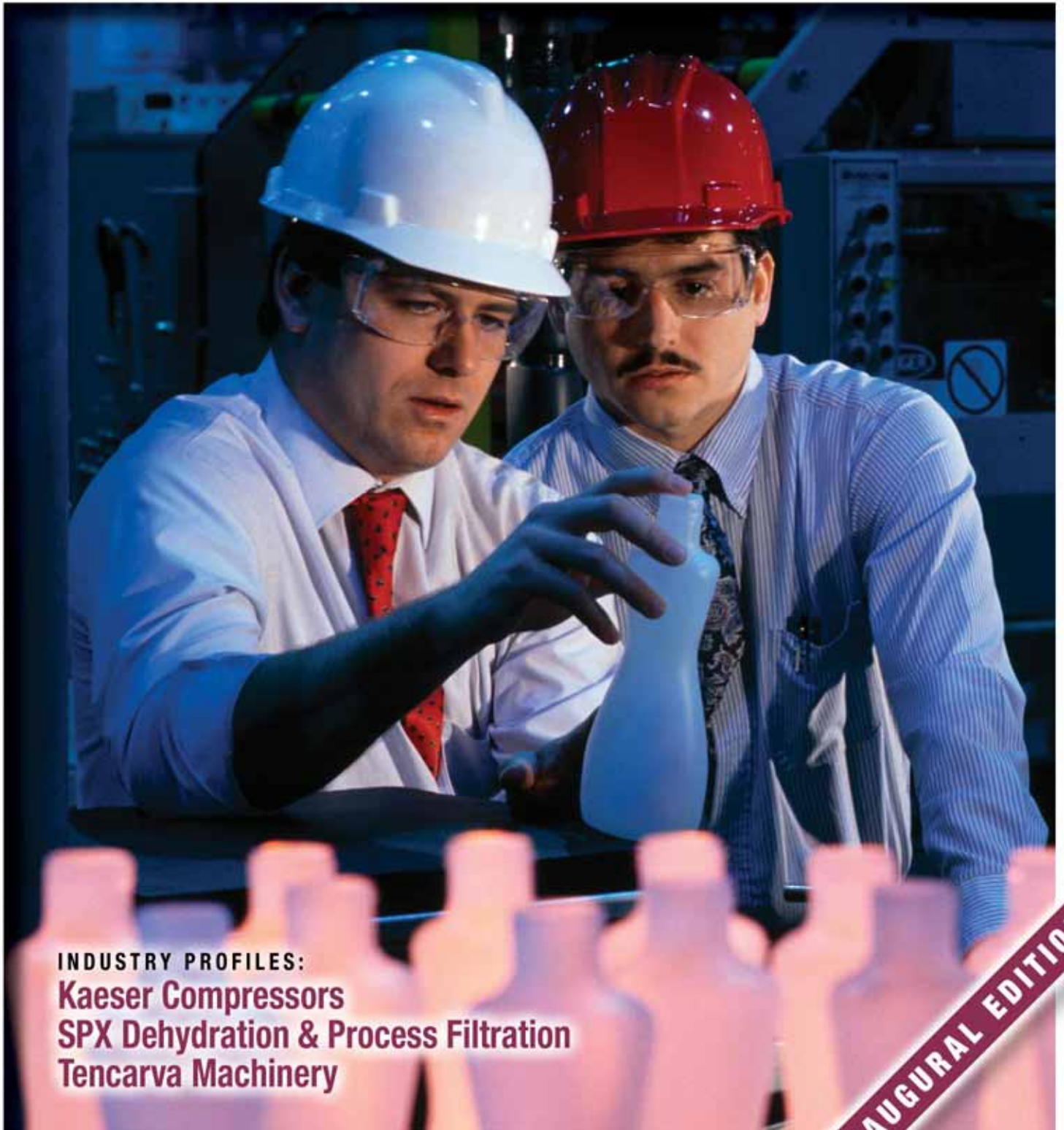


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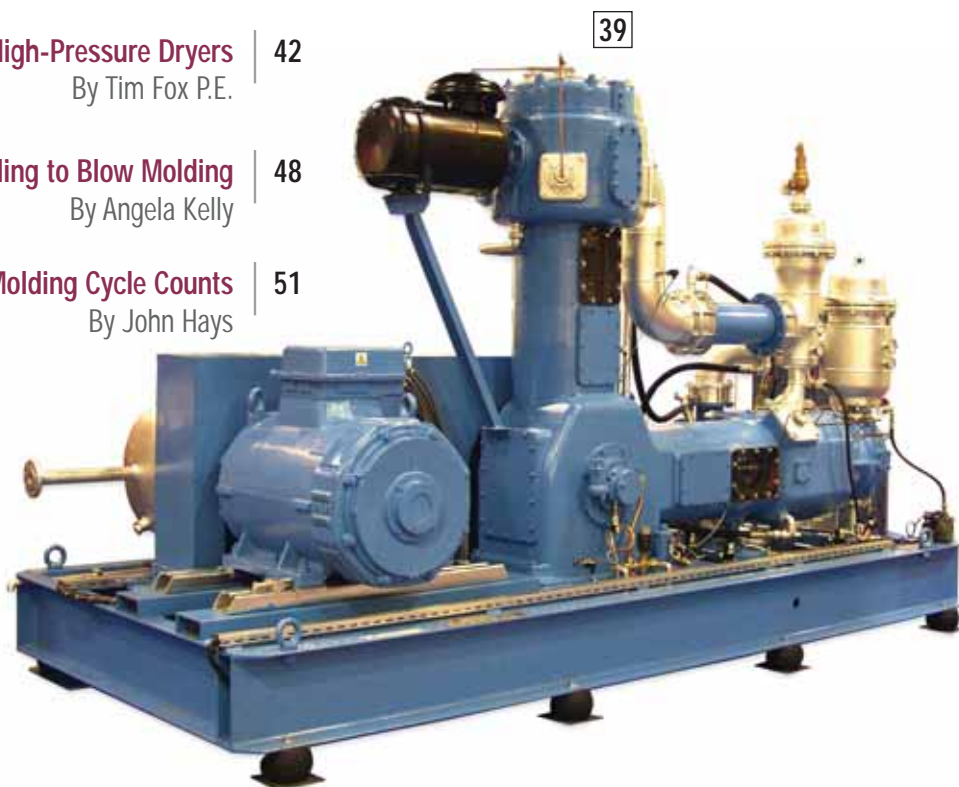
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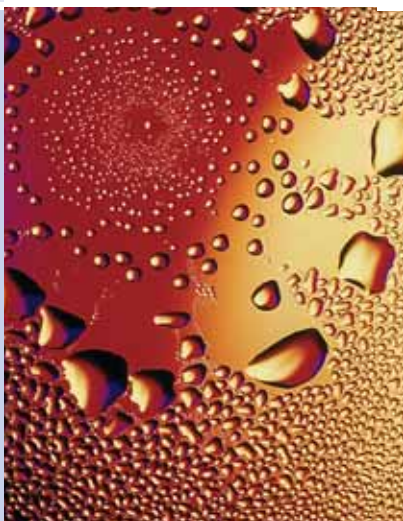
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www.bekousa.com

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www.airbestpractices.com

Advertising & Editorial: **Rod Smith**
rod@airbestpractices.com
Tel: 251-680-9154

Subscriptions & Administration: **Patricia Smith**
patricia@airbestpractices.com
Tel: 251-510-2598

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FROM THE EDITOR

A New Journey

ROD SMITH



Thank you for reading the inaugural issue of Compressed Air Best Practices Magazine and beginning a new journey with us. The objective of this monthly magazine is to assist plant engineers, plant managers, and plant maintenance managers with optimizing their compressed air systems.

These "Best Practices" will be provided for specific industries in each edition. Compressed air product manufacturers and distributors, compressed air system consultants, and end users themselves have vast amounts of knowledge, which we will make available to an international readership base.

Compressed air, known as the "Fourth Utility," plays an important role in the capability of industry to manufacture efficiently. The convenience and flexibility of compressed air makes it a very attractive power source for countless manufacturing processes. Compressed air products have also proven to be reliable and durable, ensuring minimal down time and product rejections related to the compressed air system.

Managing the energy costs associated with compressed air remains an area of tremendous opportunity for most manufacturing facilities. "Lean Manufacturing" principles are not widespread as they relate to compressed air systems. Measurement of efficiency, per product manufactured, and kaizen events are opportunities for a large percentage of compressed air systems. A significant portion of this magazine is dedicated to providing industry with guidance in this area. Just as important, information about how industry uses air will be provided to compressed air industry professionals to help them better understand the needs of specific applications.

I would like to thank my wife Patricia, who is my partner in business and in life, for encouraging me to begin the journey to become an entrepreneur and start Compressed Air Best Practices Magazine. The support of so many people in the compressed air industry is inspiring and motivating for me — and for this I thank you. The journey begins with this edition, in cooperation with 8,500 plastics industry engineers and 1,500 compressed air industry professionals. Together we strive to help you make a difference in compressed air systems.

ROD SMITH

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THE PLASTICS INDUSTRY

The plastics industry is one of the U.S. economy's largest, accounting for 1.3 million jobs and \$345 billion in shipments in 2004. The information in this article is an excerpt from the January 2006 report titled, "The Size and Impact of the U.S. Plastics Industry including State-by-State and County Tables," by The Society of the Plastics Industry, Inc., a trade association based in Washington, D.C. The report is based upon 2004 data and can be purchased in full at www.plasticsdatasource.org. It is highly recommended to professionals in the plastics and compressed air industries as an informative resource on the sectors, size, location, and trends in the plastics industry.

Plastics Industry Sectors

This article focuses on the manufacturing activity within the plastics industry. It excludes plastics wholesale trade firms and downstream using industries of plastics where additional assembly is performed. There were 874,600 employees in the year 2004, working in 15,597 NAICS (North American Industry Classification System) documented plastics manufacturing establishments in the U.S. The major industry sectors of plastics manufacturing are plastics materials and resins, plastic products, plastics working machinery, and molds for plastics. Plastics product manufacturing dominates the category with 83% of the establishments employing 89% of the work force.

It is important to add to that the "Captive Plastic Products" industry does not get classified under the NAICS code 3261, Plastics Products Manufacturing. Captive plastic products include items such as plastic milk jugs that are blow molded in dairy establishments and automobile bumpers that are injection molded in parts manufacturing plants. This industry represents the widespread manufacturing of plastics products in businesses, which fall under a different NAICS classification. Data on the number of these establishments is not available, but the workforce dedicated to captive plastic products was estimated at 429,000 in 2004. This total adds another 49% to the documented number of employees in the plastics manufacturing industries

PLASTICS INDUSTRY SECTOR	NAICS	NUMBER OF FACILITIES	EMPLOYEES (THOUS)	INDUSTRY SHIPMENTS (\$MILL)
Materials & Resins	325211	690	61.1	58,535
Products	325991 & 3261	12,950	775.1	159,521
Machinery	3332201	514	13.0	2,874
Molds	33351105	1,443	25.4	3,233
Manufacturing Total	n/a	15,597	874.6	224,163
Captive	n/a	n/a	429.4	88,302
Grand Total	n/a	n/a	1,304.0	312,465



Plastics Manufacturing Segments

The 15,597 plastics products manufacturing establishments in the U.S. are broken down into multiple segments. The largest is Plastics Products NEC (Not Elsewhere Classified).

PLASTICS MANUFACTURING SEGMENTS	NAICS	NUMBER OF FACILITIES
Materials & Resins	325211	690
Custom Compounding	325991	562
Machinery	3332201	514
Molds	33351105	1,443
Bags	326111	425
Packaging Film & Sheet	326112	287
Film & Sheet	326113	697
Profile Shapes	326121	638
Pipe & Pipe Fittings	326122	426
Laminated Plate, Sheet & Film	326130	241
Plumbing Fixtures	326191	537
Resilient Floor Covering	326192	59
Plastics Products NEC	326199	7,511
Polystyrene Foam Products	326140	553
Urethane & Other Foam Products	326150	618
Plastics Bottles	326160	396
Grand Total	n/a	15,597

THE PLASTICS INDUSTRY

Plastics Industry Compared to Other Industries

Industry size rankings depend, to some extent, on how the industries are classified and on industry cycles, such as in the petroleum industry. Plastics Products, NAICS 3261, made \$150 billion in shipments in 2003, making it the fourth largest manufacturing industry in the U.S. after petroleum and coal products, motor vehicles, and motor vehicle parts. This was a gain in ranking from being the sixth largest in 1998.

Resin, synthetic rubber, and artificial and synthetic fibers and filaments (NAICS 3252) ranked eighteenth in 2003 with shipments of \$68.1 billion. A key component of the plastics industry, plastics materials and resins, makes up 78% of NAICS 3252.

Rate of Growth

Growth in plastics manufacturing has outpaced all manufacturing since 1980 but has seen a downturn from 2000–2004. This was due to the negative effects of the 2000–2001 recession. The industry recovers but is still laboring under long term problems, primarily related to the off-shoring of manufacturing and therefore of plastics markets.

Real shipments, real value added, and productivity growth have made it one of the healthiest industries in the U.S. That being said, the plastics industry has been affected by the offshoring of U.S. industry.

PLASTICS MANUFACTURING	1980–2004 PLASTICS MANUFACTURING	1980–2004 ALL MANUFACTURING	2000–2004 PLASTICS MANUFACTURING
Employment	1.3 %	-1.1 %	- 3.5 %
Real Value Added	3.1 %	1.0 %	- 1.3 %
Real Shipments	3.2 %	0.5 %	n/a
Productivity Growth	1.8 %	1.7 %	n/a

Location of Plastics Manufacturing

Plastics products are often hollow or have shapes that don't pack well, so they are expensive to ship long distances. Most plastic products are also shipped to other industries that use plastics as a form of packaging or as a part of a product they are assembling. For this reason, plastics manufacturing tends to be found in populous areas and in regions where other industries are present that use plastics. Plastic materials and resins manufacturing are concentrated on the Gulf Coast, with its abundant raw materials and excellent petrochemical infrastructure. The ranking below is based upon employment figures that include captive industries. We use this employment number to do a ranking because the facilities number does not include captive plastics applications taking place in another industries' facility.

PLASTICS INDUSTRY EMPLOYMENT RANKED BY STATE	EMPLOYMENT (WITH CAPTIVES) (THOUSANDS)	NUMBER OF FACILITIES	EMPLOYMENT RANK FOR 2004
California	122	1,797	1
Ohio	104	1,143	2
Michigan	88	988	3
Texas	87	924	4
Illinois	86	935	5
Pennsylvania	72	742	6
Indiana	63	606	7
North Carolina	51	444	8
New York	49	647	9
Wisconsin	46	535	10
New Jersey	41	555	11
Tennessee	40	340	12
Georgia	40	377	13
South Carolina	32	212	14
Virginia	32	168	15
Massachusetts	31	421	16
Missouri	29	315	17
Minnesota	29	412	18
Kentucky	28	226	19
Florida	25	622	20
Alabama	19	176	21
Washington	18	239	22
Mississippi	18	144	23
Iowa	17	170	24
Arkansas	17	150	25
All Other	125	2,309	
Grand Total	1,339	15,597	19

For more in-depth information, please contact The Society of the Plastics Industry, Inc. and make reference to "The Size and Impact of the U.S. Plastics Industry Including State-by-State and County Tables."

Tommy Southall — Director, Industry Information & Communications Services — The Society of the Plastics Industry, Inc.

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EXTRUSION BLOW MOLDING BEST PRACTICES

Interview with Dean Smith

COMPRESSED AIR BEST PRACTICES: Good morning. Have you just returned from another auditing trip?

SMITH: Good morning. Yes, we spent the last several days, at the largest plastic blow molding facility in the U.S., working on their molding machines to increase productivity. We were able to increase their bottle production output while reducing their compressed air energy costs.



Dean Smith

What is your experience in the plastics industry?

Actually, I started my working career in plastics, and was running a small molding facility back in the 1980s. In terms of compressed air auditing, we have examined facilities in all molding technologies and in more than one hundred individual molding plants. Of late, our work has focused on increasing productivity, relative to compressed air costs, rather than just enhancing the compressed air system. This means we are working on the molding machines directly to improve their performance relative to compressed air issues.

What do you normally see in terms of compressed air installations in the blow molding industry?

The high volume stretch blow molders (SBM) working with PET, like AMCOR and Southeastern Container, usually have 2,000 hp to 4,000 hp installed. The majority is using 3- or 4-stage reciprocating compressors to provide compressed air at 580–600 psig. We also see SBM being done at extrusion/injection blow molding facilities. Normally, they supply 450–500 psig air to single SBM lines with a dedicated reciprocating booster compressor that is drawing from the plant air.

