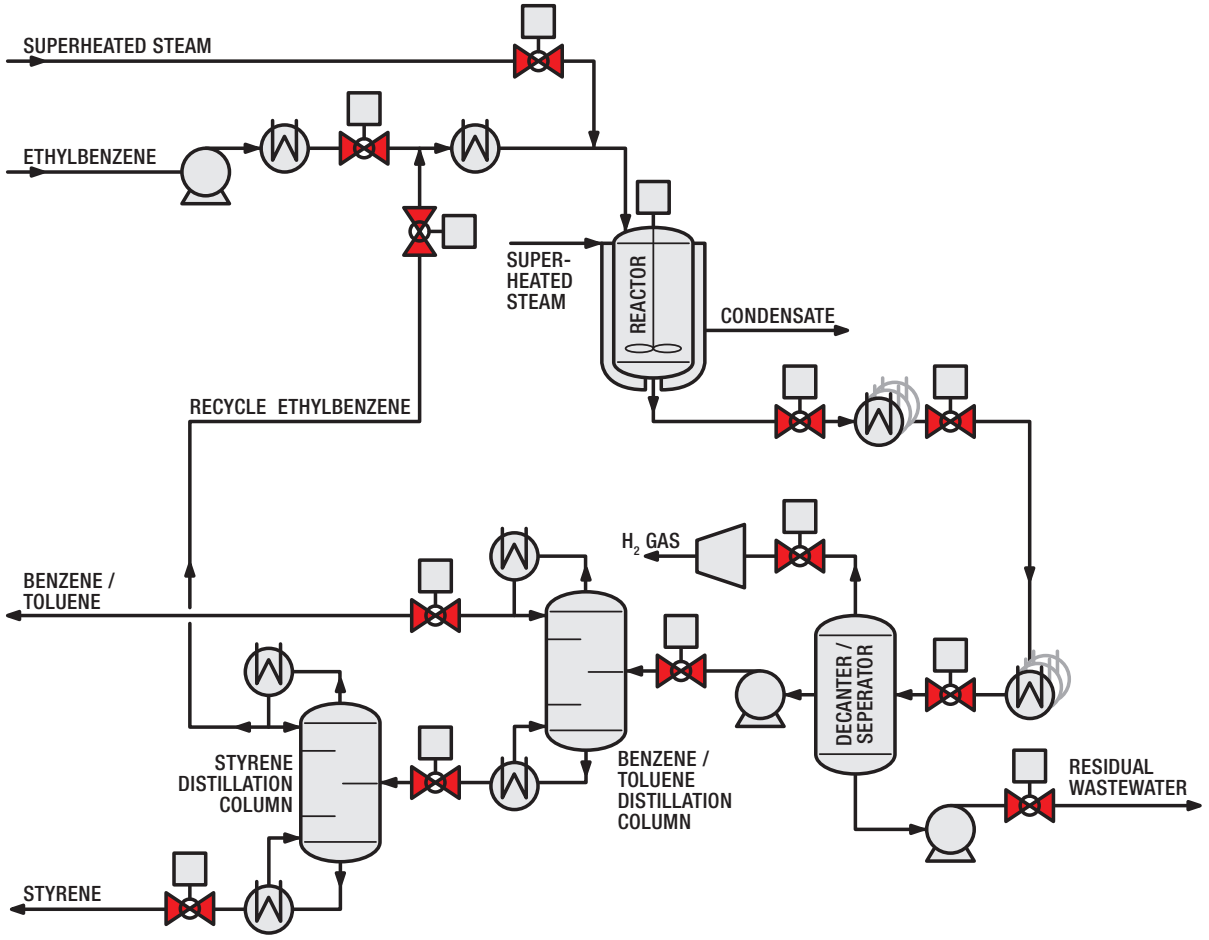
Other hazards include explosion. Auto-polymerization—when styrene polymerizes spontaneously to polystyrene with an external initiator—begins at ambient temperatures. This reaction is exothermic, with a risk of thermal runaway and explosion.

