DISTRIBUTION PIPING

Understanding Pressure Drop

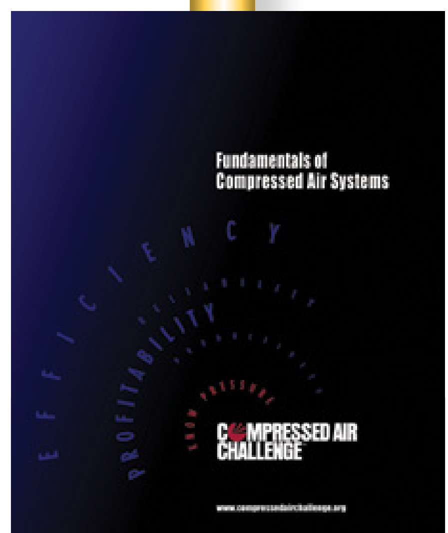
BY THE COMPRESSED AIR CHALLENGE®

The Compressed Air Challenge® (CAC) is a voluntary collaboration of industrial users, manufacturers, distributors and their associations, consultants, state research and development agencies, energy efficiency organizations and utilities. This group has one purpose in mind — helping you enjoy the benefits of improved performance of your compressed air system. The mission of the Compressed Air Challenge® (CAC) is to provide resources that educate industrial users about optimizing their compressed air systems.

One of the many issues that can affect compressed air system efficiency and pressure stability is pressure drop. "The first and foremost complaint I normally hear from an operator or production area is, 'I don't have enough pressure'," says Frank Moskowitz, one of CAC's advanced management instructors. "The air compressor operator usually gets the blame, but often the problem is actually a flow restriction that manifests itself as low pressure."

"Pressure drop problems can stem from undersized distribution piping, which leads air system operators to spend significant time and money to optimize their distribution systems," says Tom Taranto, another CAC advanced management instructor. "But often, most of the problem is between the header and machine in the last 30 feet of piping, or what I call the 'last dirty thirty'. Students of our fundamentals and advanced seminars will learn about these issues and some strategies needed to pinpoint these problems."

The Compressed Air Challenge® has developed some resources to help understand pressure drop and its effects, and point the way in what to do about it. Participants in our **Fundamentals and Advanced Management of Compressed Air Systems** training learn about pressure drop and how to recognize it in their systems. There are also some written resources available. The following are two excerpts from CAC-developed documents. For more information about these useful information sources and to access many others, please visit our website at **www.compressedairchallenge.org.**



*The Compressed Air Challenge® (CAC) is pleased to announce the launch of Fundamentals of Compressed Air Systems WE (web based) on February 22, 2010. Led by Frank Moskowitz and Tom Taranto, this web-based version of the popular Fundamentals of Compressed Air Systems training uses an interactive format that enables the instructor to diagram examples, give pop quizzes and answer students' questions in real time. The introductory rate for the course is $795 and participation is limited to 25 students. Please visit the CAC website today (**www.compressedairchallenge.org**) to access online registration and for more information about the training. The deadline for registration is February 8, 2010.*

*If you have additional questions about the new web-based training or other CAC training opportunities, please contact the CAC at **info@compressedairchallenge.org** or call 301-751-0115.*

DISTRIBUTION PIPING: UNDERSTANDING PRESSURE DROP

Pressure Drop

Following is an excerpt from CAC's **Improving Compressed Air System Performance: A Sourcebook for Industry**.

Pressure drop is a term used to characterize the reduction in air pressure from the compressor discharge to the actual point-of-use. Pressure drop occurs as the compressed air travels through the treatment and distribution system. A properly designed system should have a pressure loss of much less than 10% of the compressor's discharge pressure, measured from the receiver tank output to the point-of-use.

Excessive pressure drop will result in poor system performance and excessive energy consumption. Flow restrictions of any type in a system require higher operating pressures than are needed, resulting in higher energy consumption. Minimizing differentials in all parts of the system is an important part of efficient operation. Pressure drop upstream of the compressor signal requires higher compression pressures to achieve the control settings on the compressor. The most typical problem areas include the aftercooler, lubricant separators and check valves. A rule of thumb for systems in the 100 psig range is: for every 2 psi increase in discharge pressure, energy consumption will increase by approximately 1% at full output flow (check performance curves for centrifugal and two-stage, lubricant-injected rotary screw compressors).