The extrusion and injection blow molders typically have 500 hp to 600 hp of installed rotary screw air compressors, delivering air between 110 psig and 150 psig. We often find the installations have numerous air compressors of different brands installed in various locations in the plant. The multiple air compressors have different pressure settings with different control systems and are trying to work together rather unsuccessfully.

The air compressors also tend to have dedicated refrigerated air dryers and centralized fine filtration to remove moisture, particulates, and oil aerosols from the compressed air. The air then travels through the headers and piping system to the blow-molding machines that have coarse compressed air filters installed to protect the pneumatic circuits.

What kind of energy costs, associated with compressed air, do you find and what typical opportunities exist?

Compressed air represents the #1 or #2 energy cost center in blow molding facilities. The blow molding machines, which must heat and melt the plastics and run hydraulic pumps, are the other major energy cost center. The high volume stretch blow molders see energy costs, associated with compressed air, of \$1 million to \$3 million, per year, depending upon the facility size and utility rates. Compressed air energy costs normally represent 35–40% of the facilities' total energy bill. We normally find savings opportunities that can reduce the compressed air energy costs in these facilities by 10–15%.

“One of the most exciting results we often see, is blow molding productivity increases of 3–4%!”

The extrusion and injection blow molders see energy costs, associated with compressed air, of \$200,000 to \$750,000 per year. Compressed air energy costs normally represent 25–30% of the facilities’ total energy bill. The percentage of the total is lower than with stretch blow molding because the molding machines consume more energy relative to the volume of compressed air required and the facilities themselves are larger with higher associated lighting and heating costs. We normally find, however, higher savings opportunities, in percentage terms, which can reduce the compressed air energy costs by 35–45%.

Project paybacks are normally 18–30 months, although many blow molders are located in highly populous areas with high utility rates and see project paybacks of 6–12 months. One of the most exciting results we often see, which is not included in these payback estimates, is blow molding productivity increases of 3–4%!

Table 1

BLOW MOLDING	TYPICAL INSTALLED AIR COMPRESSOR CAPACITY	RELATED ENERGY COSTS	SAVINGS OPPORTUNITY
Stretch	2,000 hp to 4,000 hp	\$1M to \$3M	10%–15%
Injection & Extrusion	500 hp to 600 hp	\$200,000 to \$750,000	35%–45%

What “Best Practice” recommendations do you have for blow molders?

The place to start is to establish a measurement system that relates the costs of compressed air to the number of plastic products being produced or the pounds of plastic throughput. A “Best Practice” unit of measure should be a measure of flow (scfm) or compressor energy in kWh per pound of plastic output. This way you can see if you are getting better or worse, relative to your plants’ ability to manufacture product. While it is impossible to establish a fixed number good for all blow molders, we establish the existing metric as a starting point early in our work with the manufacturer and then establish measurable goals to improving overall efficiency.

How can a stretch blow molder work towards that efficiency metric?

The key to maximizing productivity in blow molding is to minimize the variations in process variables. Tighter control over the process provides greater ability to increase the cycle counts of the blow molding machinery, which results in higher output. Melt temperatures, mold temperatures, and compressed air pressure fluctuation are three of the biggest process variables they have to manage. Stabilizing air pressure is our primary objective. We find that pressure is fluctuating 50–60 psi in most stretch machines and is significantly lower than expected. Correcting this can lead to increases in productivity and reduced air consumption.

So how can blow molders stabilize their air pressure?

The first step is to stabilize header pressure with air compressor automation in order to enable them to work together to ensure reliable pressure to the compressed air piping network. We also utilize different combinations of flow control valves and additional storage tanks to assist with the process of stabilizing header air pressure.

Blow molders often have a mixture of high pressure reciprocating and rotary or centrifugal compressors (stretch blow molders) or a mixture of lubricated rotary screw compressors (injection and extrusion blow molders) that can be tied together by a PLC (Programmable Logic Controller). We program the controller to monitor and maintain air system pressure at a single reference point in the air system. The reference point can be in the main headers of the piping system or at a main storage tank. This single reference point enables the controller to calculate the rate of pressure change and then anticipate the need to load and unload air compressors to maintain stable pressure. Most of the automation we recommend includes a data collection system to provide the metrics of compressed air efficiency we discussed earlier.

Where do you find savings opportunities of 45% for extrusion and injection blow molders?

Extrusion and injection blow molders often have their whole facility running, unnecessarily, at medium pressure ranges between 150 psig and 200 psig. We find that typically only 15% of the total plant air demand is at these pressures.

We first recommend that blow molders understand the air pressure requirements of their blow molding machines. For example, the blow process consumes as much as 60% of the air and may require a peak air pressure of 150 psig. The remaining pneumatic applications, using 40% of the air for control components and packaging or decorating, will typically require only 80 psig. We recommend that the blow molder reduce overall plant air pressure to 90 psig, for example, and install a dedicated piping system to the blow solenoids.

The second step is to modify the pneumatic circuits on the blow molding machinery, which is typically sized by the manufacturer, based on average air demand (100 scfm) rather than peak air demand (500 scfm). The pneumatic circuit on the molding machines consists of solenoids, control valves, and tubing, which when undersized, creates pressure drops during the blow cycle. The pressure drop is really a lag in the flow of compressed air that slows inflation and subsequent cooling of the container. Pressure drops in these pneumatic circuits can be as high as 50 to 75 psig! If sized appropriately to match the peak air demand by examining the Cv (critical velocity) of the components, we can minimize the pressure drop, increase productivity, and reduce plant air pressure, which also saves energy.

EXTRUSION BLOW MOLDING BEST PRACTICES

Interview with Dean Smith

“Pressure drops
in these
pneumatic
circuits can be
as high as
50 to 75 psig!”

We recently went through this process at one of the nations' largest blow molding facilities and dropped their blowing air pressures from 150 psig to 90 psig. The blow molding machines were actually able to increase output, at the lower pressure, because the pressure inside the mold was stabilized!

What “Best Practices” can you recommend for air treatment?

Effective air treatment is critical to protect the quality of the products blow molders manufacture. We recommend cycling refrigerated air dryers, which provide 39° F pressure dew points, to dry the air. We often find that each air compressor has a dedicated dryer, with a pressure drop of 8–10 psig, which increases the difficulty of managing multiple compressors. Multiple dryers also mean multiple drainage locations and more contamination issues. We prefer putting all the air through one larger dryer with less than 4 psi pressure drop and built-in, redundant, refrigeration units.

Filtration of particulates and oil aerosols is also critical to protect the products. Here, we often find fine filtration in the compressor room but find very coarse filters (often part of a Filter-Regulator-Lubricator) out next to the blow molding machine. This is actually the reverse of what it should be because of the potential of contamination from the air piping itself. We recommend coarser filters, like mist eliminators with low pressure drops, in the compressor room and 0.001 coalescers and activated carbon filters at the point of use. Please note that we oversize the point-of-use filters to minimize the pressure drops

Demand drains are also important to effectively remove the condensate from the dryers and filters. The “no air-loss” type is suggested to prevent any unnecessary and wasteful blow-off of air. We particularly like the new electronic demand drains with built-in alarms to indicate a failure to pass condensate, which can prevent a contaminated system. The drained off condensate should have the oil separated from the water, so that the oil can be disposed of responsibly. Depending upon the types of lubricants present in the air system, we recommend gravitational and/or emulsion type oil-water separators.

What “Best Practices” can you recommend for air piping systems?

SMITH: A good practice is to immediately increase, by one nominal pipe size, the piping connected to the outlet of the air compressor. We often see piping matching up with the size of the air compressor outlet pipe. This is logical, but the air compressor manufacturer sized its piping for the short routing and confined space of the air compressor and not for the air system! Pipe that is too small causes restrictions to air flow and back pressure on the compressor. We also specify full port ball and butterfly valves at the compressor outlet. Often we see gate and plug valves that have reduced ports creating restrictions and pressure loss. These valves are heavy and expensive and, over long periods of time, tend to not seal well when closed.

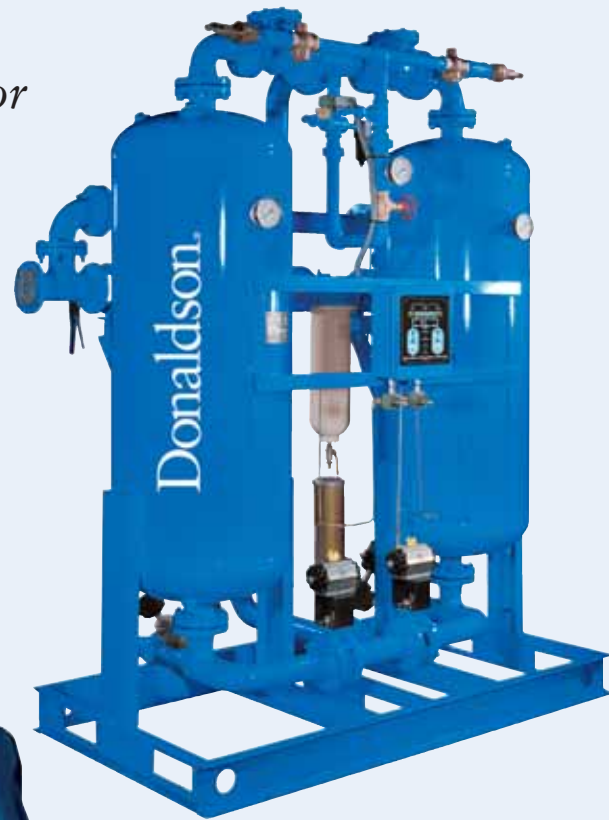
Thank you DEAN SMITH for your “BEST PRACTICES” recommendations.

Dean Smith has 15 years experience as a consultant in compressed air and gas systems having conducted complete audits on over 1000 plant air systems in a variety of industries. Contact at (678) 355-1192 and airmanagement@mindspring.com.

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BY HANK VAN ORMER

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What Is Going On?

Every process in your plant, which has a need for compressed air, has a minimum supply in CFM (flow) and PSIG (pressure required), for the process to run at optimum levels. When you supply air at a higher pressure and consequently more volume, you create extra expense, but with no increase in productivity or quality. This situation is often called “Artificial Demand”.

Do you know the lowest effective pressure / flow requirement at each process? Do you measure and monitor to stay on target? Do you use/supply too much air? The compressed air system will continue to use more air volume as the pressure rises. For that matter, do you know your cost of compressed air? How much air do you use? It is probable that some one knows the cost of your electric power and usage every month. You cannot manage the use and cost of compressed air if you do not measure and monitor.

Some Tidbits:

1. The electrical energy cost of producing compressed air is generated by the flow and pressure which creates HORSE POWER, turns into INPUT
 $\text{kW} \times \$/\text{kW RATE} \times \text{HOURS} = \$\$ \$\$ \$$ electrical cost per year associated with compressed air.
2. In order to actually reduce energy cost you must reduce the pressure and flow from the compressor supply. Actions, on the demand side, that do not translate into lower input energy do not provide an economic savings.
3. Typical Energy Cost of Air:
4. At \$.06 kWh at 8000 hours per year, with an air supply that produces 4.0 cfm per input horse power:
 - a. 1 cfm cost = \$100 per year in energy cost
 - b. 2 psig cost = \$398 per year in energy cost for every 100 HP
5. 50% of the air produced in industrial plants IS NOT USED FOR PRODUCTION!!!! This is what we call opportunity.

Where are the most common opportunities we observe in air systems during our audits?

#1 Savings Area — Management and Operator Awareness of Compressed Air Energy Costs

Air compressors driven by electric motors will use a surprisingly large amount of energy every year they are in operation. The annual cost of power for operating compressor will equal or exceed the initial cost of the unit.

The initial purchase price of a 100HP air compressor will range from \$30,000 and \$50,000 depending on the type and option. The same 100HP compressor operating some hours per year (a power rate of \$0.06/kWh and a motor efficiency of 0.90) will have an annual power cost of \$43,265. This is three shifts, 7 days a week, 47–48 weeks per year.

You can estimate the appropriate annual electric power cost of your compressors with this formula. First, multiply the horsepower of the compressor by 0.746, times the hours of operation, times your power rate (i.e.: $\text{HP} \times .746 \times \text{hours} \times \text{power rate}$). Then, divide that number by the motor efficiency.

Everyone in the plant should know the total power cost for operating the compressors. This is especially important for anyone working with air-operated equipment.

#2 Savings Area — Reduce Pressure Losses in the Interconnecting Piping and Air Treatment Equipment

The piping and air treatment equipment found between the air compressor discharge and the process is the most overlooked area in air systems. Even though the calculated “Friction Pressure Loss” may be low for the pipe, poor piping system designs (convoluted piping, crossing tee connections and dead heads) may cause significant “turbulence driven” backpressure. This not only wastes power, but also can cause the unloading controls to become ineffective. Poorly selected filters and dryers, without regard to pressure loss, merely compound this.

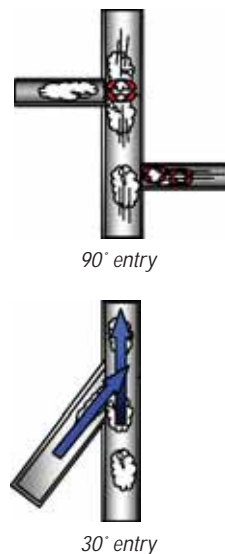
In a well laid out system, the interconnecting piping from the compressed air supply to the process (and to the header distribution piping) should create NO pressure loss — thus including the main piping headers as part of the “effective storage”. Some of the more common piping opportunities we find are:

1. TEE CONNECTIONS

A tee connection is a feed line of compressed air trying to break into a flowing stream or air. This type of connection is very common and the turbulence caused by “90° entry” often amounts to 3–5 psid pressure loss. (The pressure loss is a factor of relative pipe sizes, flow, velocity, etc.). In our 100 HP example, you spent almost \$600 to \$1000 every year to produce the pressure lost here with no increase in production.

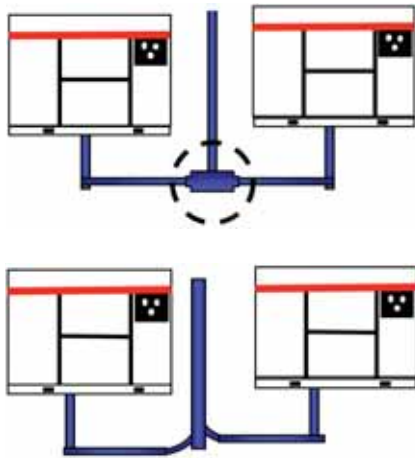
- a. The back-pressure sends a false “unload” signal to the controls, causing premature unloading or extra compressors to be on line resulting in multiple units running at part load and short cycling.

Use of a 30°–45° directional angle entry instead of a 90° TEE will eliminate this pressure loss (shown right). The extra cost of the directional entry rather than a standard TEE connection is usually negligible. When the interconnecting pipe is sized to 20 fps velocity or less, this type piping may well not create a problem.



FOUR SAVINGS AREAS IN COMPRESSED AIR SYSTEMS

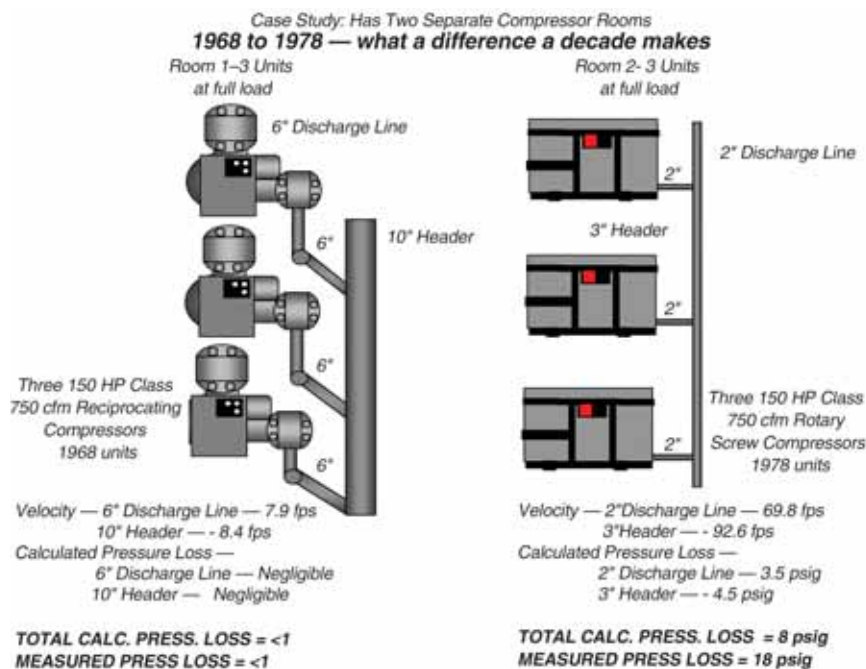
BY HANK VAN ORMER



2. DEAD HEADS

"Dead Heads" are where piping flows together at opposite ends of a TEE connection causing extreme turbulence. In the example shown below, the pressure loss was almost 10 psig. The correction of the "Dead Head" with a "long Ell" and a 30° directional entry reduced their loss to 0 psig. This is 300HP worth of air — about \$1200 per psig in our example — or \$12,000 annual power cost to produce the 10 psig wasted at the Dead Head. Plus we have two compressors at "less power efficient" part load.

