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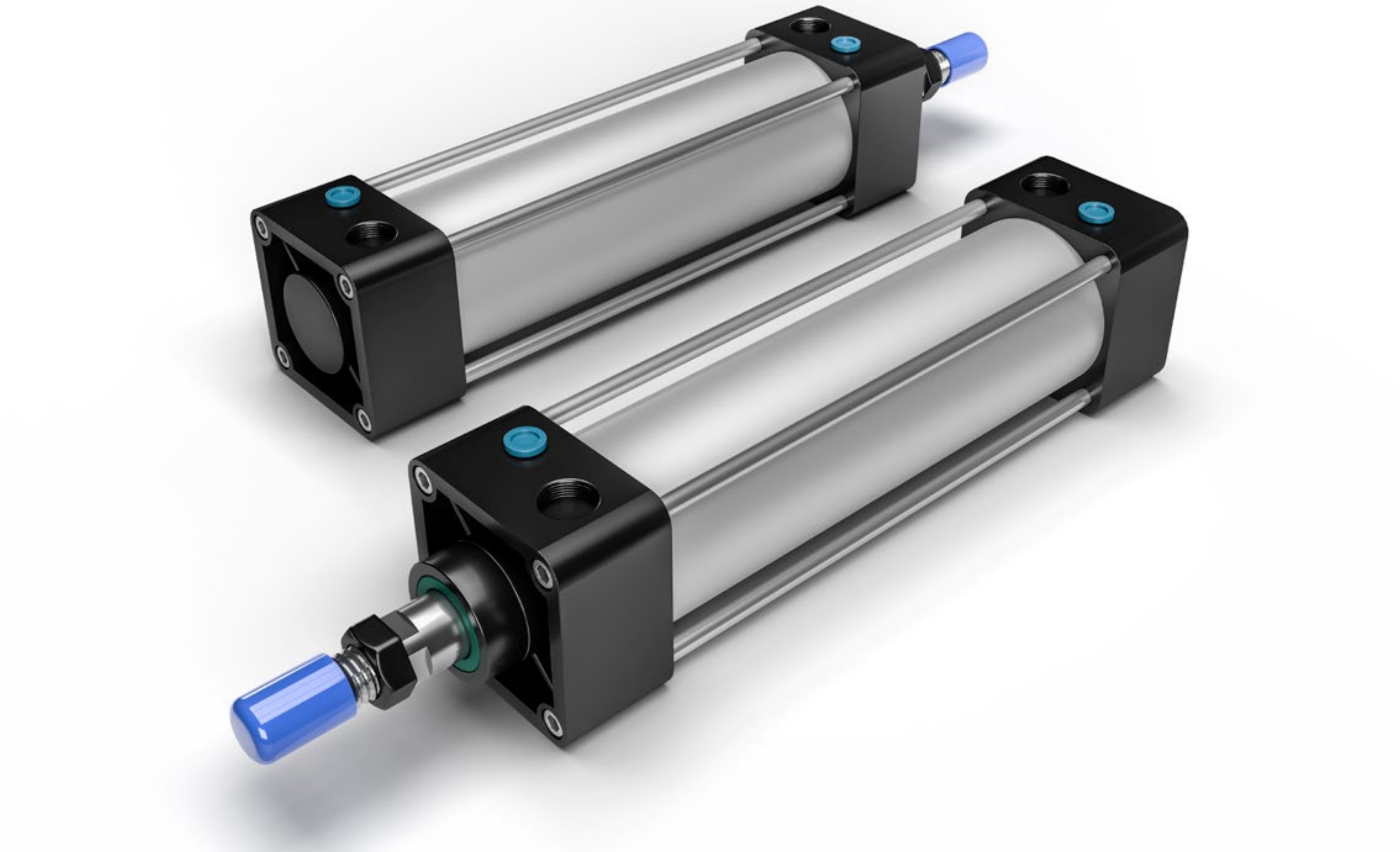

TABLE OF CONTENTS

AD INDEX

A general pneumatic specification

Check out this guideline for some points to include in a pneumatic requirement specification, or your design may suck under pressure

By Dave Perkon, contributing editor

When designing anything, it's important to follow a general requirements specification. Machine configuration, mechanical design drawings, control systems, schematics and control programs all benefit from careful development and use of specifications.

For some reason a machine system that is often missed, or one that doesn't get a lot of "press" in specifications is the Pneumatic Requirement Specification (PRS). The scope of this specification starts at the plant main air supply and ends at mechanical motion where the actual work is performed on a device being manufactured. The PRS should cover that range, so a machine that includes pneumatic devices should meet or exceed all these general requirements. The following defines some of what is required, but be sure to add what is needed for a complete PRS.

