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Pressure Drop and Leaks: Repairing Regulators/Filters on Production Equipment

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Pressure Drop and Leaks: Repairing Regulators/Filters on Production Equipment

Introduction by Rod Smith, Publisher, Compressed Air Best Practices® Magazine

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All materials presented are educational. Each compressed air system is unique and must be evaluated on its own merits.

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About the Speaker

Pete Rhoten, Hope Air Systems

- Served as President of Hope Air Systems for 40 years
- Remains active as a Senior Project Engineer designing compressed air systems for the plastics industry

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Purging Demand-Side Demons

April 28, 2016

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Introduction

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Where Did The Air Go

About 12 months ago I received a call from a senior project engineer at a major plastics firm. He had a troubling issue with one of his bottle plants.

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The Puzzle

They could not run all five high production blow-molding machines at one time even though they were able to do so until 6 months ago– Production was suffering

What happened ?

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Where Do You Start –With Any System??

- Compressor-850 HP of 580 PSI compressors were checked by factory technicians and pronounced healthy making the full 1654 CFM
- Piping -The main piping system was checked for obvious leaks
- Production Equipment-The blow machines had been serviced by the staff and were thought to be in spec

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What Tools Were Needed

- The Money Machine-Recording KW meter installed on both compressors
- System Detective-Pressure recorded at the compressor outlet and at the end of the piping system
- Just The Facts-Flow meter was used on each of the 5 blow machines to determine actual usage vs. calculated usage

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Step #1 Compressor Room

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Compressor Room-What's There

- Base loaded Belliss VH18 capable of 518 CFM at 580 PSI
- Trim Belliss WH40 H3N capable of 1135 CFM at 580 PSI
- Trim unit loads at 570 PSI and unloads at 595 PSI
- Total of 1654 CFM theoretically available

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Compressor Room Data

- Flow meters permanently installed
- KW recorded for 4 days
- KW & CFM made sense-all was well

Air Compressor	Airflow Capacity	Measured kW	CFM/kW
WH40	1135 acfm	296.7 kW	3.83 cfm/kW
VH18	519 cfm	168.5 kW	3.08 cfm/kW
Total	1654 acfm	465.2 kW	NA

Annual Hours of Operation	8,520
kWh per Year	3,963,504
Annual Electrical Cost ($)	$206,102

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Step #2
Demand Side

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Machine CFM Usage Calculations

Using bottle size/# of cavities/cycle time/inlet pipe volume you can get really close to the expected CFM for the 5 units

Projected Air Consumption for Blow-Molding Equipment per Manufacturer	
FX	**273 acfm**
HS	**123 acfm**
SLF 1, 2 and 3	**1260 acfm**
Total	1656 acfm

So the output of the compressors when new of 1654 CFM is 100% of the calculated blow machine CFM – Not Good!!

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Use Calculations-Can Be Done Any Equipment

BLOW MACHINE MODEL		SFL6/6	SFL6/6	SFL6/6	ECS FX	ECS HS
BOTTLE SIZE (LITERS):		0.503	0.753	0.503	0.856	1.061
NUMBER OF CAVITIES:		6	6	6	48	16
SAFETY FACTOR (PRODUCTION):		1.1	1.1	1.1	1.1	1.1
INLET PIPE VOLUME (LITERS):		2	2	2	2	2
BLOW PRESSURE (BAR):		40	40	40	40	40
PRESSURE ATMOSPHERIC:		1	1	1	1	1
CYCLE TIME (SECONDS):		2.87	3.42	3.08	18.06	18.6
SAFETY FACTOR (CYCLE TIME):		1.1	1.1	1.1	1.1	1.1
BOTTLES PER HOUR:		7526	6316	7013	9568	3097
CAPACITY REQUIREMENTS						
REQUIRED CAPACITY (Nl/min):		5016	5515	4674	7072	3008
REQUIRED CAPACITY (SCFM):		177	195	165	250	106
REQUIRED CAPACITY (l/min@ALT):		5051	5553	4706	7121	3029
REQUIRED CAPACITY (ACFM):		178	196	166	251	107