3. Turbulence driven pressure loss is also a function of compressed air velocity in the pipe. To be safe we size interconnecting and distribution piping to velocities of 20 fps or less whenever possible.
4. "DON'T PIPE BY OPENING SIZE": Size pipe by the length and flow required. Use conventional pressure drop charts which show loss based on entry pressure, pipe internal diameter, and flow. Select pipe size, which will register no pressure loss. When in doubt, compare the material cost of the next size pipe up or down. You may find very little difference in the installed cost. Most of the material cost in piping installation will be in the labor, valves, and fittings. You do not have to run the same valve size as the pipe; you can often "bush up" to a larger pipe and retain little or no pressure drop and minimize cost.
5. Let us see what excess backpressure does to this. Here is an example of a chemical processing plant in West Virginia.



6. In the preceding case study, eight psig of pressure loss was “frictional loss” in the pipe. Ten psig was caused by turbulence driven backpressure from the “crossing tees” at the high velocity. We see this problem in more than 90% of the multiple unit plants we review. With step controls, this would cause short cycling – keeps more than one unit on at part load and can lead to premature failure of such components such as coolers, bearings, motors, etc.

#3 Savings Area — Compressed Air Leaks:

Assuming the interconnecting piping and controls are operating correctly, and will now respond with a proportional reduction in input energy to a reduction in air demand, leaks are the next critical target.

It has been our experience that plants, which have no formal, monitored, disciplined, compressed air leak management program, will have a cumulative leak level equal to 30% or more of the total air demand.

All plants can benefit from a formal ongoing leak management program. The most effective programs are those that involve the production supervisors and operators working in concert with the maintenance personnel. Accordingly, it is suggested that all programs consist of the following:

- **Short Term** — Set up a continuing leak inspection by Maintenance Personnel so that for a while, each primary sector of the plant is inspected once each quarter or at least, once every six months to identify and repair leaks. A record should be kept of all findings, corrective measures, and overall results. Inspections should be conducted with a high quality ultrasonic leak locator during production and non-production.
- **Long Term** — Consider setting up programs to motivate the operators and supervisors to identify and repair leaks. One method that has worked well with many operations is to monitor the airflow to each department and make each department responsible for identifying its air usage as a measurable part of the operating expense for that area. This usually works best when combined with an effective in-house training, awareness, and incentive program.

Continued on page 53

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The Compressed Air Challenge® (CAC) was founded in 1997 as a not-for-profit, national collaborative of public and private organizations dedicated to enhancing industrial competitiveness by improving efficiency of compressed air systems within U.S. Industry. This mission has recently been extended with the addition of Canadian sponsors. The CAC accomplishes its mission through the development and offering of training and technical publications with no commercial bias. Training classes are currently available at three levels: *Fundamentals of Compressed Air Systems*, *Advanced Management of Compressed Air Systems*, and (in cooperation with the US Department of Energy) *Qualified AIRMaster+ Specialist*. The CAC is comprised of industrial end users, utilities, state and national energy organizations, energy efficiency associations, and representatives of the compressed air equipment industry.

The CAC's training classes are unique in that they are product-neutral and systems-focused. Students such as plant engineers, operators, and maintenance staff attend the one-day Fundamentals class to learn how their facilities can achieve 15–25 percent cost savings through more efficient production and use of compressed air. Fundamentals students also receive the state-of-the-art reference manual, *Best Practices for Compressed Air Systems*¹. Students return to their facilities with increased awareness of compressed air system operating costs and a variety of practical tools to improve productivity and reduce energy expenses. The intensive, two-day Advanced Management class provides more in-depth technical information on troubleshooting and making improvements to industrial compressed air systems. Qualified AIRMaster+ Specialist training is a 3-1/2 day class, including a rigorous exam, designed for individuals who have completed the Advanced class, have a significant amount of experience in compressed air systems, and who wish to qualify for the use of the AIRMaster+ software. For information about Qualified AIRMaster+ training, see <http://www1.eere.energy.gov/industry/bestpractices/airmaster.html>.

FUNDAMENTALS OF COMPRESSED AIR SYSTEMS TRAINING OPPORTUNITIES IN 2006 INCLUDE:

June 1	Benbrook, TX	Contact: Neal Mukherjee, 972-906-0900
June 8	Tulare, CA	Contact: Gary Pikop, 559-625-7127
June 20	Cincinnati, OH	Contact: Lawrence Boyd, 216-323-1898
June 21	Omaha, NE	Contact: David Nosal, 402-571-5004
June 28	South Portland, ME	Contact: Joy Adamson, 207-287-8350

Advanced Management of Compressed Air Systems classes are being planned for several locations including Denver, Atlanta, and Vermont.

To view the up-to-date list of training opportunities and to learn about co-hosting CAC training classes, see the CAC's website at www.compressedairchallenge.org

¹No relationship to Compressed Air Best Practices Magazine

THE TYPES OF PLASTICS USED IN BLOW MOLDING

U.S. Patent 237168 was issued on February 1, 1881, to Celluloid Novelty Co. and Celluloid Manufacturing Company, New York. This was the first patent for the processing of extruded polymer into a parison for blow molding.

The first applications for blow molding were for cellulose nitrate, and later, in the 1930s, for cellulose acetate. Continuous advancements in plastics have created more and more applications for the blow molding of plastics and have helped this become a major industry in the United States.

Low-density Polyethylene (LDPE)

Blow molding remained a relatively small part of the plastics manufacturing scene until the introduction of Low Density Polyethylene (LDPE) in the 1940s. The production of LDPE squeeze bottles by Monsanto caused a rapid expansion of the industry, with containers produced to replace glass bottles for shampoos and liquid soaps.

Low-density polyethylene (LDPE) is a thermoplastic made from oil. This was the first grade of polyethylene, produced in 1933 by ICI, using a high pressure process via free radical polymerisation. It is translucent or opaque, quite flexible, and tough to the degree of being almost unbreakable. It is widely used for manufacturing various containers, dispensing bottles, wash bottles, tubing, and plastic bags.

High-density Polyethylene (HDPE)

The mass production of High Density Polyethylene (HDPE) and Polypropylene (PP) in the 1950s led to a further ramp-up in blow molding demand, for applications such as liquid detergents, motor oil, water, and milk. The lightweight HDPE gallon milk container revolutionized the dairy industry, as glass bottles and paperboard were quickly replaced.

HDPE is a polyethylene thermoplastic made from petroleum. HDPE has little branching, giving it stronger intermolecular forces and tensile strength than lower density polyethylene. HDPE is also somewhat harder and more opaque and it can withstand rather high temperatures. HDPE is resistant to many different solvents and has a wide variety of applications, including Tupperware containers, laundry detergent bottles, milk cartons, and plastic lawn bags.

Polypropylene (PP)

Polypropylene or polypropene (PP) is a thermoplastic polymer used in a wide variety of applications, including food packaging, textiles, laboratory equipment, loudspeakers, and automotive components. An additon polymer made from the monomer propylene, it is unusually resistant to many chemical solvents, bases, and acids.

Most commercial polypropylene has a level of crystallinity intermediate between that of LDPE and HDPE. Although it is less tough than LDPE, it is much less brittle than HDPE. This allows polypropylene to be used as a replacement for engineering plastics, such as ABS. Polypropylene has very good resistance to fatigue, so that most plastic living hinges, such as those on flip-top bottles, are made from this material.

Polyethylene Terephthalate (PET)

Polyethylene terephthalate (PET) is a thermoplastic resin of the polyester family that is used to make beverage, food, and other liquid containers, synthetic fibers, and is also used for some other thermoforming applications. It is also one of the most important raw materials used in man-made fibers. Depending on its processing and thermal history, it may exist both as an amorphous (transparent) and as a semi-crystalline (opaque and white) material.

A main virtue of PET is that it is fully recyclable. Unlike other plastics, its polymer chains can be recovered for additional use.

PET can be semi-rigid to rigid, depending on its thickness, and is very lightweight. It makes a good gas and fair moisture barrier, as well as a good barrier to alcohol and solvents. It is strong and impact-resistant. It is naturally colorless and transparent.

PET bottles are excellent barrier materials and are widely used for soft drinks. For certain specialty bottles, PET sandwiches an additional polyvinyl alcohol to further reduce its oxygen permeability.

The production of PET led to the viability of rehear stretch blow molding. The strain hardening properties of PET allowed the high volume production of bottles to resist the carbonation pressure in soft drink applications. Plastic soft drink bottles (two-liter, one-liter, etc.) can withstand typical internal carbonation pressures of 2 –4 bar (30–60 psig), because the plastic is strain oriented in the stretch blow molding manufacturing process.

The high clarity and economics of PET stretch blow molding have since made this a popular production method for the production of bottles for water, detergents, and other products.

Wikipedia contributors, "Blow molding," Wikipedia, The Free Encyclopedia, http://en.wikipedia.org/w/index.php?title=Blow_molding&oldid=54923632 (accessed May 25, 2006).



THE BASICS IN BLOW MOLDING MACHINES AND PROCESSES

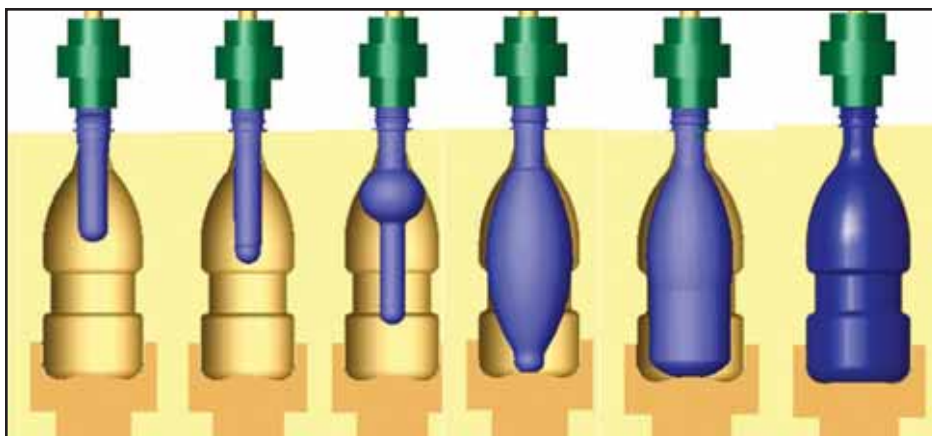
BY COMPRESSED AIR BEST PRACTICES

Blow molding is a manufacturing method involving the forming of hollow articles out of thermoplastic materials. The process involves forming a molten tube of thermoplastic material, then with the use of compressed air, blowing up the tube to conform to the interior of a chilled blow mold. The most common methods are injection-stretch, extrusion, and injection blow molding. Compressed air plays a vital role in the blow molding process and is used at pressures ranging from 60 psig to 580 psig.

Stretch blow molding—Air at 580 psig

In the Stretch Blow Molding (SBM) process, the plastic is first molded into a “preform” using the Injection Molded Process. These preforms are produced with the necks of the bottles, including threads, on one end. These preforms are packaged and fed later (after cooling) into an SBM blow molding machine. In the SBM process, the preforms are heated (typically using infrared heaters) above their glass transition temperature and then blown using high pressure air into bottles using metal blow molds. Usually the preform is stretched with a core rod as part of the process. The stretching of some polymers, such as PET, results in strain hardening of the resin, allowing the bottles to resist deforming under the pressures formed by carbonated beverages, which typically approach 60 psi.

“The most common methods are injection-stretch, extrusion, and injection blow molding.”



The stretch blow molding process. Courtesy of Ottmar Brandau, OB Plastics Consulting

This picture shows what happens inside the blow mold. The preform is first stretched mechanically with a stretch rod. As the rod travels down, low-pressure air of 5 to 25 bar (70 to 350 psi) is introduced blowing a “bubble.” Once the stretch rod is fully extended, high-pressure air of up to 40 bar (580 psi) blows the expanded bubble into the shape of the blow mold.

Compressed air for SBM processes is usually supplied by high-pressure reciprocating air compressors and/or boosters. Moisture and particulates are removed from the air by high-pressure refrigerated air dryers (cycling and non-cycling) and coalescing filters.

The main applications for SBM processes are bottles, jars, and other containers. The SBM blow molding process produces bottles of superior visual and dimensional quality compared to extrusion blow molding. The process is ideal for both narrow and wide-mouthed containers and produces them fully finished with no flash.

Extrusion blow molding — Air at 60 to 150 psig

In Extrusion Blow Molding (EBM), plastic is melted and extruded into a hollow tube (a parison). The parison is then captured by closing it into a cooled metal mold. Air is then blown into the parison, inflating it into the shape of the hollow bottle, container, or part. After the plastic has cooled sufficiently, the mold is opened and the part is ejected.

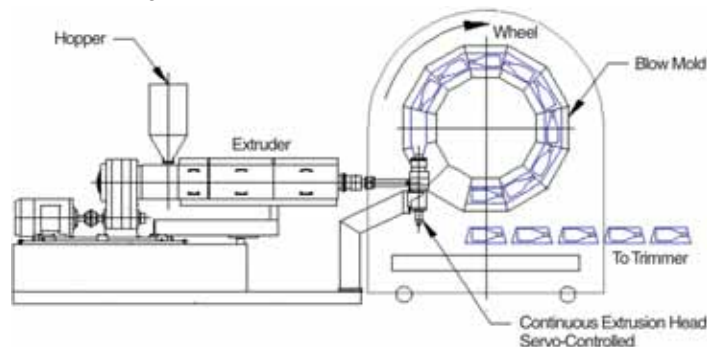
EBM is a low-pressure process, with typical blow air pressures of 25 to 150 psi. This low-pressure process allows the production of economical low-force clamping stations, while parts can still be produced with surface finishes ranging from high gloss to textured. The resulting low stresses in the molded parts also help make the containers resistant to strain and environmental stress cracking.

Compressed air for EBM processes is usually supplied by rotary screw air compressors with direct or variable speed drives. Moisture and particulates are removed from the air by refrigerated air dryers (cycling and noncycling) and coalescing filters.

EBM processes may be either continuous (constant extrusion of the parison) or intermittent. Types of EBM blow molding equipment may be categorized as follows:

I. Continuous Extrusion Blow Molding Machinery — Rotary Wheel Systems

Rotary wheel blow molding systems are used for the high-output production of a wide variety of plastic extrusion blow molded articles. Containers may be produced from small, single serve bottles to large containers up to 20–30 liters in volume—but wheel machines are often sized for the volume and dimensional demands of a specific container, and are typically dedicated to a narrow range of bottle sizes once built. Multiple parison machines with high numbers of molds are capable of producing over one million bottles per day in some configurations.



Rotary Wheel Blow Molding Machine Operation. Image provided Courtesy Graham Machinery Group, York, PA.

Rotary blow molding “wheels” are targeted to the high output production of containers. They are used to produce containers from one to seven layers. Rotary wheels, which may contain from six to thirty molds, feature continuously extruded parisons. Revolving sets of blow molds capture the parison or parisons as they pass over the extrusion head. The revolving sets of molds are located on clamp “stations.” Wheel machines are favored for their processing ease, due to having only single (or in some cases, two) parisons, and mechanical repeatability.

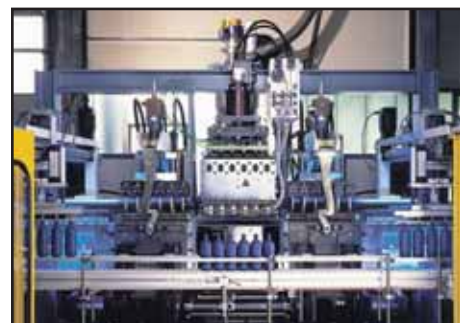
The mold close and open actuation is typically carried out through a toggle mechanism linkage that is activated during the rotational process by stationary cams. This mechanical repeatability is considered an advantage by most processors.

The method of wheel rotation is typically conducted through an electric motor with a “pinion” gear or small gear next to or in mesh with a rotating “bull” gear or large gear. All utilities for blowing containers and for mold cooling are carried through the main shaft or the axle from which the wheel rotates about. These utilities include compressed air and water. Sequencing functions necessary to inflate the parison hold the container prior to discharge and discharge is completed by mechanical actuation and by pneumatic valves—resulting in a high degree of repeatability.