To start, the machine must be capable of operating at a pressure of 115 psi. This is a pressure easily achieved by most plant main air compressors. This plant air must be connected via a quick-disconnect connection or, better yet, through a manual, lockable shutoff valve, which provides lockout/tagout (LOTO) capability, that exhausts downstream machine air when turned off.

Downstream of the main air shutoff, the plant air must be filtered and regulated to appropriate operating pressure, typically 80 psi. Although the plant air may be filtered and dried before reaching the machine, it must be filtered and moisture removed before entering the machine pneumatic circuits to ensure a long, trouble-free life for the pneumatic components. Depending on the application, a 10-micron down to as small as a 0.01-micron filter may be needed in a clean room, for example.

The regulated and filtered main air supply must also include a two-way solenoid actuated valve to disconnect and vent through a silencer the machine side of the valve to atmosphere when an emergency stop is pressed. This removes motion causing pneumatic hazards similar to how electrical hazards are removed by opening appropriate safety contacts.

A pressure gauge should also be included to clearly provide visual indication of the main supply pressure, and a digital pressure switch input to the controller is best practice. This pressure switch must be monitored in the PLC program to stop the machine and indicate the fault if the pressure drops below an adjustable setpoint.

Pressure gauges and switches are also a best practice for critical process-related functions such as pressing, crimping and forming. In these critical processes, the pressure gauges must be calibrated when installed and re-calibrated yearly, for example, during the machine lifecycle.

For operator safety, any air-venting and exhaust functions must include a muffler. The type of noise suppression depends on plant requirements, but maximum noise levels near a machine and over an extended period are in the 75-to-80-decibel (dB) range. Additionally, these venting functions must not release oil vapor into the plant environment, and some applications, such as clean rooms, may require venting of air outside of the room.

Downstream of proper machine air preparation are the control valve, cylinders, actuators, hoses, fittings and flow controls, among other devices. A common valve type is a three-way, center-exhaust that is used to advance and retract or raise and lower a cylinder. When both sides of the valve are deenergized, the air to the cylinder exhausts, which is a safe state due to the release of motion causing air from the cylinder.

On anything but the smallest, simplest machines, the control valves should be manifold-mounted with a common air supply and exhaust as it simplifies installation and control.

In the past, discrete wiring to a valve bank was used. That control method should be limited to systems with four or fewer actuators. Industrial Ethernet protocols such as EtherNet/IP, Profinet and similar should be specified in the Industrial Internet of Things (IIoT). A single Ethernet cable and power cable can easily control and monitor dozens of solenoid valves in several banks/manifolds. Pneumatic requirements should carefully document these time-saving diagnostics improving valve bank architectures.

A requirement to use different hose colors for the return or home circuit (blue) and the extend or advance circuit (orange) helps a technician to understand the circuit better when troubleshooting. Each hose must also be labeled much like a wire in an electrical schematic. The pneumatic schematic must include hose numbers similar to wire numbers and a unique device designator for each pneumatic device so it can be labeled with an engraved tag on the equipment.

The pneumatic hoses must include flow controls for all motion causing cylinders and actuators. Typically, best practice is to flow control the air out of a cylinder not into a cylinder, but careful design is required. Additional control at the cylinder, in the form of a check valve may be necessary to keep the cylinder from dropping when the air is removed.

Many more requirements are needed to design a pneumatic system, so be sure to define what is required before starting the design that will then detail exactly how it will be done.

A proportional valve by any other application

Stop to smell the roses and you might learn some new things about hydraulics and pneumatics

By Rick Rice

It's easy, in this chosen profession of control design, to lose focus on the little bits that make up our products in deference to the bigger picture. Vendors are always toting new products; the Internet is chock full of information on what the "smart" customers are using to be competitive; and all of that can be a great distraction when we have a project in front of us.

It is human nature to push the chatter off to the side so we can stay connected to the task at hand. It was in one of those shrouded moments when something popped up out of the blue that I thought I would share with you all.

I was attending an equipment checkout this past week with several of my colleagues. The "usual cast of characters" attending these events gives our group an opportunity to view these new products from various vantage points, based on our particular areas of expertise.

I have to admit that I was not as focused as I usually am on such events, but, in my own defense, I had seen the machine several times over the past six months. We have a preference for forming close partnerships with equipment vendors and leverage these relationships to help both our vendor and ourselves to think outside the box and try out new things. This particular machine is no exception.

We have about 30 horizontal packagers in our inventory. All of these are based on a single machine brand, first produced in the late 1960s. While most are pretty much the same controls package as the original offerings, some of these have been updated, either by us or by other vendors who have carved out a niche by offering modern control systems on these popular, intermittent motion packagers.