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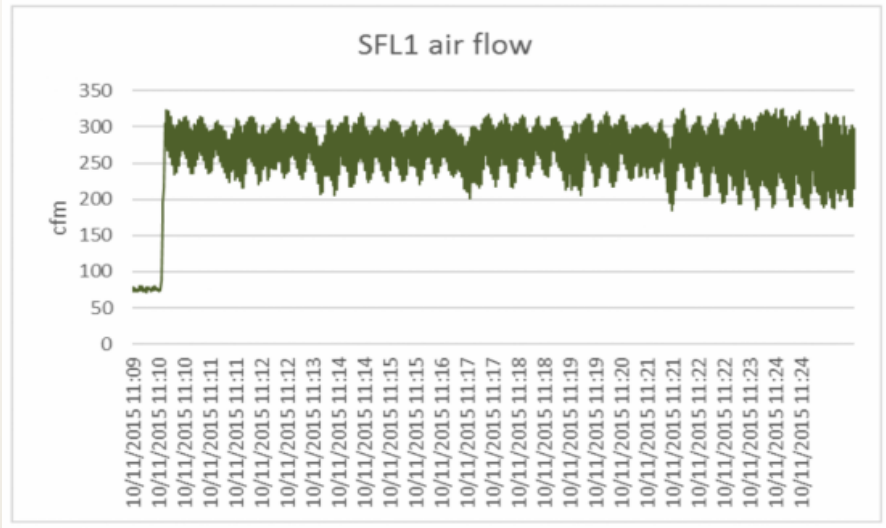
Finding the Demons-The Plan

- Installed a CDI flow meter on each blow machine – metered 5 machines
- The first unit uses 78 CFM with NO production



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A Herd Of Demons

The balance of the 4 blow molding were measured with the flow meter and we found the following

Measured Leakage per CDI Flow Meters	
FX	85 cfm
HS	160 cfm
SLF 1	77 cfm
SLF 2	280 cfm
SLF 3	54 cfm
Total	656 cfm

So 656 CFM or 39% of the available high pressure compressed air was consumed with leaks in the blow machines – the flow meters do not lie = $81,700 per year

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Not The Only Demon

So the leaks should be repaired and all is well - <u>Wrong</u>

- When the blow molders cycled there they were only seeing 470 PSI even though the compressors are making 570 PSI
- What else is going on???

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Piping Demons

- 3”pipe is 633 long and needs to carry a peak flow of 1654 CFM at 580 PSI
- Piping only provides 44.8 cubic feet of storage at 580 PSI
- Flow rate calculated to be 20.65 ft per sec which is above the recommended 20 ft per sec
- Even worse is the 1 ½ “pipe from the header to the blow machine which calculates to 44.32 ft per sec = severe pressure drop
- These calculations were done based on total flow and flow to each machine

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Pressure Demons

- At the end of each 11/2” line for the blow machine is a regulator and filter
- Calibrated pressure gauges were used and a 20 PSI was seen for line pressure
- It was also observed that the regulators where adjusted to approximately 460 PSI

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The Facts

- Immediate goal was to get the high pressure air system stabile enough to run all 5 blow molders
- Leaks consume 39% of the compressor output
- Header and drops are too small
- There is at least a 20 PSI pressure drop on filters and regulators at each machine
- Units appear to only need 460 PSI to blow good bottles based on tests

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Leap of Faith

#1 Open the bypasses for the filters and regulators to allow full line pressure to blow molders & left open as not required with the additional steps to be taken

#2 Methodically lowered the pressure setting on the Belliss compressors from 570/590 PSI to a 470/490 PSI range while production watched product quality

