Cutting Out Small Leaks Can Save Big Money p22

Keep Hydraulic Fluid Clean *and* Dry p28

Considerations for Pump Isolation Valves p34

Hydraulics & Pneumatics®

THE AUTHORITY ON FLUID POWER TECHNOLOGY

NOVEMBER 2017 hydraulicspneumatics.com

LOG HANDLER

Stacks Up Advantages p20

Modeling Case Drain Flow P / 16

$10.00

VELJAN

High Performance

Vane Pumps & Motors for Railway Track Tamping Machine

Our Other Products Range

Hydraulic Products in use on Track Tamping Machines

Model: VT6DC
Max. Pre. : 4000psi - 275bar
Max. Disp. : 3.56 - 17.75in³/rev
59.0 - 290cm³/rev
Max. Speed : 2500rpm

Model : VT6DCC
Max. Pre. : 4000psi / 275bar
Max. Disp. : 4.22 - 23.94in³/rev
70 - 390cm³/rev
Max. Speed : 2500rpm

Model : VM4C/VM4C1
Max. Pre. : 2500psi / 175bar
Max. Disp. : 1.49 - 4.89in³/rev
24 - 80cm³/rev
Max. Speed : 4000rpm
Torque : 0.24 - 0.78lb-in/psi
0.39 - 1.27Nm/bar

Model : VM4D/VM4D1
Max. Pre. : 2500psi / 175bar
Max. Disp. : 3.97 - 8.81in³/rev
65 - 144cm³/rev
Max. Speed : 4000rpm
Torque : 0.63 - 1.40lb-in/psi
1.04 - 2.30Nm/bar

For more Information on above,
please contact us.

Veljan Hydrair Inc.

Sales & Warehouse: 4034, Chamblee Road
Oakwood, GA 30566 (USA). Phone: 877.793.6405,
Website : www.veljan.in | E-mail : sales@veljanusa.com

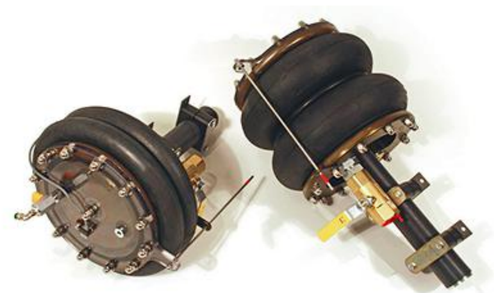
We Help You See Your Ideas Work

IN THIS ISSUE

20

FEATURES

22



28

34

DEPARTMENTS

JOIN US ONLINE

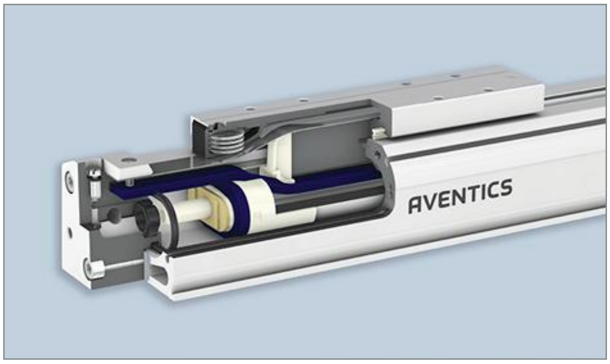
twitter.com/HPpenton
facebook.com/HydraulicsPneumatics

ISSN 0018-814X

Hydraulics & Pneumatics is published monthly by Penton Media, Inc., 9800 Metcalf Ave., Overland Park, KS 66212-2216. Phone: 216-696-7000. Periodicals postage paid at Kansas City, MO and at additional mailing offices. **POSTMASTER**: Send address changes to *Hydraulics & Pneumatics*, 1100 Avenue of the Americas, NY, NY. 10036. Copying: permission is granted to users registered with the Copyright Clearance Center Inc. (CCC) to photocopy any article provided base fee of $1.25 per copy of the article plus 60¢ per page is paid directly to CCC, 222 Rosewood Dr., Danvers, MA 01932 (Code No. 0018-814X/00 $1.25 + 60¢).

Subscriptions — U.S. and possessions outside U.S.: $70/yr; $100/two yrs. Single copy: January $15.00; all other issues $8.00. In Canada: $85.00/yr, $135.00/two yrs. Canada Post Publications Mail Agreement No. 40612608). Canada return address: IMEX Global Solutions, PO box 25542, London, ON, N6C 682. International: $100.00/yr, $165.00/two yrs. To order, phone 847-763-9670. Fax orders to 847-763-9673. Send subscription payment to: *Hydraulics & Pneumatics*, P. O. Box 2100, Skokie, IL 60076-7800. Out-of-print copies available in complete volumes as positive microfilm from NAPCO 800-420-6272 x 6578. Photocopies of articles $5.00 each. Payment must accompany request. Volume 70, No. 11, November 2017.

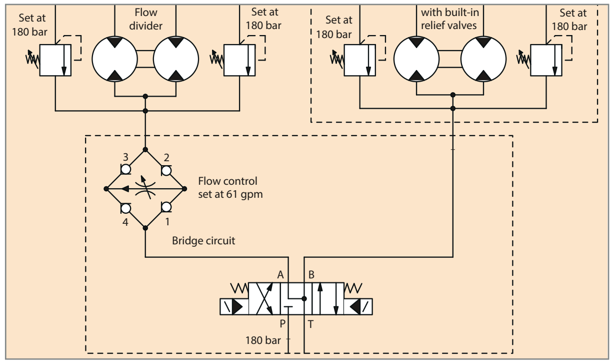
ON
HYDRAULICSPNEUMATICS.COM



Considerations for Choosing Rodless Pneumatic Cylinders

Rodless cylinders are used primarily for their compact design—they provide the same stroke of conventional cylinders, but in roughly half the space. However, they hold other advantages and require different application considerations. Understanding the different types of rodless cylinders can help design engineers select the right rodless cylinder for their specific requirements.

www.hydraulicspneumatics.com/cylinders-actuators/less-more-considerations-choosing-rodless-pneumatic-cylinders



Bridge Circuit Provides One-Way Flow

Combining four check valves into a bridge circuit ensures unidirectional flow no matter which end of the circuit branch flow comes from. The circuit ensures that fluid can only flow one way through a pressure-compensated flow control. But the central component needn't be a flow control. It could just as well be a filter or other component that requires flow in one direction only.

www.hydraulicspneumatics.com/hydraulic-valves/bridge-circuit-provides-one-way-flow

Hydraulics&Pneumatics NOVEMBER 2017

EDITORIAL

EDITOR: **ALAN HITCHCOX** alan.hitchcox@penton.com
CONTENT PRODUCTION DIRECTOR: **MICHAEL BROWNE** michael.browne@penton.com
CONTENT PRODUCTION SPECIALIST: **ROGER ENGELKE** roger.engelke@penton.com
PRODUCTION EDITOR: **JEREMY COHEN** jeremy.cohen@penton.com
CONTENT OPTIMIZATION SPECIALIST: **WES SHOCKLEY** wes.shockley@penton.com
ASSOCIATE CONTENT PRODUCER: **LEAH SCULLY** leah.scully@penton.com
CONTRIBUTING TECHNICAL EXPERT: **JACK L. JOHNSON** jack@idaseng.com
CONTRIBUTING TECHNICAL EXPERT: **ROBERT J. SHEAF, JR.** rjsheaf@cfc-solar.com
CONTRIBUTING EDITOR: **RAY SCROGGINS** ray@scroggins.biz

ART DEPARTMENT

GROUP DESIGN DIRECTOR: **ANTHONY VITOLO** tony.vitolo@penton.com
SENIOR ARTIST: **JIM MILLER** jim.miller@penton.com
CONTENT DESIGN SPECIALIST: **JOCELYN HARTZOG** jocelyn.hartzog@penton.com
CONTENT & DESIGN PRODUCTION MANAGER: **JULIE JANTZER-WARD** julie.jantzer-ward@penton.com

PRODUCTION

PRODUCTION MANAGER: **SUSAN POSKIN** susan.poskin@penton.com
GROUP PRODUCTION DIRECTOR: **CAREY SWEETEN** carey.sweeten@penton.com
PLEASE SEND INSERTION ORDERS TO: orders@penton.com

CIRCULATION LIST RENTALS & CUSTOMER SERVICE

USER MARKETING DIRECTOR: **BRENDA ROODE** brenda.roode@penton.com
USER MARKETING MANAGER: **DEBBIE BRADY** debbie.brady@penton.com
REPRINTS: **BRETT PETILLO** **F** | 877.652.5295 bpetillo@wrightsmedia.com

LIST RENTAL: SMARTREACH CLIENT SERVICES MANAGER:
JAMES ADDISON **T** | 212.204 4318 james.addison@penton.com

FREE SUBSCRIPTION/STATUS OF SUBSCRIPTION/ADDRESS CHANGE/MISSING BACK ISSUES:
OMEDA **T** | 847.513.6022 **TOLL FREE** | 866.505.7173

SALES REPRESENTATIVES

MANAGING DIRECTOR: **TRACY SMITH** **T** | 913.967.1324 **F** | 913.514.6881 tracy.smith@penton.com
NORTH AMERICA ACCOUNTS MANAGER: **RONALD KLIMKO** **T** | 216.931.9662 ronald.klimko@penton.com

INTERNATIONAL SALES
ITALY: **DIEGO CASIRAGHI** **T** | +011.390.31.261407 **F** | +011.390.31.261380 diego@casiraghi-adv.com

GERMANY, AUSTRIA, SWITZERLAND: **CHRISTIAN HOELSCHER** **T** | +011.49.89.95002778
christian.hoelscher@husonmedia.com

BELGIUM, NETHERLANDS, LUXEMBURG, UNITED KINGDOM, SCANDINAVIA, FRANCE, SPAIN, PORTUGAL:
RACHEL DISANTO **T** | +011.44.1625.876622 **M** | +011.44.7794.366887 rachel.disanto@husonmedia.com

PAN ASIA: **HELEN LAI** **T** | 866.2.2727.7799 **F** | 866.2.2728.3686 helen@twoway-com.com

ONLINE

MARKETING AUTOMATION SPECIALIST: **DAN KRAFT** dan.kraft@penton.com
PRODUCT DEVELOPMENT DIRECTOR: **RYAN MALEC** ryan.malec@penton.com
EMEDIA CLIENT SERVICE MANAGER: **JOANN MARTIN** joann.martin@penton.com

DESIGN ENGINEERING & SOURCING GROUP

EXECUTIVE DIRECTOR OF CONTENT AND USER ENGAGEMENT: **NANCY K. FRIEDRICH**
GROUP DIRECTOR OF OPERATIONS: **CHRISTINA CAVANO**
GROUP DIRECTOR OF MARKETING: **JANE COOPER**

PENTON

1166 AVENUE OF THE AMERICAS, 10TH FLOOR
NEW YORK, NY 10036 **T** | 212.204.4200

Electronic Design | Machine Design | Microwaves & RF | Source ESB | Hydraulics & Pneumatics |
Global Purchasing | Distribution Resource | Power Electronics | Defense Electronics

PENTON IS AN INFORMA BUSINESS

Phone: 586-296-7200
Email: sales@fluidynefp.com
www.fluidynefp.com

Editorial
ALAN HITCHCOX
Editor
alan.hitchcox@penton.com

The Time of Your Life

As I alluded to last month, even though hydraulic technology as we know it today has been around for about 100 years, the greatest growth occurred following WWII. Many of today's fluid power manufacturers—and *Hydraulics & Pneumatics*—were founded during this time. These people were true pioneers of our industry, and it would've been quite an adventure to witness all this innovation.