MOGAS' valve design features combat the problems when producing styrene:

- metal seat's sharp leading technology wipes and cleans the ball surface of the sticky media from polymerization reactions
- seat springs maintain constant sealing contact between ball and seats to provide pressure-energized sealing
- lapping process on ball and seat set provides 100% sealing contact through the full transition between the open and closed position
- a wide seat sealing surface means more contact area while allowing for thermal expansion of trim
- larger stem designs handle additional torque requirements
- dual-guided stem design prevents media migration and prevents stem packing leaks and risk of fugitive emissions

Polystyrene (cont'd)

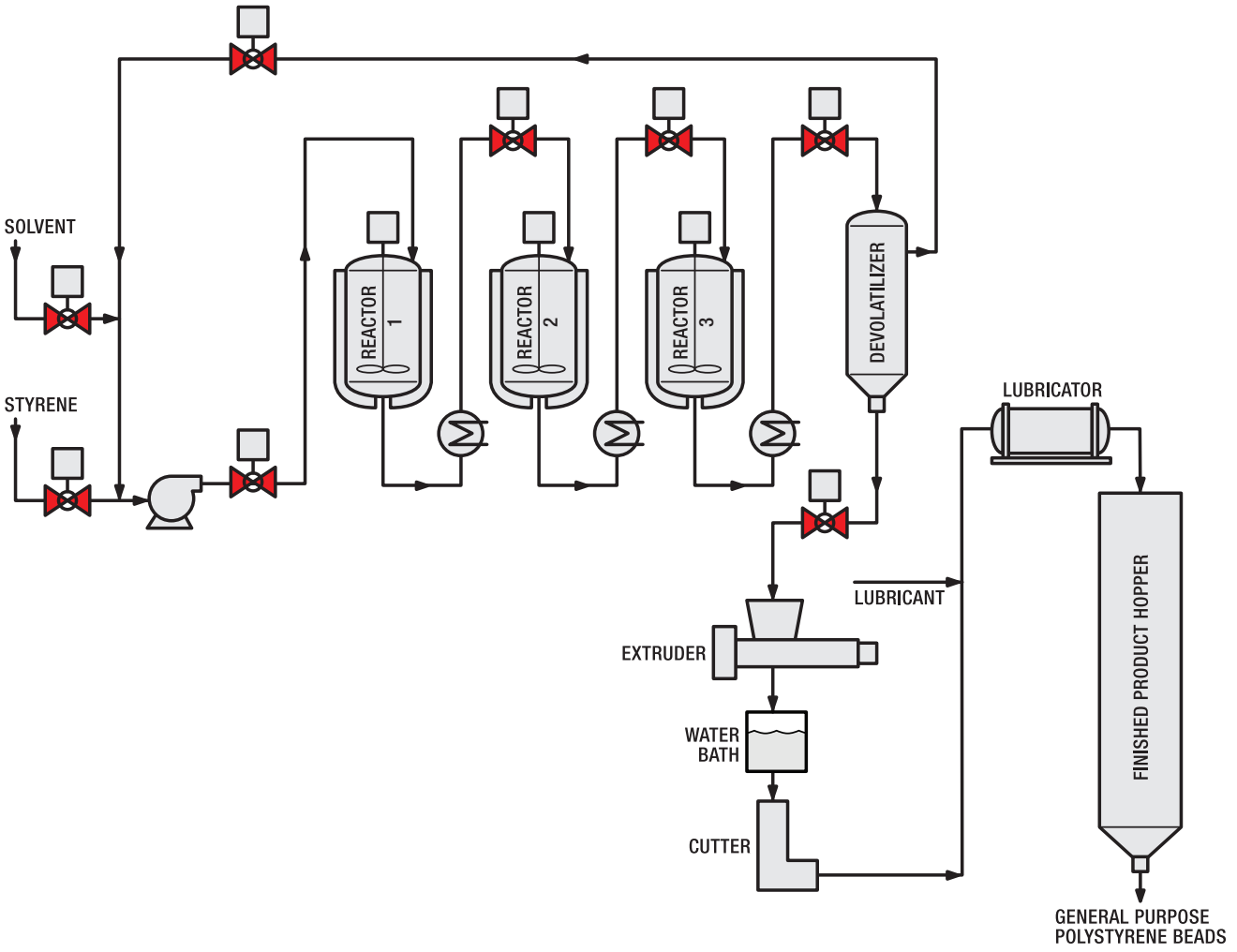
Styrene



Polystyrene

General Purpose (GPPS)

