Mechanics/Machinery

Low-Cost, Rugged High-Vacuum System

Goddard Space Flight Center, Greenbelt, Maryland

A need exists for miniaturized, rugged, low-cost high-vacuum systems. Recent advances in sensor technology have led to the development of very small mass spectrometer detectors as well as other analytical instruments such as scanning electron microscopes. However, the vacuum systems to support these sensors remain large, heavy, and power-hungry. To meet this need, a miniaturized vacuum system was developed based on a very small, rugged, and inexpensive-to-manufacture molecular drag pump (MDP). The MDP is enabled by a miniature, very-high-speed (200,000 rpm), rugged, low-power, brushless DC motor optimized for wide temperature operation and long life.

The key advantages of the pump are reduced cost and improved ruggedness compared to other mechanical high-vacuum pumps. The machining of the rotor and stators is very simple compared to that necessary to fabricate rotor and stator blades for other pump designs. Also, the symmetry of the rotor is such that dynamic balancing of the rotor will likely not be necessary. Finally, the number of parts in the unit is cut by nearly a factor of three over competing designs. The new pump forms the heart of a complete vacuum system optimized to support analytical instruments in terrestrial applications and on spacecraft and planetary landers.

The MDP achieves high vacuum coupled to a ruggedized diaphragm rough pump. Instead of the relatively complicated rotor and stator blades used in turbomolecular pumps, the rotor in the MDP consists of a simple, smooth cylinder of aluminum. This will turn at approximately 200,000 rpm inside an outer stator housing. The pump stator comprises a cylindrical aluminum housing with one or more specially designed grooves that serve as flow channels. To minimize the length of the pump, the gas is forced down the flow channels of the outer stator to the base of the pump. The gas is then turned and pulled toward the top through a second set of channels cut into an inner stator housing that surrounds the motor. The compressed gas then flows down channels in the motor housing to the exhaust port of the pump. The exhaust port of the pump is connected to a commercially available diaphragm or scroll pump.

This work was done by Paul Sorensen and Robert Kline-Schoder of Creare Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-15838-1

Static Gas-Charging Plug

Lyndon B. Johnson Space Center, Houston, Texas

A gas-charging plug can be easily analyzed for random vibration. The design features two steeped O-rings in a radial configuration at two different diameters, with a 0.050-in. (≈1.3-mm) diameter through-hole between the two O-rings. In the charging state, the top O-ring is engaged and sealing. The bottom O-ring outer diameter is not squeezed, and allows air to flow by it into the tank. The inner diameter is stretched to plug the gland diameter, and is restrained by the O-ring groove.

The charging port bushing provides mechanical stop to restrain the plug during gas charge removal. It also prevents the plug from becoming a projectile when removing gas charge from the accumulator.

The plug can easily be verified after installation to ensure leakage requirements are met.

This work was done by William Indoe of Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-25059-1

Floating Oil-Spill Containment Device

This triangular device can be used for oil and natural gas containment.

NASA's Jet Propulsion Laboratory, Pasadena, California

Previous oil containment booms have an open top that allows natural gas to escape, and have significant oil leakage due to wave action. Also, a subsea pyramid oil trap exists, but cannot move relative to moving oil plumes from deep-sea oil leaks.

The solution is to have large, moveable oil traps. One version floats on the sea surface and has a flexible tarp cover and a lower weighted skirt to completely entrap the floating oil and natural gas. The device must have at least three sides with boats pulling at each apex, and sonar or other system to track the slowly moving oil plume, so that the boats can properly locate the booms. The oil trap device must also have a means for removal of the oil and the natural gas.

