Diaphragm Compressors
Designed and Constructed for High Reliability and Low Maintenance

Certification No. 1112232.01

We perform under pressure.
Providing World-Class Diaphragm Compressors

PDC Machines is an ISO 9001:2008 certified company that provides engineered solutions for specialty gas and chemical processing equipment worldwide. Our state-of-the-art products are the preferred choice of industrial gas and renewable energy companies. We work closely with our clients to design, fabricate, test and install custom-made products from diaphragm compressors to alternative energy equipment, pilot plants, reactors, stirrers, syringe pumps and more.

Established in 1977, PDC Machines is a second generation family owned and operated business that is rooted in innovation, business discipline, fair pricing and a deep commitment to our employees, clients and the communities we serve.

Customer Oriented Philosophy

PDC Machines owes much of its success to repeat business based on building long-term relationships and complete customer satisfaction. We value our clients and demonstrate this in the way we work with them. We have earned a reputation for delivering the highest quality product quickly at the lowest cost possible. This is accomplished through a unique combination of:

- **Multi-disciplined engineering staff** – With mechanical, electrical and chemical engineering expertise using the latest customized computer software packages to increase our engineering efficiency.

- **Leading edge technologies** – The latest innovations in hardware, instrumentation, controls and automation software.

- **Stringent quality control procedures** – To insure our products exceed our customer’s expectations. PDC Machines adheres to a strict Quality Assurance/Quality Control program at each stage of the manufacturing process. We deliver exceptional and high value products in terms of safety, reliability and quality in accordance to international standards.

- **A modern manufacturing facility** – That is streamlined and efficient to machine components precisely and to keep manufacturing costs down. Fourteen computerized, numerically controlled machining centers easily perform the most complicated machining operations. Computer-aided manufacturing optimizes tool selection, cutting paths, and loading/unloading of programs into the machining centers.

- **Responsive technical and field support** PDC Machines’ staff is available to ensure its customers receive prompt technical and field support as needed. We maintain the largest spare part inventory in the industry to provide immediate delivery reducing down time.
Serving Many Industries

PDC Machines’ compressors are used in virtually every industry where non-contamination compression of gases is required. Our compressors can handle industrial, rare, pyrophoric, toxic and corrosive gases and gas mixtures. Some specific uses include but not limited to:

Trans-fill Applications
- Filling and off-loading gases from tube trailers
- Filling gas cylinders and bulk storage tanks

Industrial and Other Applications
- Diving: helium
- Automotive: Air bag filling
- Power generation: hydrogen for power plant turbine cooling
- On site gas generation: Pressure boosting and storage of industrial gases

Semi-conductor, Electronics & Fiber Manufacturing
- Ammonia, argon, carbon tetrafluoride, hydrogen, oxygen, phosphine, helium, fluoride, germane, nitrogen trifluoride, silane, xenon and other rare and specialty gases for semi-conductors, photovoltaics, LCD, LED solid state lighting, wafers and polysilicon

Pulp & Paper Manufacturing
- Oxygen for delignification, bleaching and ozone production

Chemical, Petrochemical and Pharmaceutical Applications
- Pressure boosting blending, recycling and mixing of feed stock gases for producing synthesis, intermediates, polymers and fine & specialty chemical products
- Hydrogen for hydrogenation, hydrotreating, catalyst regeneration
- Nitrogen for inerting, purging, blanketing and process cooling
- Carbon monoxide for hydroformylation and carboylation
- Protection of products from moisture and oxidation during manufacturing
- Oxygen for combustion and oxidation

Glass Manufacturing
- Industrial gases for forming and processing
- Argon for filling light bulbs and with Krypton for double glazing enclosures
- Hydrogen and nitrogen for float/flat glass

Metals Processing
- Mixtures of argon, nitrogen and oxygen for cutting, welding and heat treatment of metals
- Helium for thermal spraying

Agriculture, Food and Beverages
- Carbon dioxide and or nitrogen for disinfestation, protection and carbonation
- Nitrogen, argon and carbon dioxide mixtures for Inerting and deoxygenation of beverages
PDC Machines’ Role in the Evolution of Alternative Fuel, Fuel Cell Applications and Renewable Energy

PDC Machines’ has long been a proponent of hydrogen as an energy carrier. Over the years we have partnered with the most prominent gas producers, technology and research companies to create practical and commercial worldwide acceptance of this concept.