The growth of wheel machinery in the United States was spurred by the conversion of motor oil containers from paperboard cans to plastic bottles, and the conversion of laundry detergent from powder to liquid form. Additional high volume applications have included single serve juices and drinkable yogurt, condiments, and household cleaning supplies.

II. Continuous Extrusion Blow Molding Machinery — Shuttle Systems

Shuttle machines are a significant work-horse in the extrusion blow molding of hollow plastic articles, such as bottles for food storage. Shuttle machines are either single-sided or dual-sided machines, and can be manufactured to produce one- to six-layer containers



Shuttle machinery is used widely in the production of personal care bottles, medical bottles, and some small industrial containers — Photo courtesy Graham Machinery Group, York, PA

THE BASICS IN BLOW MOLDING MACHINES AND PROCESSES

BY COMPRESSED AIR BEST PRACTICES

—although the number of suppliers who produce 4–6 layer machines is limited. In a single-sided machine, the mold “shuttles” under the flow-head, closes to capture the parisons, and then moves away from the head. Blow pins are then forced downward into the molds, helping to “calibrate” the necks while air is forced into the cavity to blow the container. The shuttle motion allows the bottles to be blown and cooled to the side, without interfering with the parisons, which are continually extruding from the flowhead. In a double-sided shuttle machine, there is a mold on each side of the flowhead, one shuttling to the right, and one to the left, which generally doubles the output of a single-sided machine.

Shuttle machines may extrude single or multiple parisons, and are characterized by the number of parisons and the horizontal spacing between the parisons. For example, a 4x100 shuttle extrudes four parisons, spaced 100 mm between the centers. In general, shuttle machines up to 2x100 mm spacing are considered small machines; shuttles up to 6x100 mm spacing are considered mid-sized machines; shuttles larger than this are typically referred to as “long-stroke” machines.

Shuttle machinery is used widely in the production of personal care bottles, medical bottles, and some small industrial containers.

Sequence of Operation

The steps required for a shuttle machine to blow mold a hollow plastic object can be described by the following sequence of operations:

- As the dropping parisons approach the length of the object to be blown, the mold, in open position, shuttles sideways to a point directly under the head of the machine.
- The molds close to capture the parison.
- A knife cuts the parisons directly above the molds. This may be either a cold knife (cutting with a sharp edge) or a hot knife (burning through the parison).
- The molds shuttle away from the head until they are directly under the blow pin stations. If the mold movement is horizontal, the extruder head is made to bob up vertically, so that the continuously extruding parisons do not drag against the mold as it moves sideways. In some shuttle machinery, the molds shuttle down at an angle, eliminating the need for the head and extruders to bob upwards.

- The blow pins are forced down into the still-open necks of the containers, calibrating the necks of the containers. In most cases, the blow pins punch down onto striker plates, which form the top edge of the neck to a precise flat dimension.
- Compressed air pressure is applied to blow the containers. In many cases, the blow air is turned on before the blow pins enter the open neck of the parison, forcing the plastic outward and ensuring a good neck formation.
- After the containers have cooled, the molds open, and again shuttle under the head of the machine. As the molds close on the molten parisons, masking stations that are attached to the sides of the mold close over the outside of the previously blown containers, which are still held in place by the blow pins.
- The blow pins retract, leaving the containers held only by the masks.
- As the molds again shuttle sideways, the masks transfer the formed containers sideways to a punching station. Punches come forward to remove the tails, top moil, and any handle (grip) slugs away from the bottles.
- The bottles are then conveyed out of the machine. This may be done by transferring the bottles onto conveyor belts, by takeout devices, or by simply dropping the bottles into a chute or onto a take-away conveyor.

III. Intermittent Extrusion Blow Molding Machinery — Reciprocating Screw

Reciprocating screw machinery is used for the extrusion blow molding of hollow containers. Examples of parts manufactured from these machines include lightweight HDPE bottles for dairy and water, as well as large 3–5 gallon polycarbonate bottles for water coolers.

Reciprocating screw blow molding machines are characterized by the use of a reciprocating screw extruder as is used in injection molding. As the screw melts the resin, the screw moves backward, allowing the melted plastic to accumulate in the end of the barrel. When the screw pushes forward under hydraulic pressure, the plastic is pushed out of the barrel and extruded through a flowhead and die to form a plastic parison.

Continued on page 56

KAESER COMPRESSORS, INC.

Company Profile

It's been almost 25 years since Kaeser Compressors, Inc. was established in the United States. And it was, to say the least, a modest beginning with only three employees. Today it is the largest subsidiary of Germany's Kaeser Kompressoren and ranks among the top compressor providers in the country.

President Reiner Mueller remembers those first few years well. "We took a very practical approach: steady, controlled growth. We established a top notch distribution network and gave them an outstanding product to sell," reflected the elder of the two Muellers who form the leadership team at Kaeser. "But clearly, it was the hardwork and dedication of our employees that brought us to where we are today."

In fact, many of the company's first employees are still with Kaeser today, including Roy Stuhlman, Vice President of Sales. A trip through the 100,000 square foot facility reveals dozens of employees who are celebrating 10, 15, and even 20 years of service. In many ways, longevity is Kaeser's strength and a key contributor to its remarkable growth over the years.

As the long days of summer set in, General Manager Frank Mueller is settling into his fifth year at the helm. Excited by Kaeser's continuing success, he sat down for an interview and shared his thoughts on the key points of Kaeser's history and continuing focus: a systems approach to advanced technology, education, training, and service. "We have a reputation built on quality and reliability, and it only makes sense that people see us as *the* compressed air solutions provider. It's not one size fits all; not every customer needs the same technology," he points out.

Advanced Technology

Kaeser's first technology breakthrough came in the mid 70s with the development of the Sigma Profile. This proprietary design provided over 20% more air per horsepower than existing rotary screw airends. The Sigma Profile is standard on all Kaeser rotary screw compressors in the 3–600 HP range — the widest range on the market. Direct drive units feature airends optimized in size and profile to match lower rotational speeds and provide the very best specific performance.

In the past decade, Kaeser introduced Sigma Control — the first industrial-based PC control system — and combined it with the latest in variable speed drive technology to create the Sigma Frequency Control rotary screw compressors. "We pride ourselves on having the most efficient range of frequency control units, along with the expertise to properly apply the technology for maximum energy savings," explains Frank Mueller.



General Manager Frank Mueller and President Reiner Mueller

“It was the hard work and dedication of our employees that brought us to where we are today.”



Built in 1994, Kaeser's 100,000 sq. foot facility in Fredericksburg, VA was dedicated to its employees — the most valuable resource of Kaeser compressors.

KAESER COMPRESSORS, INC.

Company Profile

Taking the next logical step in addressing complete system control, Kaeser recently introduced the Sigma Air Manager (SAM). This comprehensive air system manager is the first of its kind to provide remote monitoring and management functionality for all components in the air system regardless of manufacturer. It can be applied to new or existing systems and enables reporting through a standard web browser. "When the air system is approached from this standpoint — meeting specific demands from a systems perspective — it's not unusual for customers to save tens of thousands of dollars in energy costs in the first couple of years," recounts Mueller.



Kaeser offers a complete line of stationary and portable compressors, blower packages, clean air treatment equipment, and vacuum systems as well as comprehensive controls and accessories.

This practical approach to garnering significant energy savings for businesses in multiple industries has led to a successful partnership with the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy Industrial Technologies Program. Beginning in 2001, Kaeser dispatched Wayne Perry, Technical Director, to the Compressed Air Challenge's Best Practices Steering Committee. Mr. Perry has since traveled extensively to not only promote a better understanding of compressed air energy management but also provide practical solutions for manufacturers in areas of the world such as China and Indonesia.

Kaeser is also a member of the Compressed Air and Gas Institute (CAGI), an organization that promotes awareness of the benefits and appropriate applications for compressed air as well as its efficient use. Participating along with

other OEMs and manufacturers in the organization has helped develop a uniform reporting standard that has revolutionized the industry and brought out a sense of competitiveness. "And that's been good for end users as we all strive to meet their demands and provide the most efficient equipment," commented Mueller.

Training and Education



Education and training have always been a vital part of the Kaeser equation. "We start by ensuring that our employees receive very specific training in our products — and branch out from there," indicated Mueller. Offering an extensive array of product-specific training for employees and distributors right from the beginning lead to the development of an entire technical training department and the establishment of Kaeser's Factory Certified Training (KFaCT) program.

Kaeser also offers end-user training through their compressed air seminars. These customized sessions provide important information on air system design, installation, and operation for a wide variety of industrial and commercial businesses and are tailored to the audience's specific needs and interests. Kaeser owners also have the option of selecting equipment-specific service training conducted at Kaeser's state-of-the-art training center.

Service

As with most companies these days, service is truly a differentiating factor. “We still answer the phone with a live person — that one to one interaction is something our customers appreciate. And it’s why we continue to empower our local representatives with all the tools they need to provide local, face to face service.”

Capitalizing on the remote monitoring features of Sigma Air Manager (SAM), some customers enable the local compressor service provider to log in to their air system. From there, the distributor can monitor performance, adjust controls, and schedule routine maintenance — almost eliminating unscheduled downtime. “Service contracts and remote monitoring arrangements take the burden off the customer and enable us to further increase a system’s reliability.” For those who simply want to flip a switch and get the air they need, Kaeser offers the Sigma Air Utility — a very simple arrangement where Kaeser installs the equipment on site but still owns the equipment and bills the customer by the cubic foot of air used.

“Providing the solution that’s right for the customer, not the one that’s most expensive or impressive — that’s our philosophy,” Mueller says, summing it all up. With an expanding network of representatives nationwide, dedicated employees, and a brisk economy at its back, Kaeser is focused and determined to continue its positive growth pattern. When advancing technology and service combine, the success of Kaeser is inevitable.

Vital Statistics:

Employees Worldwide: over 3,000

Privately held

Product Lines: Rotary screw compressors, clean air treatment equipment including refrigerated and desiccant dryers, rotary lobe blowers, vacuum systems, reciprocating compressors, portable compressors, and control systems.

U.S. Corporate Headquarters:

511 Sigma Drive
Fredericksburg, VA 22408
540-898-5500 Phone
540-898-5520 Fax
www.kaeser.com
info.usa@kaeser.com

For more information contact: Angela Kelly, Public Relations, Kaeser Compressor. Phone 800-777-7873 or visit www.kaeser.com.

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SPX DEHYDRATION & PROCESS FILTRATION

Company Profile

SPX Dehydration & Process Filtration was formed to better describe the breadth and depth of products and systems created by this division of global multi-industry leader SPX Corporation. “The products and systems we produce remove moisture and contaminants from air, gas, fuel, lubricating oil, and insulating fluids to improve operations, processes, and energy efficiency,” says Bill Kennedy, Director Of Marketing.

Symbolizing innovation, quality and reliability, world-renowned brands include Delair®, Deltech®, Dollinger®, Hankison®, Kemp®, Pneumatic Products®, RentalDryers.com™, and Vokes. Each offers more than 30 years of knowledge, expertise, and innovation to the industrial marketplace. In leveraging the strengths of a Fortune 500 multinational company, customers can expect premium products, leading technology, outstanding quality, and exceptional customer service. “Our goal is to deliver a premium buying experience to our customers,” states Tony Renzi, President, SPX Dehydration & Process Filtration.

SPX manufactures products that play an integral part in the daily productivity of the world’s leading manufacturers. Applications are found in everyday life. From the tires on your car, to the hospital down the street, to the countless producers of goods and services, purified air, gases, and fluids improve the performance and efficiency of everyday products and complex processes.

Products

SPX products set the standard for industry. Known for dependability, each product delivers technology to produce choice solutions for a wide range of applications that require clean, dry air and gas or process fluid cleanliness. The end-user realizes return-on-investment through process improvements, energy efficiency, and reduced maintenance.

Technological leadership leverages refrigeration, adsorption, permeation, and the principles of impaction, interception and coalescence, to protect products and processes from contaminants such as water, oil, dirt, dust, and pollen.



SPX Dehydration & Process Filtration, World Headquarters, Ocala Florida



SPX Dehydration & Process Filtration, Moers, Germany

“Our goal is to deliver a premium buying experience to our customers.”

COMING NEXT MONTH!

Dehydration products include compressed air and gas dryers; air and process filtration products; breathing air packages, condensate drains, after-coolers, oil-water separators, rental dryers, accessories, and replacement parts.

Process filtration products include high efficiency air filtration, gas adsorption and filtration, process gas filters, coalesers, fuel and lubricating oil filtration, oil mist elimination, insulating fluid treatment, oil exhaust filtration, and pipeline filters.

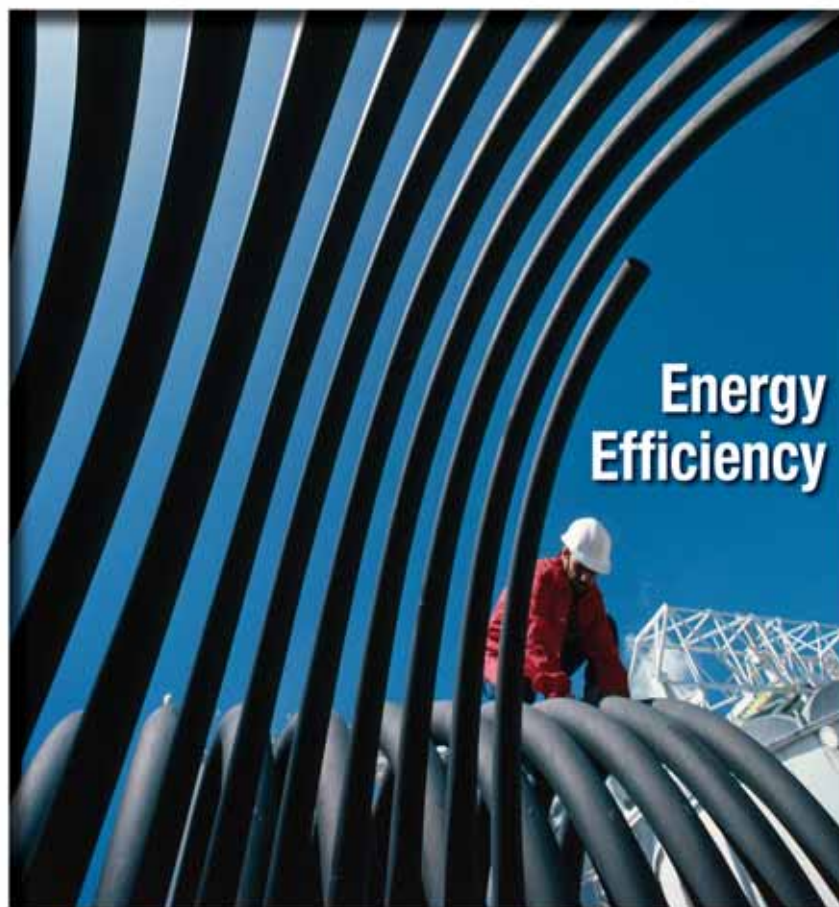
Resources

Partnered with a global network of authorized distributors or representatives, local support is just a phone call away. Factory-trained, these sales and service professionals understand how to apply the best solutions to improve plant operations and maximize productivity. Backed by SPX Dehydration & Process Filtration's 17 locations in 11 countries, global engineering and application teams have the expertise and network to ensure market-tailored results with off-the-shelf products or custom engineered systems. Industries served include: power generation, chemical, petrochemical, transportation, automotive, aerospace, machinery equipment manufacturers, semiconductor, pulp and paper, primary metal, glass, food and beverage, telecommunications, health, and medical.

For more information contact: Bill Kennedy, Director of Marketing, SPX Dehydration & Process Filtration. Phone (352) 873-5126 or visit www.spxdehydration.com

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JULY 2006

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Q&A — TENCARVA: STRONG CUSTOMER RELATIONSHIPS

Interview with Rod Lee, (President) and Bill Strong (Vice President) of the Tencarva Machinery Company

COMPRESSED AIR BEST PRACTICES: When and how was Tencarva started?

TENCARVA: The Tencarva Machinery Company was formed in 1978 by a group of 18 sales engineers, including Bill and myself, and one accountant with experience in air compressors and pumps. We formed an S Corporation, which is employee-owned, and retain that same structure today. Tencarva today has 62 owners all of whom hold sales or management positions in the company.



*Tencarva President,
Rod Lee*

What is the scope of Tencarva today?