To expand on this idea, if you could have been born at any time in history, when would that be? This was a topic of discussion with a younger colleague. I said 1900 would've been a good year. Being born then, I would've witnessed the birth of aviation, the dawn of automobiles, and been a young man during the boom of the 1920s.

Life in the early part of the 20th century was without radio and television. If you had lived in the country—as most people did back then—there was a good chance you wouldn't have had a telephone and maybe not even electricity. Imagine all that change happening in your lifetime. Movies would've graduated from silent to sound and, eventually, to color.

By the time I reached the age I am now, only the largest organizations would've had computers. These machines were the size of a small garage, yet able to perform only the most basic functions at a snail's pace. But they helped put Alan Shepard into space and John Glenn into orbit—quite a far cry from what I would've seen as a child.

Of course, I asked my colleague when she would've liked to have been born. Her reply startled me, primarily because her perceptions are so different from mine. Her world is all about smart phones, social media, and different types of messaging, so she thinks it would've been fascinating to have been born when I was, in the mid 1950s.

She found it hard to imagine going through high school with no digital technology. Our text messaging was writing notes on little pieces of paper and passing them through class. Our internet was libraries, encyclopedias, and directories. Long-distance telephone calls were for special occasions because they were so expensive. Writing letters took days for a response instead of seconds.

Imaging was done with film, where you had to wait about a week to see your results. Video was also done on film, and usually without sound. You could record sound on a magnetic tape, but only broadcasting stations could afford the expensive machines that could record audio *and* video on tape. Audio-video finally came to the masses in the early 1980s. Not too long after that came cell phones.

These analog cell phones would still be almost unrecognizable to my young colleague. Later cell phones could handle text messaging, while web browsing and early social media were reserved for personal computers. This all changed when the two technologies became almost inseparable.

Now we're seeing much of this technology working its way into fluid power systems. And I can't help but think how future generations will marvel at how primitive it all is.

EXPECT MORE WITH MOTION

More Choices

- Representing North America's leading industrial brands
- Access to over 6.9 million SKUs
- Convenient and simple ways to order via mobile, desktop, toll-free calling, or one of our locations

More Expertise

- More than 1,700 experienced account representatives
- Over 200 field product specialists available to solve your toughest challenges
- Unmatched technical and application support

More Solutions

- Local parts and supplies inventory for fast turnaround
- Repair and fabrication technicians
- Account representatives and hundreds of branches located throughout North America for your convenience

Expect More With Motion.

Scan to watch

http://esp.to/wb8Xon

MOTION® INDUSTRIES
Keeping Industry in Motion

Call. 800-526-9328
Click. MotionIndustries.com
Visit. Over 530 Locations

News

LEAH SCULLY | Associate Editor

HAWE Crafts its New Executive Leadership Team

HAWE North America (www.HAWE.com) announced the members of its new Executive Leadership team: Robert "Bob" Pettit was promoted from the role as Chief Technical Officer to Chief Executive Officer, and David "Dave" Stagg promoted from North American Sales Manager to Chief Sales Officer.

Pettit began working with HAWE North America in 1997, and has been part of the company's leadership team for more than 20 years. He is experienced with managing sales and marketing teams, as well as engineering teams. Stagg started working at HAWE NA in 2013 after the company acquired Pacific Fluid Systems. He has held the positions of Regional Sales Manager and North American Sales, managing a sales team that covers the U.S. and Canada.

"I have the utmost confidence in the people, high-quality products and services we provide at HAWE North America. We are executing our growth plans through both organic growth and potential acquisitions in North America," says Pettit.

HAWE also added two additional regional sales managers, Paul Pritchard and Milan Markovich, to its sales force in early October. Pritchard will cover the southeast United States and Markovich will cover the northeast United States and Eastern Canada. ■

BRENNAN PURCHASES VERSA Fittings

BRENNAN INDUSTRIES INC. *(brennaninc.com)* announced the acquisition of Versa Fittings Inc. *(www.versafittings.com)*, a manufacturer and distributor of fittings and tubing in Canada. Through the acquisition, Brennan will expand its distribution and manufacturing footprint in North America.

The product lines from both companies will yield more than 50,000 aerospace, hydraulic, instrumentation, push-to-connect, gas, and plumbing components from clamps and valves to accessories. This works out to a 25% increase in overall offerings.

"This acquisition represents a significant step forward for Brennan, Versa, and our customers", says Dave Carr, President of Brennan. "Versa's expertise in the Canadian market plus Brennan's U.S. strength and product breadth makes for a powerful combination. Together we'll be able to bring a larger range of products to our customers more quickly and easily than ever. I am very pleased to welcome Versa into the Brennan family."

"Versa is proud to become a part of Brennan's success", says Don Martin, General Manager of Versa. "We have always valued our customers and strived to serve them well. This move will enable us to serve them even better in the future, with an increased product line as well as additional manufacturing capabilities. I am excited about the opportunities for growth ahead and what they mean for everyone at Versa, as well as for our customers." ■

OUTDOOR TEST RIG Compares Bearings Under High Loads

AT ITS 2,750 SQUARE-METER test lab, igus assesses movements of energy chains, chainflex cables, and plastic bearings to determine optimal configurations for maximum service life.

Further expanding its test capabilities, igus announced the addition of a front-loader rig to its outdoor test lab. The rig can be used to emulate heavy-loading conditions in agricultural and construction equipment. It can be fitted with different bearing and shaft combinations to determine optimal assemblies for maximum product service life. Using online configurators, the company can analyze data recorded during trials to compare service lives for metal and plastic bearings, as well as other components.

The surface pressure of the test rig lies between 3191 and 4,279 psi, and can be changed to generate the intended force on the bearing point. For example, 4,279 psi can be applied to a bearing with a diameter and length of 20 mm to generate a load of 2,645 lb.

The test rig completes four cycles per minute, with tests lasting approximately two weeks. Interested parties can observe testing live on a webcam.

The company offers its testing services to determine the life of bearings under various loading conditions, and stores test results in a database that's accessible to customers. ■

NEW CEO OF Airline Hydraulics Talks of Quality, Leadership

FILLING THE SHOES of Joseph Miceli, who retired as CEO of Airline Hydraulics Corp.'s (www.airlinehyd.com), will be Mark Steffens, who has worked at the company for the last 22 years. Prior to the appointment, he served as Business Unit Manager for Airline's Automation Group.

"I would like to express how very grateful I am to be chosen to lead this great organization in one of the most aggressive and progressive markets I have seen in my 22 years here," says Steffens.

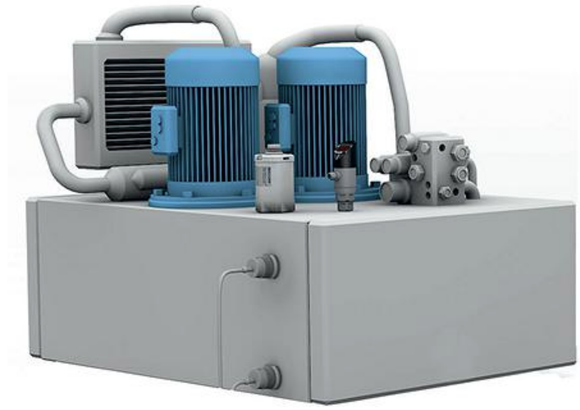
"In today's quickly changing market, our ability to embrace change and look at obstacles differently will keep us relevant. I have worked in just about every department within Airline, and I can say from first-hand experience that we have great people driving toward a great cause, the growth and success of our Employee Stock Ownership Plan (ESOP). I am a proud member of the Airline ESOP family and consider myself very lucky to have been named the CEO of this great organization."

Airline is a regional supplier of components in fluid power, automation, electrical control, and safety, with products from manufacturers including Bosch Rexroth, Eaton, SMC, HYDAC, and Omron. With offices located throughout the Mid-Atlantic and New England regions in the U.S., it also offers custom-engineered technology solutions, system engineering, manufacturing, service, repair, and installation. ■

ALAN HITCHCOX | Editor

Instrumented HPUs are a Smart Move

Today's manufacturing plants have fewer people, so routine yet important monitoring of hydraulic power units can often fall short. An effective workaround is to inject HPUs with some smarts.



Making hydraulic power units smart by incorporating level, temperature, and other sensors makes conditioning less labor-intensive while also making operations more reliable and productive. *(Image courtesy of Balluff Inc.)*

MOST INDUSTRIAL HYDRAULIC power units (HPUs) are located in less-than-accessible areas, such as cellars, utility rooms, or among other machines crowded around them. If an HPU is not easily accessible, it's less likely to be closely monitored. This means oil level, temperature, cleanliness, and other important operating conditions could go undetected, potentially leading to a breakdown.

Monitoring the HPU should occur with the hydraulic system running. However, depending on its location, the HPU may have to be checked during scheduled downtime. The problem is that many undesirable conditions (especially low oil level during cycling) only emerge while hydraulic systems are in operation. Furthermore, if the HPU is remotely located, someone needs to physically check the status of fill levels for each HPU. In large facilities, monitoring dozens of hydraulic power units can be almost a full-time job.

GIVE HPUs THE SMARTS

Ideally, HPUs should be monitored continuously. This would obviously be an impractical use of labor. However, a practical and even more effective alternative is a smart HPU. A smart HPU has all of the elements of a traditional hydraulic power unit, but is fitted with electronic instrumentation to monitor key parameters. As a result, a smart HPU provides alerts that act as preventive maintenance to improve hydraulic-system reliability and service life, thereby reducing downtime. An added benefit is that the feedback from sensors can be used in statistical process control and other factory automation communications.

Adding electronic monitoring to an existing HPU or specifying it for a new application is a wise investment. And the good news is you don't have to invest a ton of money all at once to upgrade all HPUs in your plant. Instead, you could start with the HPUs driving the most critical operations and fit them with only the bare necessities: fluid level and fluid temperature sensing.

Doing your homework can pay off, because some manufacturers offer level sensors with built-in temperature detection. Fluid contamination is also important; and although a wise investment, much of this online particle instrumentation can be expensive. Invest in technology that offers ease of expandability and integration in a step-by-step approach.

GETTING STARTED

First, identify the most important characteristics for measurement that would allow for the most impact on your process improvement. With the lean philosophy in mind, you may need to investigate what technology can help standardize cables or hardware or technology itself. For example, IO-Link is one of the technologies that enables standardizing on cables and allows for integration of various smart sensors. IO-Link offers smart communication of process data, parameter data, and event data on the same three- or four-wire unshielded proximity cable.

Almost as many different ways exist to communicate the sensor information, considering they are sensors themselves. Traditional sensors provide analog output, with 4 to 20 mA or 0 to 10 V used most often in hydraulic systems.

The problem with analog measurement is that it requires shielded cables between the sensor and the control cabinet. Shielded cables cost more and need special care when installed, because they may be sensitive to the electrical noise from vibration or high currents transmitted to electric motors. Another drawback of analog signals is that their output must be scaled to convert it to proper engineering units.