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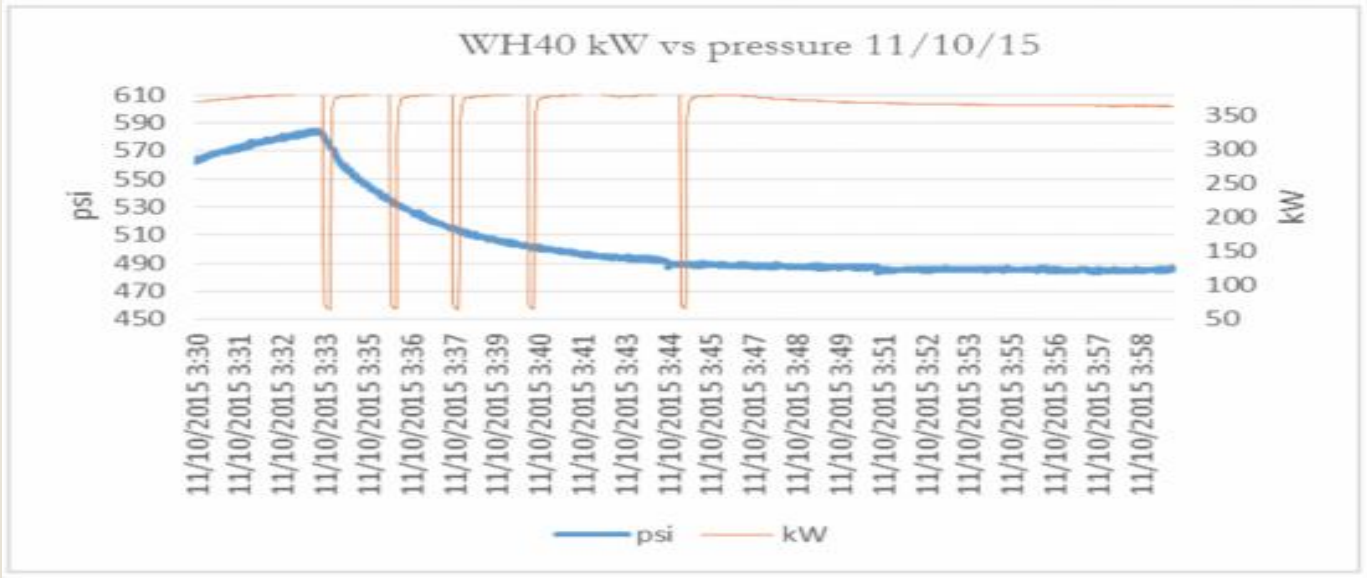
What Happened

The results were dramatic and the demons were contained *<u>for the moment</u>*

- Pressure in the system stabilized at 464 PSI
- Some of the worst blow machine leaks were repaired
- All five blow molders were able to operate at 464 PSI producing good product
- Power cost for the high pressure system was reduced by at least 12-15% = $27,000



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Regulators-Demons or Angels

- Regulators can be both
- Manufactures' include regulators to provide constant pressure to their system
- Sizing is done based on average flow and initial cost and assumes a lot about the system
- Regulators need storage at a higher pressure to be effective (angel)
- No effective storage combined with undersized piping and regulators become restrictions as in this case(demon)

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The Demons Are Contained But Not Eliminated

What has been done was a very short term fix for issues that require long term solutions

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Implement Demon Leak Program

1. The total leakage measured by a flow meter was 656 cfm. At an electrical rate of $0.052 per kWh, this leakage costs $81,743 per year.
2. Flow meters ($3100) should also be installed on each of the five blow molders. Those devices should tie into the building information system or standalone data loggers. The ROI of these actions is approximately 0.5 months.
3. The plant needs to immediately implement a blow molder leak reduction program with a budget to monitor and repair leakage on all blow-molding machines – stretch rods the biggest demons

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Install Air Receivers at Points of Use

- Install a 200-gallon air receiver at each blow machine will allow for pressure reduction and adequate flow. It will also maintain pressure at each machine for product quality stabilization.
- Estimated investment of $30,000 provides an ROI of approximately 14 months-not including product quality improvements and an increase in production
- Eliminates need for pressure regulators and filters with high delta P on each blow machine
- Compensates for the undersized piping

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Maintain System Pressure

- System pressure was 580 psi, and it can now operate between 465 and 500 psi—while maintaining production quality.
- This pressure reduction eliminated 213 cfm of compressed air consumption equaling $27,331 per year (at $0.052 per kWh, based on present compressor efficiency).