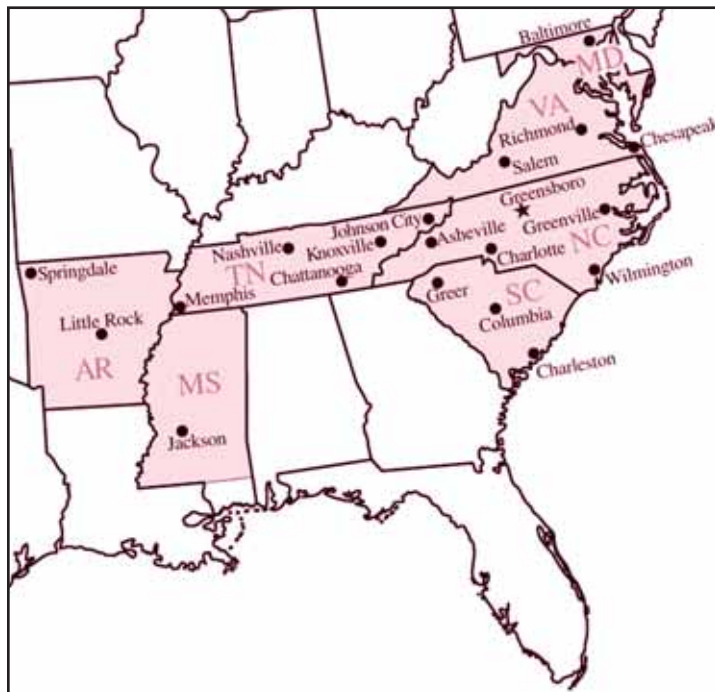
The original territories are reflected in the company name. They were Tennessee, North and South Carolina, and Virginia. Over the years we expanded into Arkansas, Maryland, and Mississippi. We are headquartered in Greensboro, NC, and have 19 additional branch locations in these 7 states staffed by a sales force of 50 sales engineers and 75 support professionals. Many branches include warehouses with pump and compressor assembly and repair facilities. Tencarva has custom fabrication capabilities in Greensboro.



Tencarva's Headquarters, Greensboro, N.C.

What brands of compressed air products does Tencarva represent?

We sell Atlas Copco air compressors and air treatment products in Maryland, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. We represent SPX Hankison air treatment products in all of our territories.



Tencarva serves 7 states with 20 offices.

What are the major industries Tencarva serves?

It would be hard to name an industry we don't serve. The southeastern USA has a very diversified industrial base. The pulp and paper, chemical, and food and beverage industries are a significant part of our business in most of our areas. The Carolinas have their traditional textile, furniture, and newer pharmaceutical and high tech industries, while Virginia has tobacco, marine/Navy, and many European and Japanese manufacturers. Tennessee is incredibly diverse with automotive and other manufacturing industries, as well as the process industries. In fact the automotive industry is now present in many of our territories. This diversity has enabled our economy in the southeast to stay stable for many years and has allowed Tencarva to follow hot industries.

How does Tencarva take compressed air products to market?

The focus is not on products but on customer relationships. The broad range of products offered by Tencarva affords the opportunity to have broader relationships with customers. We can talk about pumps and compressed air with our customers. This allows our sales engineers to get to know our customers, their processes and needs extremely well, and thereby add more value to their operation. Tencarva has 50 sales engineers calling on our customers. In any given area, we have two to three times more people than the competition, which only work with compressed air. Because we offer both pumps and compressed air products, we are able to create small sales territories, which in turn allows our sales engineers to build strong and valuable customer relationships.

There are industrial supply houses with smaller territories, but they do not have the technical expertise in compressed air products that Tencarva sales engineers have. There is an optimum point between technical product knowledge and closeness to the customer which we believe we have found.

Tencarva also sells pumps. How does Tencarva handle both pumps and compressed air products?

We feel this is a strength for Tencarva. We put a technically skilled person, with a small territory, frequently into the same plant. This sales engineer, who can handle both product lines technically, gives us the ability to spend more time in a specific facility and better understand their processes and their needs. The somewhat longer interval between compressor needs and sales is addressed by this strategy. Our work with pumps and other process equipment supports our presence until the next compressor project comes along.

The challenge this poses is to train our sales engineers appropriately in both compressed air and pumping systems. It isn't easy to do. We have to stay abreast of the changes and technological advances. For this reason, we hire people who can learn quickly and who have the technical background on how a machine works. In this manner, they can learn a broad spectrum of products.

How does Tencarva recruit, train, and retain its sales engineers?

People are at the core of Tencarva's strategy, and this is where we focus our investments. We take a long-term approach to creating a Tencarva sales engineer and/or service technician. The benefits are that those who go through our development process tend to spend their whole careers with Tencarva. We pay very well, and most of our sales engineers are part owners of the company. Turnover is next to nothing once they have been a Tencarva sales engineer for two to three years.

We begin the process by investing in recruiting at engineering schools for people with technical educations. We hire people right out of college, which is a difficult process and requires a large investment. North Carolina State, Clemson, and East Carolina have been the mainstays. Recently, we recruited at Tennessee Tech, Mississippi State, and the University of Arkansas. We look for people with sound technical foundations who are fast learners and have a strong work ethic.



Tencarva personnel using Atlas Copco's M-Box can measure and analyze customers' actual compressed usage and needs for sizing compressors for optimum efficiency and energy savings.



Tencarva service specialists utilize laptop computers to keep track of the latest factory service updates on all Atlas Copco compressors.

Q&A — TENCARVA: STRONG CUSTOMER RELATIONSHIPS

Interview with Rod Lee, (President) and Bill Strong (Vice President) of the Tencarva Machinery Company

The recruits then receive in-house training for one to two years working in customer service. They support our Sales Engineers and begin to assist them with application engineering as well as performing the support functions typical of customer service. During this time, they also go to product training courses offered by our manufacturers. Atlas Copco, which is a very innovative company, does a great job providing in-depth technical product training at factory schools for our people.

They then go to the field as a Sales Engineer where they receive sales training on fundamentals such as step-by-step sales processes and time management. Of our 50 sales engineers, over 40 have been through this process. Probably half of the new graduate hires do not complete this training process, but those who do tend to stay with us for their entire career.

How does Tencarva train its service technicians?

When the technology transition occurred from the mid '70s to the mid '80s from reciprocating to rotary screw air compressors with sophisticated computer controls, the service business changed from customers' maintenance personnel to supplier service. The reason for this has been the retirement of in-plant people with a service knowledge base on reciprocating air compressors. The new generation has outsourced the service for the new screw technology. Today, we have 18 compressor service people. Service today is much more technical with a need for strong electronics training. This requires a higher skill level from service than ever before.

Atlas Copco provides very strong service training in this regard. It is challenging because Atlas is so innovative. They offer specialized schools for specific product lines and for topics such as electronic compressor controls. We send at least 10 service technicians per year to their factory schools to stay on top of the new technologies.

What investments have been made to support the work of the sales engineers and service technicians in the field?

Although people continue to represent our core investments, we continually build our operating capabilities to support them. Tencarva has had, for example, fabrication capabilities since its inception. Today, with the advent of full-feature products, there is less demand for custom fabrication but we have the ability to offer it when required. Our service technicians are now equipped with laptop computers for accessing factory technical information updates as well as re-programming customers' compressors at the job site. We are also continually updating the systems in our branch locations and recently implemented a new computer system that links all branches together, allowing them to view inventory across the company. In 1998, we built a new 60,000 square foot headquarters in Greensboro, North Carolina.



With 18 service technicians available on 24-hour call, Tencarva is able to respond quickly to customers' needs.



Tencarva Nashville, Tenn., Branch Office

We stock parts and the small rotary screw GX Series air compressors from Atlas Copco to ensure fast deliveries. Atlas Copco provides finished goods inventory at its warehouse in Rock Hill, South Carolina, for all other models, and this functions well for our customers.

What do you recommend to end users with regards to their compressed air systems?

Customers need to always remind themselves to take a broader view of their system. Most problems are created by “add-ons” meant to take care of a specific need. After you do this six times, you can have an inefficient system. They should consult with system specialists who can provide advice on the entire system. The work of the Compressed Air Challenge has been a real benefit to the industry on this topic.

Today the focus is on compressor controls. Variable speed drives are everywhere with air compressors and pumps. They provide opportunities for greater efficiencies. Controlling and sequencing is also gaining attention.

The simple things, however, are still there. Fix leaks and don't let drain traps blow off too much air!

How can compressed air machinery manufacturers and distributors work together to better meet the needs of the industry?

The manufacturers need to be continually improving their equipment—even though this places a training burden on distribution. New materials and new drive capabilities can provide benefits to the customer.

While doing this, they need to listen to the Voice of the Customer to ensure the customer's system operates better. Distributors need to better provide this feedback to the manufacturer and then get customers to adopt the innovations. If everyone does this well, systems will run better.

Many customers don't know what they need. It wasn't long ago that few people used air dryers. People had water in their air systems but didn't think they had a problem! Distributors must help customers understand the technical issues and provide counsel to educate the customer.

Thank you TENCARVA for your insights.

For more information contact: Rod Lee, President, Tencarva Machinery Company. Phone (252) 695-0400 or visit www.tencarva.com.

“Tencarva has 50 sales engineers calling on our customers. In any given area, we have 2-3 times more people than the competition”



Tencarva Chesapeake, Va., Branch Office



Tencarva Memphis, Tenn., Branch Office

BRANDING CORPORATIONS

BY ROD SMITH

“Branding” for all corporations can be a challenge. Creating brand awareness, of the right nature and to the right people, is no simple matter. While branding has long been a key part of the marketing strategy of consumer goods companies like Nike and Procter & Gamble, it has now become a critical success factor in industrial corporations.

Corporate Branding

The consolidation of manufacturing companies, under large corporations, has created many branding challenges. When a corporation acquires a company or owns many divisions, what should the branding strategy be? Should the brand(s) retain their identities, be dual-branded with the parent, or simply be absorbed? While there is no one single solution, the answers lie with the corporation first identifying who their target market is, understanding brand equity levels, and budgeting the resources required for the chosen corporate branding strategy.

“the answers lie
with the corporation
first identifying
who their target
market is”

1. **Target: Institutional Investors Only:** creating brand awareness is critical for the parent corporation to promote the value of the company stock prices. This strategy is often chosen when the brands of the divisions have far more equity with customers than with the parent company. The marketing funding required for this strategy is relatively low.
 - a. Corporate brand designs, both standalone and with integrated divisional brands, are promoted through corporate marketing via a web site and through printed materials to investors.
 - b. Divisional branding, on products and promotional materials, does not need to change significantly, which dramatically reduces costs related to the corporate strategy. References to the parent company are made with web site links and on product literature but are not fully integrated into the divisional brand.
 - c. A good example of this strategy is executed by United Technologies Corporation, which owns major brands like Carrier, Otis Elevator, and Sullair Corporation.
2. **Target: End Users & Institutional Investors:** there are many marketing advantages to creating one giant umbrella brand name in terms of brand awareness. The costs are also significant. When a corporation that holds a major brand name with end users buys a company with reduced brand equity, it can also help that company grow.
 - a. Divisional brands become product line brand names. Products and literature either bear both brand names or just the parent company brand name in new branding designs. Parker Corporation, Ingersoll Rand, and Atlas Copco are good examples. These corporations are able to leverage the parent companies' brand name to create opportunities for different divisions.
 - b. While the investment is large for the divisions to rebrand, the exposure for the brand is tremendous to the investment community, as both individual and institutional investors see just one brand name.
 - c. Warning: the cost-savings of brand-consolidations can be tempting. Be careful not to underestimate the power of the divisional brand name. There are many examples of successful companies that, when acquired and consolidated into the parent, lost the perceived commitment to their brands and ended up losing market share. The failure in this example usually stems from underestimating either the existing brand equity or the resources required to execute the new branding strategy.

Understanding the target market, the existing brand equity levels, and the available resources for branding will guide a corporation toward the appropriate branding strategy.

This is the first of a series of articles on industrial branding. Rod Smith is the former Vice President of Sales and Marketing for Hankison, PPC, & Deltech (divisions of SPX Corporation) as well as for Quincy Compressor (a division of EnPro Industries).

INDUSTRY NEWS

Press Releases

PRECISION QUALITY CYLINDERS!

Efficient, reliable booster compressors to 650 psig

Kaeser Compressors has expanded its proven line of booster compressors. Providing pressures to 650 psig and flows to 685 cfm fad, these units are a convenient, economical way to boost existing plant pressure while eliminating the need for expensive, separate high pressure systems.

Mounted on heavy-gauge base plates with anti-vibration pads, Kaeser boosters eliminate the need for special foundations and fastenings. Standard N Series high pressure compressors come complete with TEFC motor and starter, as well as aluminum cylinder heads and finned copper cooling pipes for efficient aftercooling. Booster Extra Pressure (EP) compressors include precision manufactured, two or three cylinder pumps with 100% duty cycle and a new forced lubrication system with continuous, full filtration. These features, combined with an automatic v-belt tensioning device, provide reliable operation and extended equipment service life.



Kaeser boosters

Ideal for PET bottling systems and other applications, find out how Kaeser booster compressors can improve your plant's efficiency — call 800-777-7873 or visit our website at www.kaeser.com.

INDUSTRY NEWS

Press Releases

STATIONARY NITROGEN GENERATOR — SERIES II

BAUER SNG Series II Nitrogen Generators are self-contained, fully integrated, modular systems designed to eliminate the hazards involved with the handling of high pressure cylinders as well as the burden of merchant-supplied nitrogen gas.

Nitrogen Generation System

The SNG Series II Nitrogen Generators are complete systems designed for the on-demand supply of nitrogen gas that utilizes BAUER rotary screw compressors, a nitrogen separation module, and an integrated BAUER high pressure reciprocating compressor to supply product gas up to 6,000 PSI.

High Pressure Compressor

BAUER High Pressure Compressors are multistage reciprocating compressors that can deliver nitrogen at pressures ranging from 2,000 PSI up to 6,000 PSI to a gas storage system or directly to gas assist control units.

Nitrogen Separation Module

The SNG Series II Nitrogen Generators generate high purity nitrogen gas through membrane separation, which enables the rapid production of low cost, high purity nitrogen gas on demand at the point of use. Ambient air is compressed and supplied to the separator, where water vapor, hydrocarbons, and various gases such as O₂ and CO₂ are released to the atmosphere, resulting in high purity nitrogen gas.

Gas Storage

BAUER recommends using a nitrogen gas storage system to serve as a buffer to dampen compressor-related pulses in the process. BAUER Nitrogen Gas Storage Systems are available in either D.O.T. or A.S.M.E. approved cylinders that store nitrogen gas at pressures up to 6,000 PSI.

Contact:

BAUER COMPRESSORS Inc.

Jason Pruss, Sales Coordinator

jason.pruss@bauercomp.com

(757) 855-6006



The SNG Series II Nitrogen Generator

DONALDSON ACQUIRES AIRCEL TO STRENGTHEN PRODUCTION CAPABILITY AND PRODUCT OFFERING

Donaldson Targest the Needs of the Compressed Air & Gas Industry in North America

Minneapolis, MN, USA — January 20, 2006: Donaldson Company, Inc., leading maker of industrial filtration systems, announced today that it has acquired AirCel Corporation, a privately held manufacturer of dryers and purification equipment for compressed air and other gases.

“The acquisition of AirCel will dramatically strengthen our production capability and product offering to the compressed air and gas industry in North America,” Jim Giertz, Senior Vice President of Donaldson’s Industrial Filtration Solutions business, said. “By manufacturing in North America we can cut lead times and realize several economic advantages. Our Donaldson Ultrafilter brand is a strong line of compressed air filtration products, and AirCel’s dryer products extends our range of both refrigeration and regenerative desiccant dryers for our North American customers.”

“AirCel’s patented VariCel® refrigerant dryers perfectly complement the Donaldson Ultrafilter compressed air filters and coalescers,” Mike Zarif, a co-founder and Vice President, of AirCel Engineering, explained.

AirCel also manufactures N2Cel® nitrogen generators for use in tire inflation. “Using compressed nitrogen for tire inflation offers both safety and mileage advantages over normal compressed air,” Robert Olson, co-founder and President of AirCel, stated. “We are pleased to work with a company that has the global reach and resources of Donaldson as we further develop our product offering.”

AirCel is based in Maryville, TN with a modern facility that produces a full line of compressed air/gas purification equipment. AirCel’s refrigerant dryers all use R134a, the latest environmentally friendly refrigerant that is required to be used in all industrial products by 2010. Both AirCel and Donaldson are members of the Compressed Air and Gas Institute (CAGI).

For an updated catalog of Donaldson products under the brand names Donaldson Ultrafilter and Donaldson AirCel call 1-800-543-3634.

Further product information can be found at www.aircelintl.com and <http://www.n2cel.com/>

Donaldson is a leading worldwide provider of filtration systems and replacement parts. Donaldson is a technology-driven company committed to satisfying customer needs for filtration solutions through innovative research and development. Donaldson serves customers in the diesel engine and industrial markets including in-plant air cleaning, compressed air and gas purification, power generation, disk drive filtration, off-road equipment and trucks. Our 11,000 employees contribute to the company's success at over 30 manufacturing locations around the world. Donaldson is a member of the S&P MidCap 400 Index and Donaldson shares are traded on the NYSE under the symbol DCI.