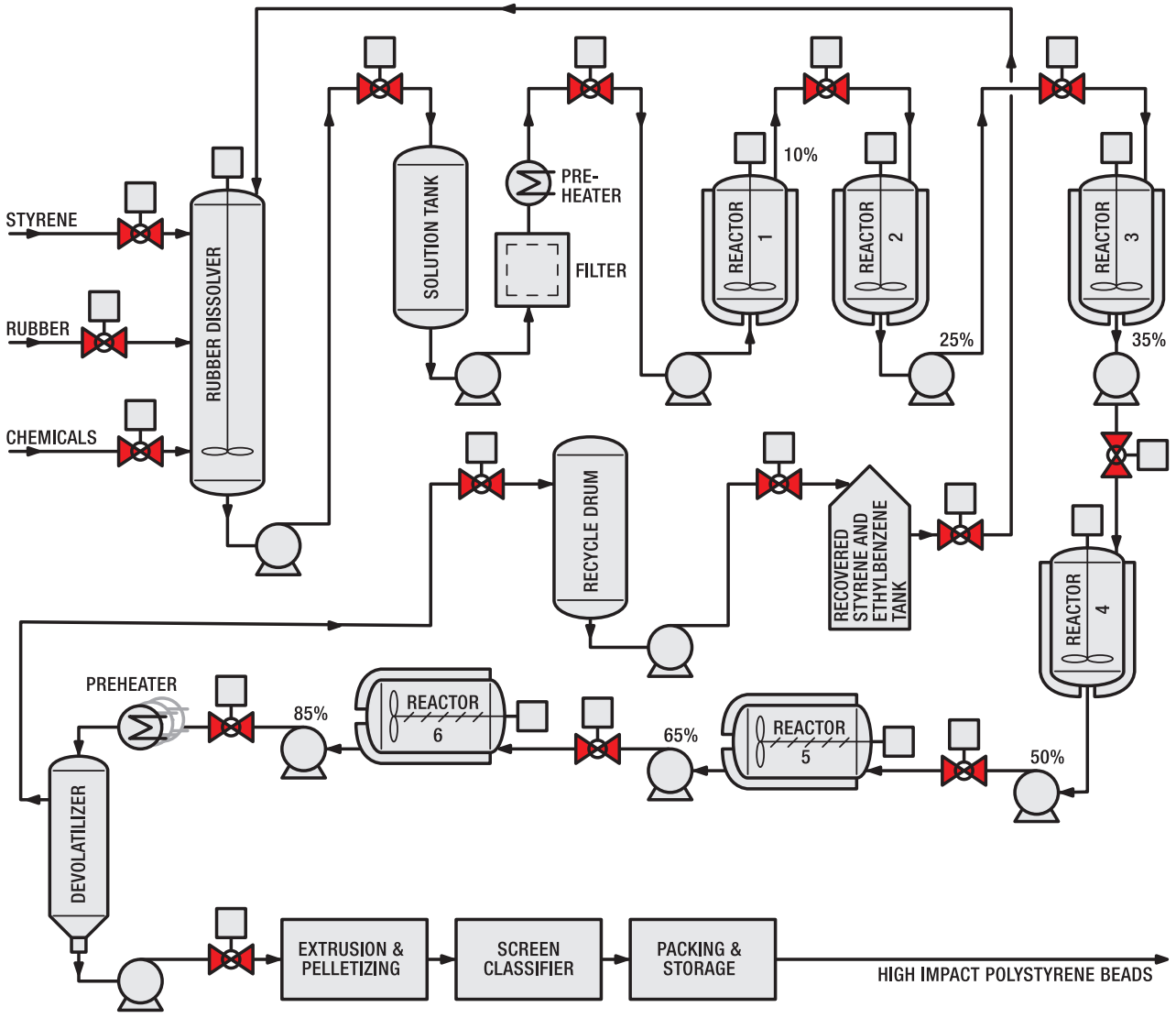
General Purpose Polystyrene (GPPS), also known as crystal-clear polystyrene, is fully transparent and rigid, and is better suited for storage and because of its transparency and its ability to be molded into shapes for packaging. It is widely used in food packaging applications or jewel cases for CDs. It is FDA compliant, low-cost, X-ray resistant, free from odor and taste, and easy to process.