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Use Flow Meters for Preventative Maintenance:

- Compressor output on piston units may be can degrade quickly – even though units were recently serviced.
- Flow meters need to be installed on the 3-inch line after each compressed air dryer to monitor compressor output and determine when service is required.
- Investment of $2000, resulting in a potential ROI of 1 year to be verified by reduced maintenance over the next year.

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Install Air Receivers Before Main Piping:

Piston air compressors are cycling rapidly sustaining excessive wear, and operating at a higher kW. To solve the issue, the facility should install a 1060 gallon high-pressure air receiver after the air dryers, along with a demand controller.

With an investment of $30,000 for the air receiver and controller, the potential ROI would be under 2 years due to reduced maintenance on the air compressors and a lower system pressure.

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Implement Leak Detection Program -Low-Pressure

It was noted that the operational air leaks are substantial on blow machines and the ancillary equipment fed by the high-pressure compressed air system. This was not the focus of this study.

- Flow meters should be installed on the 4-inch, low-pressure line from the low-pressure air compressors. Requiring an investment of $1300
- ROI would be under one year with the implementation of a leak remediation program.

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Future Demons?

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Steps To Keep Demons Contained

- List areas identified with a checklist and desired results
- Create budget with ROI expectations with management buy-in
- Assemble a team to implement with ownership -key
- Install pressure and flow monitoring equipment as recommended
- Record and review data monthly- info system
- Make repairs/adjustments based on data
- Post goals and results

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Review Every Quarter……

……Fix If Broken

(It's only $$ on the bottom line)

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About the Speaker

Roger Dennison,
President and Owner,
CDI Meters

- Spent 20 years in the energy consulting industry before founding CDI Meters, Inc.

- His first flow meter, CDI 5200, was introduced in 2002

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Application of Clamp-On Insertion Flowmeters

Roger Dennison-CDI Meters, Inc.

April 28, 2016

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Agenda

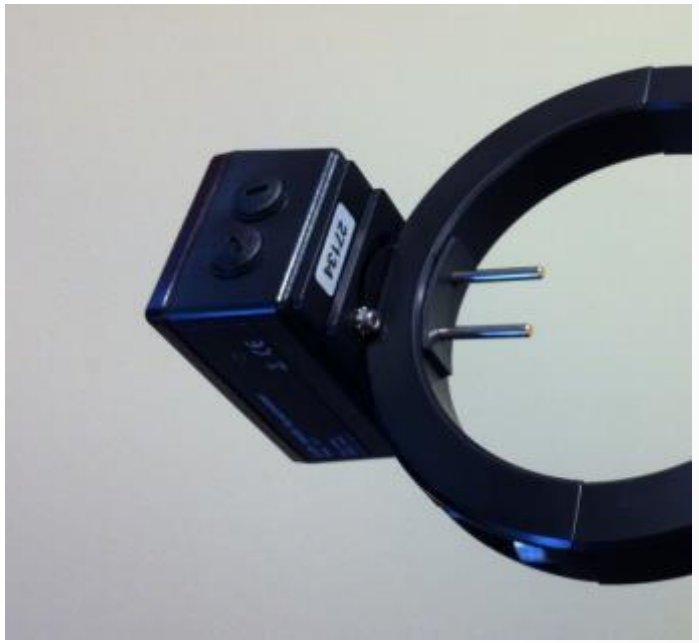
- Thermal Flowmeters for Compressed Air
- Applying the Meters
- Creating the Picture