The success of these partnerships is demonstrated with over 180 compressors currently in use in high profile demonstration and commercial installations worldwide for hydrogen refueling of vehicles, buses, material handling equipment and experimental aircraft.

PDC Machines’ continues to pursue the goal of cost effective solutions to deliver high pressure hydrogen. We are proud to be taking an active role as a component supplier, promoting the growth of commercial hydrogen refueling stations.

Vehicle, bus and material handling fueling

PDC Machines specializes in providing complete hydrogen compression solutions for the world’s most demanding hydrogen energy installation whether it is stationary, 350 and 700 barg fuel cell vehicle, bus or material handling. We offer an extensive line of standard compressors along with turn-key engineered and designed compression systems to meet an array of applications ranging from single demo sites to full-scale production stations.

Vehicle Fueling

A wide variety of models are available that can meet discharge pressures ranging from 3,500 to 15,000 psig, (241 barg to 1034 barg) and flow rates ranging from 7.5 kg/hr to 277 kg/hr (1 to 56 Nm³/hr) that can be integrated into infrastructures for fueling hydrogen fuel cell powered vehicles.

Bus Fueling

PDC Machines’ compressors can deliver 172 kg/hr (2113 Nm³/hr) of hydrogen at a discharge pressure of 6000 psig (413 barg) and fill a bus in less than 10 minutes.

Material Handling

PDC Machines’ compressors have been integrated into the fueling infrastructure for fuel cell power packs which are direct replacements for the industrial batteries used in fork lifts and other material handling vehicles. Models are available to boost pressures to 7,000 psig (482 barg) and beyond and flow rates from 5 kg/hr (50 Nm³/hr).
Residential, Power Generation and Telecommunications

PDC Machines has developed a single stage model, which can take 145 psi (10 bar) suction to 6,500 psig (448 barg) discharge with a flow rate of 1 Nm³/hr, with power consumption of less than 1.5 kW. Customers incorporate this compressor in their portable cabinets along with their electrolyzers, reformers, cylinders, storage, fuel cells and electrical gears as a complete power producer.

Converting Wind or Solar Power to Hydrogen Power

The hydrogen produced from wind power and or solar power can be compressed and stored for later use, either in a stationary fuel cell to produce electricity when there is no wind or sunlight.

Compressing and Recycling Process Gases from Renewable Sources

As the world pursues a greener environment, the trend is to develop and promote clean renewable energy. PDC Machines has partnered with firms active in this field by providing diaphragm compressors for delivering feedstock gases such as syngas for production and reformation.

Equipment Packaging

With over 30 years of experience in high-pressure hydrogen compression system integration and process knowledge, we are the preferred source for component and systems packaging for hydrogen fueling applications.
Benefits of PDC Machines’ Diaphragm Compressors

**High Product Purity**
Triple diaphragms isolate hydraulic oil from process gas. The quality of gas entering and exiting the compressor are the same.

- PDC Machines uses static seals and there is no migration of process gas to the crankcase. The crankcase does not require purging or venting.

**High Reliability and Uptime with Low Maintenance and Worry-free Operation**
Due to superior diaphragm life, some customers experience 10,000 to 40,000 hours of continuous operation.

- Our unique oil distribution system is designed to prevent knocks, vibration, and cavitation; and yield smooth, quiet compressor operation.

**High Efficiency, Lower Energy Use and Lower Capital Costs**

- Duplex and two-stage diaphragm compressors are horizontally opposed designs for optimal power consumption.

- Duplex and two-stage designs are available to accommodate a wide range of pressures and flows in one or two stages instead of multiple stages.

- Duplex and two-stage designs handle high inlet pressures without the need for regulators, saving energy and optimizing costs.

**Quiet Operation**
- Noise levels below 85dBA at one meter and eliminate the need to provide sound proofing enclosures.

**Shortest Delivery in the Industry**

- Critical components are manufactured at PDC Machines, assuring the highest levels of quality control. In house manufacturing allows us the flexibility to accommodate tight delivery schedules.

- Popular models can be delivered in as few as 2 to 6 weeks.

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**Pumping silane gas for producing silicon.**
Voltaix, USA

**Pumping oxygen.**
Grupo Infra, Mexico

**Recycle compressor for gas-to-liquids project.**
ORYX GTL, via DOPET, Qatar
Experience, Reliability & Service

PDC Machines is committed to continuous product improvement and the development of innovative designs and manufacturing processes to maximize compressor performance and value.