IO-LINK

A workaround that eliminates the need for shielded cables' expensive analog-conversion cards in the controller is to use the aforementioned IO-Link technology. IO-Link also offers enhanced diagnostics and parameterization features that make it easy to replace a sensor simply by plugging in a new one.

Because IO-Link is point-to-point communication, it requires an IO-Link master or a gateway module that collects the IO-Link data from all of the sensors and sends it to the controller in consolidated fashion—tremendously reducing hardware and assembly costs. The IO-Link master module typically offers data collection from eight IO-Link sensors. Therefore, depending on requirements for the data, one IO-Link Master module could collect information from one or multiple HPUs at once.

The collected information is then sent to the controller over a fieldbus or an industrial network of choice. Because so many different fieldbuses and networks are available, IO-Link offers another advantage by making your sensor's fieldbus independent. The IO-Link master (gateway) would be the only fieldbus- or network-dependent device in a system. hp

THIS INFORMATION was provided by Balluff Inc., Florence, Ky. For more information, call (800) 543-8390, or visit www.balluff.com.

FREE THREAD IDENTIFICATION AND MEASUREMENT GUIDE

BRENNAN INDUSTRIES INC., Solon, Ohio, recently introduced its pocket-sized "Thread Identification & Measurement Guide," which contains 28 pages of helpful information and illustrations, plus tips for measuring and identifying common threads found on hydraulic fittings. A visual identification and size guide applies to multiple fitting types, and a thread dimension chart covers 15 different thread types. The guide is printed on high-quality coated paper to stand up to workplaces typically encountered in heavy industry.

To request a copy, visit *brennaninc.com/freeguide* and fill out a short form.

Specifying Special Cylinders Just Got Easier

AS THE SAYING GOES, the devil is in the details, and this certainly holds true when it comes to all of the dimensions and specifications needed for ordering a made-to-order hydraulic or pneumatic cylinder. The work isn't difficult, it just requires paying attention to details and taking the time to do it right the first time.

Peninsular Cylinder Co., Roseville, Mich., feels your pain. The company just launched an electronic version of its application datasheet. For years, the datasheet has made it easier to provide all of the information necessary to receiving a recommended custom cylinder design from Peninsular. The new electronic version, though, makes it faster, easier, and a more pleasant experience than filling out a form by hand. From mounting styles, weight of load moved, environmental conditions, and more, this e-version consolidates what were once scattered questions into an intuitive, straightforward online document.

Bill Tyler, Peninsular's National Sales & Marketing Manager, states, "Every detail in the custom cylinder design process is crucial. This new web-based version of the application datasheet allows us to retrieve more information in less time from our customers."

In addition to a clean interface, intuitive functionality was also a priority during the planning process. Tyler explains that the e-form prompts users only with questions relevant to the cylinder type (pneumatic or hydraulic) being selected. Users can also upload images with their submission.

Earlier this year, Peninsular launched a new website equipped with other useful tools, such as their popular cylinder configurator. The cylinder configurator lets users preview 3D images, download 2D drawings, and request a quote, all from one portal. The web-based version of the application datasheet joins the steady list of technologically driven initiatives brought to the forefront of the fluid power industry by Peninsular. hp

FOR MORE information, call (800) 526-7968, email sales@peninsularcylinders.com, or visit www.peninsularcylinders.com.

Cast Body is Key to Valve Performance

WANDFLUH AG, FRUTIGEN, SWITZERLAND, recently redesigned its entire line of NG10 hydraulic spool valves. The valves are based on a cast-body design, which is used for both direct- and pilot-operated valves. All valves in the range are capable of system pressures to 350 bar (5,000 psi) and some can operate at levels to 420 bar (6,000 psi).

Emphasis was placed on the symmetrical design of the valve. As a result, valves exhibit the same flow and pressure characteristics in both operating directions.

Direct-operated valves can control flows to 160 l/min (42 gpm) at a very low pressure drop (ΔP). A soft-shift spool valve has been developed to reduce pressure shocks in sensitive systems. Valves can be optimized to a particular application by adjusting damping orifices individually.

Proportional versions offer low hysteresis for flows to 100 l/min (26 gpm) through flow simulation during design and flow optimization. Flow forces in the valve are kept low, flow rate improves at higher pressures.

A superimposed dither signal combined with a pulse-width-modulation (PWM) power amplifier provides high-response control. In addition, closed-loop control circuits can be integrated through fieldbus interfaces with machine control systems.

Pilot-operated valves, designed for compact installation, are pilot-operated by an NG4 spool valve. The result is reduced installation space and solenoids operating with low power draw. For example, solenoid power consumption has been reduced from about 30 W to 20 W for size NG6 switching valves. Maximum flow capacity at low pressure drop is 160 l/min (43 gpm). Weighing less than 4 kg (9 lb), the pilot-operated valve is lighter than the direct-operated NG10 valves.

The pilot-operated proportional valve is fitted with an NG4 mini pressure-control valve, one of the most compact available. The pilot control builds pressure to 40 bar (580 psi) to control the main valve up to 200 l/min (53 gpm). Users choose between external or internal pressure control within the valve.

Valves are fitted with exchangeable slip-on coils, which are available with different types of connectors, electrical power, and surface treatments. All are available with special design features, such as explosion protection, increased corrosion resistance, switching position monitoring, and operation in low temperatures.

Explosion-proof valves—the pilot control of the explosion-proof version uses Wandfluh's NG4 mini valve technology, a modular system providing the entire NG10 range with the same performance as valves without explosion protection. Explosion-proof valves are often used in applications with low ambient temperatures. This means that versions of the NG10 explosion protection valves can be built for temperatures as low as –40°C.

The NG10 range also includes explosion-proof proportional valves, which can be used in applications with high flow rates, high operating pressures, *and* tight control.

FOR MORE information, call Wandfluh of America Inc. at (847) 566-5700, email sales@wandfluh-us.com, or visit www.wandfluh-us.com.

Wandfluh's NG10 line of switching and directional valves are designed to accommodate high flows at high pressures with low pressure drop. Explosion-proof versions offer the same performance as Wandfluh's standard NG10 valves.

JACK L. JOHNSON | Contributing Technical Expert

Case Drain Issues with Pumps and Motors

The more variables a math model incorporates, the more realistic it becomes. Case drain flow is one such variable that should be included when modeling a hydraulic pump or motor.

Four different levels of analytical schematics of pump and motor models exist, arbitrarily numbered as Type 0 through Type 3, each one progressively more complex and more inclusive. Type 0 Models are *ideal* because they contain no losses. They are perfectly efficient, having 100% volumetric, mechanical, and overall efficiencies. They are referred to in industrial jargon as models for calculating the "theoretical" performance of pumps and motors. More-practical models include the theoretical imperfections encountered in the real world.

In analytical schematics, the idealized portions of the circuit are identified with an I inside the pump or motor symbol. The elements associated with losses are characterized as being external to the idealized elements. As more of the real performance of real machines is incorporated into the models with more and more theories, the model actually becomes more practical, not more theoretical, assuming, of course, that the modelers have applied the various theories correctly.

THE ROLE OF A MODEL

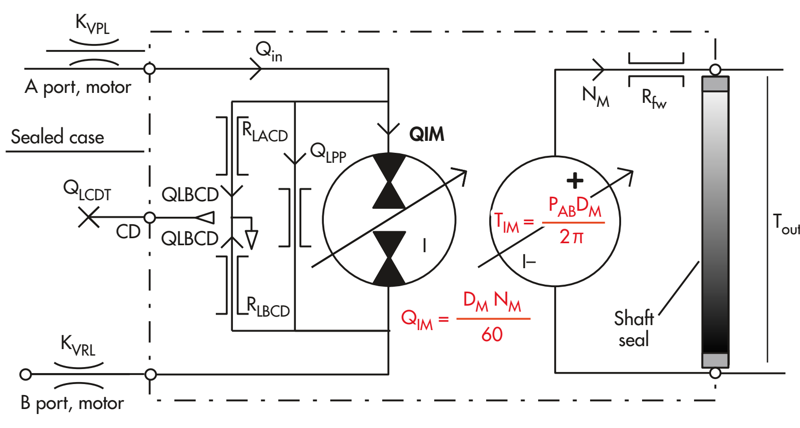
The purpose of mathematical models is to present a set of mathematical expressions that can be used to derive values for the variables that emulate the real machines they were designed to represent. Comparison to actual machine test data verifies the validity and usefulness of the model. The process of model verification with real data is called *correlation*, which provides a quantitative measure of the goodness-of-fit for the data.

A model can occur in at least two basic forms. The first is an analytical schematic, so called because the schematic is in a form that facilitates analysis of the circuit. That is, it facilitates the writing of descriptive equations. The second form is the set of describing equations themselves. The use of schematic models requires that the writer and user of the models agree on how, very specifically, the equations are to be written. Schematics are attractive to technical people because we like illustrations that convey details that mere equations sometimes cannot.

The equations themselves are always the more precise and unambiguous way to convey the exact nature of the model. The user will have less interpretation with the equations. However, equations present less opportunity for creative enhancements. On the other hand, analytical schematics facilitate non-mathematic interpretations better than equations do. The non-mathematical model will be covered here. However, the schematic models have undergone evolutionary improvements. They differ slightly from basic versions because details have been added.

ANALYZING A SCHEMATIC

Figure 1 shows the analytical schematic for a Type-2 hydraulic motor. The mechanical shaft circuit is characterized as a



1. An analytical schematic for a Type-2 hydraulic motor shows the displacement symbol, internal leak paths, and torque generation.

hydraulic equivalent circuit—with torque analogous to pressure and shaft rotational speed analogous to hydraulic fluid flow. This figure contains a somewhat pictorial representation of the shaft seal and a pair of open triangles in the vicinity of the leakage orifices, R_{LACD} and R_{LBCD}, near the case drain port *(CD).*

The hydraulic displacement element is shown as a combination pump-motor. This is the most general configuration of any motor, or pump, for that matter. They will, depending upon circumstances, function as either a pump or a motor, because they are capable of converting power from hydraulic to mechanical and vice versa. Variable displacement is the default configuration, as shown.

A boundary rectangle encloses those elements in the analytical schematic that comprise the motor. It represents the physical case surrounding the active elements of the motor.

UNBEATABLE FALL BOOK OFFER

PURCHASE A COPY of Jack Johnson's *Designers' Handbook for Electrohydraulic Servo and Proportional Systems* between now and December 3, 2017, and you'll also receive a **free copy** of *Fluid Power Systems & Circuits*, by Russell W. Henke, PE. (an $80 value).

The fourth edition of the *Designers' Handbook for Electrohydraulic Servo and Proportional Systems* contains useful information about:

- How to calculate and control pressure losses in hydraulic circuits, subplates, and manifolds;
- How to analyze and control a variety of mechanical loads, including conveyors and belts and triangulated loads;
- Dynamic properties of proportional and servovalves and how to incorporate them in your system;
- Practical information about electronics, especially transducers and signal conditioning; and
- Mobile equipment electrical systems, including batteries and charging systems.

Henke's book was written as a textbook to accompany his comprehensive seminars teaching fluid-power technology. However, it serves well for self-study and as a standalone reference. It contains 27 chapters and nearly 800 pages.