Thermal Mass Flowmeters

- Meter mass flow of air
- Sense heat dissipation
- Little sensitivity to pressure
- Temperature compensated
- Not for use where water droplets present
- Do not indicate direction of flow

Clamp-On Insertion Design

- Separate probes
- Small holes in pipe
- Gasket seals
- Rugged probes
- Usually no adjustments



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Range of Application and Required Adjustments

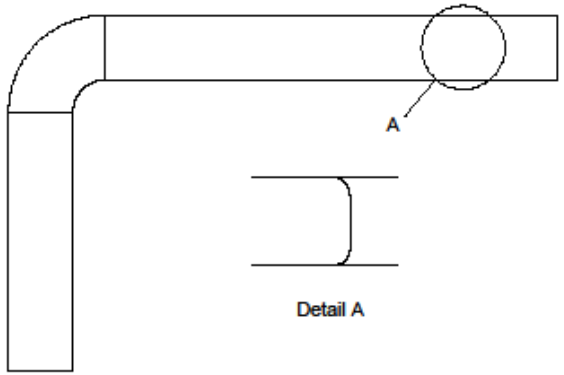
- Temperature: 20 to 120 degrees F
- Pressure: 0 to 650 psig; consult CDI above 200 psig
- Adjustments for pressure or pipe area may be required

Locating the Meters

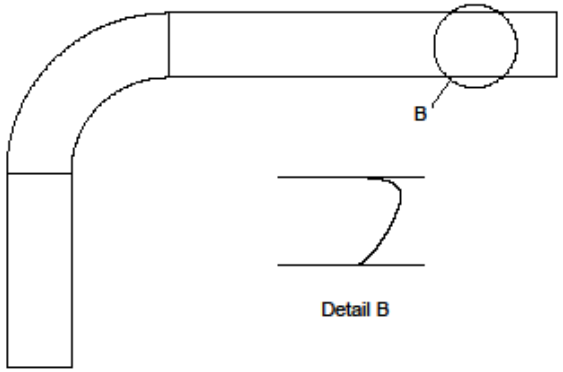
- Ample upstream pipe
- Think visibility
- Avoid fittings that distort or concentrate the flow