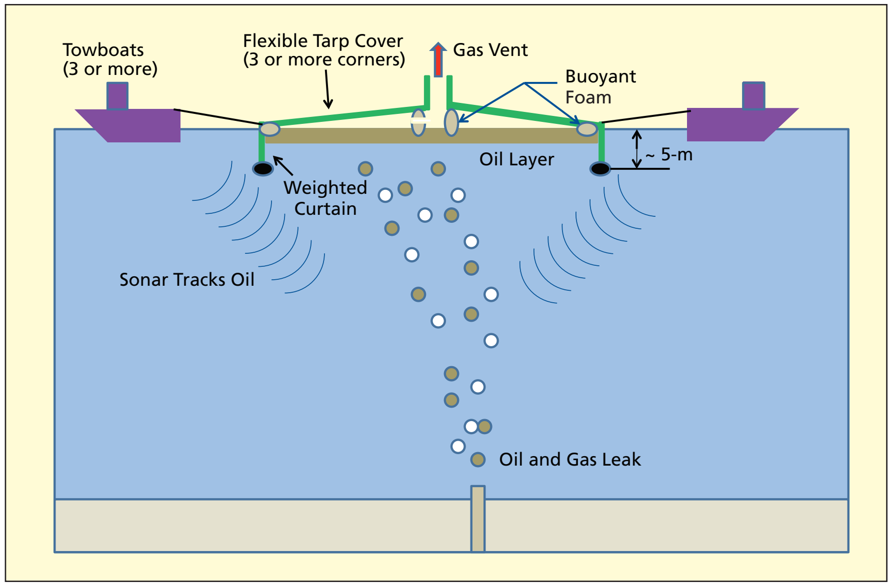
A second design version has a flexible pyramid cover that is attached by lines to ballast on the ocean floor. This is similar to fixed, metal pyramid oil capture devices in the Santa Barbara Channel off the coast of California. The ballast lines for the improved design, however, would have winches that can move the pyramid to always be located above the oil and gas plume.

A third design is a combination of the first two. It uses a submerged pyramid to trap oil, but has no anchor and uses boats to locate the trap. It has ballast weights located along the bottom of the tarp and/or at the corners of the trap.

The improved floating oil-spill containment device has a large floating boom and weighted skirt surrounding the oil and gas entrapment area. The device is triangular (or more than three sides) and has a flexible tarp cover with a raised gas vent area. Boats pull on the apex of the triangles to maintain tension and to allow the device to move to optimum locations to trap oil and gas. The gas is retrieved from a higher buoyant part of the tarp, and oil is retrieved from the floating oil layer contained in the device.

These devices can be operated in relatively severe weather, since waves will break over the devices without causing oil leaking. Also, natural gas is entrapped and can be retrieved. All designs can use sonar to locate the moving oil plume, and then be relocated by using boats or winches to move the oil trapping devices. These devices can be constructed of treated, non-permeable DuPont Kevlar cloth (or similar material).

This work was done by Jack A. Jones of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO47679



An **Improved Floating Oil-Spill Containment Device** features a flexible tarp cover with three or more corners that is pulled by three or more towboats.

Stemless Ball Valve

Potential applications include hazardous fluids and chemicals, and where fugitive emissions from valves are a concern.

Lyndon B. Johnson Space Center, Houston, Texas

This invention utilizes a new method of opening and closing a ball valve. Instead of rotating the ball with a perpendicular stem (as is the case with standard ball valves), the ball is rotated around a fixed axis by two guide pins. This innovation eliminates the leak point that is present in all standard ball valves due to the penetration of an actuation stem through the valve body.

The VOST (Venturi Off-Set-Technology) valve has been developed for commercial applications. The standard version of the valve consists of an off-set venturi flow path through the valve. This path is split at the narrowest portion of the venturi, allowing the section upstream from the venturi to be rotated. As this rotation takes place, the venturi becomes restricted as one face rotates with respect to the other, eventually closing off the flow path. A spring-loaded seal made of resilient material is embedded in the upstream face of the valve, making a leak-proof seal between the faces; thus a valve is formed. The spring-loaded lip seal is the only seal that can provide a class six, or "bubbletight," seal against the opposite face of the valve. Tearing action of the seal by high-velocity gas on this early design required relocation of the seal to the downstream face of the valve.

In the "stemless" embodiment of this valve, inner and outer magnetic cartridges are employed to transfer mechanical torque from the outside of the valve to the inside without the use of a stem. This eliminates the leak path caused by the valve stems in standard valves because the stems penetrate through the bodies of these valves.

This design requires high precision during assembly for proper performance of the face seal. Slight variations in tolerances result in unacceptable seal performance. An effort was made to replace this design with a less demanding arrangement of component parts. A rotating gate was proposed to be installed between the two faces of the valve. This gate would rotate in and out of the flow path of the venturi, opening and closing the valve. Although this new gate design would require a seal on both sides of the gate, it would eliminate the requirement of rotating the entire downstream side of the valve. This would simplify the valve and allow for larger tolerances for proper performance. Magnetic cartridges would again be used to actuate the valve in a stemless design.

A MagBall concept replaces the rotating gate with a rotating ball. The ball does not rotate lock-step with the magnetic cartridge as the rotating gate did. Instead, the torque has a more complex rotation that allows the ball to go from fully open to fully closed.