Level 1 NFPA 99 Medical Air Breathing Air

SEPTEMBER 2006

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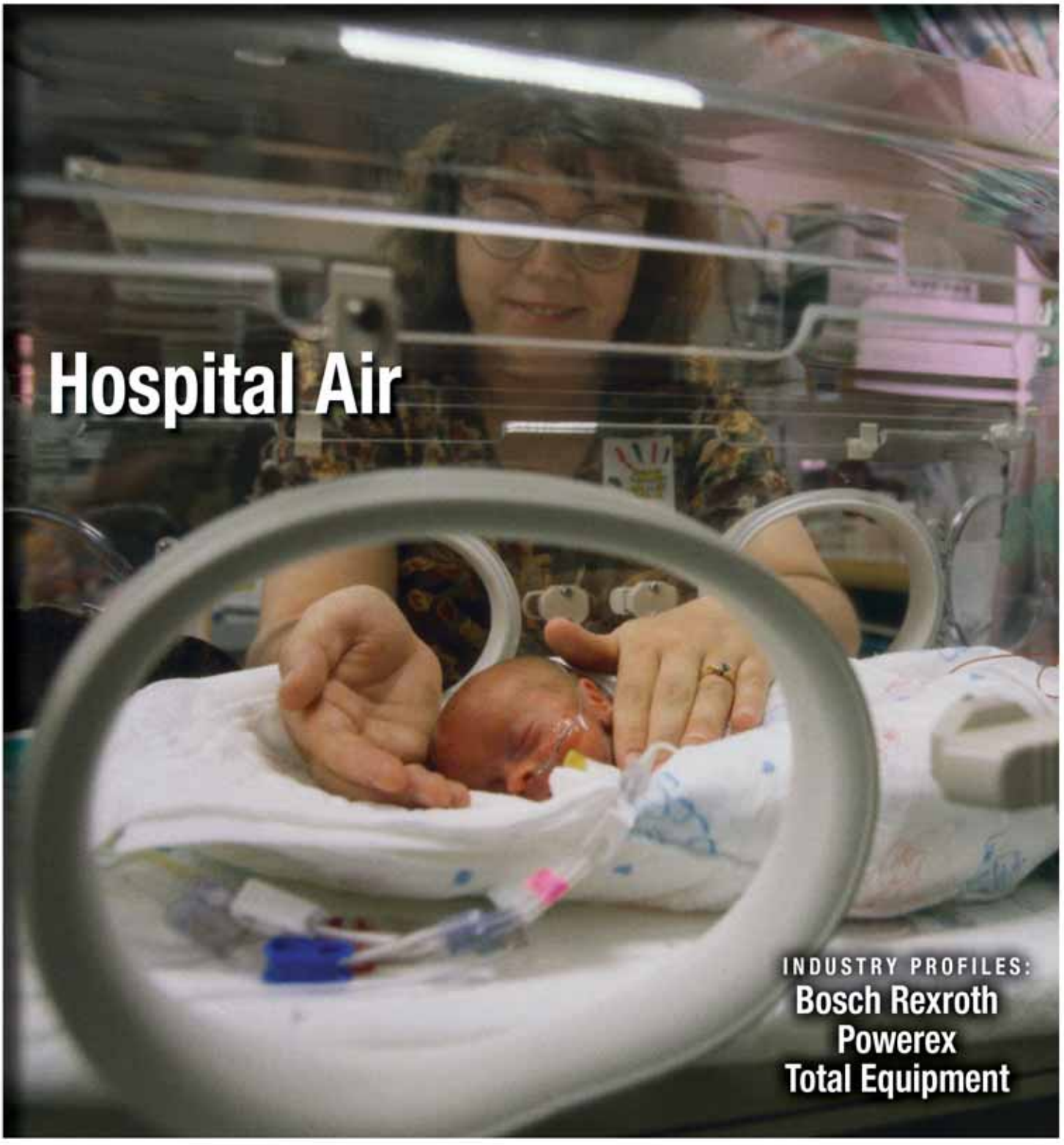

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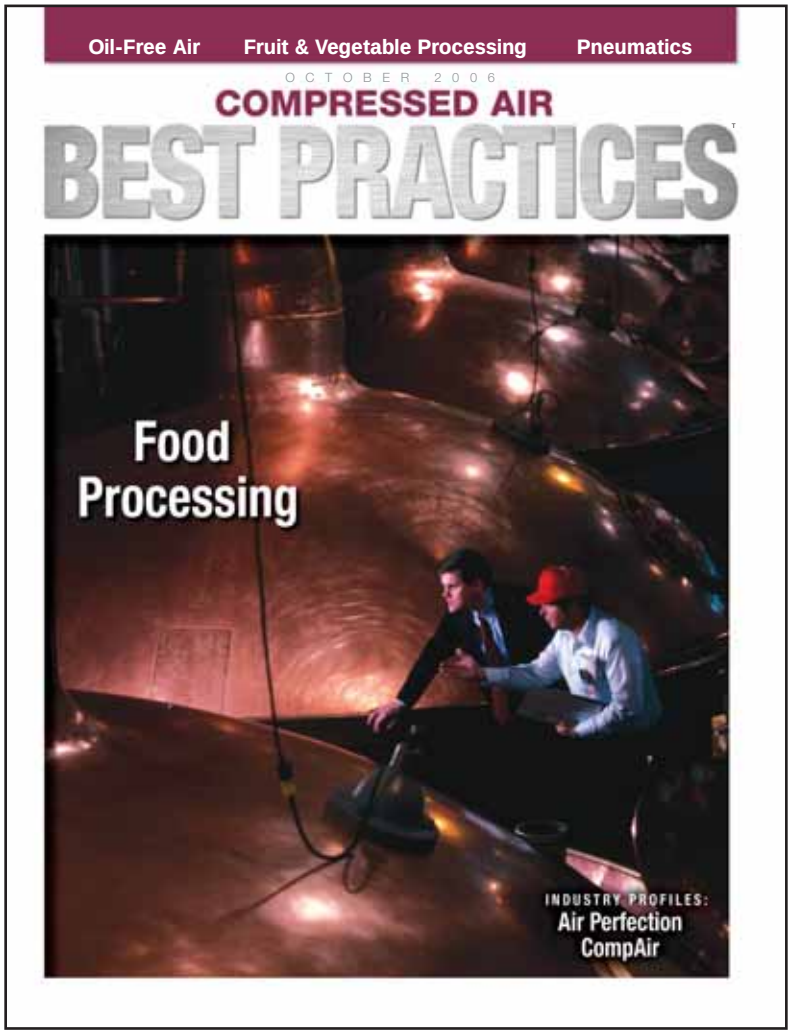

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FROM THE EDITOR

Reliability and Durability "Best Practices"

The voice on the other end of the phone said, "Mr. Smith, we have had a near-interruption in the supply of breathing air to the neonatal unit. All the children are fine, since we were immediately able to restore the supply of air. We are asking all the suppliers, of components of the system, to visit us and examine the system, to ensure this doesn't occur again." Talk about getting your attention. The system was thoroughly examined and checked against NFPA 99 guidelines and issues were found with the maintenance of the automatic redundancy system and not with any of the equipment providers.

In reality, the person didn't tell me, in the second sentence, that all of the children were all right. I just didn't want to worry you. We worried for three days until we were told that the doctors were convinced that the children had suffered no ill effects. The lasting effect it had on me was the reminder of how important durability and reliability is with compressed air systems.

"Best Practices" is sometimes thought to represent only energy savings. In the way this magazine uses the term, we consider energy savings to be one very important component. Durability and reliability, however, are equally important. Medical air is a stark reminder of how important durability and reliability is. This edition features articles on a variety of breathing air applications-they all require reliability to protect human health. As far as energy costs go, a friend told me of an automotive assembly application where they had done energy audits estimated to save the company $500,000 per year in compressed air costs. As they were wrapping things up and feeling good about themselves, the plant engineer said, "We are also pleased with the results of these audits. Keep in mind, however, that if our compressed air system goes down-our production line also goes down — and this production line contributes $650,000 of net profit per hour to this corporation."

Ensuring the quality of breathing air (and all compressed air systems), every day, should bring real credit to the manufacturers, to the system designers (like Total Equipment in this issue), and to the hospital/plant engineers and maintenance staffs. It normally doesn't — it's their job. That's ok too. I've not run into any one requesting credit for doing what they feel is their responsibility to do. Those involved work in a business environment asking us to lean out our maintenance crews and our manufacturing processes, while simultaneously optimizing the "manufacturability" of our product designs.

Yet since they aren't asking for credit, let's give them a little. I'd like to say that maintaining reliability and durability, of compressed air systems, is a tremendous accomplishment which all involved should be proud of. Quality is being delivered and applications using compressed air are allowed to assume reliability and durability.

ROD SMITH

Feedback is invited on this column and on any other thoughts. Contact me at rod@airbestpractices.com

ASK the EXPERTS

This area is designed for readers of Compressed Air Best Practices Magazine who have questions regarding their compressed air systems. The editors of this magazine invite readers to email us questions and issues they may have. We will forward the questions to experts in compressed air systems with whom we work and provide answers to 100% of the questions. We will choose a few questions, each month, and print them in the magazine so that others may learn from the process.

Please note that answers provided are done so with limited information. Answers should be considered guidelines to consider. In no way, do the writers or this magazine assume responsibility for any actions taken as a result of these answers. Questions may be sent to rod@airbestpractices.com

Question #1 From Engineering Consultants — Columbus, OH

We continue to see specifications for hospital air calling for —"to assure an uninterruptible flow of [compressed] air." Is there a specification for this and what type of compressor is this?

"What is the difference between an oil-less and a oil-free compressor?"

As with all machinery when we want to assure uninterruptible service, we are really talking REDUNDANCY of all equipment. In the case of hospital air, the specification are often based on the applicable or current NFPA-99 Standard for Health Care Facilities. I believe the 2005 edition is currently in effect. Certain government agencies, local regulators, and standards may also address this along with specific corporate regulation at the facility may impact on this.

However, generally, this description covers the two up to 30-hp (can be larger) tank-mounted "oil-less air compressors" and specifically the support equipment and packaging. I will not try to rewrite the specification but will give some highlights. For current specifications, contact NFPA Catalog (http://www.nfpa.org/catalog/), NFPA 99 Current Edition Standard for Healthcare Facilities.

Over the years, this specification has always had the same goal: create an air system with total automatic redundancy to assure as much as possible an uninterruptible supply of vital compressed (breathing) air when needed. This package commonly consists of:

Duplex (two) oil-less compressors packaged in an appropriate receiver and motors with:

- Automatic start/stop
- Two valve receiver bypass
- Extra pressure gauge to indicate hospital or medical air system pressure if the receiver is bypassed
- Liquid level indicator to show any moisture in the air receiver
- Compressor isolation valves
- High air temperature switch with reset sensing temperature in each compressor discharge block
- UL and CSA approved combination alternator panel which includes NEMA-rated starters with overloads and a control relay for the alternator
- Two non-fused disconnects with door interlock
- Two 120-volt control transformers
- Two high air temperature shutdown lights
- One lag (follow) compressor "on" light
- Two horn alarms with reset — alarm lights having dry contact to connect a remote alarm, etc.