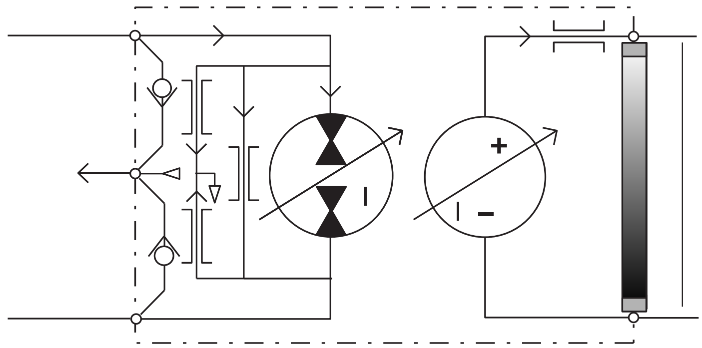
***The Designers' Handbook* sells for $159. To order, visit** www.hydraulics-pneumatics.com/Bookstore-0. Fill out the PDF order form, and mail, fax, or e-mail it to us. ■

The case also forms a repository for the outflow from some of the internal leakage paths. It is a sealed shell around the motor so that internal leakage does not drop on the floor and instead can be routed to tank.

Two internal leakage paths drain into the case. The lumped, equivalent, laminar orifices are labeled R_{LACD} and R_{LBCD} in *Fig. 1*, and the leakage components are labeled Q_{LACD} and Q_{LBCD}, respectively. Interpretation of the subscripts is "leak path from pressurized port *A* to case drain port" and "leak path from pressurized port *B* to case drain port," respectively.

Visualize these pressure-port-to-case-drain port leak paths by imagining the internal workings of, say, an axial piston pump. Because of clearance between each piston and its bore, leakage must occur through all those clearances. In addition, it is common design practice to pressure balance the slippers, or shoes, riding on the swash-plate. A small passage drilled through the center of the piston and slipper carries pressurized fluid to the slippers, providing, at once, pressure balance and required lubrication. But it, too, is an internal leak path.

The third leakage path is labeled Q_{LPP}, meaning the leakage path from port to port. Visualize this by looking at the clearance between the rotating cylinder block and the stationary port plate in an axial piston pump or motor, for example. The flow merely goes from the high-pressure port to the low-pressure port and is taken to tank in the case of the motor. It is not a contributor to the issues with the case and the shaft seal, so will be ignored for now.



2. Check valves are added to the analytical schematic to show how the case can be drained without external case drain plumbing.

HIGH- OR LOW-PRESSURE SEAL?

Figure 1 can be used to illustrate the need for—or the lack of the need for—a high-pressure shaft seal. Normally, any fluid collected in the case is carried back to tank via plumbing connected to the case drain port. It will do so at relatively low pressure, and the case pressure will be commensurately low. This is the point of the open arrows inside the motor envelope: The one downward-pointing open arrow carries leakage from the motor's work ports and "releases it" to the internal cavity of the motor case. The other open arrow "points to" the external case drain port, and the implication is that it connects the case drain port to the internal cavity of the case. In this manner, internal leakage is eventually sent out the case drain port if the necessary external plumbing is provided. The analytical schematic helps illustrate both the problem and its solution.

However, a new argument is presented: What if the case drain port is blocked? Connecting the case drain plumbing is costly and is not necessary in all cases. Suppose the pressure of the motor's Port *A* is high and Port *B* is low. Leakage will flow through R_{LACD} to the case. With the case drain blocked, the only escape route will be backwards, through R_{LBCD}! If the machine is relatively symmetrical—that is, if all piston to bore clearances are similar—then it stands to reason that the values of R_{LACD} and R_{LBCD} will be similar. Furthermore, if it takes high pressure to force leakage through the *A* side, then high pressure will be needed to drain off the leakage through R_{LBCD} on the *B* side. This fluid joins the port-to-port leakage and is carried to tank on the low-pressure side.

Check valves are often mounted integral with the motor body to relieve the case drain pressure without external case drain plumbing *(Fig. 2)*. This strategy ensures that the case will always be relieved at the lower of the two port pressures. However, this does not ensure that a low-pressure shaft seal can be used—especially if the motor has a valve for speed and directional control. When in doubt, use high-pressure shaft seals or connect the case drain port to the reservoir with its own dedicated plumbing.

Assuming that the two leakage paths are similar in effective size, then the case drain pressure will settle to about one-half the pressure on the higher side if we also assume that the low pressure is at or nearly at tank pressure. Allowing for normal backpressure to tank, and imperfect symmetry in the internal clearances, the case drain pressure can be between 30% and 70% of supply pressure. Both the shaft seal and the physical case envelope must contain this pressure without rupture. This reality is easy to see when viewing the motor in its Type-2 analytical schematic form. hp

RAY SCROGGINS | Contributing Editor

LOG LOADER Stacked with Hydraulics

Extensive use of hydraulics for motion and control applications helps a new log loader deliver high performance and productivity.

Logging equipment has to be tough and reliable to deliver productivity under demanding conditions. Hydraulics are used extensively to meet these requirements in the new Komatsu PC290LL-11, the latest addition to the company's line of log loaders. These machines sort logs that have been cut, stack them into piles, and load them onto trucks.

Powered by a 196-net hp Komatsu SAA6D107E-3 diesel engine that meets stringent EPA Tier 4 standards, the machine is available in either a live-heel log loader configuration with a 40-ft. reach or a road builder configuration with a 34-ft. reach. Log loader and roadbuilder operating weights are 40,700 kg (89,730 lb) and 37,300 kg (82,240 lb), respectively.

Komatsu PC290II-LL log loader uses hydraulic power with sophisticated controls for its swing and travel drives as well as for boom, arm, and heel functions.

TANDEM PUMPS POWER MULTIPLE FUNCTIONS

The heart of the machine's hydraulic system contains two variable-displacement piston pumps. Pump displacement has been increased over previous models to provide greater flow output and ensure operation at the most efficient engine speed. Each pump has a maximum output of 65 gpm (245 lpm) for a total maximum flow of 490 lpm (130 gpm).

The pumps' displacement is controlled by load-sensing pressure, in which the load-induced pressure is sensed, and pump flow is adjusted by appropriate valves to maintain a constant pressure drop—and, therefore, constant flow. In addition, electronic proportional control solenoids provide load-sensing and horsepower control.

Each of the log loader's tracks is driven by a variable-displacement piston motor powered by each main pump. Each hydraulic motor has a maximum displacement of 182.4 cm^3/rev (11.13 in^3/rev) and drives a planetary gearbox, which reduces rotational speed and increases torque. The final drive generates 64,250 lb of drawbar pull. By pairing the variable-displacement motors and pumps, Komatsu's machines can achieve three travel speeds (low, medium, and high) instead of the more common two. This is accomplished by changing motor displacement and controlling pump displacement electronically.

Hydraulic power for the swing function is provided by a bent-axis piston motor. Its theoretical displacement is 167.5 cm^3/rev (10.22 $in.^3$/rev), which provides a swing speed of 9.4 rpm and maximum torque of 10,949 m-kg (75,902 lb-ft).

MORE HYDRAULIC FUNCTIONS

The main pump drives many other machine functions, including the boom, arm, and heel or bucket circuits. The boom cylinder has a 150-mm (5.9-in.) bore and 1247-mm (49-in.) stroke, the arm cylinder has a 185 mm (7.28 in.) bore and 1,421 mm (60-in.) stroke, and the heel cylinder has a 140-mm (5.5-in.) bore and 1,063 mm (41.85-in.) stroke. The heel, used on many boom type loaders, assists in handling the logs by protecting the boom and controlling the end of the log. The PC290LL-11 has a *live* heel, as opposed to the fixed heel used on some machines. The live heel is operated by a separate hydraulic cylinder for increased control in positioning the log.

Inside the cab, low-profile pilot proportional control (PPC) levers let the operator control the boom, arm, and heel functions. Thumb-actuated electroproportional control sliding buttons give the operator smoother and more precise control of attachments than would be possible with hydraulic pilot controls.

Komatsu designed and manufactured the major hydraulic components used in the machine, including pumps, motors, control valves, and cylinders. The hydraulic system also includes a wide-fin oil cooler, high-pressure in-line filters, and hydraulic track adjusters. In addition to the hydraulics, Senior Service Engineer Joe Loeffler of Komatsu America Corp., says that the engine and most major components are designed and manufactured internally by Komatsu to help achieve *Komatsu Harmony*. He says this creates a harmony of components that are designed specifically to work with each other, allowing the machine to fulfill the customer's production needs in almost every application, "whether it be a workhorse, a fuel saver, or a little of both."

ELECTROHYDRAULICS IMPROVE CONTROL

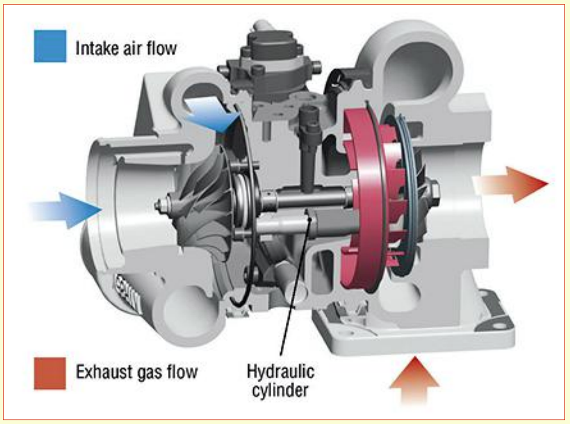
The machine's hydraulics are controlled by Komatsu's HydrauMind (Hydraulic Mechanical Intelligence) system, a closed-center system with load-sensing valves and pressure-compensation valves. The system enhances energy efficiency and operation with simple electronic controls that can be adjusted to match work conditions. Unlike typical open-center systems, HydrauMind's closed-center design combined with load sensing matches pump output to work conditions automatically. Six working modes match engine speed and pump output to load conditions based on the positions of operator controls. Those modes are:

- P Mode – Power Mode (heavy-load operations)
- E Mode – Economy Mode (emphasis on fuel economy)
- L Mode – Lifting Mode (fine control operations; increased pressure combined with lower engine speed)
- B Mode – Breaker Mode (for breaker operation or other single-acting attachments)
- ATT/P Mode – Attachment Power Mode (operation of double-acting-way attachments, such as crushers)
- ATT/E Mode – Attachment Economy Mode (operation of double-acting attachments, such as crushers, with emphasis on fuel economy)

Another feature that improves productivity is the machine's Power Maximizing system. "The system is a short-term *Power Boost*," explains Loeffler. "When the operator presses and holds the 'One Touch Power Maximizer' button, system relief pressure increases by 7% and engine speed increases by 17% for increased flow at rated pressure for up to 8.5 seconds. This function is useful in situations where the operator may hit patches of higher density or heavier material that would generally slow or stall the hydraulic system at standard relief pressure and flow." hp

HYDRAULIC TURBO CONTROL IMPROVES FUEL ECONOMY

KOMATSU AMERICA ALSO uses hydraulics in its Variable Geometry Turbocharger (VGT) to improve engine performance directly. Standard turbochargers use a turbine in the engine's exhaust stream to capture the kinetic energy of exhaust gas and convert it to rotational power. This rotational power is then transmitted through a shaft to a blower impeller, which pressurizes (charges) air in the engine's intake manifold.