There is also another penalty for higher-than-needed pressure. Raising the compressor discharge pressure increases the demand of every unregulated usage, including leaks, open blowing, etc. Although it varies by plant, unregulated usage is commonly as high as 30–50% of air demand. For systems in the 100 psig range with 30–50% unregulated usage, a 2 psi increase in header pressure will increase energy consumption by about another 0.6–1% because of the additional unregulated air being consumed. The combined effect results in a total increase in energy consumption of about 1.6–2% for every 2 psi increase in discharge pressure for a system in the 100 psig range with 30–50% unregulated usage.

An air compressor capacity control pressure signal is normally located at the discharge of the compressor package. When the signal location is moved downstream of the compressed air dryers and filters to achieve a common signal for all compressors, some dangers must be recognized and precautionary measures taken. The control range pressure setting must be reduced to allow for actual and potential increasing pressure drop across the dryers and filters. Provisions also must be made to prevent exceeding the maximum allowable discharge pressure and drive motor amps of each compressor in the system.

Pressure drop in the distribution system and in hoses and flexible connections at points-of-use results in lower operating pressure at the points-of-use. If the point-of use operating pressure has to be increased, try reducing the pressure drops in the system before adding capacity or increasing the system pressure. Increasing the compressor discharge pressure or adding compressor capacity results in significant increases in energy consumption.

Elevating system pressure increases unregulated uses, such as leaks, open blowing and production applications, without regulators or with wide-open regulators. The added demand at elevated pressure is termed "artificial demand", and substantially increases energy consumption. Instead of increasing the compressor discharge pressure or adding additional compressor capacity, alternative solutions should be sought, such as reduced pressure drop and strategic compressed air storage. Equipment should be specified and operated at the lowest efficient operating pressure.

What Causes Pressure Drop?

Any type of obstruction, restriction or roughness in the system will cause resistance to air flow and cause pressure drop. In the distribution system, the highest pressure drops are usually found at the points-of-use, including undersized or leaking hoses, tubes, disconnects, filters, regulators and lubricators (FRLs). On the supply side of the system, air/lubricant separators, after coolers, moisture separators, dryers and filters can be the main items causing significant pressure drops.

The maximum pressure drop from the supply side to the points-of-use will occur when the compressed air flow rate and temperature are highest. System components should be selected based upon these conditions, and the manufacturer of each component should be requested to supply pressure drop information under these conditions. When selecting filters, remember that they will get dirty. Dirt loading characteristics are also important selection criteria. Large end users who purchase substantial quantities of components should work with their suppliers to ensure that products meet the desired specifications for differential pressure and other characteristics.

The distribution piping system often is diagnosed as having excess pressure drop because a point-of-use pressure regulator cannot sustain the required downstream pressure. If such a regulator is set at 85 psig and the regulator and/or the upstream filter has a pressure drop of 20 psi, the system upstream of the filter and regulator would have to maintain at least 105 psig. The 20 psi pressure drop may be blamed on the system piping rather than on the components truly at fault. The correct diagnosis requires pressure measurements at different points in the system to identify the component(s) causing the excess pressure drop. In this case, the filter element should be replaced or the filter regulator size should be increased, not the piping.

Minimizing Pressure Drop

Minimizing pressure drop requires a systems approach in design and maintenance of the system. Air treatment components, such as after coolers, moisture separators, dryers and filters, should be selected with the lowest possible pressure drop at specified maximum operating conditions. When installed, the recommended maintenance procedures should be followed and documented. Additional ways to minimize pressure drop are as follows:

- Properly design the distribution system
- Operate and maintain air filtering and drying equipment to reduce the effects of moisture, such as pipe corrosion
- Select after coolers, separators, dryers and filters with the lowest possible pressure drop for the rated conditions
- Reduce the distance the air travels through the distribution system

Specify pressure regulators, lubricators, hoses and connections having the best performance characteristics at the lowest pressure differential. These components must be sized based upon the actual rate of flow and not the average rate of flow.

Best Practices and Tips for Compressed Air Piping Systems

A brief synopsis of "Section 3, Distribution System" from **Best Practices for Compressed Air Systems** follows. This 325-page book is available at our **bookstore.**

Pressure losses due to inadequate piping will result in increased energy costs and variations in the system pressure, with adverse effects on the production process.

How to Select Pipe Sizes:

The compressor room header into which the air compressor(s) discharge(s), should be sized so that the air velocity within the header does not exceed 20 ft/sec, thus allowing for future expansion. Distribution header piping leaving the compressor room should be sized to allow an air velocity not to exceed 30 ft/sec, to minimize pressure drop.

It also is recommended that the air from each compressor not enter the header at 90° to the header axis, but at a 45° angle in the direction of flow and always using wide radius elbows.