These fully packaged systems will also have appropriate dryers, filters, etc. packaged and piped in similar manner.

Obviously, the point is to run the lead compressor — if something happens to the lead compressed air system or the demand grows, the second (lag or follow) unit and system will immediately start and continue to supply air. The alarm says both units are on or trying to be and this calls for an immediate investigation.

In these size compressed air systems, the permissive start time is very low and when well manufactured and maintained, these units will usually assure uninterruptible air very well.

Changes to the more current specification, if applicable, cover such things as:

- Epoxy-coated air receiver
- Use of electric and manual condensate drains
- Stainless steel discharge tubing and fittings, when appropriate
- Use of NEMA12 instead of NEMA1 enclosures, as required
- Single point electric and air connections
- Proper sizing at remote inlet piping, etc.

Question #2 Albuquerque, New Mexico

I keep hearing about "oil-free compressors" and "oil-less" compressors. These both sound the same to me. Is there a difference? What is it? And more importantly, why? How does this apply to my hospital air supply?

Compressors that fit both these descriptions are all designed to do the same thing — deliver compressed air with no oil added or left in from the compression process. The design of these units is dramatically different.

Oil-free — This refers to an air compressor unit that has *no oil present in the compression area*, but there is oil in the unit's driving area such as crankcase, transfer case, etc. Examples of these would be oil-free rotary screws with lubricated driving gears, oil-free reciprocating compressors with a lubricated crankcase and a distance piece in the crosshead design to keep oil from migrating from the crankcase to the compressor area.

Oil-free Reciprocating — These compressors can be single-acting, double-acting, air-cooled or water-cooled, and can be in-line, X, Y, or W design. Sizes range from fractional hp to 600 hp (2 cfm–2,500 cfm) with the average being 5 hp to 200 hp (20–1,000 cfm).

ASK THE EXPERTS

Oil-free Rotary Screw — These compressors can be single- or two-stage, air- or water-cooled and are usually sized from 40 hp to 800 hp with the average being from 40 hp to 350 hp (150 cfm to 1,600 cfm).

In some cases, the maintenance cost of oil-free rotary screws may be somewhat higher than the lubricated version. In others, many believe the hourly maintenance cost between lubricated and oil-free to be about even. Generally speaking, these are industrial air units and designed with up to 25,000 to 50,000 hours of operation between overhauls.

"I have been asked to select a new vacuum system for the operation and don't know where to start. How do you start this?"

In the last several years, water-injected/cooled single-rotor compressors have been introduced by several manufacturers to enter the oil-free compressor market.

Centrifugal compressors are oil-free in the compression area with a lubricated bull gear/pinion drive assembly. Many of these units are available in water-cooled and some in air-cooled configuration. The horsepower ranges from 100 hp to several thousand (500 cfm–30,000 cfm).

Oil-less — Refers to an air compressor that has no oil in the air compressor units whatsoever — not in the compression area — not in the drive area. Many of these use lubricated sealed bearings in some configuration. These are usually a pressed on fit — factory exchange.

Oil-less units are generally available in reciprocating rotary screw and orbiting scroll compressors. The horsepower range is usually from fractional to 25 hp (2 to 100 cfm).

Because they are "oil-less," each unit often has a predetermined life in operating hours before it is exchanged for a new compressor head. This is available from the manufacturer and should always be considered when a compressor selection is being made. This predetermined life will usually range from 1,500 to 10,000 operating hours. Many of these units are air-cooled, but some are water-cooled.

As you can see, although they both can deliver "oil-free" air, they serve totally different markets and have totally different operating characteristics.

Years ago, hospital and medical air often had lubricated compressors with effective drying and filtration equipment. Later, many of these became "oil-free" with lubricated drives. Some of the rationale at the time was: "Why worry about oil from the compressor when there are many sources of hydrocarbon already in the inlet air?" Today, "oil-less" has almost become the standard where the sizes apply. One primary reason often given by users is "considering the oxygen-rich atmosphere in many parts of hospitals and other health care facilities, the presence of oil may significantly increase the fire hazard." I will leave you to sort that out.

Question #3 Wichita, Kansas

I work at a surgical center and clinic. We do general surgery but specialize in such procedures as prostate surgery, seed implant, follow-up work, radiation work, etc. We have six operating rooms and all are full anesthetizing locations. There are two very large recovery rooms curtained off along with five ICUs. There is only one Emergency Room. We have several multipurpose rooms.

I have been asked to select a new vacuum system for the operation and don't know where to start. How do you start this?

This is a question that to get to the proper answer will require diligence. Always ask…compare your answer with what you are running now and planned growth and does the proposal action seem logical?

To start with, since we are sizing a vacuum system to handle the workload, we must identify the workload. How many inlet terminals are throughout the facility? You should expect to find 3 to 5 vacuum connections per room in most anesthetizing locations including the operating rooms. Most ICUs, recovery rooms, emergency rooms, CCU (cardiac arrest), etc. will have 2 to 3 per bed.

If there are some "sub-acute" care locations (non-anesthetizing) such as nurseries, patient rooms, exam and treatment rooms, etc., you can expect 1 to 2 per bed. There may be others in such areas as central supply, equipment repair, calibration, etc.

These will vary some by percentage of use. The more active inlets (Type A) in the operating rooms generally run at a relatively high simultaneous use factor, while the others (Type B) at a lower simultaneous use factor. Based on the number and type of outlet, the chart to the left will identify some basic accepted rules-of-thumb to determine this utilization. This is an excellent place to start, but realize that we are using rules-of-thumb to estimate the usage and this should be checked against reality, whenever possible and should be tied to a use factor which is very critical. You can be conservative and calculate all at Type A. We strongly suggest you try to monitor this performance during what you consider to be "busy times" to verify the accuracy.

For example, let's assume you have 100 inlets for vacuum — 65 in Type A and 35 in Type B. The basic formula for this is:

$(N_A + UF_A \times 0.25) + (N_B + UF_B \times .025) * (N_{OR} \times 1.15)$

where: N_A = number of Type A inlets

UF_A = simultaneous use factor Type A

N_B = number of Type B inlets

UF_B = simultaneous use factor Type B

N_{OR} = number of operating rooms

Conventional method:

$(65 + 77 \times 0.25) + (35 + 43 \times 0.25) + (6 \times 1.5) = (35.5 + (19.5) + (9) = 64$ scfm

Conservative method:

80 scfm

The selected method gives an answer in scfm, which is usually called the peak calculated load (PCL), which is the maximum anticipated load the system is expected to meet.

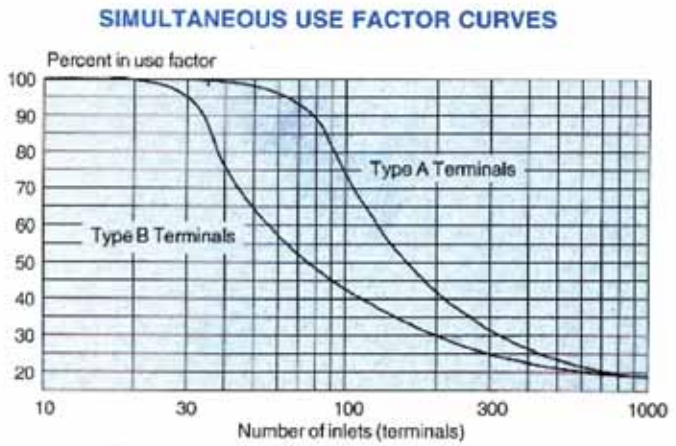
This is usually addressed by sizing a main and back-up vacuum pump, each sized for 100% load. Another way with less capital dollars is to size three vacuum pumps for 50% of the load each and run any two as the primary supply and the third as a "back up." This same scheme can be carried out using four pumps at 33% load each, and so on.

In this example, the 100% vacuum pump would be about 5 hp to 7½ hp.

REMEMBER — Don't rely on rules-of-thumb. Experience says this is a good place to start, but you must identify and verify your own data!

These compressors are usually oil-less reciprocating scroll or oil-free screw or reciprocating units.

Answers provided by Hank Van Ormer. Mr. Van Ormer is a leading compressed air systems consultant who has implemented over 1200 air improvement projects. He can be contacted at (740) 862-4112, email: hankvanormer@aol.com, and www.airpowerusainc.com



BREATHING air

BY COMPRESSED AIR BEST PRACTICES

An estimated 619,400 private-sector workplaces, in the U.S., used respirators for some purpose in 2001. The information in this article is taken from the September 2003 report titled, "Respirator Usage in Private Sector Firms, 2001", by the U.S. Department of Labor's Bureau of Labor Statistics (BLS) and by the National Institute for Occupational Safety and Health (NIOSH). The report is based upon a 2001 survey sent to a sample of 40,002 establishments, designed to represent all private sector establishments. There was a 75.5% response rate to the survey. Public-sector and self-employed establishments were excluded from the survey.

Required vs. Voluntary

Of the 619,400 establishments using respirators, 281,800 workplaces reported that use of respirators was required. Voluntary use of respirators is, for example, when a worker chooses to wear a simple dust mask which filters ambient air particulates. Required respirator use was estimated to affect 3.3 million employees, or about 3% of all private-sector employees. The highest rate of usage, by industry, was 13% for manufacturing. Of all the establishments with some required respirator use, 95% used air-purifying devices, whereas 17% percent used air-supplied devices. Many establishments use both. This article will cover only establishments which require the use of respirators.

"Of all the establishments with some required respirator use, 95% used air-purifying devices, whereas 17% percent used air-supplied devices."

Air-Supplied vs. Air-Purifying Respirators

Respirators are devices worn by workers to protect against the inhalation of a potentially hazardous atmosphere. Respirators are categorized into two principal types, air-purifying and air-supplied.

Air-purifying respirators remove contaminants from the ambient air. Air purifying respirators can be powered or non-powered. With non-powered air-purifying respirators, the user draws the air through a dust mask which removes particulate or gas/vapor by inhalation only, unassisted by a blower. This is the most common type of required respirator, with simple dust masks being used in 68% of workplaces. Powered air-purifying respirators use a blower to draw air through a particulate or gas/vapor filter. These are used in 15% of required respirator-use workplaces.

REQUIRED RESPIRATOR TYPE	NUMBER OF ESTABLISHMENTS	% OF TOTAL
Air-Purifying		
Non-powered	192,410	68%
Powered	42,100	15%
Air-Supplied		
SCBA	21,900	8%
Airline	25,390	9%
Total	281,800	100%

APPLICATIONS IN THE U.S.

Air-supplied respirators provide air from a source other than the surrounding atmosphere and are present in 17% of the workplaces with required respirator use. Air-supplied respirators are classified according to the method by which air is supplied and the way in which the air supply is regulated. These methods include self-contained breathing apparatus (SCBA) and airline respirators. SCBA applications fundamentally represent an application where the user takes the breathing air with him in tanks. A typical example is a SCUBA application. Airline respirators applications normally represent a situation where a compressed air system is providing breathing air — like in a hospital. Please note that this study only covers private-sector, so the large public hospital segment is missing in these numbers.