A limitation of standard turbochargers is poor low-speed performance. At low engine speeds, the stream of exhaust gas does not have enough velocity to provide sufficient charging of the intake air. However, Komatsu's VGT uses a hydraulic cylinder to vary the effective area of the exhaust turbine impeller. This causes the blower impeller to rotate fast enough to charge the intake air at lower engine speeds.

The hydraulic cylinder controls the axial position of a nozzle ring, changing the effective area of exhaust turbine impeller. At high engine speeds, the cylinder is fully retracted, which exposes the full width of the turbine to the stream of exhaust. However, at lower engine speeds, a directional control valve—commanded by the engine's electronic control system—causes the cylinder to extend. This removes a portion of the turbine (the right side, as shown in the drawing) out of the exhaust flow. The narrower flow path of the exhaust passage increases laminar velocity of the exhaust flow, which causes the turbine impeller and blower impeller to rotate faster from lower exhaust flow. The result is cleaner exhaust and higher fuel economy without sacrificing engine performance.

KELLY PAFFEL | Inveno Engineering LLC

Air-System Leak Assessment in 12 Steps

Implementing a thorough compressed-air system analysis can eliminate up to 22% of a typical industrial plant's compressed-air energy costs.

A compressed-air system analysis consists of a complete review of the compressed-air system from the air intake to the end users, plus a compressed-air leak detection and correction program. To achieve success in your compressed-air system analysis, follow these 12 steps:

Spraying a suspected leak area with soapy water can verify the presence and location of a compressed air leak if bubbles continually form at the site. Experienced practitioners can also assess the severity of the leak by examining the size of the bubbles.

1. Conduct a walk-through of the entire plant or specific areas to be reviewed. This will single out some of the issues or major areas of concern that demand a higher priority. Pay special attention to areas that require regular human interface, such as quick coupling points, regulators, oilers, drip traps, filters, and areas where plant personnel work. High compressed-air leakage typically occurs in these spots.

2. Set clear goals for the analysis. Examples include:

- Get everyone involved. The most effective programs involve all levels of plant personnel.
- Eliminate the need for one or more air compressors.
- Understand the system's needs and requirements.
- Determine the air-pressure requirements of the system.
- Benchmark the different components of the system.
- Compare different types of connections. Different types of connections leak at different rates.
- Determine the projected cost of the program and document the cost to produce the compressed air.

How many goals are best? Define and document no more than three major objectives or goals to be accomplished during the system analysis. (Example: removing one or more air compressors from operation by increasing the reliability and efficiency of the compressed-air system.) Define and document no more than four minor objectives or goals to be accomplished during the system analysis. (Example: documenting the performance of a component in the compressed-air system.)

Sometimes a compressed-air system analysis originates as a request from one area in a facility to overcome a specific problem or issue. Therefore, it may not focus on improving the overall efficiency of the system. Chances of success drop significantly if you lack all the required information and a clear focus on the goals of the system analysis.

3. Determine which methods will be used to accomplish the goals, and do not institute a program unless personnel are available to complete the task. The first question: Who will

perform the work—in-house staff or a third party? Advantages and disadvantages exist for either choice.

In-house—If you do the work in-house, the people involved are more likely to know the compressed-air system. Plus, the analysis will ultimately give plant personnel a greater knowledge of what is happening in the facility. However, some specific skills are required to conduct a proper compressed-air system analysis, and if plant personnel are not completely dedicated to the program, chances are, the analysis will fail.

Also, the equipment needed for a compressed-air system analysis can be expensive, with high-end ultrasound guns costing as much as $15,000 to $20,000. However, detecting and repairing leaks should not be a one-time occurrence. Therefore, the cost of an ultrasonic instrument can pay for itself many times over if used at regular intervals.

Outsourced—Contracting out the analysis to an engineering or compressed-air system analysis firm can ensure a positive outcome. The contracted firm will provide the necessary labor and testing equipment. However, that contracted firm will not know the facility layout or operating conditions. As such, outside compressed-air leak-detection professionals may have a more difficult time defining the locations of leaks. We always recommend assigning someone from your facility to join the outsource team.

In either case, leak-detection analysis is typically the first objective of a facility's compressed-air-system efficiency improvement program. Once the compressed-air leaks are identified, prioritize them for repair.

4. Sell the program to management to obtain funding for the project. Here are several ways to prepare for your meeting with management:

- Know the cost of compressed-air operation.
- Define the objectives and goals.
- Create a road map on how to accomplish the goals.
- Articulate the expected results of the program.
- Explain how the program will continue.

5. Benchmark the compressed-air system to later determine if the program is a success or failure. This benchmark will also define the roadmap for improving the system. Review the standard operating procedures (SOPs) for the compressor operation. If SOPs do not exist, then institute a program to write them. Without SOPs, the success of the compressed-air program could be jeopardized.

6. Determine the equipment or method to be used for leak detection. Any or all of three following options are used most often:

The human ear—This is the most common process for finding leaks, but should be conducted with caution. Many plant environments require hearing protection, which makes this method ineffective. Human hearing is often unable to pinpoint the location of a leak. Furthermore, small leaks may be inaudible even to the sharpest hearing. Yet, every one of these small leaks wastes energy. Adding up the grand total of the many inaudible leaks in a plant may produce a shocking amount of energy wasted annually. For these reasons, an ultrasonic detector is much more effective at locating and quantifying compressed-air leaks.

This view shows bubbles forming at a suspected leak site. The relatively large size of the bubbles indicates a substantial leak at low pressure.

Liquids—Liquid detectors are inexpensive and easy to use, but they can be more time consuming than, say, ultrasonic detectors. One benefit to liquid: it can often be purchased in a low-temperature version if leak detection is done outside in colder weather. Another benefit: bubble size can help determine the size of the leak.

Ultrasound—The average human threshold for sensing high-frequency sounds is about 16.5 kHz. Some will not hear signals this high, while others are capable of detecting even higher-pitched sounds. The highest frequency most humans can detect is 20 kHz (20,000 Hz). Airborne ultrasound technology is the solution for sounds at frequencies ranging from 20 through 100 kHz.

7. Prioritize the largest leaks. With a compressed-air leak-detection and correction program, what degree of leakage will be corrected and what degree will not? Obviously, the larger the leak, the more energy it wastes. Some leaks may require lines to be shut down, making it important to determine when this can be done to avoid affecting production.

Once the compressed-air leaks have been fixed, maintenance personnel should remove the tags and return them to the system-analysis coordinator. The tags can then be cross-referenced back to the leak system-analysis sheet to confirm that the repairs were made.

8. Prioritize the areas to be tested based on the following criteria:

- Ease of accessibility
- Highest concentration of equipment
- Ability to document cost savings or production

9. Determine what documentation will be required. The program's success depends on documenting the compressed-air system and quantifying aspects of the system that require corrective action. Vague reports or documentation will discourage plant personnel and typically lead to program failure. Documentation should identify the location of the leak, the component that is leaking, and the severity of leakage (in cfm, if possible).

10. Find a qualified contractor. Several issues must be addressed when evaluating a contractor for conducting a compressed-air system analysis. Will the analysis be a total system review, or will the system be reviewed in sections? A common area for review is detecting and correcting compressed-air leaks. Companies that mainly conduct compressed-air leak surveys typically do not have full system-analysis capabilities.

When selecting a contractor to conduct a compressed-air system analysis, develop and follow a pre-system analysis checklist of selection objectives and goals. This will help you map out the system-analysis process from beginning to end.

Following is a suggested checklist of what to look for with a contracting firm:

• Can the firm do all of the work that you require? Or will you have to hire another company to finish a section of the project?

• Does the firm have a good safety record?

• Has the firm done this type of work before in your sector, and does it have references?

• Does the firm have an ulterior motive for doing the survey? That is, is it trying to sell a new compressor, filter, piping system, or the like?

• Is the firm involved in organizations or groups that work toward energy efficiency?

An ultrasonic detection gun is among the most effective methods of pinpointing the location and severity of compressed-air leaks.

Assigning someone from your facility to join the system analysis helps ensure that the areas you want to review are covered, and any issues that arise can be dealt with in a timely manner. The person who joins the system-analysis team can also help clarify questions about the system's operation or procedures. Assigning someone to the team will help ensure that it is operating in a safe manner and not doing anything that may cause a problem or shut down your operation.

When selecting a contractor, be sure to have a clear understanding of the scope of the work, and that your contractor knows what is expected of it. If you have any specific site requirements for training or safety certificates, ensure that the contractor knows and has the appropriate training.

Firm dates should be set for the system analysis and delivery of the report. Try to get the report within a week of the system analysis. That way, any questions or issues that arise will be easier to remember and resolve.

11. Conduct the compressed-air system analysis and make the corrections to the system. Pay particular attention to safety and verification.

How often should you conduct such an analysis? Set up continuing leak inspection by maintenance personnel so that each primary section of the plant is inspected to identify and repair leaks once a month or at least every six weeks. Keep a record of findings and results. Qualify and measure each leak to estimate its flow and assign a measurable cost value to it.

Consider setting up programs where production personnel (particularly operators and supervisors) are positively motivated to identify and repair leaks. Establish and monitor continuing air-conservation programs.

12. Market the program's results to plant management. This will keep the program top of mind, keep it moving forward, and ensure continuing success.

- Benchmark the system.
- Document the results.
- Calculate the energy savings.
- Determine the improvements in product quality.
- Resolve any issues with equipment.

KELLY PAFFEL is technical manager at Inveno Engineering LLC, Tampa, Fla. For more information, call (239) 289-3667, or visit www.invenoeng.com.

ALAN HITCHCOX | Editor

Keeping Fluid Clean in the Reservoir

Desiccant breather filters are effective in reducing the amount of dirt and water from entering hydraulic reservoirs. The ultimate solution, though, completely eliminates contaminant ingression by isolating the hydraulic fluid in the reservoir from its surroundings.

The atmosphere surrounding a hydraulic system sometimes is underestimated as a source of dirt and moisture that can infiltrate hydraulic systems—usually through the reservoir breather. The oil level continually rises and falls as cylinders extend and retract, and system cycles occur. As the oil level rises, air pushes out of the reservoir, and as it drops, ambient air is drawn in through the breather.

Thousands of microscopic airborne particles can pass through the breather filter with every machine cycle. These particles can get into the fluid and damage sensitive hydraulic components as they travel through the system.