JOB MARKET

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BENEFITS OF A THREE-STAGE RECIPROCATING COMPRESSOR FOR PET BLOW MOLDING APPLICATIONS

BY JOE MASHBURN

Since being developed over a century ago, the reciprocating air compressor has been used in countless applications and proven to be a very reliable piece of equipment. Today, you can still find these workhorses in operation after as many as 50–75 years of use. Since the mid 1960s, most plant air applications requiring your typical pressures of 100 to 125 psi were replaced with the introduction of the rotary screw air compressor. Therefore, the reciprocating compressor lost market share and now is used in “niche” applications.

One such niche application is the stretch blow molding of PET (polyethylene terephthalate) plastic containers. Starting in the 1970s, the PET container has succeeded in replacing glass in a variety of applications including soft drinks, water, food, dairy, medical, household products, and beer. As more and more products are packaged in PET containers, the blow-molding machines that produce these containers have become larger and more efficient, with some machines capable of producing over 60,000 bottles per hour.

There is a variety of stretch blow molding processes used today. The most common is what is referred to as a two stage process where a plastic preform is made from an injection molder. This preform, which resembles a large plastic test-tube, is transferred to a stretch blow molding machine. In this machine, the preform is heated before being placed in the mold. The preform is then stretched in a vertical direction by a stretch rod and preblown with compressed air at 175–350 psi (12–25 bar). A second blast of air at pressures up to 580 psi (40 bar) is made and the bottle is blown to its final shape.

To satisfy both the pressure and capacity requirements for stretch blow molding, the three-staged, oil-free compressor has been the primary choice for these applications. While some compressor manufacturers have introduced booster packages and centrifugal designs, the three-stage reciprocating compressor still maintains advantages in reliability and power consumption when compared to alternative units.

Three-staged compressors come in a variety of cylinder configurations including L-design, Y- and W- shapes, as well as horizontally opposed cylinders. The operation of these is basically the same with each design. Air is taken through the intake into the first stage piston and compressed to approximately 60 psi (4 bar). The air is cooled through an inter cooler and moisture is removed before the air enters the second stage and compressed to approximately 175–250 psi (12–17 bar). The air is cooled again through a second intercooler and is compressed to its final 580 psi (40 bar) discharge pressure in the third stage cylinder. This air is then cooled through an after-cooler so that it can be further treated through the downstream drying equipment.

“the three-stage reciprocating compressor still maintains advantages in reliability and power consumption when compared to alternative units.”



Oil-Free, 40 Bar, Ateliers Francois

BENEFITS OF A THREE-STAGE RECIPROCATING COMPRESSOR FOR PET BLOW MOLDING APPLICATIONS

Compressor With A Rated Capacity Of 777 CFM

The different cylinder configurations that are available can either increase or decrease the amount of parts within the compressor. The preferred choice for most customers is a design that reduces the number of moving parts. This will in turn reduce maintenance cost in both labor and spare parts. The different designs can also dramatically affect the number of valves that the compressor utilizes. With some compressors requiring twice the number of valves than others, the compressor with fewer valves to maintain will again reduce the cost of maintaining the compressor. Finally, the design and size of the cylinders will determine the speed of the compressor. Most customers prefer a compressor with a slow RPM to reduce the wear and tear on the moving components. It is important to note that if a compressor operates at 250 RPMs more than a competitor's model, the faster compressor will turn 15,000 more revolutions in one (1) hour, 360,000 more in a 24-hour period, and 120,000,000 more in one year (8,000-hours).



Three-Stage Ateliers Francois

The manufacturers of PET stretch blow molding machines specify that the air must be "oil-free." Most three-stage compressor suppliers utilize a PTFE or Teflon-coated material for their compression and wear rings. This ring material has been proven both dependable and reliable in a variety of applications requiring oil-free compressors including medical, chemical, and food industries. There are some manufacturers that offer lubricated screw/booster systems for PET applications. These types of systems are not recommended by the blow mold machine manufacturers due to possible contamination of their equipment as well as to the bottles that are produced.

The blow molding machines also require dry air to a pressure dewpoint of 38°F (3°C) with removal of particles "one micron and larger." To meet this air quality specification, refrigerated air dryers and filtration are also typically provided by the compressor manufacturer as part of their package. The refrigerated air dryer, located downstream of the compressor and receiver, will maintain a consistent pressure dewpoint for the system. Some competing manufacturers offer oil-free rotary screw/booster packages with a heat of compression dryer between their oil-free, low-pressure compressor and booster. In some cases, these types of dryers operate below their rated capacity, therefore lowering the heat of compression that is normally utilized to perform regeneration of the desiccant. This can cause a rise in moisture within the air stream to the point that the specified dewpoint to the blow molder will not be achieved. Moisture within the system will cause defects in the bottle and, with some systems, shut down the entire production line as a result of high dew point alarms from system-installed dew point monitors.

Compressor Installation

With the advancement of better skid design and anti-vibration mounts, most three-stage compressors do not require an expensive foundation or grouting during installation. Typically, most manufactures require only a level floor that can handle the static weight of the compressor. Units can be purchased with many of the components, including aftercoolers and receivers, prepiped and mounted on the compressor skid. This makes installation much easier and keeps the cost of installation low. Along with the before mentioned drying and filtration systems, most compressor manufacturers offer the option of a cooling water system to supply the cooling water for the compressor.

Finally, the potential power cost savings of a three-stage reciprocating compressor versus that of a booster package is quite significant. The booster packages typically use an oil-free rotary screw compressor to supply low pressure air to the booster. Since the oil-free rotors cannot be in direct contact, these compressors offer low capacity/power ratios when compared to an oil-free piston compressor. The energy required for the rotary screw/booster systems is typically 12–15% higher than that of a three-stage compressor. Furthermore, since the majority of the piston compressors operate with load/no load controls, some

manufactures utilize only 10–12% of the full load shaft power when operating at no load. This can help lower the power cost versus that of a screw/booster system when the system is not operating at full capacity.

Reciprocating air compressors have proven their reliability since their introduction over a century and a half ago. In particular, the three-stage oil-free compressor has consistently performed and maintained its reliability for PET blow molding plants throughout the world. Its robust design and potential power savings over a booster system helps keep operating costs to a minimum. Without question, the three-stage reciprocating compressor is the preferred compressor for such a demanding application.

For more information contact: Joe Mashburn, AF Compressors USA, Phone (770) 214-2241 or visit www.afcompressors.com.

Note: AF Compressors USA is the U.S. subsidiary of the Belgium-based firm, Ateliers Francois, which has over 100 years experience in manufacturing compressed air equipment. Today, we specialize in the production of 40-bar, oil-free air compressor packages with capacities up to 3,058 CFM for the PET blow molding industry.

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HIGH-PRESSURE DRYERS

BY TIM FOX P.E.

Industry's increasing demand for clean, reliable sources of high pressure compressed air requires that system designers become more educated in dehydration and filtration at these elevated operating pressures. Control valves and motion controllers used in PET bottling and other high pressure applications use smaller orifices and are made with higher precision tolerances than their low pressure counterparts. It is critical that the air flowing through these components be free of all liquids, oil, and particulates. This article will describe where these contaminants originate, and how to eliminate them.

Note that the use of the term "high pressure air" will refer to systems operating at 500 psig to 700 psig (35 barg to 48 barg). By contrast, "low pressure air" or "general plant air" is assumed to be in the 100 psig to 125 psig (7 barg to 9 barg) range.

Sources of Contamination

The three (3) primary contaminants of concern for compressed air systems are moisture, oil, and solid particulates.

“ It is critical that the air flowing through these components be free of all liquids, oil, and particulates. ”

Moisture: As with low pressure air generation, moisture is introduced into the high pressure air system at the compressor intake. Ambient water vapor, commonly expressed as relative humidity, is ingested with the surrounding air. Compressor inlet filtration cannot capture this water vapor. As this mixture of air and water vapor is compressed, the temperature increases, aiding the air's ability to "hold" water vapor. Conversely, the increase in pressure decreases the air's capacity to retain the water in vapor form. The influence of temperature overrides the pressure effects and the moisture remains as a vapor throughout the compression process. Problems arise as the air is cooled in the subsequent system aftercoolers and downstream piping, and liquid water is formed by condensation.

Oil: Hydrocarbons and lubricants are introduced during the compression process. Oils are supplied to the machine's bearing and sealing surfaces and small amounts are swept away by the compressed air. Integrated air/oil separators (if present) are not 100% efficient in capturing the entrained oil aerosols. If present in the ambient air, additional hydrocarbon contamination, in vapor form, may also be admitted at the compressor inlet. As with water, these vapors will condense into liquids in the compression and subsequent cooling process. Compressor inlet filtration does little to prevent this at the source.

Particulates: Solid contaminants have three (3) sources in a typical installation: ambient air, the compressor internals, and the piping/accessory components. Compressor inlet filtration will prevent many environmental particulates from entering the system. Therefore, prompt and regular inlet filter maintenance is imperative for optimum system efficiency. While normal wear of the metallic parts within the compressor generates a minor source of solid contaminants, the primary source of system particulate contamination is the corrosion and erosion within the piping system. System materials of construction, piping size, and the piping layout must be carefully considered.

System Design Considerations

In order to properly construct a compressed air dehydration and filtration system, the designer must have a good understanding of the operating conditions—inside the piping system as well as the surrounding ambient. The following questions should be answered:

- What are the maximum and minimum ambient temperatures at the compressor intake?
- What is the expected maximum ambient relative humidity at these temperatures?
- What is the minimum ambient temperature of the piping system?
- What level of compressed air dryness is needed? Is the absence of any liquid all that is required, or does the process demand the absence of water vapor?
- What level of particulate and oil contamination can be tolerated?

And finally,

- What type of compressed air dryer/filtration system will satisfy my requirements?

Moisture Elimination

Understanding the relationship between the compressed air's ability to hold water vapor (not condense into troublesome liquid) and its temperature and pressure is the key to designing an economical and effective drying system. Industry typically expresses the air's moisture holding capacity as its "pressure dew point," or the temperature at which the air becomes saturated with water vapor at a given pressure. If the air temperature drops below this value, moisture will condense. Much has been written about these values for typical low pressure systems. The values change dramatically for the high pressure applications. Table 1 lists pressure dew point temperatures at different operating pressures for various ambient temperatures and relative humidities. Note the increase in pressure dew point as the system operating pressure increases. Table 1 can be used to understand the ambient conditions at which liquid will form in the system piping.

Table 1. System Pressure Dew Point Temperature

	SYSTEM PRESSURE	SYSTEM PRESSURE						
		0 PSIG	50 PSIG	100 PSIG	250 PSIG	500 PSIG	600 PSIG	700 PSIG
AMBIENT TEMPERATURE AND RELATIVE HUMIDITY	20°F	25% r.h.	-12 °F	20 °F	34 °F	55 °F	73 °F	82 °F
		50% r.h.	3 °F	37 °F	52 °F	75 °F	95 °F	104 °F
		75% r.h.	12 °F	48 °F	63 °F	88 °F	108 °F	119 °F
	40°F	25% r.h.	7 °F	42 °F	57 °F	81 °F	101 °F	111 °F
		50% r.h.	23 °F	61 °F	77 °F	103 °F	125 °F	137 °F
		75% r.h.	33 °F	73 °F	90 °F	117 °F	141 °F	153 °F
	60°F	25% r.h.	24 °F	62 °F	79 °F	105 °F	127 °F	139 °F
		50% r.h.	41 °F	83 °F	101 °F	130 °F	155 °F	167 °F
		75% r.h.	52 °F	96 °F	115 °F	146 °F	172 °F	185 °F
	80°F	25% r.h.	41 °F	83 °F	101 °F	129 °F	154 °F	167 °F
		50% r.h.	60 °F	105 °F	125 °F	157 °F	184 °F	199 °F
		75% r.h.	71 °F	119 °F	140 °F	174 °F	203 °F	212 °F
100°F	25% r.h.	58 °F	102 °F	123 °F	154 °F	181 °F	189 °F	195 °F
	50% r.h.	78 °F	127 °F	149 °F	184 °F			
	75% r.h.	91 °F	143 °F	166 °F	203 °F			

Once the desired level of dryness for the system has been determined, equipment selection needs to be considered.

Types of Compressed Air Dryers

Refrigerated: By far, the most common compressed air dryer used in high pressure systems is the refrigerated dryer. This product uses a refrigeration system and an air to refrigerant heat exchanger to cool the compressed air and condense the unwanted water vapor into liquid. The liquid is then separated from the compressed air stream and removed from the piping system with a drain valve. The air is typically precooled before entering the air to refrigerant heat exchanger by employing an integral air to air heat exchanger using the cool exiting air. The air to air heat exchanger allows the use of smaller refrigeration systems and produces warm, dry air at the outlet of the dryer. Refrigerated dryers come completely assembled in a cabinet, requiring only air, power, and drain connections for installation. The refrigeration systems are available in either air-cooled or water-cooled versions, requiring the designer to consider the ambient temperature at the installation site and/or the cooling water temperature when sizing this equipment.

HIGH-PRESSURE DRYERS



725 PSI Rated Refrigerated Dryer

Refrigerated compressed air dryers can achieve pressure dew points as low as 39°F (3°C). Therefore, as long as the compressed air piping downstream of the dryer is not exposed to temperatures below 39°F (3°C), liquid will not form in the piping. The operating costs for this system are simply the power consumed by the refrigeration system and any pressure drop through the heat exchangers and moisture separator. As with all high pressure compressed air system components, care must be taken to ensure that the dryer selected is designed for the maximum expected operating temperature and pressure of the system. Sizing factors for temperature, pressure, and ambient temperature are supplied by the manufacturer.

Desiccant Dryers

If the piping system or manufacturing process requires pressure dew points below 39°F (3°C), then desiccant dryers must be considered. Desiccant dryers use adsorbent materials—typically activated alumina, silica gel, or molecular sieve—to remove the moisture present. The water vapor is transferred from the compressed air stream to the adsorbent by taking advantage of the desiccant's high affinity for water molecules. No cooling or condensation takes place in this process. The desiccant bed is periodically regenerated in order to remove the adsorbed water. Typically, this regeneration is done by using a portion of the dried air, reducing it to atmospheric pressure (increasing its moisture holding capacity), and flowing it over the moisture-laden desiccant. Two towers of desiccant, a system of switching valves, and a timer complete the design so that one tower can stay on-line and dry the compressed air while the second tower is being regenerated. This method ensures a continuous flow of dry compressed air downstream.

Desiccant dryers achieve pressure dew points down to -40°F (-40°C) and can be designed for -100°F (-73°C) pressure dew points. The cost of operating this type of equipment is calculated by considering the amount of dried compressed air used for regeneration. Other forms of regeneration include heating the purge air (increasing its moisture holding capacity) and using heated ambient air and a blower. Initial capital costs versus operating costs must be considered when choosing the optimum system. In general, desiccant dryers have higher initial costs and operating costs than refrigerated dryers.



2,500 PSI Rated Desiccant Dryer in Production

Elimination of Oils and Particulates

Filtration: Compressed air filters remove solid particulates, oil aerosols, and oil vapor. These system components are specifically designed for one of these contaminants and care should be executed when placing filters in any piping system.

Particulate filters consist of sheets of fibrous media material with predictable particle capturing capabilities. Filter elements are constructed by layering this media in wrapped or pleated fashion around a perforated support core. As the compressed air flows through the layers of media, solid contaminants are captured within the interwoven fibers of the media. Over time, the filter elements become filled with contaminant, resulting in increasing and unacceptable pressure drop. The elements should then be replaced.

Oil aerosols are removed by a process known as coalescence. In this process, aerosols are captured on crosslaid fibers within filter medias. These minute liquid droplets then move along the fibers reaching points of intersection. Additional droplets then join together, forming larger droplets. The process continues until enough mass is accumulated for gravitational movement to occur toward the bottom of the filter element. The liquid then drains into the filter housing and is removed from the air system by a drain valve.

Oil vapors cannot be removed with plain filter media. These molecules must be removed by adsorption using materials that attract and retain oil. Activated carbon is a typical choice. The carbon can be integrated into a filter element-style device, or the compressed air can flow through a bed of activated carbon. Over time, the adsorbent sites on the carbon become used, and the element or bed must be replaced.

Filters should be placed in a system in order of filtration efficiency; i.e., course filtration should be done first, moving to finer filtration and ultimately, adsorption, if necessary. This system will extend the life of the filter elements. Single bulk moisture and particulate filters may be required immediately after an aftercooler to remove any condensed liquids. A prefilter may be required before the refrigerated dryer. Prefiltration is always required immediately before any desiccant dryer, as all condensed liquids and oils must be removed in order to protect the desiccant from contamination.