Industry Categories

Workplaces with required respirator-use, excluding those using dust masks, numbered 89,390. It is estimated that 700,772 employees utilize these respirators. Manufacturing represents the largest category, from a workplace and employee perspective. Services and Construction were the next largest categories.

INDUSTRY CATEGORY	AIR PURIFYING — POWERED RESPIRATOR		AIR SUPPLIED RESPIRATOR	
	WORKPLACES	EMPLOYEES	WORKPLACES	EMPLOYEES
Mining	422	7,287	592	8,234
Construction	9,341	56,494	10,546	96,637
Manufacturing	8,980	66,547	12,702	158,657
Transportation & Utilities	1,522	31,734	3,786	42,125
Wholesale trade	5,665	26,322	6,816	29,848
Retail trade	2,000	13,514	2,879	16,952
Services	11,434	79,210	9,490	61,967
Other	2,736	3,700	479	1,544
Total	42,100	284,808	47,290	415,964

Note:The same workplace may have both types of required-usage respirators.

Mining & Construction Segments

The mining segment was made up of metal mining (SIC 10), coal mining (SIC 12), oil and gas extraction (SIC 13), and mining and quarrying of non-metallic minerals/except fuels (SIC 14). Oil and gas extraction and non-metallic minerals represented 83% and 85% of the workplaces using powered air-purifying and air-supplied respirators respectively. Roughly 50% of the applications used SCBA units.

The construction segment was made up of general building contractors (SIC 15), heavy construction-other than buildings (SIC 16) and special-trade contractors. The majority of applications in construction (80%) were special-trade contractors (SIC 17) doing specialty-construction work requiring breathing air.

Transportation & Utilities Segment

Trucking and warehousing (SIC 42) represented approximately 30% of the powered air-purifying applications and 20% of the air-supplied respirators in the segment. Common applications include transportation-tank cleaning, sandblasting, and spray painting. The largest group was electric, gas, and sanitary services (SIC 49) with 74% of the air supplied applications and 50% of the powered air-purifying applications. Common applications include underground sewer and utility service and gas-line inspections and repairs.

Wholesale and Retail Trade Segments

Wholesale trade of durable (SIC 50) and non-durable goods (SIC 51) reported an even mix between air-supplied and powered air-purifying respirators. It was not specified what types of companies were represented. The retail trade segment came exclusively from automotive dealers and gasoline service stations (SIC 55). It was interesting to note that only .02% of these business used powered air-purifying or air-supplied respirators. A much larger number, representing 5% of all SIC 55 workplaces, reported using dust masks (non-powered air purifiers).

Services Segment

The majority of applications in this segment came from automotive repair (SIC 75), health services (SIC 80) and engineering services (SIC 87). Powered air-purifiers were reported used by automotive repair and engineering services. Air-supplied respirators were also

BREATHING AIR APPLICATIONS IN THE U.S.

reported to come primarily from the automotive repair segment. As noted earlier, most hospitals were not reported in this study, since many belong to the public-sector.

Manufacturing Segment

The manufacturing segment was the largest, and most diverse, of the reporting segments. Air-supplied respirators were spread out amongst many manufacturing groups with the largest being food products (SIC 20), chemical products (SIC 28), fabricated metals (SIC 34), industrial machinery (SIC 35), and transportation equipment (SIC 37). Common applications in the chemical industry are emergency leakage, system purging, and tank cleaning. Common applications in metalworking are grinding, welding, sandblasting, spray painting, plating, acid baths, degreasing and tank cleaning. Transportation equipment can include aerospace and shipbuilding. Aerospace applications can be rocket fueling, sandblasting and spray painting airframes and vehicles, and fuel tank cleaning. Shipbuilding applications can be tank cleaning and repair, welding, spray painting, sandblasting, cleaning and repairs of the ship's hold and inner hull. Powered air-purifiers were also present in these industries-although they were found in many other manufacturing groups.

NUMBER OF ESTABLISHMENTS BY MANUFACTURING SIC MAJOR GROUP	SIC MAJOR GROUP	POWERED AIR-PURIFYING	AIR-SUPPLIED
Food and Kindred Products	20	425	762
Textile mill products	22	134	—
Lumber and wood products	24	187	160
Chemicals and allied products	28	926	2,113
Rubber and misc. plastics products	30	636	859
Stone, clay, and glass products	32	570	513
Primary metals industries	33	508	569
Fabricated metals products	34	1,405	2,285
Industrial machinery and equipment	35	1,098	2,141
Electronic and other electric equip.	36	340	523
Transportation equipment	37	795	1,320
Instruments and related products	38	481	584
Misc. manufacturing industries	39	1,159	399
Other	21,23,25,26, 27,29,31	316	474
Number of Establishments Total	n/a	8,980	12,702

Required usage respirators are found in an important number of U.S. businesses. An interesting question is, "what percentage of the firms in each SIC Group are practicing a solid required respirator program." How many firms are using dust masks when they should offer their employees an air-supplied breathing air system? Education and awareness, as usual, are the key.

For more information contact Rod Smith, Compressed Air Best Practices Magazine, tel: 251-680-9154, email: rod@airbestpractices.com

"The largest group was electric, gas, and sanitary services (SIC 49) with 74% of the air supplied applications and 50% of the powered air-purifying applications."

ATMOSPHERE-SUPPLYING SYSTEMS AND RESPIRATORS

BY COMPRESSED AIR BEST PRACTICES

Atmosphere-Supplying respirators are also known as airline respirators or SCBA (Self-contained breathing apparatus) respirators. The classification stands for respirators, which allow a person to use breathing air not supplied by the local atmosphere. In atmosphere-supplying respirators, there are three types of breathing air systems, constant flow, demand flow, and pressure-demand flow. These systems supply five basic types of personal respirators; hood and helmet, mouthpiece, half-facepiece, full-facepiece, and full-pressure suits.

Three Types of Systems

Compressed breathing air systems are used only when supplying air to workers in atmospheres that are not immediately dangerous to life or health — or from which a worker can escape without a respirator. These systems protect workers from atmospheres which:

1. May produce physical discomfort immediately
2. Will result in chronic poisoning after repeated exposure
3. Will create acute adverse physiological symptoms after prolonged exposure

To protect workers, three basic types of compressed breathing air systems are used; constant flow, demand flow, and pressure-demand.

Constant Flow

Constant, or continuous, flow systems are the type most commonly employed in industrial plant environments. In such systems, purified air continuously sweeps through a worker's personal respirator to minimize leakage of external contaminants into the respirator, to ventilate the personal respirator with either cool or warm air — depending upon workplace conditions, and to provide clean, breathable air. Constant flow systems are used in wide-ranging industrial atmospheres. The only requirements are that the personal respirator selected must be appropriate to the hazard, and that an ample supply of air must be provided, such as from an on-line air compressor.

Demand Flow

In demand flow systems, purified air is supplied only as the worker inhales from a personal respirator. Upon exhalation to the atmosphere, a valve shuts off the air flow until the next breath. Demand flow systems adjust automatically to the worker's breathing rate. However, their application is sometimes limited because negative pressure within the respirator, during inhalation, may permit leakage of external contaminants. Tight-fitting personal respirators are used with demand flow systems. Designed for economy of air use, in relatively short-duration tasks, demand flow systems may incorporate an on-line compressor but are normally used where the air is supply comes from high-pressure compressed air cylinders.

Pressure-Demand

Pressure-demand systems maintain positive pressure in the worker's personal respirator at all times by providing a constant airstream, with increased air flow delivered upon inhalation. By continuously providing a small stream of air above atmospheric pressure, leakage of external contaminants,

ATMOSPHERE SUPPLYING SYSTEMS AND RESPIRATORS

into the personal respirator, is minimized. Like demand flow systems, pressure-demand systems require the use of tight-fitting personal respirators. However, the positive pressure aspect of of pressure-demand systems enables them to be used in many applications, including atmospheres containing toxic contaminants. Also designed for economy of air use, pressure-demand systems may utilize an on-line air compressor of high-pressure compressed air cylinders as the air source.

Five Types of Respirators

There are five basic types of personal respirators used with compressed air breathing systems. The type you select depends on the system and the hazards your workers face.

Hood and Helmet Respirators

Loose-fitting personal respirators with integral hood or helmet assemblies are normally used with constant flow systems only in atmospheres of low toxicity. Constant air flow is necessary to ventilate the head piece and provide sufficient air pressure to prevent contaminants from entering the respirator. Because they are loose fitting, hood and helmet respirators provide protection only against contaminants such as dirt, dust, powders, grit, heat and smoke. A familiar example is the industrial sandblaster's hood, which protects the worker's eyes, ears, nose, mouth and hair from sand particles and silica dust.

Mouthpiece Respirators

Used only with demand systems, mouthpiece respirators are designed solely to deliver breathable air. Since they do not provide skin, eye and head protection, or prevent the in-take of atmospheric contaminants, mouthpiece units should not be used in toxic environments. Their use is essentially limited to operations where insufficient oxygen is the problem. Mouth-piece respirators are used, typically, by divers performing underwater inspections, repairs, or construction.

Half-Facepiece Respirators

Half-facepiece respirators cover the nose and mouth and are designed for use primarily in demand and pressure-demand systems. They are usually tight-fitting and provide breathing protection for extended work periods in atmospheres not harmful to eyes or skin. Often worn with goggles or protective glasses, they are used in applications such as spray painting, metallizing, welding, effecting repairs in confined spaces, cleaning tanks, installing underground sewer and utility lines, and in other atmospheres of relatively low toxicity.

Full-Facepiece Respirators

Full-facepiece respirators cover the entire face and are designed for use with constant flow and pressure-demand systems in atmospheres of moderate to high toxicity. They are tight-fitting, and are often worn with full protective clothing in tasks that expose the worker to toxic or corrosive liquids, gases and mists — such as in chemical tank cleaning. They are also used with protective clothing in high radiation and high temperature areas. Since they provide eye protection, full-facepieces are also used in tasks where this type of protection is required such as: welding, metallizing, periodic inspection of tanks and tunnels, and other similar tasks performed in pungent or oxygen-deficient atmospheres.

Full-Pressure Suits

Full-pressure suits are used only with constant flow systems that maintain positive pressure and ventilation. They range in design from loose-fitting, body-protective clothing with integral air-supplied hood or helmet assemblies, to astronaut-like suits that provide total environment life support. They are generally used in atmospheres that contain highly poisonous or corrosive gases and mists, and in atmospheres that contain biological contaminants. Some NASA workers, for example, wear full suits when fueling rockets with highly toxic propellants.

For more information please contact Rod Smith, Compressed Air Best Practices Magazine, email: rod@airbestpractices.com, tel: 251-680-9154.