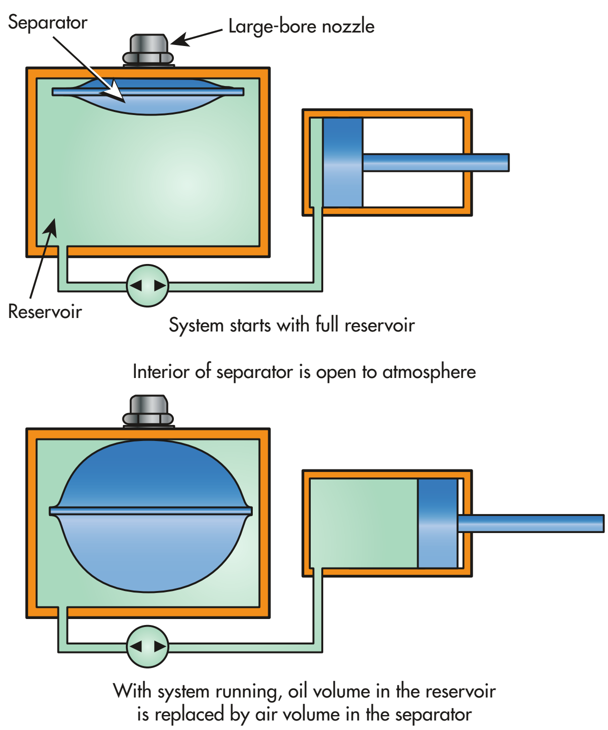
A similar condition exists with water. Moisture in the air can also enter the reservoir through the breather. The water may remain a vapor as long as the hydraulic fluid in the reservoir is at operating temperature. But when the system is shut down, temperature drops, and water can condense on the internal surfaces of the reservoir. The liquid water is then free to flow into the hydraulic fluid and also promote corrosion of the reservoir walls' inner surfaces.

Water contamination in the hydraulic fluid may deplete some additives and react with others to form corrosive byproducts. On top of that, it can increase air entrainment potential and lead to hydraulic pump cavitation.

Fortunately, most hydraulic system designers are aware of these potential problems and compensate by using a breather-filter combination to keep large airborne particles out of the reservoir. However, breather filters are not designed to exclude moisture.

Industry has answered by offering breather filters incorporating a desiccant to also dry the air entering the reservoir. These products help reduce the amount of dirt and moisture entering the reservoir, but they don't eliminate it. Furthermore, they must be replaced periodically, so the cleaner, dryer air comes at the cost of additional maintenance.

Although the variety of the reservoir filtration products available works to minimize the effects of dirt and moisture contamination, other unconventional products are available to provide a more-effective solution. These work by providing a physical barrier between the interior of the reservoir and the surrounding area. At least one solution goes a step further by reducing the amount of oxygen within the reservoir, thereby inhibiting oxidation of the fluid.



A volume compensator expands to fill the void inside a reservoir as fluid level changes, keeping ambient air from coming in direct contact with the fluid. (www.pronal-usa.com)

INTERNAL VOLUME COMPENSATOR

Unless the air is first filtered and dried, contaminants can enter the system as the fluid level changes and air is drawn into the reservoir. A sealed or pressurized reservoir is able to solve that problem, but it increases system cost and complexity. A simpler solution, offered by Pronal USA, is a volume compensator. It consists of an inflatable bladder made of heavy synthetic fiber, coated and vulcanized inside and out with an oil-compatible elastomer.

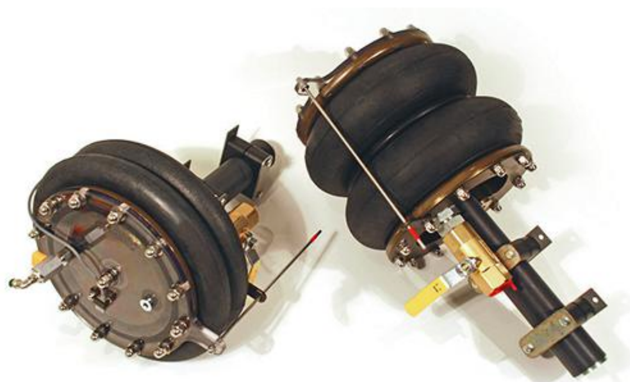
The bladder fits inside the reservoir and inflates to occupy any voids as the dropping fluid level would otherwise create a vacuum. As fluid returns to the reservoir, its pressure pushes the air out and deflates the compensator. Because the interior of the compensator contains ambient air, but its exterior is housed within the sealed reservoir, no ambient air contacts or contaminates the hydraulic fluid.

If the top of the reservoir is cluttered with valves or other components, the compensator can be placed outside the reservoir and connected with tubing. As a closed system, it still keeps ambient air from coming into direct contact with the hydraulic fluid in the reservoir. The compensator also can be configured so that the reservoir is able to work while submerged under water.

VARIABLE-VOLUME COMPENSATOR

For applications such as mobile equipment that must be transported to remote locations, a variable-volume reservoir (VVR) becomes a good option to replace a conventional reservoir. It reduces reservoir weight and space by a ratio of 20:1 or more, according to Sobacor Inc. Being sealed and airless, the VVR isolates the system's hydraulic fluid from external solid contaminants and moisture.

VVRs can be used in other applications where space and weight are concerns. Because the fluid they contain is never exposed to the environment and its contaminants, it will last three to four times longer than in a conventional reservoir, according to Sobacor. The VVR's smaller volume also enables the use of biodegradable fluids at a significantly reduced cost, with resulting environmental benefits as well.



A variable-volume reservoir, which isolates hydraulic fluid from external contaminants, significantly reduces reservoir size and weight. Typical expanded and retracted positions are shown. (www.variablevolumereservoir.com)

METAL-BELLOWS RESERVOIR

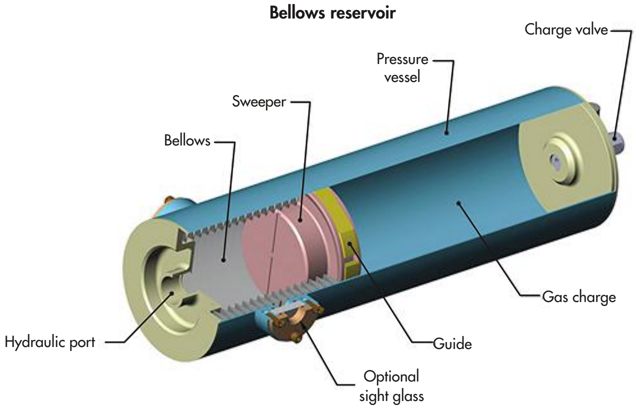
Technically, a gas-charged accumulator could be used as a hydraulic reservoir. A piston accumulator is susceptible to internal leakage, especially as the seals age. Bladder accumulators tend to leak as the bladder material becomes less flexible over time. A more robust alternative for many applications is a metal-bellows-type reservoir, designed and manufactured by Senior Bellows.

The all-welded metal construction of a bellows reservoir eliminates the leakage problems associated with traditional accumulators. Welded construction provides contamination-free operation, maintenance-free service, high reliability, long life, and being impervious to temperature extremes or corrosive environments. The elastomeric seals of a conventional accumulator may shed particles into the hydraulic fluid—not so with a metal-bellows reservoir.

A welded metal bellows is manufactured by stamping individual diaphragms from metal foil stock. Pairs of diaphragms are welded together at the inside diameter to create a single convolution. Convolutions are stacked together and welded at the outside diameter to create the flexible metal-bellows capsule. This creates an expandable/collapsible, all-metal fluid chamber.

To make the reservoir, the completed metal bellows is welded into a reservoir housing or pressure vessel. The housing or vessel may be spring-energized or gas-charged. The gas-tight, hermetic construction of the metal-bellows reservoir makes it possible to use a helium gas charge, which can offer performance superior to air or nitrogen. In contrast, helium may not be used with a piston or bladder reservoir because of possible leakage.

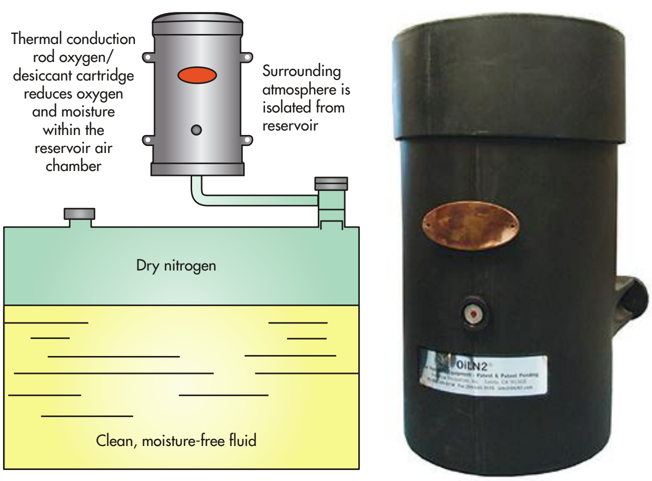
Metal bellows reservoirs typically are manufactured from high-strength stainless steel. However, titanium is often used for lightweight aircraft applications, and high-nickel super alloys also may be used in corrosive or high-temperature environments.



A metal-bellows reservoir incorporated into a pressurized housing provides contamination-free operation, high reliability, and resistance to temperature extremes or corrosive environments. (www.metalbellows.com)

LESS DIRT, WATER, AND OXYGEN

Another solution converts an open breather system to an expandable bladder system, and passes air within the reservoir through a desiccant dryer and oxygen absorber to remove moisture and prevent corrosion. The OilN$_2$, invented by John A. Paoluccio, P. E., of Inventive Resources Inc., combines a bladder that physically isolates the air in a hydraulic system's reservoir with a thermal conduction rod that attracts and captures oxygen and moisture already in the reservoir into a replaceable cartridge.



The OilN$_2$ incorporates a bladder to isolate air within the system as well as a combination thermal conduction rod and cartridge with oxygen absorber and desiccant dryer media. (www.oiln2.com)

A variation on the bladder principle is Parker Hannifin's KleenVent reservoir isolator. It uses an external elastomeric bladder as a "lung" that allows changes in gas volume in the reservoir, but prevents mixing with outside air.

Once the $OilN_2$ has been connected to either the reservoir's breather vent port or remotely mounted and connected, it physically isolates the air in the system from ambient conditions. The air still existing in the reservoir, however, typically contains airborne dirt, moisture, and oxygen.

The $OilN_2$ protects the system by altering the interior environment of the reservoir to a clean, dry nitrogen state. Oxygen and moisture molecules in the internal air are attracted and captured by a combination thermal conduction rod and cartridge with oxygen absorber and desiccant dryer media. The attracted oxygen molecules undergo a chemical reaction that locks them in the cartridge. This reduces the oxygen in the air, leaving a high concentration of nitrogen. The easily replaceable cartridge may last for years in a tight system.

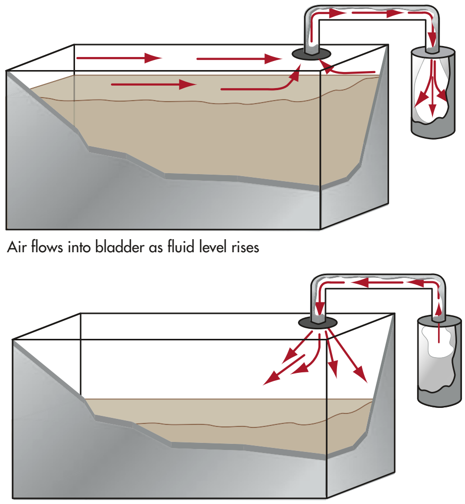
A cool spot is formed on the thermal conduction rod, which causes condensation of oxygen and moisture. The rod works continuously, even when the hydraulic system itself is idle. However, it is more aggressive when equipment is turned off and cools after each operating cycle. When the system operates and heats the oil, water molecules are driven from the oil and enter the isolated air chamber. Depending on the system, return on investment can occur in just a few months, according to the inventor.