Polystyrene

High Impact Polystyrene Beads (HIPS)

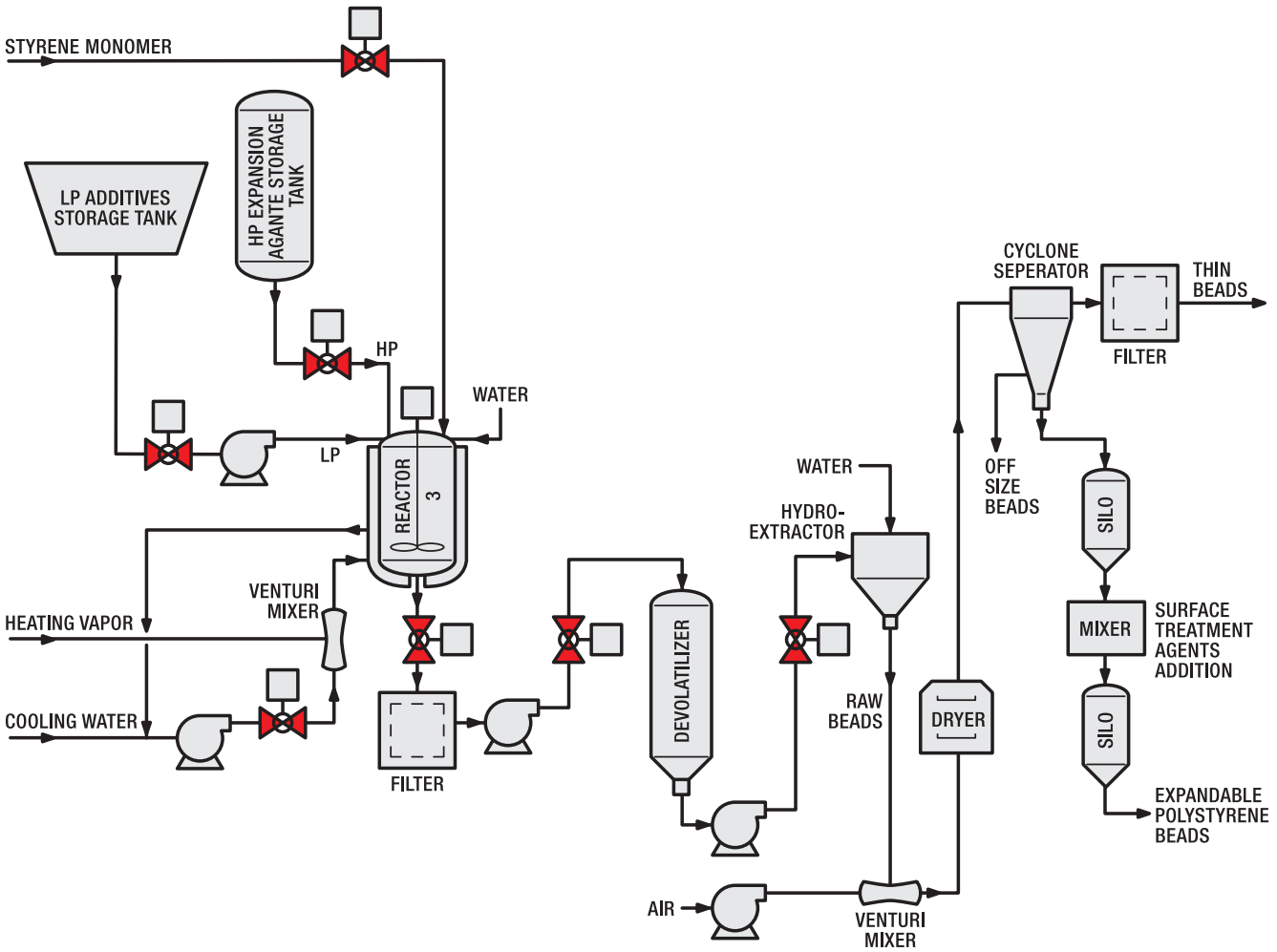
High Impact Polystyrene (HIPS) has a high impact strength, but not naturally clear or transparent. It can be printed on and glued, cut and formed (including thermoform), has good dimensional stability, and fully recyclable. It has economical and easy manufacturability but is more expensive than GPPS. Products from HIPS include: appliance components, toys, automotive panels, drinking cups and computer housings.



Polystyrene

Expandable Polystyrene Beads (EPS)

Expandable Polystyrene (EPS) is not Styrofoam (or extruded polystyrene), but expanded polystyrene. EPS very light weight (98% air), low thermal conductivity and moisture absorption (good for insulation), and excellent cushioning. can be shape-molded or cut into shapes. Applications range from drinking cups to packaging to helmets. EPS is 100% recyclable



Urea

MOGAS CA-1AS valves reliably and safely operate to produce urea from ammonia and carbon dioxide.

Robust, dependable MOGAS valves offer many performance features for the production of polystyrene.

Also known as carbamide, urea is a colorless, odorless, non-toxic solid organic compound that is highly soluble in water.