Other Design Concerns

High pressure compressed air systems present additional concerns for the designer. The most obvious issue is that of safety. It is imperative that great care is used when selecting system components. The maximum design pressure for each and every device must be verified, including all piping, valving, and fittings.

At higher operating pressures, the density of the compressed air is greater than systems operating at a nominal 100 psig (7 barg). These higher densities equate to lower actual flow velocities in the system, allowing smaller diameter piping to be used while maintaining equivalent system pressure drops. Therefore, pressure drop information used for low pressure piping cannot be used accurately.

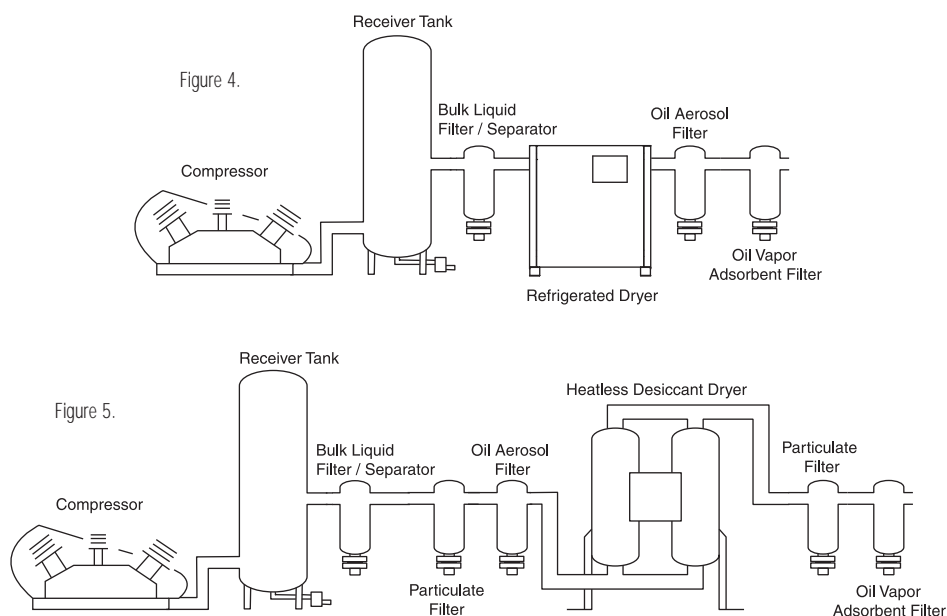


Filter

HIGH-PRESSURE DRYERS

Typical High Pressure System Layout

Figure 4 suggests a dehydration and filtration design for a high pressure compressed air system (500 psig to 700 psig) using a refrigerated dryer. For desiccant systems, Figure 5 shows the proper component arrangement. Note that these figures assume that oil vapor removal is required. For applications where this is not necessary, simply remove the oil vapor filter.



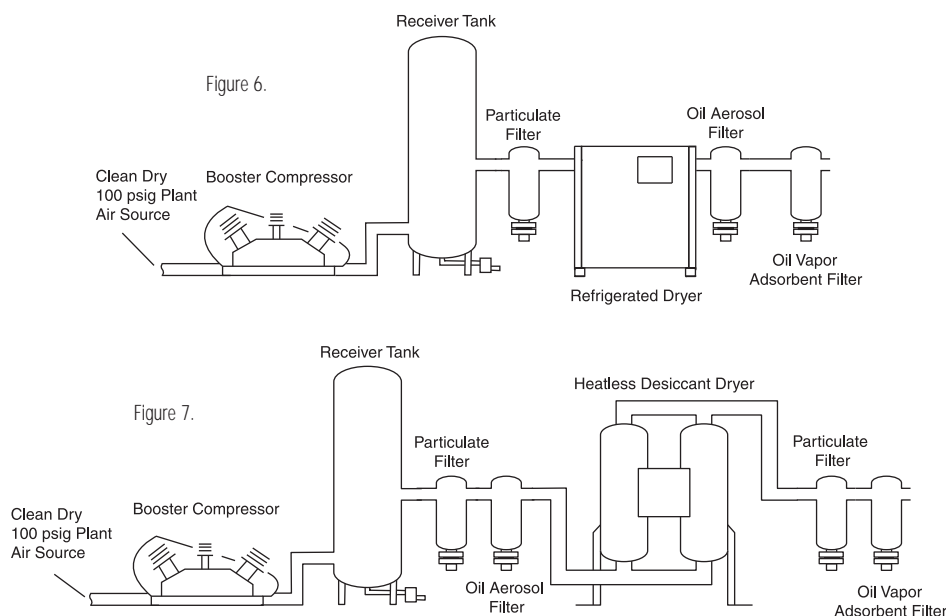
In some plant systems, point-of-use high pressure compressed air is generated by compressing general plant air (at 100 psig) in a booster compressor. The question arises: if the general plant air has already been cleaned and dried, do I need additional drying and filtration? The answer to this question depends on the final boosted pressure and the desired dryness of the high pressure air. Table 2 shows the pressure dew point temperature of high pressure air generated from a plant air supply that has been dried to a 39°F (3°C) pressure dew point. As the boosted pressure increases, the saturation temperature of the compressed air increases. In general, for a piping system to remain liquid-free at ambient temperatures near 65°F (18°C), additional high pressure drying equipment is needed for boosted pressures in excess of 300 psig (21 barg). Figures 6 and 7 suggest component layouts for such an application.

Table 2. System Pressure Dew Point Temperatures at Various Boosted Pressures

SYSTEM PRESSURE	100 PSIG	200 PSIG	300 PSIG	400 PSIG	500 PSIG	600 PSIG	700 PSIG
Pressure Dew Point	39 °F	56 °F	66 °F	74 °F	80 °F	85 °F	89 °F

Typical Booster System Layout

Figure 6 suggests a dehydration and filtration design for boosting clean, dry 100 PSIG Plant air using a refrigerated dryer. For desiccant systems, Figure 7 shows the proper component arrangement. Note that these figures assume that oil vapor removal is required. For applications where this is not necessary, simply remove the oil vapor filter.



Summary

To eliminate unwanted moisture, oil, and particulates from high pressure compressed air systems, the design presents many of the same issues as a general plant air supply. By carefully defining the desired compressed air purity, components can be properly selected and placed appropriately in order to achieve an efficient and reliable solution. Higher operating pressures will increase the dew point temperature for a given moisture content as compared to a low pressure application. However, the equipment and technology for dehydration and filtration equipment is nearly the same. Follow the guidelines set forth here and use good engineering practices when making the equipment selections. A reliable supply of clean and dry high pressure compressed air will serve your manufacturing processes for many years to come.

For more information contact: Tim Fox, Manager Research and Development, SPX Dehydration & Process Filtration. Phone (724) 873-8443 or visit www.spxdehydration.com.

FROM BOTTLING TO BLOWMOLDING

New Mexico bottler gets hard dollar savings and new business from new blowmolding line

BY ANGELA KELLY, KAESER COMPRESSORS, INC.

Essence Bottling in Albuquerque, NM processes 5,000 bottles of spring water *per hour* through its 20,000 sq. ft. facility. Business was good and growing, but there were no local bottle blowmolders in the region. Purchasing plastic bottles from out of state manufacturers and paying freight was becoming increasingly expensive and problematic. Essence decided to invest in blowmolding machinery and make their bottles on-site. Since blowmolding relies heavily on compressed air, Essence began plans to upgrade their compressed air system.

The current process air needs for bottling were minimal and were met by a small, but noisy, 15 HP rotary screw compressor. However, they needed more than just additional capacity for the blowmolding process. The new air system had to provide a reliable source of clean, dry air and a significant portion of that air would need to be at a much higher pressure. After developing the base equipment specifications, Essence contacted their existing air compressor vendors.

Larry and Gary Trujillo from Advanced Compressor Systems in Albuquerque, NM reviewed the specifications and provided a quotation for the required equipment, plus the plumbing, piping, and installation factors. Because Albuquerque sits at 5,000 ft., there were special high altitude considerations for the system. Larry recommended a 250 HP direct drive rotary screw compressor, a high-pressure refrigerated dryer, and a booster compressor, as well as schedule 80 pipe and fittings. The rotary screw compressor would provide over 800 cfm at a base pressure of 190 psig. While the air compressor featured a built-in aftercooler, the refrigerated dryer would further cool the air and remove moisture to a 39°F dew point before the air entered the booster.

More Than They Bargained for...

The booster is a reciprocating compressor designed to further compress air and “boost” the pressure at the point of use. Increasing the pressure for only a portion of the compressed air is considerably more efficient than building an entire high pressure system and regulating the pressure back down.



Patrick Chavez and John Wilson inspect their new ESD 250 and discuss its smooth, quiet operation.



Once the ambient air is compressed in the main compressor, the Booster uses pistons to boost the pressure to 590 psig. This two-stage system is ideal and economical for PET bottling applications.



The new compressed air system consists of a 250 hp direct drive rotary screw compressor, a 60 hp reciprocating booster compressor, and a high pressure refrigerated dryer.

The blowmolding application required a reliable, constant pressure of 590 psig. A decision had to be made on whether to purchase a high pressure compressor or go with the booster system. A couple of factors helped shape the decision. “The owner wanted quiet,” said Larry Trujillo, “and the rotary screw compressor’s split cooling air flow design and low noise radial fans provide incredibly quiet operation.” Further, there was no additional investment required for special foundations, a separate compressor room, or extensive noise attenuating fixtures as required by many large high pressure systems.

The Trujillo brothers designed the system layout with the rotary screw compressor in front of the booster, allowing it to act as a noise buffer. Plus, the booster compressor is water-cooled as another sound-dampening factor. The plant layout necessitated the air system’s placement less than 50 feet from the blowmolding machine and, due to the open layout of the shop, Essence was concerned about noise. They would be pleasantly surprised.

“It’s more than
ten times bigger,
but ten times
quieter!”

Albert Murray, Chief Executive Officer and John Wilson, Executive Vice President for Essence accepted the Trujillo brothers’ proposal and a date for the installation was set. Working around the plant’s production schedule, the new system was installed without shutting down operations and the moment of truth arrived. Murray came out to view the new system and said “Well, let’s turn it on!” But much to his surprise the system was already running. Comparing the rotary screw 250 HP air compressor and booster to the existing 15 HP, Wilson said, “It’s more than ten times bigger, but ten times quieter!”



Essence found it could produce its own bottles at a significant cost savings.

FROM BOTTLING TO BLOWMOLDING

New Mexico bottler gets hard dollar savings and new business from new blowmolding line



Starting with a small plastic pellet and a mold, these bottles are formed by injecting clean, dry compressed air at 590 psig.



The blow molding system produces over 40,000 bottles in one eight hour shift.

Essence is up and running with its new blowmolding line and saving \$0.03 per bottle — that's over \$1,200 per 8-hour shift — certainly enough to justify the investment in new equipment! The new compressed air system supplies process air for the entire facility. The booster system ensures a reliable source of clean, dry air for the bottles, keeping quality control issues to a minimum and reducing product rejection. "Zero problems" is how Wilson described the new air system. In fact, the new line is so successful that the entire focus of the business is changing from bottling to blowmolding, filling a void in the region for quality plastic bottles. Watch for a second Essence facility opening soon!

For more information contact: Angela Kelly, Public Relations, Kaeser Compressor. Phone 800-777-7873 or visit www.kaeser.com.



All Kaeser photo credits: Ivy Associates

DEEP-COLD COOLING INCREASES BLOW MOLDING CYCLE COUNTS

BY JOHN HAYS

During a two-day seminar in April of 2001, at the University of Warwick in the U.K., delegates from leading manufacturers, suppliers, and users of blow molding equipment gathered in attendance to discuss advances in blow molding technology. The seminars were organized by BEKO Technologies and the Warwick Manufacturing Group. They provided the delegates one of the first opportunities to learn hands-on about deep-cold cooling of compressed air in blow molding.

Deep-Cold Cooling of Compressed Air Increases Cycle Counts

The concept involved introducing compressed air, cooled and dried to -42°F, into the blow molding process in order to quickly cool the thermoplastics leaving the blow molding machine. The product, called the BEKOBLIZZ, was demonstrated in a trial blow molding process in front of the delegates.

The results were carefully timed and monitored. The selected product was a Ricoh photocopier toner bottle, weighing 93g. The first production was done without the BEKOBLIZZ, and took 25 seconds including 20 seconds cooling time. The product release temperature straight from the mold, over a number of samples, averaged 176°F. Upon introducing the BEKOBLIZZ into the same process, the cooling time was reduced from 20 seconds to 15 seconds, which is a reduction in the total cycle time by 20%, or an increase in production by 25%. Despite a lesser cooling time, the sample temperature was lowered by roughly 18°F down to approximately 158°F.

Gerald Strzebin, the former BEKOBLIZZ manager in Germany, had this to say when asked about some of the global trends that have placed additional pressure on the plastics industry, "Recognizing that cooling times could account for up to 80% of the total cycle time, we looked at our existing technology to see how it could be adapted to reduce cooling times. The result was the BEKOBLIZZ, which enabled us to provide a more cost-effective route to help businesses compete both on quality and on product cost."

At the conclusion of this seminar, attendees were left with a great deal of food for thought and an impressive collection of figures and statistics on improving cycle counts by using deep-cold cooling of compressed air. One delegate from SIG Plastic Technologies summarized his experience by saying, "It's not often we have a chance to attend such a useful, factual, and informative session. I think everyone appreciated seeing the equipment in operation and perhaps it's an example other manufacturers in the field should follow."

“BEKOBLIZZ®, which enabled us to provide a more cost-effective route to help businesses compete both on quality and on product cost.”



The new BEKOBLIZZ

DEEP-COLD COOLING INCREASES BLOW MOLDING CYCLE COUNTS

Improvements in Quality

Since the introduction of this new technology, the majority of blow molders who are using deep-cold cooling of compressed air have found their molded parts quality is better than before, in addition to seeing a significant impact on cycle time. This means less re-grind, more parts passing quality control checks, and lower JIT intervals. Therefore, the actual benefit to the user is two-fold and the economic payback is twice as fast as it would be if you were to calculate only the reduction in cycle time. This was proven after further reviewing the results from a number of BEKOBLIZZ installations, covering a variety of molded part shapes and sizes from a one liter bottle to a 1,000 liter tank. Across the applications surveyed, the break-even period was remarkably similar, ranging from five months to just under eight months.

Replacing Liquid Gas for Cooling

Deep-cold cooling of compressed air provides a safe and lower-cost alternative to those using liquid gas or large amounts of refrigerants to cool thermo plastics. Using environmentally friendly and economical off-the-shelf refrigeration compressors and refrigerants, the product functions as follows:

1. Compressed air enters the first refrigerant circuit consisting of an exchanger, condenser, compressor, etc., where it is pre-cooled to 41°F.
2. The air then enters a dual filtration system where condensed moisture and oil aerosols are removed from the air.
3. Air then enters a pressure-swing desiccant dryer which can be set to pressure dew points of -100°F. This pressure dew point is controlled, where a high dew point alarm is constantly monitoring the condition of the air at the desiccant stage.
4. Solid particulates, to 1 micron, are then removed by a filter.
5. Extremely dry air now enters the second refrigerant circuit, which is configured the same as the first but using components with design tolerances for the now very cold air, where the air temperature is lowered to up to -48°F. No moisture condensation occurs due to the extremely low pressure dew point of the air.
6. Air is now ready to be introduced into the blow molding machine where the blow pin can blow it on the thermoplastics for deep-cold cooling.

For more information contact: John Hays, BEKO Technologies Corporation. Phone (704) 663-6621 or visit www.bekousa.com.



Two refrigeration compressors provide deep-cold cooling



Provides dew points to -100°F

*Four Savings Areas in Compressed Air Systems**Continued from page 19***#4 Savings Area — Running The Header Pressure Higher Than Required:**

This is often caused by excessive system pressure float, which are piping, regulator, or sometimes compressor control problems. However, more often than not, it is a certain process or processes, which “need” a certain “minimum pressure.” These claims should always be reviewed as to where they come from, “Perceived” operation, OEM specifications, etc.

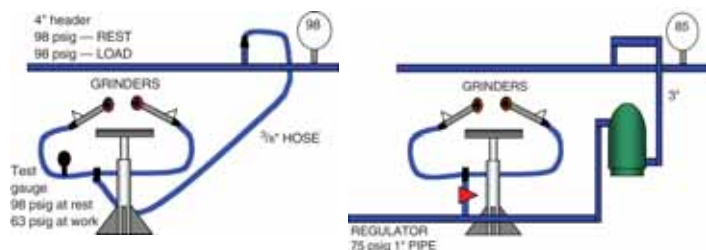
For example:

“My grinders need 98 psig to run right? Therefore the air system has a required minimum of 98 psig”.