**Source Document: "How to Purify Low Pressure Breathing Air", Bulletin 270 Revision H, pgs 2-3, 2001 SPX Dehydration and Process Filtration*

SUPPLIED AIR RESPIRATORY PROTECTION

BY BILL KENNEDY

Hazardous breathing conditions exist in routine industrial operations, such as hospitals, abrasive blasting, paint spraying, industrial cleaning, and arc welding. In these and other operations that introduce contaminants into the workplace, supplied-air respirators are frequently used for worker protection. These applications utilize "low pressure" air (normally between 90 and 125 psig) and are designed to meet with OSHA and CSA breathing air quality requirements. This article outlines breathing air requirements and describes common applications, identifies commonly-found contaminants, and outlines a five-step contaminant removal process.

Breathing Air Requirements

OSHA and CSA provide specific air quality requirements to provide worker protection. Individual industries, like the hospital industry, may have more specific requirements which provide specifications as to the type of machinery and alarms required to achieve breathing air quality — reliably and consistently. The breathing air requirements are set forth in the table below.

TABLE 1: MAXIMUM ALLOWABLE CONTAMINANTS AND LIMITS FOR BREATHING AIR

CONTAMINANT	OSHA (U.S.) GRADE D	CSA (CANADA)
Oxygen	19.5%–23.5%	20%–22%
Carbon Monoxide (CO)	10 ppm	≤5m L/m3
Carbon Dioxide (CO2)	1,000 ppm	500m L/m3
Oil (Condensed Hydrocarbons)	5 mg/m3	1 mg/m3
Odor	"lack of noticeable odor"	"free of detectable odor"

OSHA Regulations: CFSR 1910.134(d)
Canadian Standards Association (CSA): Z180.1-00

Hospital Applications

Hospitals use purified air for such processes as respiratory therapy, hyperbaric oxygen therapy, life support systems, and neonatal infant care. Patients may be using breathing air through various types of respirators, from half-face respirators to "iron lungs" in situations where the patient cannot take breaths on their own. Due to the critical, life-dependant nature of these installations, rigorous adherence to the 2005 NFPA 99 Specification (National Fire Protection Association) is practiced. Reliability, of course, is the primary objective in this situation. Specifications for equipment, alarm systems and back-up systems, which ensure breathing air quality and reliability, are detailed in the specification.

SUPPLIED AIR RESPIRATORY PROTECTION

Abrasive Blasting Applications

Abrasive blasting operations most commonly use sand to clean iron and/or steel surfaces. This technique is also used to clean other materials such as brick, stone, concrete, sand castings, aluminum, brass, copper, wood, glass, and plastic. Silica dust (SiO2) is created when sand is used as the abrasive material. In terms of worker health, silica dust is of special concern because it may cause silicosis, a lung disease which develops slowly and often leads to death years after exposure has ceased. Dust is also a very serious health hazard in this industry. Dust is created by broken-down abrasives, pulverized surface coatings and encrusted substances, and abraded material from the object being blasted.

TABLE 2: TYPICAL TASKS REQUIRING BREATHING AIR

INDUSTRY	PROCESS	PRODUCT FINISHING	MAINTENANCE
Aerospace	Rocket fueling	Sandblasting and spray painting airframes and vehicles	Fuel tank cleaning
Automotive and trucking		Sandblasting and spray painting	Transport tank cleaning
Chemical	Emergency leakage and system purging		Tank cleaning
Diving	Underwater salvage, exploration		Underwater inspections and repairs
Foundry	Smelting	Sandblasting, grinding	Cleaning coke ovens
Medical	Respiratory therapy, neonatal care		
Metalworking	Grinding, welding	Sandblasting, spray painting and plating	Acid baths, degreasing and tank cleaning
Nuclear			Containment chamber maintenance, core inspection
Petrochemical	Emergency and system purging		Tank cleaning
Pharmaceutical	Drying, transporting and packaging drug products		Tank cleaning
Shipbuilding	Welding	Spray painting and sandblasting	Hold, inner hull, tank cleaning and repairs
Utilities	Underground sewer and utility service, installation		Gas line inspections and repairs

Paint Spraying Applications

Paint spraying operations are subject to ambient air hazards presented by the common presence of organic vapors and mists from paints, lacquers, enamels and solvents. Please note that it is common, in this industry, to use only disposable, particle-type, face-masks. These face-masks, which afford only dust particulate protection, are commonly selected based upon comfort and not upon their ability to provide safe respiratory air.

Industrial Cleaning Applications

Tank cleaning and other industrial cleaning operations require solvents which can pose threats to worker safety. While the most common result of contact with organic solvents is dermatitis (inflammation of the skin), inhalation of solvent vapors will have more grave effects since all organic solvents may have some effect on the central nervous system. Trichlorethylene and perchloroethylene, two of the more toxic solvents, are used extensively in the vapor degreasing of metals and equipment. Known effects of exposure to these solvents include dizziness, headaches, loss of inhibitions, lack of coordination and central nervous system depression.

Arc Welding Applications

Arc welding processes create metal fumes and gases, which cause health concerns. Ozone and the oxides of nitrogen are the principal toxic gases produced by the arc welding process. Other contaminants may arise from the various components of the welding rods, oxides of the metals and the alloying elements being joined. Ozone, an intensely irritating gas, is produced by the action of the electric arc through air. Some paints may produce toxic fumes when heated with the welding torch. Other toxic fumes are generated when the welded metals contain, or are coated with, alloys of lead, zinc, cadmium or beryllium and are capable of producing metal fume fever. Symptoms usually occur a few hours after exposure and are similar to those of influenza: a metallic taste in the mouth, dryness of the nose and throat, weakness, fatigue, muscular and joint pain, fever, chills and nausea. These symptoms usually last less than 24 hours after which follows a temporary immunity. This is why welders are more susceptible to this condition on Mondays or on workdays following a holiday.

Common Compressed Air Contaminants

Supplied air respiratory protection systems originate with oil-lubricated or oil-less air compressors. These air compressors are placed in a multitude of different ambient air conditions from which they compress air. Ambient air may contain carbon monoxide, water vapor, oil, and dirt —— to name a few of the contaminants. Identifying and removing these contaminants is the function of the system.

Carbon Monoxide

Carbon monoxide combines readily with the hemoglobin in red blood cells, rendering them incapable of carrying oxygen to tissues. Called anoxia, it causes dizziness, loss of motor control, unconsciousness and, in extreme cases, death. Since hemoglobin takes up carbon monoxide about 200 times as fast as oxygen, even low concentrations are very dangerous, and anoxia can develop even though the oxygen supply to the lungs is ample.

Carbon monoxide originates from ambient vehicle exhaust and other sources of hydrocarbon combustion. Air compressors, exposed to this type of ambient air, will send it downstream. Air compressors, supplying breathing air, must therefore have their ambient air intakes installed in a clean ambient air environment, with reduced ambient contaminants and normal concentrations of oxygen. Carbon monoxide can also be produced by overheated conditions in the air compressor itself. OSHA requires high temperature alarms on lubricated air compressors because overheated conditions can produce carbon monoxide by the partial oxidation of oil and oil vapors.

Water/Water Vapor

Ambient air contains moisture, which is drawn into the air compressor and is entrained in the airstream in a vapor state. As compressed air flows through the breathing air system it cools, causing water vapor to condense in face-pieces and helmets, obscuring vision. Even in small concentrations, moisture combines with oil and solid contaminants in the system to form sludge, which can clog or damage critical components, such as pressure regulator valves. It also causes rust in pipelines, that increases wear on breathing air components. Moisture can freeze in air lines, exposed to cold weather, and partially or completely block the flow of air. This is of particular concern to workers, who work outdoors, where their air lines are exposed to freezing temperatures.

Oil/Oil Mist

In systems using oil lubricated air compressors, oil is a major potential contaminant in the system. In reciprocating compressors, lubricating oil applied to cylinders is fragmented into fine particles by the shearing action of the piston and enters the airstream in mist form. In rotary screw compressors, oil is injected directly into the compressor chamber, and although most of the oil is removed by a separator, some ultimately enters the air stream.

In addition to the risk of producing carbon monoxide, in an overheated lubricated compressor, oil in mist form can present other problems. Although of limited toxicity, oil mist can cause breathing discomfort, nausea, and in extreme cases, lipoid pneumonia. It can also create unpleasant tastes and odors which interfere with a worker's capacity and desire to complete a task. Oil can also act as a chemical corrosive and accelerate the deterioration of gaskets and seals. Oil, when combined with water, can also form a sludge which can clog pneumatic valves and controls.

Solids

Solid particulates have adverse effects on workers and can cause breathing difficulties. This can increase the chances of allergic reactions and, in extreme cases, cause sympton similar to those of silicosis. Solids generally enter the system through the air intake. In a typical metropolitan area, concentration of atmospheric solids may be as high as four million particles per cubic foot of air. When air is compressed to 100 psig, this concentration can be eight times greater. In some systems utilizing non-lubricated

SUPPLIED AIR RESPIRATORY PROTECTION

compressors, however, it is possible for the air compressor to introduce solid particulates. Teflon, carbon, and other materials are used in place of oil as a lubricant. Frictional wear on these compressor materials can cause particles to enter the airstream.

Five-Step Air Purification Process

Breathing air purifiers follow a five-step process to eliminate contaminants and to provide OSHA Grade D Breathing air quality.

1. Liquid Oil is removed from the air stream with a coalescing filter. Compressed air flows into a blended-fiber filter element which removes oil droplets to 0.01 ppm.

2. Water vapor and liquid is removed by a compressed air dryer. Depending upon the system specifications, a refrigerated dryer or a desiccant air dryer may be used. Dew points may be achieved, depending upon the dryer type, between 32˚ F and -40˚ F. Desiccant type dryers may use one or two beds of desiccant. Desiccant materials used are typically activated alumina, silica gel, or molecular sieves, which have a high capacity to capture and retain large quantities of moisture. Continuous-duty applications will normally use a dual tower desiccant dryer which can regenerate one desiccant bed in one tower, while the other tower dries the compressed air. An electric timer, or a sensor, will automatically cycle the air flow through the desiccant beds to provide a continous supply of dry air.

3. A catalytic converter converts carbon monoxide (CO) to carbon dioxide (CO2). The bed of catalyst oxidizes the CO to CO2, drawing oxygen from the air. The reaction is: 2CO + O2 fi 2CO2. The conversion rate decreases markedly when the air contains moisture or other contaminants. Since air from a compressor or an aftercooler is generally at or close to 100% relative humidity, the relative humidity must be lowered before the air passes through the catalyst.

4. Oil mist (or hydrocarbons) are now removed from the compressed air stream with a filter which uses activated carbon to remove this taste- and odor-causing contaminant. Although not toxic, tastes and odors can interfere with worker comfort and performance.

5. Solid particulates are filtered out by a final filter. Entrained particulates and desiccant dust are removed in this final stage of air purification.

For more information, please contact Bill Kennedy, Director of Marketing, SPX Dehydration and Process Filtration, Tel: 352-873-5126, email: Bill.Kennedy@dehydration.spx.com.