Locating the Meters

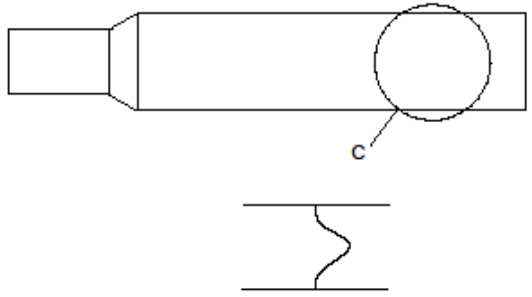
Standard 90° Elbow



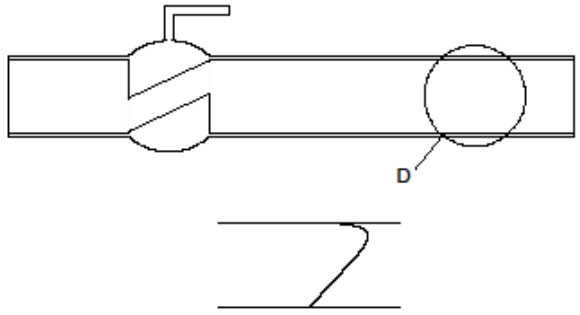
Long Radius Elbow



Increase in Pipe Size



Partially Closed Ball Valve



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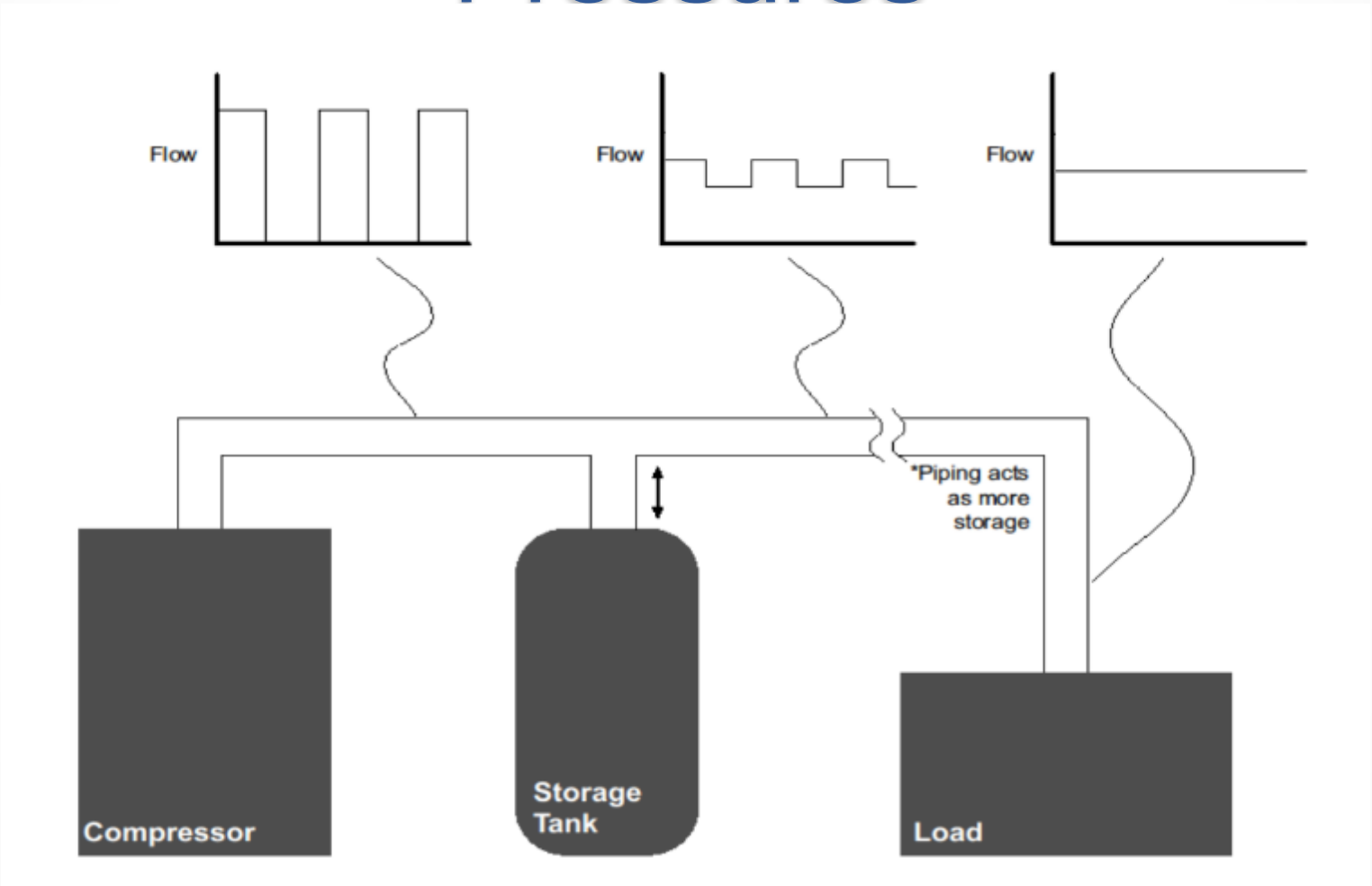
Storage Volumes With Changing Pressures