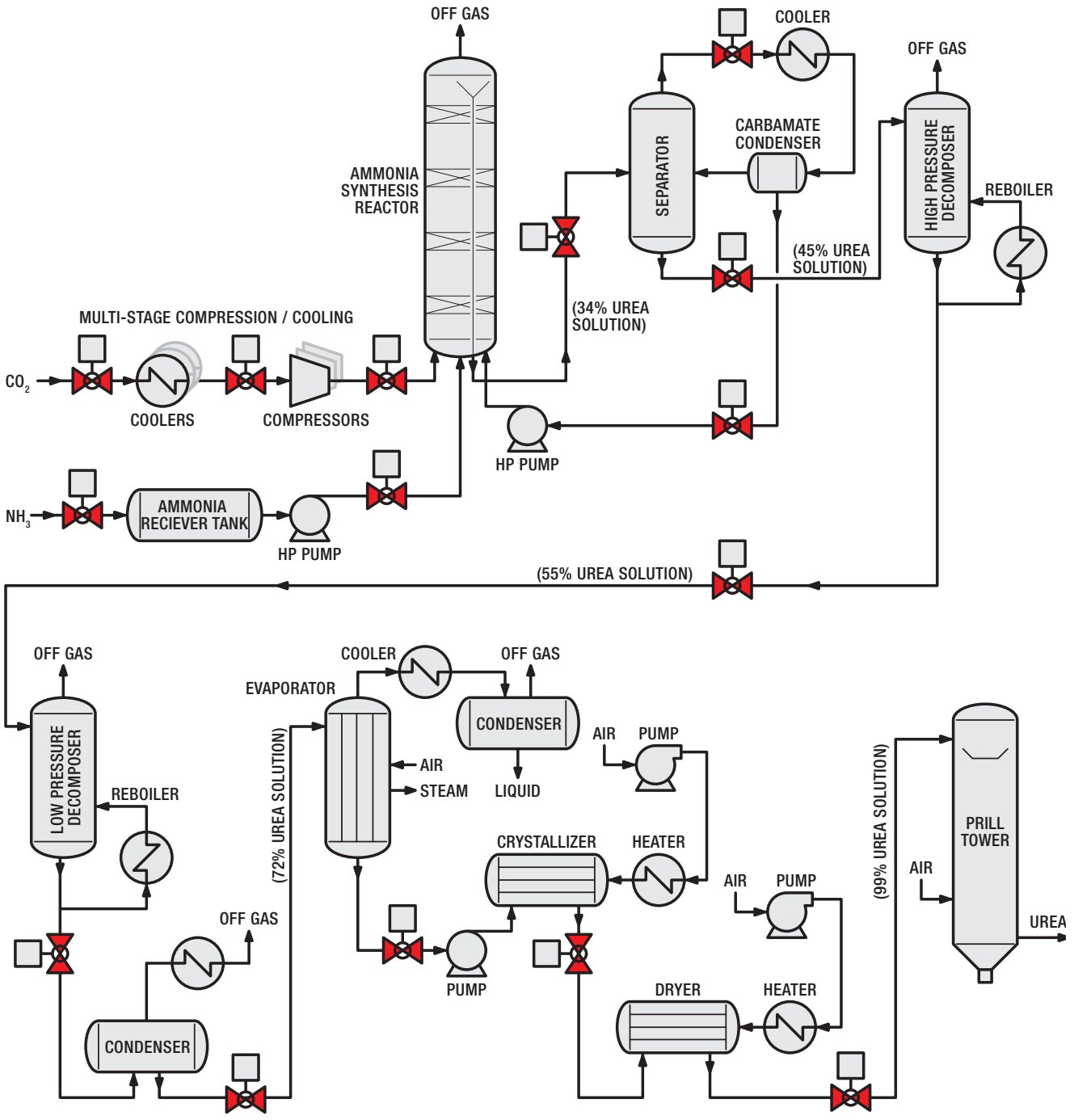
Essentually, it is the waste produced when the body metabolizes protein. In the manufacturing process, urea is produced from ammonia and carbon dioxide, and used for fertilizer-related products, usually in the form of granules, prills or crystals. Since it contains nitrogen, it is an effective feed additive that can aid animal growth.

In manufacturing, as urea is formed it coats metallic parts and needs to scraped or the valve's sealing effectiveness is compromised. Ammonia carbamate is also highly corrosive, and as temperature is increased for higher urea yields, there is potentially a higher risk of corrosion and leakage. Ammonia or ammonium carbamate leakage to atmosphere would cause serious environmental and safety problems.