LEVEL 1

MEDICAL COMPRESSED AIR SYSTEMS

BY DON BAER

Located in the bowels of most hospitals, you will find the source of the Level 1 Medical Air compressed air system. Per the NFPA Section 99 Specification (National Fire Protection Association), Level 1 air compressor systems provide air for human consumption within the hospital facility. Level 2 Systems are used where patients are not dependent upon mechanical ventilation (such as driving pneumatic tools). Level 3 Systems are used to drive hand pieces in dental offices or hospitals. Medical air may be supplied from cylinders, bulk containers and/or medical air compressors. The definition of a medical air compressor (per NFPA) is a compressor that is designed to exclude oil from the air stream and compression chamber and that does not, under normal operating conditions or any single fault, add toxic or flammable contaminants to the compressed air.

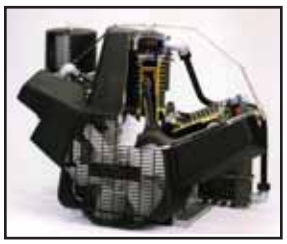
A Level 1 medical compressed air system is made up of four major sections; the compressors, control panel, receiver, and purification. The air system supplies compressed air through hundreds, if not thousands, of feet of copper pipe that has been cleaned and installed per requirements established by the NFPA Section 99 Specification. The pipeline leads to many areas of the hospital with the most vital area being surgery. Surgery and patient rooms are equipped with medical outlets that act as quick connections for attaching respirators and ventilators.

Powerex SOS Scroll Medical Compressors

LEVEL 1 MEDICAL COMPRESSED AIR SYSTEM

Air compressors used in medical systems have been evolving over the last twenty years. Historically, air compressors were mostly of two different technologies; liquid ring and oil-free reciprocating. Liquid ring pumps are very reliable, however, they require water to cool and seal the pump, which increases operating costs due to the additional cost of the water and sewage. Oil-free reciprocating air compressors have a oil-free piston and cylinder with an oil-lubricated crankshaft and crankcase. The piston and crankcase areas are separated by a extension shaft. This extension shaft is required, by NFPA 99, to be within visual access, to insure that the extension seals are not leaking oil that could find its way to the piston and cylinder.

Oil-less Scroll Air Compressors



Powerex Oil-less Reciprocating Compressor

The primary technologies used today are oil-less reciprocating and oil-less scroll air compressors. Reciprocating oil-less pumps have proven to be reliable in applications requiring less than a 50 % duty cycle. A lower duty-cycle reduces the temperatures of the piston and cylinder areas. Powerex reciprocating pumps are designed and built with composite piston technology that greatly reduces the temperature of the cylinder areas and the temperature on the wrist pin bearing.

Oil-less scroll technology has become the technology of choice. Scroll technology is capable of a 100% duty cycle, because its low bearing loads, and higher speeds, allow the pump to be air-cooled with high-velocity cooling fans. Scroll compressors are physically smaller and provide high output.

Powerex offers the scroll pumps in 3 and 5 horsepower sizes. Smaller horsepower compressors provide lower operating costs and extend service intervals. These relatively small horsepower systems, with multiple compressor pumps, fit the demands of a hospital system very well. Medical air systems in the hospital have varying demands all day long. The morning hours, when most surgeries are scheduled, provide the greatest demands on the air system. At night, these systems experience very low air demand. Banking multiple 3 to 5 horsepower air compressors allows energy costs to more closely match air demand by turning off un-needed air compressor horsepower.

Control Systems and Panels

Powerex combines scroll technology with its demand control system to drive down the costs of ownership. Newly released enclosed scroll compressor systems offer lower noise levels of 53 dbA (similar to the noise level of a microwave oven) and come in 15 and 20 horsepower models. Each module comes with a solid-state circuit board to allow the operation of each module while alternating between each enclosure. Powerex enclosed systems allow the advantage of adding cooling air ducting and hot exhaust air ducting which will lower the temperature and noise of the mechanical room. Control panels manage the operation and protection of the systems electrical

Multi-unit Scroll Compressor Package

NFPA 99 Required Alarms

- Reserve pump in use
- Low pressure
- High dew point (above 39 degrees F)
- High carbon monoxide (above 10 PPM)
- High discharge temperature
- Motor overload
- Reserve transformer in use

components. These control panels contain all of the regulator components used in industrial electric motor applications as well as a circuit of alarms.

Latching relays are used to control the sequence of operation along with timers. Many manufacturers are using more advanced control circuits that include solid-state circuit boards or PLC's (Programmable Logic Controllers). Powerex is registered by the Underwriters Laboratory to manufacture control panels per UL508A. This listing is required by the NFPA. Receiver Tank The receiver tanks vary in size and configuration. The receiver is required to be registered by the National Board and must comply with ASME (American Society of Mechanical Engineers). The receiver tanks are required to be lined with a coating to prevent corrosion. Most corrosion-resistant materials are epoxy linings or galvanized coatings. Powerex uses an FDA (Food and Drug Administration) approved phenolic lining, that is baked on, to prevent any chance of off-gassing after being applied. Receivers are required to provide bypass piping per NFPA 99. Air Purification It is critical to remove moisture from the compressed air system. Compressed air leaving the air compressor flows through the receiver tank and into compressed air dryers. The NFPA 99 Specification requires the installation of two dryers — keeping one dryer in reserve in case of a malfunction.

The two acceptable types of air dryers are refrigerated and desiccant-type dryers. The NFPA requires that the dryer produce a dew point of 32˚ F or lower. The alarm system for this requirement is set at 39˚ F. Refrigerated dryers are not able to deliver the 32˚ F requirement at the commonly used pressure of 100 psig (pounds per square in gauge). In-order for refrigerated-type dryers to deliver the required 32˚ F dew point, the air must be expanded. This is accomplished after the final line pressure regulator, which is to be set at 55 psig. The average refrigerated dryer would provide a 39˚ F dew point at 100 psig and when expanded to 55 psig would deliver a 21˚ F dew point which is well within the 32˚ F requirement of the NFPA 99 code. Lower-pressure, liquid-ring compressor systems make it even more difficult to achieve the 32˚ F requirement and can cause frequent nuisance dew point alarms. The trend today is to move towards systems using desiccant-type air dryers. These regenerative drying systems utilize chemical drying techniques to adsorb the moisture and then have the moisture vented back to atmosphere. Desiccant dryers are constructed of two towers filled with either

Medical Air Installation With Desiccant Air Dryers

LEVEL 1 MEDICAL COMPRESSED AIR SYSTEM

molecular sieve or activated alumina. Powerex desiccant dryers have four modes of operation that provide clean dry compressed air:

1. **Expansion Phase —** pressure in one tower is released to ambient with a blast of air through the muffler
2. **Dehumidification Phase —** dried compressed air is bled by orifice through the decompressed chamber
3. **Pressure Phase —** after dehumidification the chamber will pressurize so that the switchover from regeneration to adsorption can take place
4. **Standby Phase —** the dew point monitor signals when the chambers are to switch. This reduces the amount of purge air consumed, lowering the operating of the system.

After the air leaves the dryer it then flows through a particulate filter and a carbon filter. These filters remove particles of .01 micron, oil vapors and odor from the air stream. These filters are required to be backed-up by a secondary set of filters to enable replacement without interrupting the air stream. The plumbing throughout the air system must be cleaned for oxygen service per CGA (Compressed Gas Association) 4.1, the specification which outlines the process for pipe cleaning. Final-line pressure regulators are then placed in the pipeline to reduce the air pressure before entering the hospitals' pipeline. This regulator is required to be backed up by a second regulator. After leaving the regulator, the air is monitored for carbon monoxide (CO) and dew point. Carbon monoxide must not exceed 10 PPM. When levels of CO register higher than this, a visual and audible alarm will sound locally at the air compressor and at a location that is manned 24 hours — typically the nurses station or the security department. A second alarm system is usually found in the mechanical room of the hospital. The required alarms and defined locations are listed in the NFPA 99 code. The dew point alarm is required to activate when moisture levels go above a 39˚ F dew point.

Medical Air Level 1 compressed air systems reliably provide purified air for hospitals. The four major components of the system (compressors, control panels, receivers, and purification) meet with very specific specifications, which ensure safe and reliable air for the hospital.

For more information, please contact Don Baer, Product Manager, Powerex Inc., tel: 888-769-7979 ext. 8580, email: dbaer@powerexinc.com, www.powerexinc.com

Powerex (Pure Air Technology) Inc. is located in Harrison, Ohio and was established in 1982. Powerex manufactures compressed air and vacuum systems for healthcare, laboratory, process, and environmental applications.

COLLABORATION
is Stronger than Competition

BY WOLFGANG DANGEL

Wolfgang Dangel, Bosch Rexroth CEO and President, says their distribution model is based on the idea that collaboration is stronger than competition

Coming off a century most remarkable for its pitched competitive battles, many business experts are predicting that this century will be more distinguished for its cooperative efforts. For years, we at Bosch Rexroth have been following a collaborative approach with customers and suppliers. Now we are extending that model to our distribution partners.

Manufacturers haven't always had the best relationships with the distribution channels that sell their products to end users and to others who apply them in real situations.

In some ways, that's not surprising: there certainly is creative tension. Manufacturers, on the one hand, always want their channel partners to buy more. Meanwhile, distributors clearly understand that large inventories are expensive to maintain, especially for extensive product lines that have a multitude of options, but relatively few sales of any individual part number. And they ask what their manufacturers are doing to help them move products.

For Bosch Rexroth, there were several important reasons why we are bucking the trend and seeking closer relationships with our channel partners. First, with the breadth of our product line — drive and control products across almost every industry — we cannot reach all of our potential customers without their assistance.

Secondly, our most advanced products often need to be customized or engineered to achieve their full potential for providing sustainable competitive advantage. Thus our distributors have the opportunity to offer tremendous value to the customer. That's why our first question to distributors is not, "How many sales engineers do you have?" but "How many applications engineers do you have?"

As a result, though we may not have as many distributors as some of our competitors, we are fortunate to have the best, most technically astute distribution partners in the industry. And I consider them to be an extension of our company, an integral part of the Bosch Rexroth family.

I believe this level of cooperation and collaboration is unprecedented in our industry. We exchange information with our channel partners that many companies will not share even with their own employees, let alone another business. Some examples include:

- Sharing of confidential information about margins, profits, investments, and plans for the future.
- Access to internal inventory, order entry, order status, and collaboration software.
- Close cooperation in applications engineering.

The last item is of particular importance, since "applications engineering expertise" is one of our core competencies and one of our clear advantages in the marketplace. In essence, we are giving our distributor partners a share of the brand positioning we have built for ourselves over the past several decades.

The benefit to customers is significant: they get a technically-advanced consultant within driving distance, who can access a world-class product development and manufacturing organization. The result? Solutions with engineering sophistication well beyond the reach of most of our competitors.

COLLABORATION IS STRONGER THAN COMPETITION

ONE DISTRIBUTOR'S VIEW

DALLAS, TX — Mike Rowlett, CEO and president of Womack Machine Supply Co., has seen a lot of adversarial relationships between manufacturing companies and their distribution partners in his years in the drive, motion, and control industry.

"There were times," he said recently, "where distributors became protective, even defensive, and you almost had to battle with the manufacturers for the right to sell the product."

That's why he's so excited about the unprecedented partnership between Bosch Rexroth and his company, a major supplier of fluid power, electrical control and industrial automation components in the south-central United States.