The original machine used a single drive with all functions based on cams mounted to the main cycle shaft. The newer conversions that we purchased offered servo control of a decoupled system where the machine cycle shaft, indexer and film feed systems are independently driven.

We have had these refurbished machines for the better part of 12 years, and, good and bad, we have some in-depth experience that made a partnership very beneficial when looking at more horizontal packaging machines.

I mention vendor partnerships often because I really think these are the future of automation. Coming from an OEM background, I remember that our livelihood was based entirely on client need. As a machine builder, we were dependent on the client having a need to produce a product in a different way. Sometimes we were lucky and had a sales representative that was good at helping the client to identify a need where the client may not have realized one existed.

This particular partnership probably originated out of convenience at first as the vendor is located less than an hour from our facilities. Over the years, we'd counted on the vendor's specific expertise with replacement parts for our large inventory of horizontal packagers. While we were aware of the vendor's capacity to rebuild and produce new machines, it wasn't until about two years ago that we began entertaining the idea of having a new machine built for us.

Unlike most capital purchases, we didn't have a particular product in mind for this new machine, so we decided to put as many features as possible into this unit so we wouldn't be limited by capabilities. Both teams attacked this process with zest and the resulting machine is quite the thing to see.

It's easy, with all that was going on with this long build project, to overlook the fine details that go into building a packaging machine. The control system is modern, with a PAC driving multiple servos and variable-frequency drives on a common Ethernet I/P network.

This base control allowed us to add a lot of wish-list items to the machine function. There are lots of coordinated motion activities, and plenty of thought has gone into normal and abnormal stopping of the machine and what actions would take place

Traditional control of a dancing bar comes in two forms, mechanical springs or motor/servo control to relieve the bar and then bring it back to a starting position.

to quickly recover the machine to a known position for restart.

The factory acceptance test that day generated the usual scrutiny associated with such an event and the overall experience was very positive. The vendor delivered a machine that was everything we asked for.

Lost in all the hubbub of activity was the function of an obscure part of the machine that might have been totally overlooked had I not been admiring the electrical panel and just happened to notice a device sitting on a cart beside the machine. While it was being used in the control system, it had yet to be mounted on the finished assembly.

On many production machines that work with web media, the passage of the media through the machine is managed through the use of a sub-assembly called a dancing bar. The purpose of the bar is to respond to the pulling of web (film) off a roll by contracting a bar, or series of bars, to straighten out the path of the web and then, when the web stops pulling, relax the bars into an extended position that pulls additional web off the roll to make up the relative length of the next web pull.

The point of this assembly is to isolate the pulling of the roll linearly from the unwrapping the web off a cylindrical roll. This process is the same for sheet-metal processing as it is for newspaper production and for the making of pouches for food and mechanical parts.

Traditional control of a dancing bar comes in two forms, mechanical springs or motor/servo control to relieve the bar and then bring it back to a starting position. For this particular type of machine, the dancing bar is usually mounted on a rack and pinion with mechanical springs to absorb the pull of the linear drive and then relax back to the original position to pull out enough film (web) for the next index.

What was unique about this particular application was the use of a pair of air-actuated cylinders. Normally, air is not used for such an action due to the compressibility of air.

> What was unique about this particular application was the use of a pair of air-actuated cylinders.

In this situation, however, the vendor had sourced a proportional valve, monitored and activated by analog signals. What was surprising to me is I have used proportional valves in hydraulic applications but never even considered that it might be used for air.

This revelation probably has some of you thinking, “What the heck has Rick Rice been doing all these years?” I have to admit I was somewhat reluctant to write about this, but I finally decided to discuss it because I don’t think I’m alone in thinking that, despite our best intent, we only know what we are exposed to.

I have been so busy doing my job that I missed a development that has been in use for at least 14 years and likely more. I started researching the use of pneumatic proportional valves and was startled to discover they aren’t very new after all.

What I especially like about the solution I viewed that day was the use of an analog proximity sensor to monitor a lobe on a cam at the pivot point of the dancing bar. By using this feedback single, the control of the valve can be quite precise. The lobe is shaped so that the full retract of the dancing bar provides the largest feedback signal while the motion toward the resting position results in a parabolic feedback that gets ever finite as it gets closer to the endpoint. The tension on the film web is very smooth and reduces the tendency to snap as the dancing bar makes its movements.

There are many lessons to be learned from this particular situation. The primary one for me was the benefit of collaboration. We learn more when we put our collective minds to an objective. The unique combination of a world-class machinery OEM with a company that has been in the contract packaging business since the late ’60s brought about a team of highly creative individuals who worked for over a year to elevate the performance of an already well-performing piece of machinery.