MOGAS valve designs offer:

- forged body and end connections with greater wall thickness in critical areas
- sharper leaning edge on seat to scrape ball surface for repeatable tight isolation
- metal seats that wipe sealing surface of ball clean during operation
- greater sealing contact area
- dual-guided stem design and live-loaded packing to prevent stem packing leaks and risk of fugitive emissions
- application-specific coatings that provide enhanced erosion and corrosion resistance

Urea (cont'd)



Ammonia

MOGAS Valve Applications

These 10-inch ASME 900 Class ESD valves installed in an ammonia plant have a stroke time of under 3 seconds.

MOGAS valves for ammonia production have design features ideal for extreme high pressures.

Ammonia is a colorless gas that consists of nitrogen and hydrogen (NH3). Because of its low boiling point, as a liquid it must be stored under pressure or at a low temperature.

Industrial ammonia is sold either as ammonia liquor or as pressurized or refrigerated anhydrous liquid ammonia transported in tank cars or cylinders. Household ammonia or ammonium hydroxide is a solution of NH3 in water. Most ammonia is consumed in the manufacturing of fertilizer. It is also a building block for the synthesis of many pharmaceutical products and is used in many commercial cleaning products.

Dangers during the production of ammonia include:

- extreme high operating pressures and high-pressure steam
- rapid skin or eye irritation when exposure to low concentrations of ammonia
- coughing and nose and throat irritation from inhalation
- extreme risk of frostbite if liquefied ammonia is exposed to ambient condition in the presence of personnel

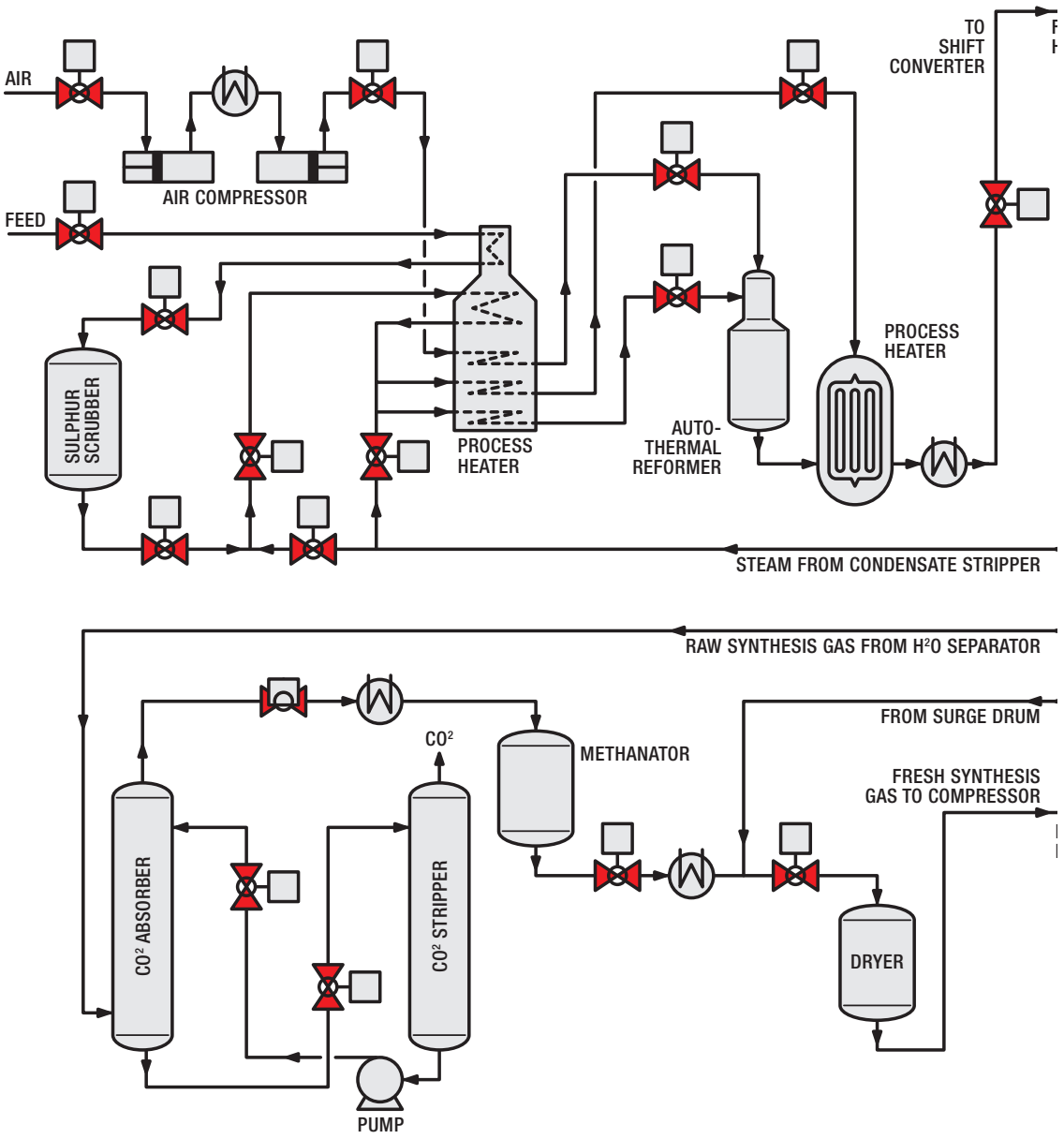
MOGAS valve designs include specific features to protect from the dangers of ammonia production, such as:

- pressure-energized sealing
- a dual guided stem to prevent packing leaks and risk of fugitive emissions
- application-specific materials to combat severe service conditions

Multiple MOGAS product lines are applicable at varying price points.

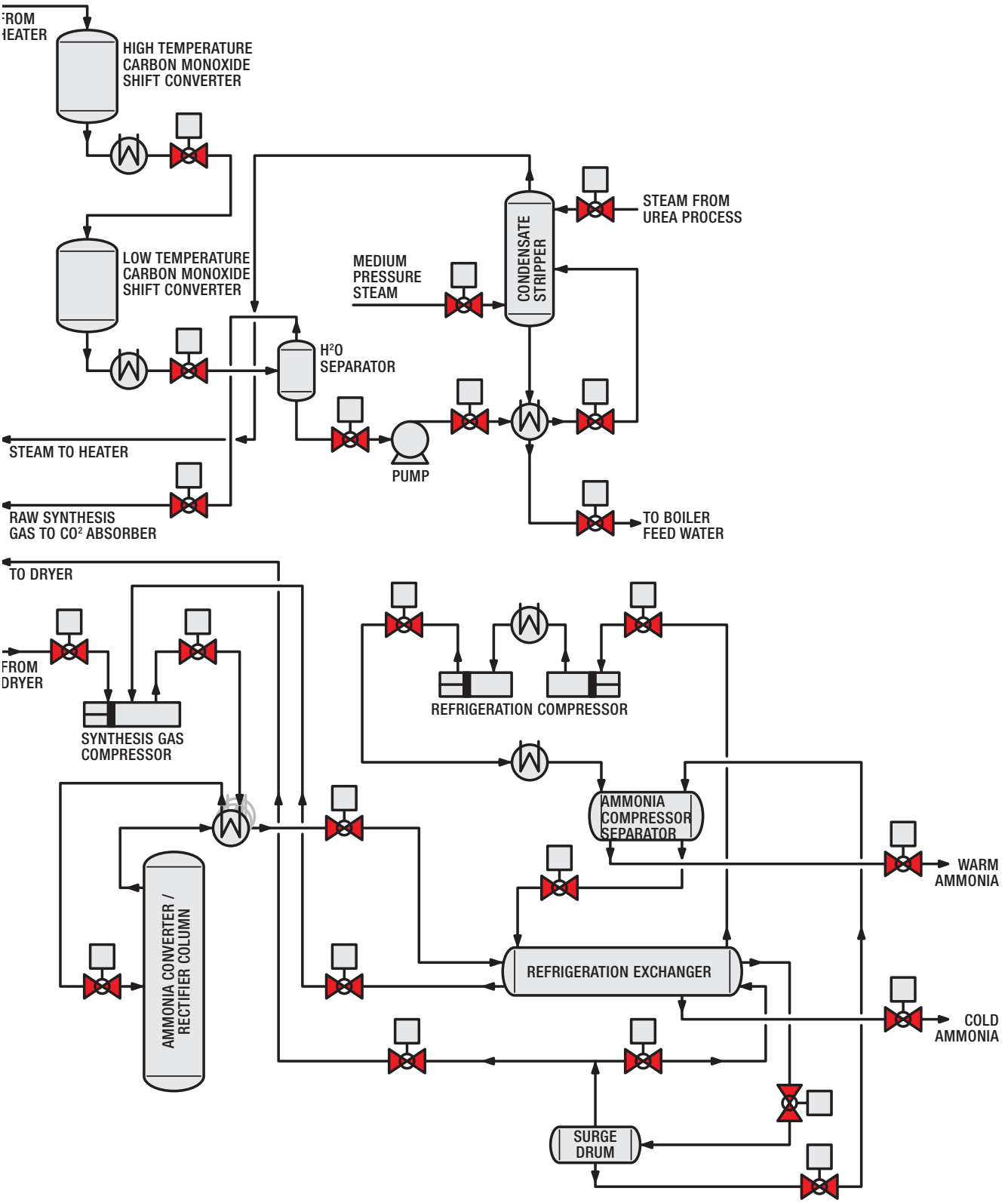
Ammonia (cont'd)