"They are looking at distribution as a real partner, instead of as an adversary," he noted. "They have opened their arms and even allowed us to participate in the creation of policy."

Other companies, he pointed out, may respond when there's a problem, but only unilaterally, without considering the needs of distribution or even customers. The classic illustration of Bosch Rexroth's approach, he said, was PitStop, the company's information portal on the web.

"We told German management all the things that could be improved, and they had the foresight and integrity to see what needed to be done and invited us to help them fix it."

He credited Bosch Rexroth president and CEO Wolfgang Dangel with providing the senior management direction that cemented the stronger relationship between the company and its channel partners.

That relationship includes information sharing — sales, margins, customer lists, customer needs or purchase history, for instance — on a scale hardly imaginable before, or with other manufacturers.

"We would absolutely never do that before," Rowlett explained, adding that in his business, customer information is absolutely critical. "That would have been like having a fox in the hen house."

The result, he said, is that manufacturers and channel are working together to solve customer problems and meet their needs.

"The time we used to waste fighting our suppliers we can now use to fight our competitors," Rowlett explained. "As a result, we give the customer a better, fuller package. It's a breath of fresh air."

With the equivalent of a factory employee around the corner, they get much better customer service. Not only can our distributors help analyze the situation, they can provide the products and, in some cases, be there in minutes.

For distributors, the benefits are equally significant: we have clear understanding about how both partners add value for the customer. And while the industry has been in the midst of a rather lackluster recovery, our sales through U.S. distributors have doubled since 2002. And I expect more of the same: in order for us to achieve our rather ambitious sales goals ($2.5 billion in North America by 2014), sales through distribution will have to *triple*.

In the collaboration model Bosch Rexroth routinely hosts its distributors for tours of the corporate manufacturing and research facilities in Europe, introducing key distributors to top management. There are regular quarterly meetings for a council of leading distributors where they have direct access to company management. And we encourage them to stay in touch with the senior-level executives they meet to continually discuss ideas.

We believe that we have achieved significant sales increases, gained market share, and had higher Bosch Rexroth content on machines as a result of these cooperative efforts. The secret is that we have attempted to foster a collaborative relationship with and between distributors. Specifically, we've granted them exclusivity in their territories, so that they don't have to worry about competing with us or with another distributor.

Bosch Rexroth distributors have exclusivity in their territories so they don't compete with other distributors.

And that depth and degree of collaboration, information sharing, mutual trust is unique: no other drive, motion, and control competitor is willing to provide these assurances to their channels and give them such a clear way to add value to their customers. In fact, some of our competitors have a business model with competitive distribution creating an almost adversarial relationship with *and between* distributors, preventing any significant information sharing.

We are totally committed to our partnership. So our distributors are partnering with a company known worldwide for its collaborative relationships with distributors, customers, and suppliers. It's who we are. And, I believe it's the best strategy for doing business as a technical leader in the 21st century.

About the Author

Wolfgang Dangel was appointed president and chief executive officer of Bosch Rexroth Corporation in April 2003. Prior to his appointment, Dangel was executive vice president and chief financial officer for Bosch Rexroth from 2001 to 2003. He has also served Bosch Rexroth in key overseas positions: as managing director of Mannesmann Rexroth China Ltd. (1996-2000) and as head of controlling for Mannesmann Demag, Johannesburg, South Africa (1991-95). Dangel holds a Master's of Business Administration and a bachelor's degree in finance, both from the University of Munich (Germany).

Bosch Rexroth AG, part of the Bosch Group, achieved sales of approximately $5.7 billion (4.6 billion Euro) in 2005 with over 28,200 employees. Under the brand name of Rexroth the company offers all drive and control technologies, from mechanics, hydraulics and pneumatics to electronics and associated service. Over 500,000 customers worldwide utilize Rexroth's unique technological know-how to implement their innovative and future-oriented systems and machine concepts. The global player, represented in over 80 countries, is an extensive supplier of components and systems for industrial and factory automation and mobile applications.
Visit www.boschrexroth-us.com
for more information.

DISTRIBUTOR SAYS TRUST MAKES ALL THE DIFFERENCE

BENSALEM, PA — Every few years, said Joe Loughran, president of the fluid power and automation distributorship Airline Hydraulics (www.airlinehyd.com), someone comes out with another book about trends in the industry and talks about the distrust that exists between manufacturers and distributors. Apparently, those books aren't being followed very closely by Loughran's company or by Bosch Rexroth Corporation, a drive and control automation technology manufacturer in Hoffman Estates, IL.

"It's a very unique relationship that Bosch Rexroth has with its distributors," Loughran said. "There's a spirit of trust, honesty, and openness on both sides. And that is so unusual."

Loughran says based on that level of trust, his company has recently made some significant investments, including two acquisitions. Plus he's hired several more people to service the Bosch Rexroth business.

"I don't want to let them down," Loughran explained, referring to Bosch Rexroth. "When you know you're going to be treated fairly, you're willing to stretch the rules a little. Because you know they're going to help you do whatever it takes for both of us to succeed."

As a result, he said, his company is willing to make the investments in expanding the Bosch Rexroth business. The secret, he noted, is the exclusive relationship the company has with its channel partners.

"I don't have the intra-brand competition that makes things so inefficient," said Loughran. "We've replaced that inefficiency with mutual trust, and now both horses are pulling in the same direction."

Bosch Rexroth and its distributors, he said, are "totally in sync." "What can be better than a distributor and a manufacturer really working together for the same things," he asked. "That's the way you're going to win in the marketplace."

COMPANY PROFILE TOTAL

Total Equipment, Pittsburgh, Pa.

When and how was Total Equipment started?

The Total Equipment Company was started in 1982 by two former Ingersoll Rand sales managers. We entered the West Virginia, Western Pennsylvania, and Eastern Ohio markets by acquiring an Ingersoll Rand Air Center in Charleston, West Virginia. Our corporate office moved to Pittsburgh, Pennsylvania and opened a full service shop in 1984.

What is the scope & structure of Total Equipment today?

Currently we have two stocking facilities: St. Albans, West Virginia (15,000 square feet) and Pittsburgh, Pennsylvania (30,000 square feet). We manage by committee with all of our senior salespeople and managers as stockholders. Our management is split between four senior salespeople. While all four of us maintain our own sales accounts, we have assigned specific operational responsibilities amongst us.

What brands of compressed air products does Total Equipment represent?

Ingersoll Rand is our major supplier of air compressors and compressed air components. We also represent Hankison air dryers and filters, Roots blowers, and Dekker vacuum pumps.

How is the hospital market in Pittsburgh? How do you address it?

Within Allegheny County there are aproximately 35–40 hospitals. Just downtown we have ten major hospitals. UPMC (University of Pittsburgh Medical Centers) owns 80% of the hospitals. West Penn Hospitals own another 15% and then there are another 5% of miscellaneous hospitals. We also have VA hospitals here like everywhere else.

We have a market specialist who focuses on all the hospitals in Allegheny County. Total Equipment has also been a member, for many years, of the HESP (Hospital Engineering Society of Pittsburgh). We have attended their monthly meetings for many years and often lead technical discussions on hospital air and vacuum systems

EQUIPMENT COMPANY

Compressed Air Best Practices interviewed Mike Weir (President) of the Total Equipment Company

with the membership. The real priority, however, is to provide them with top service. Outside of Allegheny County we use our outside sales engineers, who live in the same community, to service the local hospital. Our strong staff, of twenty service technicians, provides the service support required.

What kind of compressed air products does the hospital market use and for what applications?

A good-size hospital with 200 beds and ten operating rooms can have a medical air system, a laboratory air system, and pneumatic air systems. The medical air systems must all follow the NFPA 99 guidelines. We follow these guidelines, from the beginning, when we assess the demand for air in a hospital. For example, you multiply the number of operating rooms times the air-flow (scfm) per outlet times the usage factor, to calculate the scfm needed for operating rooms. Add up all the applications and you arrive at a total scfm required. We then size up a system which can supply the air flow needed — and, per NFPA 99, provide a redundant system to provide the hospital with 100% back-up.

NFPA 99 SIZING GUIDELINES

TYPE OF SERVICE	SCFM PER OUTLET	USAGE FACTOR
Operating room	3.5	1.0
Delivery	3.5	0.5
Recovery	2.0	0.5
ICU & CCU	2.0	0.8
Neonatal ICU	2.0	0.8
Emergency room	2.0	0.15
Nursery	0.5	0.25
Respiratory therapy	0.5	0.75
Exam & treatment	0.5	0.2
Patient room	0.5	0.1

From an equipment standpoint for our NFPA 99 medical air systems, we use only Ingersoll Rand oil-less, reciprocating or scroll air compressors. Oil-less means there is no oil at all in the compression chamber or in the crankcase — or gear area. Air-cooled systems are preferable to water-cooled. Water-cooled systems require chillers and can run-up costs for water and sewage. We estimate that water costs $11 per thousand gallons in the Pittsburgh region. In some situations,

Total Equipment, St. Albans, West Virginia

TOTAL EQUIPMENT COMPANY

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space is a consideration and the installations are in basements where water-cooled is the only option. We therefore recommend air-cooled compressors whenever the hospital has the ability to provide fresh intake air. NFPA 99 Guidelines are very specific on intake air. Intake air must be free of contaminants and special care must be taken to keep it away from loading docks or exhaust. We normally pipe to the roof. A common error we find is that intake piping is undersized. If you undersize the intake piping, you'll experience rapid cycling and premature wear and tear on the compressor.

> "A good-size hospital with 200 beds and ten operating rooms can have a medical air system, a laboratory air system, and pneumatic air systems."

Medical air requires 50 psig air pressure. We normally, however, produce air between 80–110 psig as there are typically thousands of feet of piping (of small diameter) in a hospital. With medical air, you must always guarantee enough air pressure and the right air quality.

We install the appropriate NFPA 99 Medical Air Dryers, CO2 monitors and dew point monitors. In 2002, NFPA 99 changed the dew point specification to a +32˚ F dew point. We normally use Hankison Medical Refrigerated Air Dryers for these applications. We are also seeing membrane dryers, as a viable system up-grade to some older air systems using refrigerated dryers. Membrane dryers offer the advantage that they can offer dew points down to -40˚ F and do not require any electric connections.

How is laboratory air different?

Laboratory air may not use the same air system as the NFPA 99 medical air system.

Laboratory air normally supplies the research & development areas in a hospital. Specifications often call for oil-free air. This provides us with more options for departments with budget constraints. We can use oil-free and oil-lubricated compressors with appropriate filtration systems. Oil-free air compressors do require filtration since oil is present in the crankcase of the air compressor. If there was a mechanical failure of a seal, oil could end up in the compression chamber and be sent downstream. For this reason, we install over-sized coalescing filters, which could handle an oil slug — in a worse-case scenario. We will also provide oil-free air by installing the appropriate filtration systems after a lubricated rotary screw compressor. Dew point specifications will vary, depending upon the lab, from -40 to +38˚ F pressure dew points.

How about vacuum?