Our goal is to minimize down time, spare parts, and maintenance costs for our customers. We are committed to extensive R&D to develop new techniques to further reduce diaphragm stresses and extend fatigue life through advances in engineering design and manufacturing processes. Increasing diaphragm life reduces down-time and the cost of spares.

Drawing on decades of experience and the use of our proprietary software for sizing, finite element stress analysis, and the latest software to provide detailed engineering drawings, PDC Machines provides high reliability and low maintenance diaphragm compressors.

Our compressors also include an automatic unloading system to re-prime the compressor at start up. Manual start-up requires an experienced compressor technician to be present all the time to re-prime the compressor. Incorrect priming will cavitate the compressor and damage the heads, bolts, diaphragms, o-rings, process and hydraulic system.

After assembly, every compressor is subjected to rigorous in-house testing and is made available for customer inspection, factory acceptance testing and hands on training.

PDC Machines sets the industry standard for customer after-market support whenever and where ever it is needed. We have established a worldwide network of service centers to ensure our customers receive prompt support. PDC Machines’ engineers are available at any time to answer technical questions to support our installations. We maintain the largest spare part inventory in the industry to provide immediate delivery, typically shipping within 24 to 48 hours on emergency cases.
Emergency compressor for re-cycling hydrogen.
Naftna Industrija Srbije, Serbia via Heurtey Petrochem, France

Pumping Helium gas.
Japan Helium Center, Japan

700 bar hydrogen refueling station.
Korean Automobile Testing & Research Institute (KATRI), Korea

Codes and Standards

*PDC Machines designs our compressors to comply with a wide range of domestic and international standards:*  
- American National Standards Institute, ANSI  
- American Society of Mechanical Engineers, ASME  
- American Welding Society, AWS  
- Canadian Standards Association, CSA  
- Canadian Registration Numbers, CRN  
- CE marked, European Union  
  - ATEX Directive  
  - Pressure Equipment Directive (PED)  
- Chinese, SQL  
- The High Pressure Gas Safety Institute of Japan, KHK  
- Korean Gas Safety, KGS  
- Korean Occupational Safety and Health Agency (KOSHA)  
- National Electric Code, NEC  
- National Fire Protection Association, NFPA  
- Occupational Safety & Health Administration, OSHA  
- Underwriters Laboratories, UL, cUL  
- Russian certificate of conformity, GOST-R
A Wide Range of Compressor Solutions

PDC Machines provides standard and custom-designed diaphragm compressors with a comprehensive assortment of options. We can provide single push button controls or sophisticated PLC controlled compression systems to meet any applications.

Discharge pressures range from 50 psi to 60,000 psi (3.4 bar to 4137 bar), power consumption from 1 hp to 200 hp (0.75 Kw to 150 Kw) and flow rates based on compression ratio to over 3000 Nm³/hr.

<table>
<thead>
<tr>
<th>Model Series</th>
<th>Suction Pressure PSIG (BARG)</th>
<th>Outlet Pressure PSIG (BARG) General Industry</th>
<th>Outlet Pressure PSIG (BARG) Cylinder Filling</th>
<th>Outlet Pressure PSIG (BARG) Hydrogen Energy</th>
<th>Capacity Max SCFM [Nm³/hr]</th>
<th>Horsepower (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDC-1</td>
<td>Varies</td>
<td>Varies</td>
<td>2900-6500 [200-484]</td>
<td>14504 [1000]</td>
<td>&lt;1 [1.6]</td>
<td>&lt;1 [0.75]</td>
</tr>
<tr>
<td>PDC-4</td>
<td>Varies</td>
<td>Varies</td>
<td>2900-6500 [200-484]</td>
<td>14504 [1000]</td>
<td>Up to 100 [160]</td>
<td>30 [22]</td>
</tr>
<tr>
<td>PDC-13(100)</td>
<td>Varies</td>
<td>Varies</td>
<td>2900-6500 [200-484]</td>
<td>14504 [1000]</td>
<td>Up to 1865 [3000]</td>
<td>220 [175]</td>
</tr>
</tbody>
</table>
Diaphragm Compressors Explained

PDC Machines’ metallic diaphragm compressors are ideal for compressing all types of gases without incurring any contamination of the process media or leakage of gas to ambient air that results from reciprocating and other types of compressors. Traditional reciprocating compressors are subject to leakage past the piston rings which can result in contamination of the process gas with the hydraulic oil.