MOGAS Valve Applications



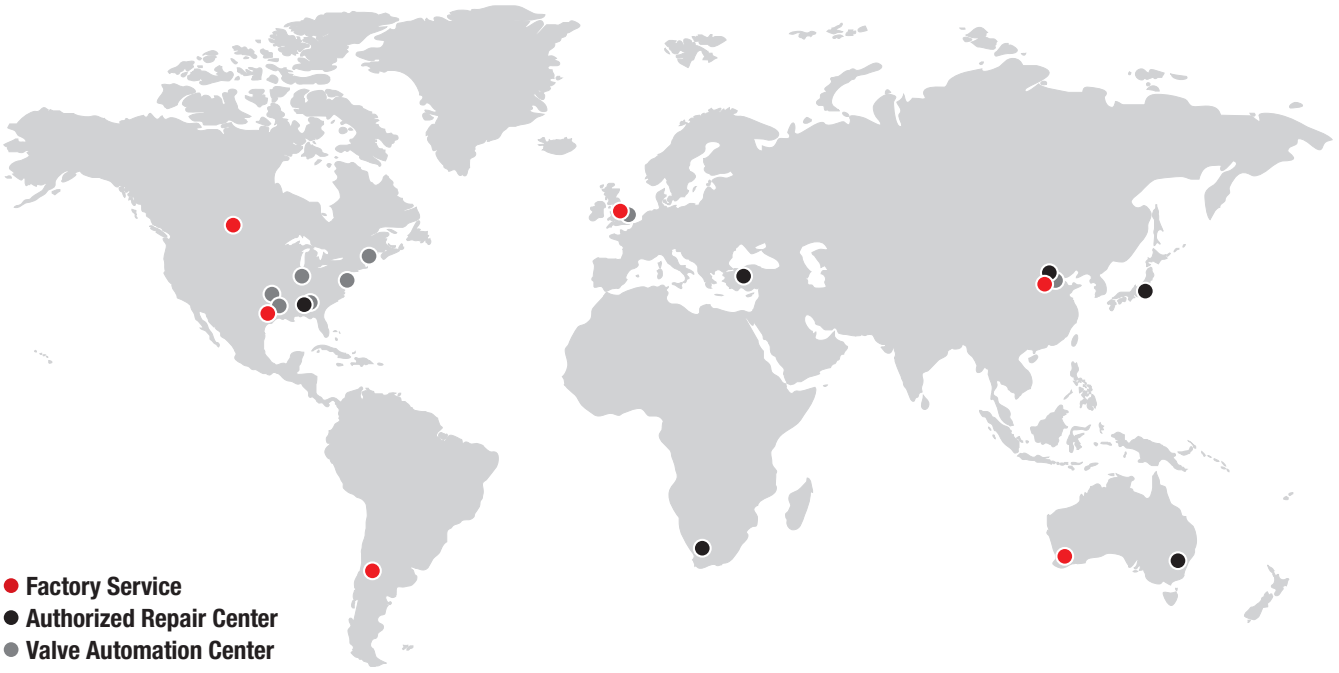
Ammonia (cont'd)

MOGAS Valve Applications



Service

Global Capabilities



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

MOGAS valves are designed to be repaired in situ. Balls, seats and springs are easily replaced; no measurements or preloading are required.

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

Continuous years of research and development, design innovation, advanced manufacturing techniques and field experience allow us to offer an application-specific PERFORMANCE GUARANTEE on our isolation and control valves…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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For other MOGAS locations or a distributor in your area, visit us online at www.mogas.com