We recommend liquid-ring, air-cooled, vacuum pumps. We use Dekker vacuum products. We recommend air-cooled over water-cooled products for the same reasons mentioned before. The same areas of a hospital, which use compressed air, use vacuum. Requirements for vacuum are normally at 19–20 inches Hg vacuum per NFPA 99. Many hospitals go to 20–22 inches Hg for extra security.

How is the steel industry? Please explain your experience with the steel industry.

The steel industry is very strong, operating at full capacity. Not much capital spending.

The steel industry is a major consumer of air and has great potential for air surveys, PM (Preventative Maintenance) contracts and dryers and filters. The environment is harsh and requires a knowledge of the ambient conditions with respect to temperatures and dust.

What kind of compressed air products does the steel industry use and for what applications?

Depending on plant size, they use all types from centrifugals to rotary screw and reciprocating. They typically have low power rates thus not a lot of emphasis on high efficiency equipment.

How does Total Equipment practice sales management?

Salespeople report to one of three owners and go to them for support and training. We feel our salespeople should be technically competent. Many are degreed engineers and spend one to two years as an application engineer, learning the products, before going into outside sales. We expect them to spend the majority of their time developing customers and supporting them.

Do you have market specialists in sales?

In addition to being assigned a geographic territory, our salespeople have been assigned specific markets. This market focus allows them to leverage contacts and build knowledge in a specific industry. The markets are:

- Municipal
- Primary Metals (Steel/Aluminum)
- CPI (Chemical & Petroleum industry)
- General Industry
- Mining
- Institutions (Schools/Hospitals)

TOTAL EQUIPMENT COMPANY

Company Profile

How does Total Equipment practice product/supplier management?

Senior salespeople are given supplier responsibility and paid a bonus for reaching goals. They are responsible for being the champion of this product line, reaching sales goals, going to meetings, and distributing supplier information.

Total Equipment also sells pumps. How do you handle both pumps and compressed air products?

Total Equipment Company specializes in rotating equipment, particularly equipment which moves compressible and incompressible fluids. Our business is split equally between pumps and compressor/blower/vacuum pumps. Our salespeople and servicemen are expected to know and sell all products. We feel pumps get us into larger accounts and help us develop strong relationships, which keep us in touch with new air compressor needs. Air compressors force us to call on lighter industry, which has fewer pumps. This helps us diversify our markets served.

Focus on Aftermarket and Customer Systems

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

Customers need to spend more time analyzing their entire system rather than individual components. We recommend energy and system audits to hone in on the entire air system. This allows the customer to select the most economical components which can be put together to provide the most efficient and reliable system.

How has the compressed air market evolved?

The market has changed a lot since our founding almost 25 years ago. In 1982, we sold compressors, dryers, and parts with little service. Now, almost 50% of our invoicing comes from aftermarket service and parts. We have grown to 80 employees and have an emphasis on aftermarket and customer systems. We have a full service machine shop with complete CNC capabilities and dynamic balancing equipment. The market is constantly changing, and as a small business, we have the capability of being flexible and can change direction quickly. This strategy, combined with our people, has lead to our success as a company.

Thank you Total Equipment for your insights.

For more information please contact: Mike Weir, President, Total Equipment, phone: 412-269-0999 or visit www.totalequipment.com

INDUSTRY NEWS

Press Releases

VAISALA HAND-HELD METER MEASURES DEWPOINT DOWN TO -60 °C

August 2006: Vaisala DRYCAP® Hand-held Dewpoint Meter DM70 measures dewpoint temperatures down to -60° C with an accuracy of ±2° C. The unique probe has a sensor purge feature that heats and dries the sensor prior to measurement. As a result, the response time from ambient to dry conditions is exceptionally fast. The DM70 is lightweight and does not use bulky desiccant containers.

The new DMP78 probe with sensor purge builds on the Vaisala patented auto-calibration system that maintains instrument accuracy by regularly monitoring dry-end performance and correcting for any drift. Auto-calibration is fully automatic and requires no external apparatus or calibration gas.

With its smart user interface and interchangeable probes, the DM70 sets the standard for portables. Features include data logging, a rechargeable battery system, and a selection of humidity parameters for display. Each probe includes a calibration certificate traceable to NIST. Sensors can directly measure pressure dewpoint in process pressures up to 280 psig and down to vacuum.

Vaisala provides and array of sampling accessories that easily adapt the DM70 to most applications. The instrument is ideal for compressed air measurements, spot checking and for monitoring air-drying systems.

The Vaisala Group is a successful international technology company that develops and manufactures electronic measurement systems and equipment for meteorology, environmental sciences, traffic safety and industry. Vaisala employs over 1,100 professionals and achieved net sales of EUR 189.2 million in 2003. Vaisala serves customers throughout the world. In 2003, exports accounted for 96.6% of net sales. Vaisala's A-series shares are quoted on the Helsinki Exchanges (HEX).

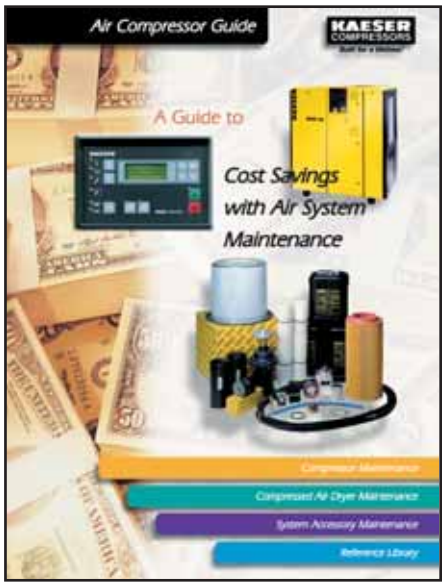
VAISALA
Reliable.

SAVE WITH SYSTEM MAINTENANCE!

Free Step-by-step Guide to Cost Savings in Compressed Air Systems

Kaeser Compressors, Inc. announces our latest compressed air system guide: "Cost Savings with Compressed Air System Maintenance." This step-by-step guide is a helpful resource for any industrial facility that uses compressed air.

This full color, eight page reference manual outlines maintenance activities for each component in the system including: compressors, dryers, filters, drains, and aftercoolers. It describes the different maintenance needs for varying component types including reciprocating vs. rotary screw compressors, and refrigerated vs. desiccant air dryers. Our Problem Solved! section provides practical solutions for common air system problems, and the 5 Steps to Save Money with Maintenance section offers sensible suggestions for impacting your bottom line. Contents also include comprehensive maintenance checklists, product diagrams, rules of thumb and a helpful reference library.



For your free copy or more information on our other helpful resources, please call 800-777-7873 or visit us at www.kaeser.com.

INDUSTRY NEWS

Press Releases

ATLAS COPCO FIRST MANUFACTURER TO OFFER 100% CERTIFIED OIL-FREE COMPRESSED AIR

Antwerp, Belgium, June 15, 2006: Atlas Copco's Oil-free Air division has announced that the company's Z series of oil-free rotary screw air compressors is the first in the world to be TÜV certified ISO 8573-1 CLASS 0. Risk of any contamination by oil is effectively eliminated during food and beverage processing, pharmaceuticals manufacturing and packaging, electronics manufacturing, automotive paint spraying and powder coating as well as textile manufacturing. Certification was carried out using the most stringent test methods available, simulating realistic industrial installation environments. At all test conditions, no traces of oil could be determined and the compressed air was certified to be in the Category 'Class 0' in terms of oil content.

Atlas Copco has proven its world leadership in the compressor market by setting a new standard for compressed air purity. "We are very pleased to offer our customers a compressed air solution which eliminates risk of contamination by oil," said Mr. Luc Hendrickx, President of Atlas Copco's Oil-free Air division. "These test results prove that Atlas Copco's oil-free rotary screw compressors are not just the right choice in terms of operating costs, but also constitute the best choice when it comes to managing risks."

Oil-free Air Helps Manage Risk

Contamination by even trace quantities of oil can result in damaged batches or products, high rejection rates and returns, and costly production downtime and clean-up. Industries that risk contaminating their products with oil may expose themselves to product recalls, legal action and the negative consequences these have on company reputation and brand equity. The industries concerned include food and beverage processing, pharmaceutical manufacturing and packaging, electronics manufacturing, automotive paint spraying, powder coating, textile manufacturing, and others.

Certification Process

Due to rising customer concern with safeguarding their industrial processes and end products, Atlas Copco Oil-free Air division received frequent requests for certifications for the air quality level provided by the flagship Z series of oil-free rotary screw air compressors. In 2005, the division initiated a certification procedure for its compressors under the ISO 8573-1 standard.

To carry out the testing, the independent Technische Überwachungs-Verein (German Technical Monitoring Association, or "TÜV") was selected to evaluate the compressors. At Atlas Copco's request, TÜV applied the most stringent test methods available, adding further temperature and pressure constraints. The results have been made public and show that no traces of oil could be determined in even the most stringent test conditions.

The ISO 8573-1 compressed air standard of 1991 was revised in 2001 to address the needs of critical applications where air purity is essential. The revision established a more comprehensive measuring methodology, including all three forms of oil contamination by air compressors — aerosols, vapor and liquid — to provide a true picture of air quality. To the existing purity classes 1 through 5, a new and more stringent class was added: ISO 8573-1 CLASS 0.

The Atlas Copco Z series compressors were evaluated using the most demanding set of tests. For example, testing employed the standard's Part 2 B1 full flow test method, which examines the entire air flow, measuring both aerosols and wall flow. In comparison, the standard's Part 2 B2 partial flow testing method does not capture all wall flow, or liquid oil deposits. Vapors were measured by means of the stringent Part 5 methodology.

One aspect influencing the efficiency and purity of air systems is temperature. While the ISO 8573-1 test methodology establishes reference conditions of 20°C and 1 bar(a), tests on the Atlas Copco Z series were carried out at three different temperatures: 20° C, 40° C and 50° C at the measurement point, and at both 1 bar and 8 bar in pressure. Even so, no traces of oil were found in the output air stream.

Over the past 60 years, Atlas Copco has pioneered the development of oil-free air technology, resulting in a range of oil-free air rotary screw compressors to suit applications that cannot compromise when it comes to the purity of compressed air. With certification to ISO 8573-1 CLASS 0 standard, Atlas Copco sets a standard for the industry: "100% oil-free air".

Learn more at www.atlascopco.com and at www.classzero.com

COMPAIR ANNOUNCES NEW OIL-LESS AIR COMPRESSOR

CompAir is a world leader in the manufacture and sale of compressed air technology, specifically designed for energy-efficiencies and savings, for a world-wide variety of applications and industries.

CompAir launched a national campaign to showcase the new Oil-Less, Speed-Regulated, environmentally-protective compressors, capable of providing real energy and cost savings while meeting requirements of stringent environmental goals. These 20-100 horsepower compressors offer pressures to 150 PSIG, with absolute-lowest overall maintenance costs. Target markets for these water-injected, completely oil-less machines include computer-chip manufacturing, pharmaceuticals, food processing, the medical and health-care industry, electronics, chemical, paint applications, bio-technology, petro-chemical plants, and paper mills, among others.