The secondary, although perhaps dual primary, lesson in this was the importance of taking time to expand the focus when considering our designs. We can build in our own obsolescence by going back to our successful designs over and over again out of convenience. Sometimes it is best to take some time and, to use and old saying, “smell the roses.”

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Energize Your Efficiency

How to ensure your pneumatic system is robust

When it comes to the use of compressed air in automated machines, there are pneumatic circuits and components that are required to get it all installed correctly

By Dave Perkon, technical editor

Automation controls many types of mechanical motion in industrial machines. When motion control is discussed, many designers think of servos, stepper motors and linear actuators. However, the fact is, pneumatic systems provide many of the simplest options to control motion. As long as the basics of pneumatics are followed, these systems can be easily installed, and there are many benefits.

First of all, what is a pneumatic system? A pneumatic system uses compressed gasses, fluid power, to provide linear or rotary mechanical motion in a cylinder, actuator or motor, for example. A constant supply of compressed air, typically through a plantwide distribution system, connects to a machine-mounted air-preparation unit that distributes the clean-dry air—the energy—to operate the motion-causing devices.

Starting from where the motion is doing work, at the part, package or product being manufactured, there are many common machine-motion functions that are ideally suited for pneumatic system operation.

The pneumatic system delivers and controls energy used to clamp, crimp, press, raise, lower, open, close, extend, retract, push, rotate, divert, nip and more. Just add one of these verbs in front of the word part, package, tooling or device, and then use this verb-noun description for a PLC output that energizes a solenoid valve providing direction

> With just a little vendor support, any technician or maintenance personnel can specify proper air preparation units, solenoids, cylinders and actuators.

control of a cylinder or actuator. It's simple motion control.

The plant compressed air system includes devices that help to distribute clean, dry air to each machine. Typical plant systems include a compressor, cooler, separator and receiver tank to compress, reduce compressed air temperature, remove moisture from the air and store it. However, more needs to be done at the machine level.

There are many opportunities in the compressed air distribution system for moisture and particles to enter into this closed system. As an industry best practice and a robust design, the compressed air delivered to a machine must connect to an air-preparation system to ensure clean, dry air.

There are many parts to this air-preparation unit, which is often called an FRL because it contains a filter and regulator, as well as a lubricator that may be used in special circumstances, such as when the pneumatic motor in an air tool needs lubricated air.

Other best-practice parts of the air-preparation unit include a lockable manual shutoff valve, and an electrically operated air dump/soft-start valve, all of which are included for machine safety.

Similar to an electrical disconnect switch, the manual shutoff valve protects the operator during maintenance by dumping and providing the ability of locking off the supply of compressed air to a machine. The electrically operated air dump removes motion causing pneumatic energy during an emergency stop or other similar machine safety events.

Almost all pneumatic control devices that control the energy or create the mechanical motion are located downstream of the air preparation and shutoff valves. Solenoid valves are a first stop for much of the prepped air in a pneumatic system.

There are many types of directional valves, and couple often used are five-way, three-position, center exhaust or center block valves. With these valves each direction of air is controlled by a PLC output, extend and retract, or open and close.

> Solenoid valves are a first stop for much of the prepped air in a pneumatic system.

Center exhaust is often used to ensure that motion causing air is dumped from the cylinder or actuator when an emergency stop is pressed. However, some motions may benefit from a center block configuration to hold tooling up under an emergency stop condition, but beware of the safety hazards of blocking air to a cylinder when clearing jams.

Check valves also affect the flow of air into and out of a cylinder or actuator. Instead of a center blocked valve, a pilot operated check valve could be used to hold up a cylinder during an emergency stop. Regardless of the method used, use caution when trapping air in a cylinder, as unexpected motion is a possibility.

Flow controls also meter the air into or out of a cylinder. It is an important pneumatic system component used to limit the speed of a cylinder during operation by restricting air as it leaves or, depending on the application, enters a cylinder.

The primary reason a pneumatic system is so popular in machine motion control is its simplicity—the components are easy to install. A variety of fittings, flexible tubing and hoses and rigid pipes connect the solenoid valves, check valves and flow controls to cylinders, actuators, motors, grippers and air nozzles.

With just a little vendor support, any technician or maintenance personnel can specify proper air preparation units, solenoids, cylinders and actuators. With proper selection and a straightforward pneumatic design, high reliability and durability is the likely result in a variety of harsh, industrial and even hazardous, explosive environments.

It starts air preparation and proper selection and installation of pneumatic solenoid valves, cylinders and actuators. Then the simple adjustment of flow and pressure controls optimizes mechanical motions during operation. The air preparation provides clean dry air; solenoid valves control direction; cylinders and actuators do the work; and flow control and pressure regulators affect cylinder speed and cylinder force. All combine to help ensure reliable and efficient machine operation.