Iron and carbon steel piping is generally sized by the nominal bore diameter. Copper and steel tubing normally is sized by outside diameter.

Any type of obstruction, restriction or roughness in the system will cause resistance to air flow and cause pressure drop.

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How About the Future?

The main header and distribution piping should be sized to take into account anticipated future expansions. If the initial piping is sized only for present flow requirements, then any additions will cause increased pressure losses in the entire system.

The next-larger size pipe will add to materials costs, but may add little to installation labor costs and should reduce the pressure drop substantially, with corresponding savings in operating costs.

How about Materials?

Many industrial plants use schedule 40 steel piping, with or without galvanizing, for 100–125 psig service. Many food, pharmaceutical, textile and other plants that use non-lubricated compressors install stainless steel piping to avoid potential corrosion problems and the resulting downstream contamination.

For special applications, federal, state and local codes should be consulted before deciding on the type of piping to be used. The usual standard to be applied is ANSI B31.1. For Healthcare facilities, consult Standard NFPA 99 of The National Fire Protection Association. BP

For more information, please visit www.compressedairchallenge.org.

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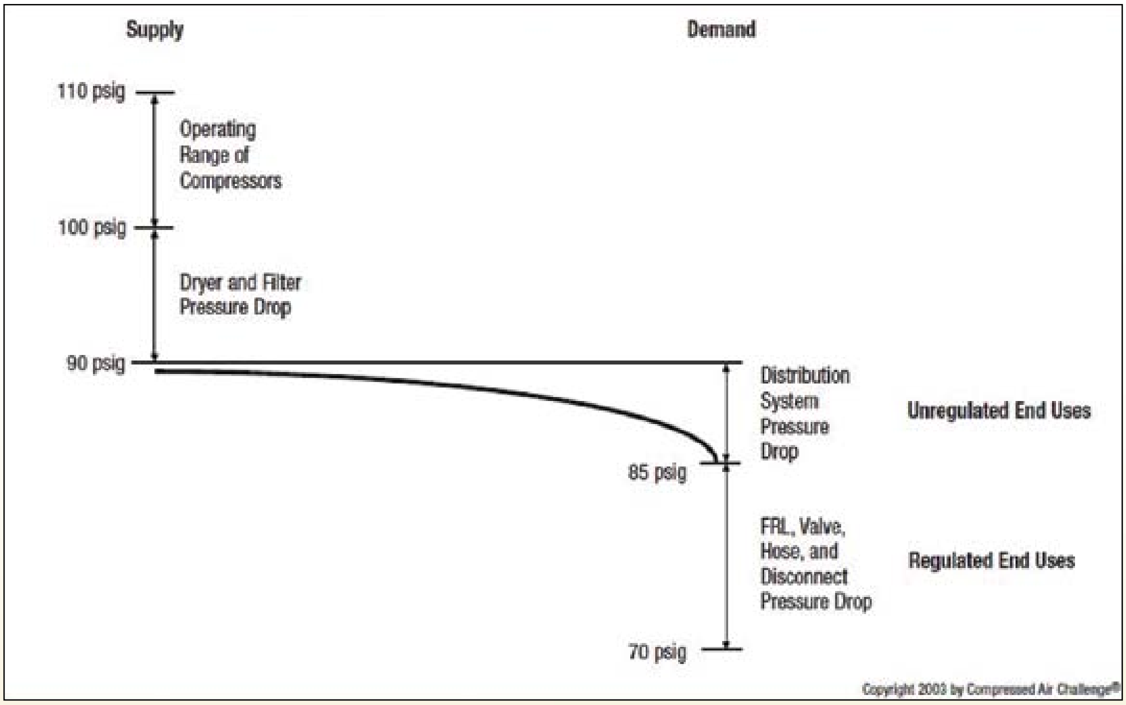
— Frank Moskowitz, CAC's Advanced Management Instructor



CAC Training can help you discover your plant's pressure profile

RESOURCES FOR ENERGY ENGINEERS

TRAINING CALENDAR

TITLE	SPONSOR(S)	LOCATION	DATE	INFORMATION
Compressed Air Challenge® Fundamentals of Compressed Air Systems	MREA Great River Energy	Maple Grove, MN	2/11/10	Shari Wormwood Tel: 763-424-7231 email: shari@mrea.org www.compressedairchallenge.org
Compressed Air Challenge® Fundamentals of Compressed Air Systems	Compressed Air Challenge®	Online Web Training	2/22/10	Register by Feb. 8, 2010 Tel: 301-751-0115 www.compressedairchallenge.org
Compressed Air Challenge® Advanced Mgmt of Compressed Air Systems	Massachusetts Energy Efficiency Partnership National Grid	Waltham, MA	2/22/10	Mark Gerrish Tel: 413-545-2853 email: mfgerrish@ecs.umass.edu www.compressedairchallenge.org
Intro to Compressed Air Systems	Association of Energy Engineers Globalcon 2010	Philadelphia, PA	3/22/10	Gary Wamsley Tel: 678-977-1508 email: gary.wamsley@comcast.net

Editors' Note: If you conduct compressed air system training and would like to post it in this area, please email your information to rod@airbestpractices.com.