This is accomplished by isolating the process media from the piston and related components with a set of metal diaphragms. The piston moves a column of hydraulic fluid, which in turn moves the diaphragm-set, and displaces the process media. The process side of these units is constructed of corrosion-resistant materials to prevent further contamination.

Diaphragm compressors are well-suited for applications ranging from vacuum to pressure as high as 60,000 psig. Because of the large surface areas of the heads and diaphragms, the presence of pulsing oil and cooling of the upper heads (process side) PDC Machines compressors typically run considerably cooler than conventional piston-type reciprocating compressors.

Our compressors are more isentropic than adiabatic. The exponent runs between isothermal and adiabatic. In some cases, compression ratios as high as one hundred to one is possible.

Cavity And Its Design

The deflection and inherent stresses of the metal diaphragms are controlled by a carefully designed cavity contour.

We use state-of-the-art design and analysis with the assistance of sophisticated computers to create these cavity contours. Optimum displacements are obtained while assuring maximum fatigue life for the diaphragms. Finite element analysis is used to calculate the deflections of the compressor heads that house these cavities.

Oil Relief Valve

This relief valve will accomplish the following:

- Limits maximum oil and gas pressure generated by the diaphragm unit.
- Assures that diaphragms completely sweep the cavity and contact the upper cavity contour, thus maximizing displacement.

Injection Pump

Pdc provides an automatic plunger type injection pump on all motor-driven diaphragm units. The pump’s function is to inject a specific volume of oil during the suction stroke of the machine. This volume of oil compensates for the following losses:

- Normal leakage of oil across the hydraulic piston.
- Compressibility of oil under pressure.
- Over pump as defined above.

Triple Diaphragm Construction

This is comprised of a stack of three metal diaphragms. The process side is made of a material compatible with the process media (stainless steel, Monel, etc.). The oil side is made of the same material. The middle diaphragm is made of brass. The middle brass diaphragm is to prevent metal to metal from gall-sticking together.

Leak Detection System

Our leak detection system utilizes a set of three diaphragms, a closed chamber into which the leaked media (gas/oil) accumulates, a relief valve, pressure switch, pressure gauge, and a manual blow down valve which is normally closed.

The middle brass diaphragm has radially scribed lines on both sides of the diaphragm. These serve as leak paths for moving any media that have leaked through a crack in either the upper or lower diaphragm to the leak collection area. Any failure of either the main oil or gas seal (O-ring) would also be detected in the leak collection area.

Priming Pump

We provide an automatic positive gear pump on all motor-driven compressors. This pump eliminates priming problems that are typically associated with gravity-fed pumps. Depending on the size of the unit, the priming process can take up to a few minutes. This pump is driven by the main crankshaft.
Your source for processing
For decades, we have helped companies around the globe seize new market opportunities.
We can provide you with the following equipment:

- **Pilot Plants** – PDC Machines supplies pilot plants on a turnkey basis for a vast array of processes. Our modular skid mounted process equipment is completely piped, wired, instrumented, configured and tested requiring minimal installation for trouble-free quick start up. Our pilot plants can be designed as laboratory scale systems, demonstration plants and small scale commercial plants.

- **Stirred Metal and Glass Reactors** - PDC Machines’ custom designs stirred reactors ranging for laboratories, pilot-plants and small scale production applications. Each system includes the pressure vessel, supporting stand, mixing assembly, accessories and controls. Capacities range from 1 liter to 50 gallons (189 liters).

- **Syringe Pumps** – Rugged, industrial heavy-duty simplex and duplex syringe pumps for batch and continuous operation. PDC Machines’ syringe pumps are ideal for handling all types of fluids where pulse-less and extremely accurate flow is required at constant output pressure. Flow rates range from (0.004 mL/min to 4 mL/min) to (0.4 mL/min to 400 mL/min).

- **Magnetic Stirrers** – PDC Machines’ magnetic stirrers are designed to suit most mixing requirements in laboratories, pilot-plants and small scale production applications. Our magnetic mixers are ideal when working with toxic, hazardous or high purity materials to protect the health of the workers, the environment and the integrity of the product. We offer a wide selection of magnetic mixers ranging in torques from 8 in lbs to 2,000 in lbs (0.9 to 226 Nm).