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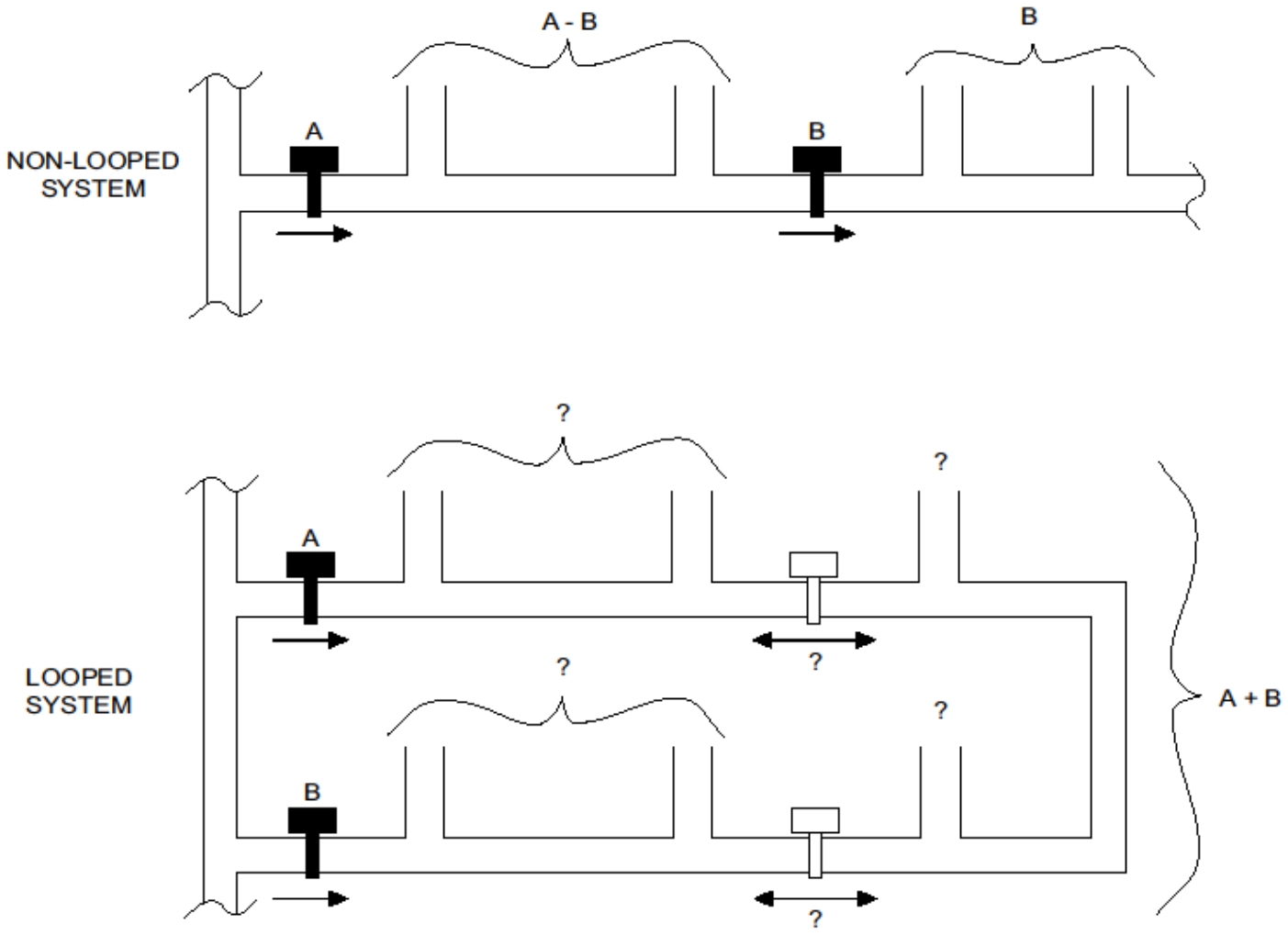
The Problem with Loops



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Create the Picture

- Local view
  - Useful for operator
  - Consider averaging
- Central monitoring:
  - Milliamp to PLC
  - RS485 wired network to Ethernet adaptors
  - Wireless coming from CDI
- Is all air usage justified?

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Thank You

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