When you hear these words, start looking for what the operator is really telling you — “When the system header pressure falls below 98 psig his grinders don’t work well!” Often the production personnel do not know the actual pressure at the tool — probably do not know how much air the tool uses.

Selection of the production accessory equipment was:

- 1/2" hose is too heavy, use 3/8" hose
- Use (2) 3/8" Quick Disconnects — **lower cost**



We found this scenario on a recent Air System Energy Audit. The rest of the plant could run on 80 psig. The system was at 98 because the grinding area (20% of the total demand) required it.

Testing revealed that the actual inlet pressure to the tool was 63 psig at load — the header pressure stayed at 98 psig. In other words, we had a 35 psig of pressure loss through the 3/8" hose and Quick Disconnects. Further test indicated that the optimum inlet pressure for these particular tools was 75 psig.

The standard 3/8" quick disconnect with a combined pressure loss of 23 psig per station were changed to industrial quick disconnects (\$2.50 extra per set - \$5.00 per station) with a combined pressure loss of five psig per station.

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Four Savings Areas in Compressed Air Systems

The 3/8" hose was replaced with a 1" pipe running to the base of the station (cost \$30 per station). A regulator was selected to deliver full flow to the grinders at 75 psig with 80 psig feed pressure (eliminate artificial demand). The header pressure was lowered to a controlled 85 psig. Results after 18 months:

- ✱ Tool repair went down for the grinders
- ✱ Production was increased throughout the plant by 30% (including 17 new grinders) and other new equipment
- ✱ The cost of implementation to change grinder area distribution:

9 STATIONS:

Quick Disconnects:	\$180.00
Piping	\$270.00
Regulator	\$912.00
TOTAL	\$1362.00 (Not a bad return)

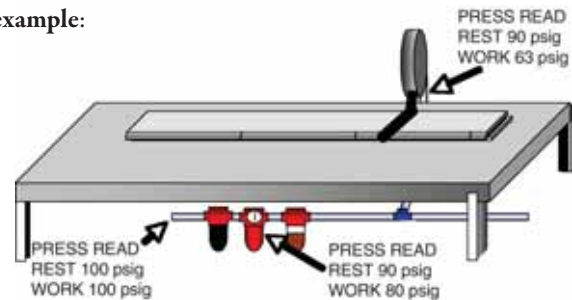
- ✱ Total air demand fell from 1600 to 1400 cfm average — Production was increased by 30% with an actual drop in air usage.

What did we do here? We started with the process of — what pressure do you really need at the tool — how much air — how can we get it to the tool in a consistent and economical manner.

The trick here is to calculate or measure the airflow to the tool or process workstation inlet pressure both at rest and at work while measuring the header pressure at the same time. If the header pressure stays steady and the process inlet pressure falls, then we know the restriction is in the feed from the header to the process.

Shown below, the work table and bander is an example of the most common errors in header feed to process — FRL's (filter, regulator, lubricator) and QD's (quick disconnects). In many cases these are selected with little or no thought given to performance, i.e.: How much pressure loss at actual flow — rather they are usually selected by "hole size" — What size quick disconnect is needed? 3/8", this is the connection size to the hose, pipe or tool, it has nothing to do with application sizing.

For example:



In the preceding example, we have 17 psig of pressure loss through the 3/8" pipe and the bander — this bander draws about 50 cfm when it operates.

The operating pressure loss is (80-psig-entry pressure)

- ✱ 30 ft 3/8" pipe @ 6 psig loss (1/2" would have 0 psig loss)
- ✱ Standard 3/8" disconnects (1 set of 2 at bander = 22 psig loss)

Replacing the "standard quick disconnect" with an "industrial" rated disconnect (set of 2) for more flow/less drop (see insert) reduces pressure loss from 22 psig to 8 psig. Extra cost per set of quick disconnects \$3.36. Energy wasted for 7 psig, using our example, \$1400 per year.

The obvious "real fix" for this 1/2" pipe and 1/2" industrial disconnects and eliminate most, if not all, of the pressure loss.

Using the same example (Fig. 5) let us look at the FRL selection at 20 psig of pressure loss or droop — How did we select this equipment?

- ✱ What size regulator? 1/2"
- ✱ Do you need a filter and lubricator? — Why?
- ✱ The filter protects the regulator and the lubricator lubricates the bander — OK

Let us examine the actual case. The regulator selected is "rated for 140 cfm flow" — so, will it be OK for 100 cfm? It is a rare regulator selection that gets this much thought! But this is still not enough. What is the "droop" or outlet pressure at 100 cfm flow — 30 psig for just the regulator. What about the filter and lubricator — as a team the total droop is now 45 psig.

Do you need the filter? If you don't, why waste the energy? The lubricator is not well applied to the air motor on the bander. The bander would be better served with a correctly selected lubricator applied right ahead of it.

Summary

All too often FRL's quick disconnects, and feed lines to the process are selected by size, convenience, and price with little or no regard for flow and or pressure loss allowance. The cornerstone of any effective compressed air energy savings program on the distribution or process side is to identify the **LOWEST** effective pressure that will run the process at optimum performance. Programs can then be implemented to deliver this at the lowest possible cost and pressure loss. Utilizing all the tools we have, piping, connections, pressure / flow controllers, appropriate storage, etc.

When you have a plant with a low-pressure problem, "Because the area is too far away from the compressors"? — most of the time (90 – 95%) we find the problem is **NOT** in the header, but in the feeds from the header. Headers should be sized to 20 – 30 fps or higher velocity and looped whenever possible.

SUPPOSE THERE REALLY IS A HIGH PRESSURE NEED:

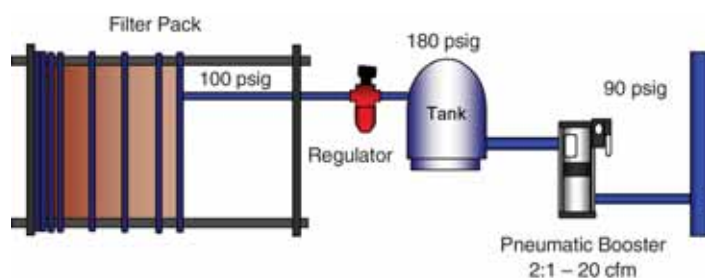
You may want to supply the local high-pressure need with a secondary smaller high-pressure unit or an appropriate "booster" rather than drive whole system higher. The filter press shown here required 100 psig minimum while the rest of the chemical plant ran well on 90 psig.

In this situation a Compressed Air Audit, always checks whether the high-pressure air is actually required. If it is, the next question is, can we modify the process to lower pressure air? For example: change to a larger diameter air cylinder! If not, there are several alternate ways to handle this situation.

For example:

The first job is to calculate or **MEASURE** the amount of air (cfm), the required pressure (psig), and the cycle time (time on/time off). With this data, we can calculate the most effective and efficient answer:

- Use a separate air compressor and system to supply dedicated air to the process
- Use a booster compressor or hydraulic booster to supply high-pressure air.
- Use storage



Summary

I believe you can see this journey through the system has been one of **INVESTIGATION** — We observe measure, calculate, test, and treat the compressed air like an expensive utility — **WHICH IT IS!** Identify its cost and apply it to a controllable production cost to a process, just as you would with electricity, steam, etc.

Compressed air is a Very "ENERGY EXPENSIVE" utility — 7 to 8 times more expensive than electricity – yet, it continues to stand in the "Doorway of Opportunity" rather than moving through to area of Effective Cost Control and Management.

Control and management of this utility cost have significant opportunities at both the Supply and Demand Side. In order for any program to "optimize" the economical opportunities those responsible for short and long term implementation must be focused on all the interrelated parts of the system and understand the working parts.

Hank Van Ormer is a leading compressed air systems consultant and has implemented over 1200 air improvement projects. Contact at (740) 862-4112 and www.airpowerusainc.com.

The Basics in Blow Molding Machines and Processes

Continued from page 24



Lightweight HDPE Bottles — Courtesy Graham Machinery Group, York, PA



Reciprocating Screw Blow Molding Machine for Lightweight Dairy Containers — Courtesy Graham Machinery Group, York, PA



Reciprocating Screw Machine for Production of 5-Gallon Polycarbonate Water Bottles — Courtesy Graham Machinery Group, York, PA



Five Gallon PC Water Bottle Being Removed from Blow Mold — Courtesy Graham Machinery Group, York, PA

Unlike shuttle machinery or rotary wheel machinery, which are characterized by continuous extrusion, reciprocating screw machinery utilizes an intermittent extrusion process. This allows the parisons to be dropped quickly (in some cases less than one second), followed by the rapid closing of the molds.

In most cases, the molds are stationary and do not shuttle sideways. Rather, the parts are extracted from the molds, and then the parison is dropped between the open mold halves. These machines can be broken down into at least two major families: lightweight bottle machinery and water-bottling machinery.

Lightweight Bottle Machinery

Although typically referred to as “Lightweight Dairy” machines, this family of machines may also be used for the manufacture of bottles for water, as well as juice, household chemical containers, and some industrial parts. The introduction of this family of machines caused a massive conversion in the dairy industry, with HDPE bottles replacing glass and paperboard.

Bottles may be manufactured with either a “pull-up” or “ram down” neck finish. In the United States, the pull-up finish is most common. A pull-up finish forms a pre-cut inner ring in a round, horizontal ledge at the top of the bottle’s neck, requiring a plug seal. A ram-down prefinish is capable of forming a “vertical” tube section at the top of the neck—without a horizontal ledge. This is analogous to a blowpin neck finish on shuttle machinery.

Most one-gallon dairy containers are manufactured on 4-head or 6-head machines, although recently more producers have gone to 8-head machines to drive down bottle costs. It is estimated that over 2,500 reciprocating screw blow molding machines for production of HDPE containers have been delivered in the United States—and over 3,200 worldwide.

Water Bottle Machinery

In the mid to late 1970s, the 5-gallon polycarbonate water bottle market began to develop and special blow molding machines were developed to meet this need. This “niche” market enjoyed significant domestic growth in the ‘80s and significant growth worldwide in the ‘90s.

The equipment was originally engineered to be simple, versatile, and capable of producing basic bottles and containers. This family of machines utilizes a reciprocating screw extruder with a direct feed “flow through” die head design for forming the parison. Cantilevered clamp systems are nonshuttling for simplicity and provide open access for convenient part extraction.

Both Single and Dual Head configurations are common in the industry. Hydraulic extruders are commonly used. The use of hydraulic compaction blow pin assemblies to allow the production of necks with unblemished sealing surfaces has improved the performance of the containers by greatly reducing the number of “leakers.”

Sequence of Operation

Reciprocating screw blow molding machinery is characterized by the following sequence of operations:

- Plastic resin is melted by an extruder. As the screw rotates to melt the plastic, it also retracts, allowing molten resin to form in the front of the barrel.
- When enough plastic is melted, hydraulic pressure is activated to push the screw forward, forcing the resin through flow-heads and dies to form parisons.
- When the parison is fully extruded, the mold halves are closed under hydraulic pressure.
- Compressed air enters the hollow parison, forcing it outward against the chilled mold halves. Air pressure is maintained until the plastic has cooled sufficiently to eject the part from the mold.
- Compressed air pressure is relieved before opening the mold halves.
- The parts are removed from the mold. Parts may be released by gravity or removed using a part extractor. The parts are then ready for external trimming of “flash,” or scrap plastic.

IV. Intermittent Extrusion Blow Molding Machinery — Accumulator Head Systems

Accumulator head machinery is used for the extrusion blow molding of large industrial hollow parts. Examples of parts produced on this machinery include drums, trash cans, automotive panels, playground equipment, and large containers for liquid storage. Most parts produced on accumulator head machinery are single layer; however, specialized machinery is capable of producing parts with up to seven unique layers of plastic. These machines are used primarily to manufacture automotive gasoline tanks with barrier layers.

Description

Accumulator head machinery is characterized by the accumulation of melted plastic resin in one or more extrusion heads. As extruders melt the plastic, it accumulates in the heads until the resin is ready to be extruded into parisons. An internal plunger is then activated, using hydraulic pressure, to extrude the parison through an extrusion die, between two open mold halves.

Unlike shuttle machinery or rotary wheel machinery, which are characterized by continuous extrusion, accumulator head machinery utilizes an intermittent extrusion process. This allows large, heavy parisons to be dropped in a few seconds, followed by the rapid closing of the molds. Due to the large, heavy weight of the parisons, it is not practical to slowly extrude the plastic while the prior parison is blown and cooled in the molds. Cycle times of 30 to 120 seconds or more are common in thick-walled parts, and the parisons would cool and sag if extruded slowly over this time period. The intermittent process also allows the machinery to function without shuttling the molds, which is not economical with large, heavy molds and clamping structures.



Typical dual head accumulator head blow molding machine near final stage of assembly. Provided courtesy Graham Machinery Group, York, PA

The Basics in Blow Molding Machines and Processes

In some applications, the parison is extruded over one or more blow pins, which are used to form precise openings in the part, as well as provide an entry point for the blow air. In other applications, the blow air may enter the part through the center of the extrusion heads, or through needles, which puncture the parison.

Due to the size of parts produced, the extruders and flowheads are typically positioned, with the use of large clamps, on an upper, “mezzanine” level. The clamp, electrical cabinets, operator station, and hydraulic system are typically positioned on the lower “ground” level.

Sequence of Operation

Accumulator head machinery is characterized by the following sequence of operations:

- Plastic resin is melted by an extruder and fills an accumulation chamber in the extrusion heads. As the melted plastic fills the head, a hydraulic plunger is pushed back by the pressure in the extrudate.
- When the accumulation chamber is full, hydraulic pressure is activated to the plunger, forcing the resin through a die and forming a parison.
- When the parison is fully extruded, the mold halves are closed under hydraulic pressure.
- Compressed air enters the hollow parison, forcing it outward against the chilled mold halves. Air pressure is maintained until the plastic has cooled sufficiently to eject the part from the mold.
- Compressed air pressure is relieved before opening the mold halves.
- A part extractor moves into place. In most cases, the part is gripped between the mold and flow-head, where the unformed parison forms part of the scrap that will be removed later from the formed part.
- The molds open, releasing the part, which is now held into place by the part extractor. If necessary, blow pins are retracted or “unspun” (if forming threads in the part).
- The part extractor moves the parts from the molds. The parts are then ready for external trimming of “flash,” or scrap plastic

Injection blow molding

The process of Injection Blow Molding (IBM) is used for the production of hollow plastic objects in large quantities. In the IBM process, the polymer is injection molded onto a core pin; then the core pin is rotated to a blow molding station to be inflated and cooled. IBM is typically used to make small medical and single serve bottles, notably the PET preforms for stretch blow molding. The process is divided into three steps: injection, blowing, and ejection.

The injection blow molding machine is based on an extruder barrel and screw assembly, which melts the polymer. The molten polymer is fed into a manifold where it is injected through nozzles into a hollow, heated preform mold. The preform mold forms the external shape and is clamped around a mandrel (the core rod), which forms the internal shape of the preform. The preform consists of a fully formed bottle/jar neck with a thick tube of polymer attached, which will form the body.

The preform mold opens and the core rod is rotated and clamped into the hollow, chilled blow mold. The core rod opens and allows compressed air into the preform, which inflates it to the finished article shape.

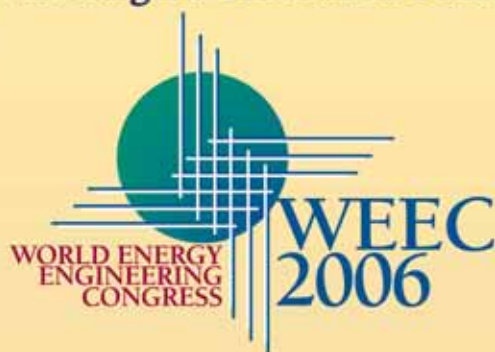
After a cooling period the blow mold opens and the core rod is rotated to the ejection position. The finished article is stripped off the core rod and leak-tested prior to packing. The preform and blow mold can have many cavities, typically three to sixteen depending on the article size and the required output. There are three sets of core rods, which allow concurrent preform injection, blow molding, and ejection.

Another application of injection blow molding is in the production of soft elastic gelatin capsules for pharmaceutical applications. Two strips of gelatin are pressed together in a rotary die, which cuts out the desired shape of capsule while the fill liquid is injected. Afterwards, they are cooled and dried to yield a firm, strong capsule.

Wikipedia contributors, "Blow molding," Wikipedia, The Free Encyclopedia, http://en.wikipedia.org/w/index.php?title=Blow_molding&oldid=54923632 (accessed May 25, 2006).

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