HYDRAULIC FLUID ISOLATOR

A variation on the bladder principle is Parker Hannifin's KleenVent reservoir isolator. It uses an external elastomeric bladder as a "lung" that allows changes in gas volume in the reservoir, but prevents mixing with outside air.

In operation, when the hydraulic reservoir is filled, the air on top of the oil goes into the bladder. When the oil level in the reservoir goes down, the bladder pushes air back into the reservoir. This containment approach completely eliminates the potential of pulling in outside air. The atmosphere acts against the outside of the bladder isolator, while internally the same air is exchanged continuously between the reservoir and the bladder.

This separation allows the system to operate normally, while preventing ingestion of airborne contaminants. Unlike conventional breather-vent filters, the reservoir isolator provides positive separation without clogging, making it maintenance-free. With proper bladder material selection, these units are compatible with virtually any type of hydraulic fluid. They are available in standard capacities up to 100 gal and can be used in parallel to achieve even larger capacity. hp



The Parker KleenVent reservoir isolator uses an elastomeric bladder as a "lung" that allows changes in gas volume in the reservoir, but prevents mixing with outside air. (www.parker.com/kleenvent)

Air flows into bladder as fluid level rises

Air flows back into reservoir as fluid level drops

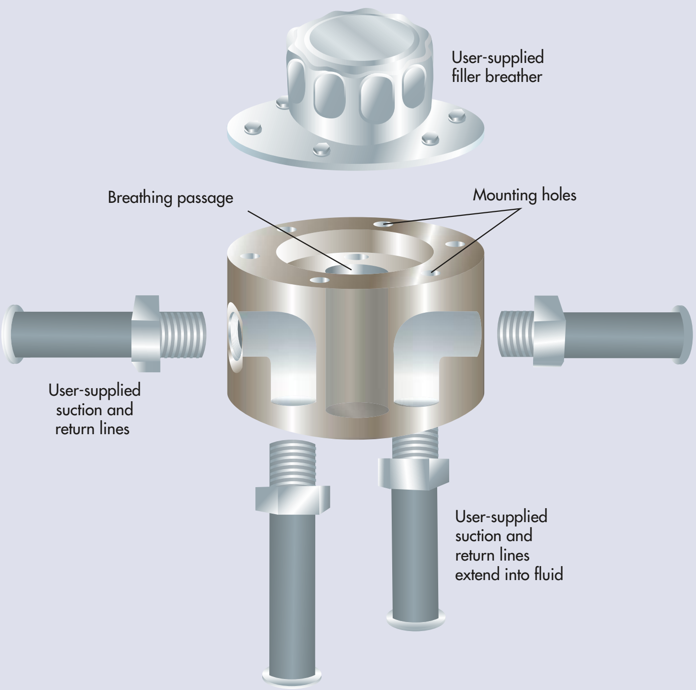
FILLER-BREATHER ADAPTER SIMPLIFIES HOOKUPS

THE SOLUTIONS DESCRIBED here are great for preventing dirt and moisture from entering the system through the reservoir. But reservoirs aren't the only source of contamination. Dirt and moisture can also enter through actuators, especially piston rod seals on cylinders. Moreover, contaminants may be self-generated by pumps, motors, and degradation products from the fluid itself. So, even if you completely eliminate dirt and moisture from entering the hydraulic system through the reservoir, you still need to add filters within the system.

One of the most effective filtration methods is offline filtration, often referred to as a kidney loop. A kidney loop uses a circulating pump to draw hydraulic fluid from the reservoir, route it through a filter, and pump the clean fluid back into the reservoir. Heat exchangers often are incorporated into the kidney loop to control fluid temperature within prescribed range.

The problem is, installing a kidney loop or adding an auxiliary circuit to an existing system requires making sure any lines you work on are not pressurized after shutting off power. Only at this point should you open the hydraulic line you'll be tapping into, drain the fluid from the line, install a tee or other fitting, and then connect everything back up. You then have to repeat this process for the return line. However, you're still not done, because you may have to bleed air from the line, and you certainly should check for leaks.

To eliminate these difficulties, Tom Nell, certified fluid power engineer at Flpwr.com, developed an adapter that contains connections to draw fluid from, and return fluid to, a hydraulic reservoir. The adapter fits between the reservoir and filler breather. It comes with the hardware to mount the adapter to a standard filler-breather port on a reservoir and provides a surface for mounting a filler breather on top of it. The adapter incorporates a pair of SAE -12 ports that each lead to a ¾-in. vertical tube, which extends into the hydraulic fluid in the reservoir.



One tube can be used for suction and the other for return, simply by connecting suction and return lines to the respective port. The adapter makes it easy to tap into an existing hydraulic system to add an off-line filtration circuit (kidney loop) or other auxiliary circuit. The ports also can be used to add fresh fluid to the reservoir without having to remove the filler-breather cap, which would open the reservoir to the atmosphere.

BRENDAN CASEY | HydraulicSupermarket.com

Pump Intake Line Isolation: Good Idea or Bad?

Designers of hydraulic power units often specify a shutoff valve to isolate the pump inlet line from the reservoir, primarily as a maintenance aid. But there's more to consider than what you might initially suspect.

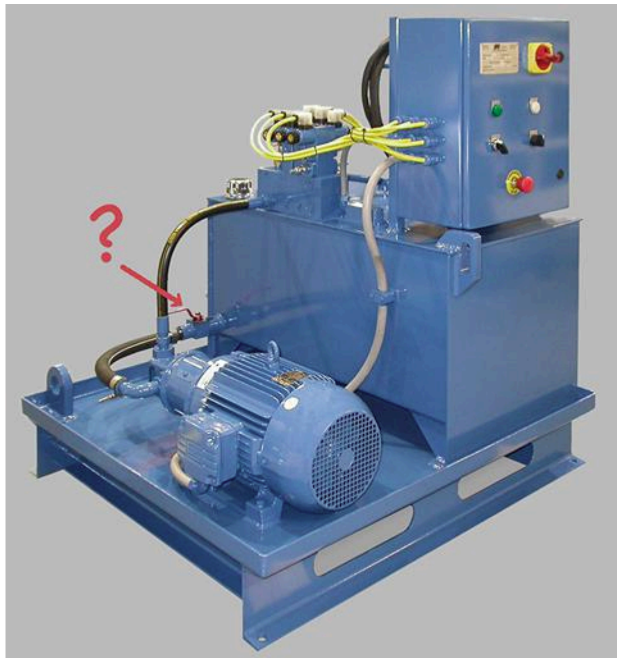
In two previous articles, I've challenged traditional thinking about the installation of suction strainers in pump intake lines and depth filters in the drain lines of piston pumps and motors. To recap, although the installation of both of these devices is a great idea purely from a contamination control perspective, both can have a serious, negative impact on overall reliability of the hydraulic machine.

This time, I have a third, similar quandary for you to ponder: the installation of pump intake isolation valves. As background to this issue, at a recent hydraulic maintenance workshop I presented, I was asked for my opinion on isolation valves on pump intake lines and whether a more-expensive ball valve is mandatory, vis-à-vis the generally cheaper butterfly type.

THREE CHOICES

At the root of this question is the negative effect of turbulence in the pump intake line. The argument for using a *ball valve* as an intake line isolation valve is that, when it's open, the full bore of the valve is available for oil flow. So if you have a 2-in. ball valve installed in a 2-in. intake line, when the valve is open, it's as if it isn't there at all—at least from the oil's point of view.

A butterfly valve, on the other hand, is not full-bore. Even when fully open, the butterfly remains in the fluid path and presents a partial restriction, which is irregular in shape. This causes turbulence, which can result in dissolved air coming out of solution in the intake line. If this happens, these air bubbles will collapse when exposed to pressure at the pump outlet. In other words, a butterfly valve may cause gaseous cavitation.



This hydraulic power unit has a ball valve acting as an isolation valve for the pump. Would a butterfly valve be a better choice, or does a third option exist?

So if an intake line isolation valve is installed, which is best: ball or butterfly type? As with a lot of issues in hydraulics, it depends. In a perfect world, I would always choose a ball valve ahead of a butterfly valve. And there is virtually no cost penalty involved in doing so for intake line diameters up to 3 in.

But when you get into 4-, 6-, and 8-in. diameters, ball valves are very expensive in comparison to their butterfly counterparts. And ball valves take up a lot more space—particularly in overall length. So, in a mobile machine, for example, not only may the cost of a large-diameter ball valve be prohibitive, there may not even be enough space between the tank outlet and the pump inlet to install it.

But as you may have guessed from my introduction, there is a third alternative: don't install an intake line isolation valve at all. Intake line isolation valves are like suction strainers, insofar as many people wrongly believe they are essential. When in reality, but for a few exceptions, they are not.

CONSIDERATIONS OF NOT USING THE VALVE

Here are a few of the benefits of not installing an intake line isolation valve:

- The cost of the component is saved.
- The distance between the tank and the pump can be shortened.
- Best of all, the pump can never be started with the intake isolation valve closed.

Of course, the first question that pops into most people's minds in response to this is: "But how can I change out the pump if there is no isolation valve on the intake line?" There are two answers to this. First, if the pump has failed catastrophically and you are doing things "right," the oil should be pumped out of the tank using a filter cart and into clean drums or other suitable container. Then the tank should be thoroughly cleaned, the pump changed out, and the oil—assuming it is still serviceable—pumped back into the tank using a filter cart.

The common objections to this are: "Oh, we don't have time for that," or "We don't have 10, 20, or however many clean drums sitting around!" A workaround for those who don't want to do the job right is to seal off all penetrations into the tank headspace and connect an industrial vacuum cleaner to the tank breather penetration. Switch the vacuum cleaner on while the pump is changed out. Then, when the debris from the previous pump failure causes the replacement pump to fail, repeat the exercise.

I know, there are exceptions. If there's more than one pump drawing from the same tank. Or it's just not practical to pump, say, 3,000 gal of oil out of the tank. But even in these cases, pulling a vacuum on the reservoir headspace will still work. With that said, I am willing to concede intake-line isolation valves sometimes are a necessity. In which case, it's wise to make sure they've got proximity switches to prevent the pumps from being started when the valves are closed.

My preferred approach to pump intake line isolation is: fit neither ball valve nor butterfly valve if you can get away with it. If you have to have one, use a ball valve if cost or space aren't issues.

But despite the odd exception, my preferred approach to pump intake line isolation is: fit neither ball valve nor butterfly valve if you can get away with it. If you have to have one, use a ball valve if cost or space aren't issues. But if either of these things is a problem, then a butterfly valve is the only choice left.

How bad can that be? In truth, I can think of many applications where butterfly valves are used as pump intake isolation valves. Large hydraulic excavators are a common example. They have multiple pumps drawing fluid from big tanks through large diameter intake lines and not much space between the tank and pumps. All these conditions can rule out my other two, more preferred options (no valve or ball valve).

WHAT EXPERIENCE TEACHES

I don't think I've ever seen a pump taken from a large hydraulic excavator that didn't have at least some cavitation erosion damage. The damage in this severe-duty application can be regarded as normal wear and tear. Could this cavitation damage be attributed to turbulence caused by the presence of a butterfly valve? Sure, it could. But many other things could be responsible, too. The only way to know for sure would be to compare two pumps operating under the exact same conditions—one with a butterfly valve installed and one without. If you know of a hydraulic machine OEM who has this type of empirical data, I would love hear about it; contact me at info@HydraulicSupermarket.com.