INDUSTRY NEWS

Independent Testing Verifies the Performance of Ingersoll Rand Compressed Air Dryers

Ingersoll Rand's refrigerated dryers have been verified against CAGI (Compressed Air and Gas Institute) data sheets by independent third-party testing. Based on this testing, the refrigerated dryers are now certified by CAGI. Of the many dryer manufacturers that have participated in this verification process, Ingersoll Rand is one of only three to receive the CAGI certification. The certification means that Ingersoll Rand dryers perform exactly to the standards the company publishes. Certification is an assurance that an Ingersoll Rand dryer will meet the users' intended performance.

The verification of the product was done through CAGI's Performance Verification Program. During the testing, energy consumption, pressure drop and pressure dew point are compared with data provided by Ingersoll Rand on standardized data sheets available from CAGI. The program applies to stand-alone type refrigerated dryers with 200–1,000 standard cubic feet per minute (scfm) capacities. The program is available to all manufacturers of refrigerated compressed air dryers, regardless of whether they are a CAGI member of not.

The CAGI program provides a means for users to assess and compare brands and models before purchasing, and eliminates the need for interpretation of non-standard data. Because Ingersoll Rand units perform in accordance with the information on the data sheets, they are certified to carry the official CAGI Performance Verification Program label. Ingersoll Rand is one of the few dryer manufacturers to receive this certification.

Compressed air users are invited to view the data sheets for air dryers at www.ingersollrandproducts.com, or contact their local Ingersoll Rand representative for information.

LITERATURE & SERVICES PICKS

The Compressed Air System Solution Series©

Scot Foss has provided his expertise to many of the world's leading manufacturing and processing corporations by finding solutions to their problems. Foss is one of the world's leading experts in compressed air systems, known for his sometimes-controversial approach to the issues that face plant engineers, maintenance managers and production engineers.

Written in a conversational format, this 1,100-page book with 165 illustrations brings you solutions with a straight on, common sense approach supported by technology. The author focuses on concepts and applications, which are guaranteed to improve production results and energy efficiency. The chapters of the book are as follows:

1. Change Your Way of Thinking about Compressed Air
2. Designing a New System
3. Troubleshooting the System
4. Instrumentation and Information Management
5. Compressed Air Storage and Using Potential Energy
6. Piping and Piping Systems
7. Compressor and System's Controls
8. The Business of Demand
9. Supply Energy
10. Cleaning Up Compressed Air
11. Standards and Specification

The cost of the book is $195.99. To order the book, make a check or PO out to: Air's a Gas, Inc., 3728 Berenstain Drive, St. Augustine, FL 32092, or call 904-940-6940, fax 904-940-6941 or e-mail: airsagas@aol.com. A portion of the proceeds from this book will be donated to selected children's charities.

New Edition of "Best Practices for Compressed Air Systems®" from the Compressed Air Challenge®

The Compressed Air Challenge® has released the Second Edition of their authoritative "Best Practices for Compressed Air Systems®."* The Best Practices manual provides tools needed to reduce operating costs associated with compressed air and to improve the reliability of the entire system. The 325-page manual addresses the improvement opportunities from air entering the compressor inlet filter, through the compressor and to storage, treatment, distribution and end uses, both appropriate and potentially inappropriate. Numerous examples of how to efficiently control existing and new multiple compressor systems are provided in one of the many appendices.

The Best Practices manual created by the Compressed Air Challenge® begins with the considerations for analyzing existing systems or designing new ones. The reader can determine how to use measurements to audit their own system, how to calculate the cost of compressed air and even how interpret electric utility bills. Best practice recommendations for selection, installation, maintenance and operation of all the equipment are included in each section. BP

**The Best Practices for Compressed Air Systems® manual is a product of the Compressed Air Challenge®, co-authored by Bill Scales and David McCulloch and is not associated with Compressed Air Best Practices® Magazine.*

Compressed Air Challenge®
www.compressedairchallenge.org