A ball valve produces no appreciable restriction to flow, but a comparably rated butterfly valve can cost less requires less and has a shorter length. So how do you decide which is best for your application, or to go with neither?

BRENDAN CASEY is the founder of *HydraulicSupermarket.com* and the author of *The Definitive Guide to Hydraulic Troubleshooting, The Hydraulic Troubleshooting Handbook, Insider Secrets to Hydraulics, Preventing Hydraulic Failures, The Hydraulic Troubleshooting Handbook, The Mobile Hydraulics Handbook, Hydraulics Made Easy, Advanced Hydraulic Control,* and *The Definitive Guide to Hydraulic Troubleshooting*. A hydraulics specialist with an MBA, he has more than 25 years' experience in the design, maintenance, and repair of mobile and industrial hydraulic equipment.

Compact Air Cylinders Come in Various Models

COMPACT AIR CYLINDERS come with an F Series mounting option, eight standard bores from $^{9}/_{16}$ to 4 in. and stroke lengths ranging from 0.125 to 16 in. with 0.001-in. increments. Several front-and rear-end cap mounting styles are available as well. Thanks to permanent grease lubrication, L-option seals, and hard chrome-plated piston rods, they have an improved rod-seal life and performance rated for 3,000 miles of travel. The bumper is designed for maximum performance, and thick-walled aluminum and composite cylinder bodies can also be included. Models can be chosen for low-pressure hydraulic designs, metallic scrapers, and compatibility with magnetic reed switches.

BIMBA MFG., (708) 534-8544, www.bimba.com

Cylinders Automatically Accommodate Varying Loads

THE IMI NORGREN ISOLINE family of ISO 15552 standard cylinders features adaptive cushioning that naturally accommodates varying loads, as well as application changes without any adjustments to the cushion screw. Weighing 20% lighter than previous models, they reduce machine weight and shipping costs, and adhere to tight tolerances for smoother piston movements and lower leakage in lock-out systems. Featuring switch mounting on three sides, robust construction, and a clean profile, they are flexible in food-processing applications and heavy-duty industrial settings.

IMI PRECISION ENGINEERING, (800) 514-0129, www.imi-precision.com

Devices Protect Against Hose Leak Dangers

THE HOSEGUARD FROM the Proportion Air Line of Safety Regulators protects against dangers from broken air hoses such as uncontrolled whipping or injury of personnel. It can be easily installed on pneumatic systems and pre-set based on internal flow levels. When activated, a small bleed hole will allow for air to move through the line so it can be replaced without having to shut down the entire system. The Hoseguard will automatically reset once the line is replaced.

PROPORTION-AIR INC., (877) 760-7049, www.proportionair.com

Shaker Cylinders Feature Rugged Design for High Load Support

PNEUMATICALLY-DRIVEN COMPACT shaker systems are beltless feeders that can be used in conveyor systems typically found in the stamping industry or other parts-transfer and scrap-removal applications. They have minimal moving parts, and are installed by connecting mounts to a die base. They do not require any electrical connection, and can be directly connected to a compressed air source. Their piston design delivers smooth operation with low noise and high energy absorption without the need for lubrication. Five standard base models are available with bore sizes from ¾ to 2½ in. They fit specific die openings and tray loads up to 50 lbs, and support maximum loads up to 140 lb.

COMPACT AUTOMATION PRODUCTS, (864) 647-9521, www.compactautomation.com

Electrohydraulic Drivers are Bluetooth-Configurable

COMPACT XMD ELECTROHYDRAULIC drivers offer advanced features such as simplified configuration via a free cell phone App, SAE J1939 CAN communication capabilities, a selection of pre-programmed profiles for common tasks, a comprehensive diagnostic mode and the ability to easily shape and apply output curves. The drivers are sealed in an IP69K-rated, solid-potted enclosure to stand up to the extreme environmental conditions. They are both CE and E-Mark rated, achieving 100-V/m radiated immunity (Level 3, Class A).

Initially offered in two models (the XMD-01 has a universal input and PWM output; the XMD-02 has two universal inputs and two PWM outputs) the drivers accept a wide range of common input formats, all of which are software configurable. PWM outputs can superimpose 30- to 500-Hz dither in 1-Hz intervals to improve the performance and precision of pumps, valves, cylinders, motors and other components. Also included are integral diagnostics for open/short circuit detection, integrated fly-back protection, a +5-Vdc reference output, and a 0-65-second ramp time programmable in 1-mS increments.

SUN HYDRAULICS CORP., (941) 362-1200, www.sunhydraulics.com/model/XMD-02

Biodegradable Hydraulic Fluids Withstand High Temps

BIOFLO AW BIODEGRADABLE Anti-Wear Hydraulic Fluids are made of readily biodegradable renewable resources, delivering high thermal and oxidative stability for long service life and minimal changes to viscosity over a vast range of temperatures. They contain high-lubricity base oils coupled with proprietary nontoxic anti-wear and anti-corrosion additives. They are credited with reducing operating temperatures, friction, and wear in mobile and industrial hydraulic systems. Available in ISO grades 32, 46, and 68, and a sheen-free product, they are suitable for ecologically sensitive applications. Synthetic formulations are available in ISO grades 15, 22, 32, 46, and 68. In addition, BioFlo 68 is a fire-resistant fluid made from oleic vegetable oils. It is compatible with most mineral oils and polyolester-based hydraulic fluids.

ELEMENTBIO, (888) 995-7913, www.elementbio.com

Advertisers Index

Although every effort has been made to ensure the accuracy of this index, the publisher cannot be held responsible for any errors or omissions.

ROBERT J. SHEAF, JR. | Contributing Technical Expert

Tube Bender Has Drift Problem

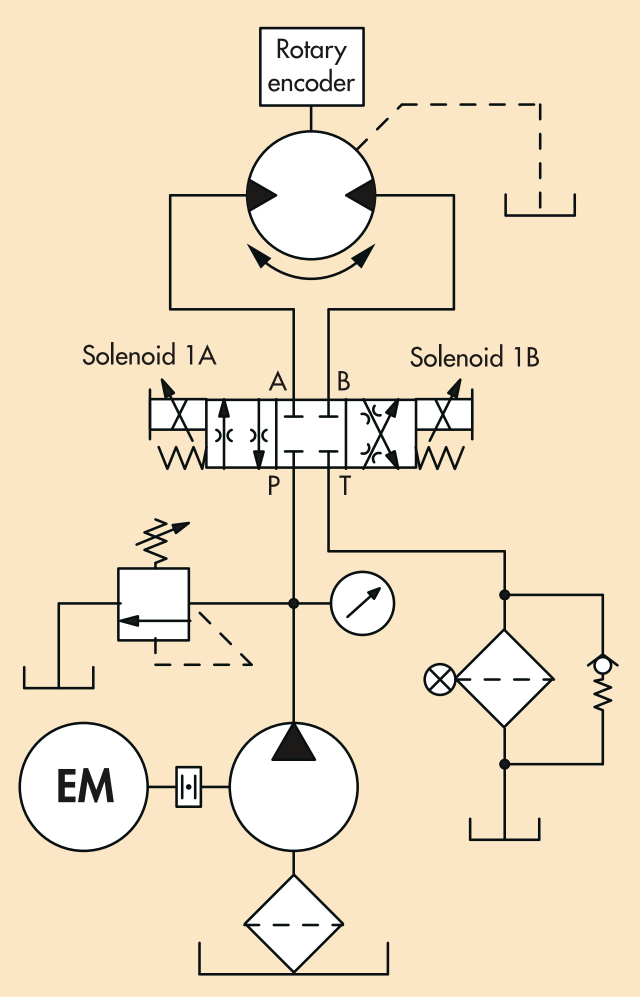
VOSS VALE FABRICATES stainless steel aircraft tube assemblies. Lightning struck one of their buildings, destroying the control panel of an old 1985 automated tube bender that had been updated around 2000.

A new, more modern control was installed, but it did not maintain the needed position accuracy on three proportionally controlled hydraulic motors. A closed-loop PID position-control loop program using a rotary encoder on each motor for feedback signals, would send a conditioned output to each existing amplifier card. The cards received the PID command signal from the new controller and drove the proportional valves. There wasn't any adjustable function on the cards that could condition or adjust the signal to the valve. The size D03 proportional valves had standard overlapped spools (properly sized for the flow) but without spool position feedback.

The owner was technically sharp and felt that the control technician wasn't tuning the PID loop correctly. The technician, on the other hand, felt the rotary encoder was causing the problem. However, installing a new one had no effect on the problem.

I looked at the application, and spoke with the operator. I found he knew the machine well and that the old controller also had a similar drifting problem. However, he knew how to compensate for the problem, and most of his parts would pass inspection. The new drifting problems were somewhat different, and the owner wanted different operators to be able to use the machine. The basic circuit for one of the motor circuits is shown.

What do you think would solve the problem?



FIND THE SOLUTION

Think you know the answer to this month's problem? Submit your solution by emailing rjsheaf@cfc-solar.com.

All correct solutions submitted by November 24, 2017, will be entered into a random drawing for a $50 gift card. The winner will be notified, and his or her name will be printed in a future issue. Only one gift card will be awarded to any participant within a calendar year.

Congratulations to Doug Hite, of Charlotte, N.C., whose name was chosen from those who correctly solved last month's challenge.

SOLUTION TO LAST MONTH'S CHALLENGE:

Telescopic Cylinder Drops Unexpectedly

WHEN TELESCOPIC CYLINDERS extend, all the moving stages should go out together. When the outer (largest) stage extends to its limit, the remaining stages should continue to extend until the next outer stage bottoms out. Only then should the final (smallest) stage extend. When retracting, the sequence occurs in the reverse order.

At the engine plant, adjusting one of the cylinder's head nuts corrected the improper staging. The head nut on the non-moving stage holding the seal packing in place against the outer moving stage needed to be tightened to increase friction on the large outer sleeve. Another fix would be to loosen the head nut on the outer sleeve to decrease friction where it contacts the inner moving sleeve.


Industrial shock absorbers
Safety shock absorbers
Industrial gas springs
Vibration control
Hard
Soft

Why Settle for the Kids' Table?

Some technical magazines cover a wide range of topics to capture a wide range of advertisers. Trouble is, their readers have so many interests that only a small fraction is interested in fluid power technology. A couple of magazines have fluid power in their title, but a name is no match for having served the industry for 70 years and an editorial staff with more than 30 years' experience and knowledge of the technology.

The kids' table is fine for kids, but wouldn't you rather reach 37,000 qualified subscribers with a grownup appetite for fluid power technology?

Get more details on all future opportunities at DESmarketing.penton.com.

UPCOMING MENUS:

Coming down the road in *H&P*

December	January/February*	March
• 2018-2019 Fluid Power Handbook & Directory • Electropneumatics in Automation • Hydraulic Hose Technology • Hydraulic Filtration	• 70th Anniversary Issue • Pneumatic Cylinders • Designing with Hydraulic Cylinders • Manufacturers Index	• Hydraulic Pumps • Pneumatics in Factory Automation • Industy Focus: Construction Equipment • Specifying Hydraulic Hose

**Bonus Distribution at Work Truck Show — 3/6 to 3/9/18, Indianapolis*

Hydraulics & Pneumatics