This line of compressors offer:

1. Isothermal compression, tip sealing and Standard VFD Drive for optimum energy savings.
2. Extended equipment life due to low rotational speeds.
3. NO OIL whatsoever. A low sound enclosure adds to the low environmental impact.
4. Very low maintenance cost due to fewer components and absence of oil.
5. As a result of a non-ferrous compressed air path, contaminates are eliminated to help ensure environmental compliance.

This launch premiered a fresh marketing concept for CompAir USA, with the introduction of the ***"CompAir Road Show"*** featuring the marketing strategy of getting the customer to the showroom by actually driving the showroom directly to the customer. This is achieved by the moving showroom of a fully-decorated and decaled truck bringing the operating product directly to the front door of the distributor or customer where it can be operated for a hands-on, visual demonstration event, set up for the convenience of the customer.

*CompAir continues to offer compressors — **Engineered to Save** — to the United States and World-wide industrial community. www.CompAir.com*

INDUSTRY NEWS

Press Releases

ALUP PRESS RELEASE

Alup introduces a complete compressed air treatment product line that includes refrigerated air dryers, compressed air filters, condensate drain valves and oil water separators.

Alup's refrigerated air dryers are available 20 to 2250 CFM. Non-cycling, high temperature and cycling type dryers are all available. These dryers use diaphragm type solenoid valves, stainless steel thermal expansion valves and the latest heat exchanger technology for long term durability, energy efficiency and solid reliability under varying load and ambient conditions. They are backed by a full five year warranty-the best in the industry!

Alup's compressed air filters have aluminum housings and a differential pressure indicator that is standard on all models ¾" and up. Automatic drain valves with push to lock drain connectors are also standard on filters. All filter elements have machined aluminum end caps and stainless steel mesh element retainers on both sides of the pleated element media. These filters have very low pressure drop and are available in particulate, coalescing and activated carbon. A threaded rod connection ensures an easy element replacement and the double O ring seal between element and housing eliminates internal leaks.

Alup's condensate drain valves include an electronic timed drain valve that includes ball valve, Y strainer and 4 mm orifice. Zero loss drain valves are available in two styles, both of which use capacitance technology to precisely sense liquid level in the internal chamber 50 times per second and then dependably open when necessary to drain condensate without loss of expensive compressed air.

Alup's oil water separators are suitable for all types of lubricants and have replaceable media that bonds to the lubricant and lets the pre-treated water move on. They are simple to install, include element change indicators and are designed to allow the maintenance of the unit to be very clean, easy and quick.

For more information, please contact Tom Milton at (800) 528-5192 extension 232 or e-mail info@alupcompressors.com

REXROTH EXTENDS AS SERIES FRLS

New AS3 optimized for greater flow

The new Series AS3 FRLs from Rexroth fulfills high demands in terms of air preparation. The Air Service (AS) system has a modular construction and is comprised of filters, regulators, lubricators, and accessory devices such as shut-off valves and distribution blocks. The AS3 complements the smaller Series AS2 FRLs. With a width of 63 mm, an AS3 regulator provides a substantially higher flow rate of max. 184 SCFM as compared to a 52-millimeter AS2 regulator with max. 95 SCFM. The AS3 compressed air preparation system is offered with ⅜" and ½" NPT, and G3/8 and G1/2 ports with a pressure range of 232 psi and can be used at temperatures between +14° to +122°F.

The AS Series feature a smooth surface which is easy to clean. The modern industrial design and compact dimensions, along with the application of advanced polymers, make the AS3 very light-weight. A patented oil filling system permits semi-automatic filling of the lubricator unit: the oil is directly vacuumed out of a container through a hose and the level is measured and displayed with a sensor. Plus, the unit is easy to maintain, as a large window provides a clear view of the filter and lubricator levels. Users can disassemble individual components even while the system itself remains assembled.

Included among the many options for the Series AS FRLs, are multiple filter options — 5, 0.3 or 0.01 micron filtration. Drain valves on the filters can be semi-automatic or automatic. Regulator options include standard, precision or continuous pressure models. Shut-off (lock-out) valves can be lockable or non-lockable. Also, choose from a variety of mounting options. On-line cad drawings are available for OEM design requirements.

The Bosch Group is a leading global manufacturer of automotive and industrial technology, consumer goods, and building technology. In fiscal year 2004, some 242,000 associates generated sales of 40 billion euros. The Bosch Group today comprises a manufacturing, sales, and after-sales service network of some 260 subsidiaries and more than 10,000 service centers in over 130 countries.

In North America, the Bosch Group manufactures and markets automotive original equipment and aftermarket products, industrial automation and mobile products, power tools and accessories, security technology, thermo technology, packaging equipment and household appliances. Bosch employs nearly 23,000 associates in more than 80 primary and 20 associated facilities throughout the region with reported sales of $7.8 billion in 2004.

Under the industrial automation and mobile products segment, Bosch Rexroth Corporation is a wholly owned subsidiary of Robert Bosch GmbH. In the year 2004, Bosch Rexroth achieved sales of approximately $5.3 billion (4.1 billion Euros) with 26,400 employees worldwide.

Under the brand name of Rexroth, the company offers all relevant drive, control and motion technologies: from mechanics, hydraulics and pneumatics to electronics and associated services. Rexroth has 500,000 customers in over 80 countries and is an extensive supplier of components and systems for industrial and factory automation and mobile applications. For more information, visit www.boschrexroth-us.com.

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Rexroth Series AS3 FRL is characterized by a modular construction and modern industrial design. A width of 63 mm permits higher flow.

Dewpoint in COMPRESSED Air

BY STEVEN JIROUTEK

Dewpoint or dewpoint temperature (Td) is simply defined as the temperature at which a gas, maintained at constant pressure, becomes saturated with water vapor. Saturated conditions can be achieved by either increasing the amount of water vapor or by reducing the temperature of the gas. When saturation has been reached, water vapor will condense into liquid water when in contact with a colder surface forming tiny water droplets called dew.

Dewpoint is generally the preferred parameter for measuring the amount of water vapor in a dry gas such as compressed air since small changes in water vapor concentration produce large, measurable changes in dewpoint temperature — an important phenomenon when trying to monitor and control a drying system.

When managing dewpoint levels in a compressed air system, it becomes helpful to understand some background information about the measurement itself, such as:

1. What is dewpoint?
2. What is the difference between dewpoint and "pressure dewpoint?"
3. What is the effect of pressure on dewpoint?
4. Why is knowledge of dewpoint in compressed air important?
5. What is the typical range of dewpoint temperatures to be found in compressed air?
6. What are the standards for quality of compressed air?
7. How is dewpoint in compressed air measured reliably?
8. What are the telltale signs of a malfunctioning dewpoint sensor?
9. How often should a dewpoint sensor be checked or calibrated?
10. How do I choose the right sensor for my requirements?

1. What is dewpoint?

Dewpoint temperature is a measure of how much water vapor there is in a gas. Water has the property of being able to exist as a liquid, solid, or gas under a wide range of conditions. To understand the behavior of water vapor, it is first useful to consider the general behavior of gases.

In any mixture of gases, the total pressure of the gas is the sum of the partial pressures of the component gases. This is Dalton's law and it is represented as follows:

$$P_{total} = P_1 + P_2 + P_3 \ldots$$

The quantity of any gas in a mixture can be expressed as a pressure. The major components of air are nitrogen, oxygen, and water vapor, so total atmospheric pressure is composed of the partial pressures of these three gases. While nitrogen and oxygen exist in stable concentrations, the concentration of water vapor is highly variable and must be measured to be determined.

The maximum partial pressure of water vapor is strictly a function of temperature. For example, at 60˚ F (20˚ C), the maximum partial pressure of water vapor is 23.3 millibars (mb). The value of 23.3 mb is said to be the "saturation vapor pressure" at 60˚ F (20˚ C). In a 60˚ F (20˚ C), "saturated" environment, the addition of more water vapor results in the formation of condensation. This condensation phenomenon can be exploited to measure water vapor content. Gas of unknown water vapor concentration is passed over a temperature-controlled surface. The surface is cooled until condensation forms. The temperature at which condensation forms is called the "dewpoint temperature." Because there is a unique correlation between temperature and saturation vapor pressure (remember, the maximum partial pressure of water vapor, also known as saturation vapor pressure, is strictly a function of temperature), measuring the dewpoint temperature of a gas is a direct measurement of the partial pressure of water vapor. Knowing the dewpoint temperature, the corresponding saturation vapor pressure can be calculated or looked up. The following table shows some values for temperature and the corresponding saturation vapor pressure:

TEMPERATURE °F (°C)	SATURATION VAPOR PRESSURE (MB)
68 (20)	23.3
32 (0)	6.1
14 (-10)	2.8
-4 (-20)	1.3
-40 (-40)	0.2

> "Dewpoint temperature is a measure of how much water vapor there is in a gas."

2. What is the difference between dewpoint and "pressure dewpoint?"

The term "pressure dewpoint" is encountered when measuring the dewpoint temperature of gases at pressures higher than atmospheric pressure. It refers to the dewpoint temperature of a gas under pressure. This is important because changing the pressure of a gas changes the dewpoint temperature of the gas.

3. What is the effect of pressure on dewpoint?

Increasing the pressure of a gas increases the dewpoint temperature of the gas. Consider an example of air at atmospheric pressure of 1013.3 mb with a dewpoint temperature of 14˚ F (-10˚ C). From the table above, the partial pressure of water vapor (designated by the symbol "e") is 2.8 mb. If this air is compressed and the total pressure is doubled to 2026.6 mb, then according to Dalton's law, the partial pressure of water vapor, e, is also doubled to the value of 5.6 mb. The dewpoint temperature corresponding to 5.6 mb is approximately 30˚ F (-1˚ C,) so it is clear that increasing the pressure of the air has also increased the dewpoint temperature of the air. Conversely, expanding a compressed gas to atmospheric pressure decreases the partial pressures of all of the component gases, including water vapor, and therefore decreases the dewpoint temperature of the gas. The relationship of total pressure to the partial pressure of water vapor, e, can be expressed as follows:

$$P_1/P_2 = e_1/e_2$$

By converting dewpoint temperature to the corresponding saturation vapor pressure, it is easy to calculate the effect of changing total pressure on the saturation vapor pressure. The new saturation vapor pressure value can then be converted back to the corresponding dewpoint temperature. These calculations can be done manually using tables, or performed by various kinds of software.

Vaisala DRYCAP® Hand-held Dewpoint Meter

DEWPOINT IN COMPRESSED AIR

4. Why is knowledge of dewpoint in compressed air important?

The importance of dewpoint temperature in compressed air depends on the intended use of the air. In many cases dewpoint is not critical (portable compressors for pneumatic tools, gas station tire filling systems, etc.). In some cases, dewpoint is important only because the pipes that carry the air are exposed to freezing temperatures, where a high dewpoint could result in freezing and blockage of the pipes. In many modern factories, compressed air is used to operate a variety of equipment, some of which may malfunction if condensation forms on internal parts. Certain water sensitive processes (e.g. paint spraying) that require compressed air may have specific dryness specifications. Finally, medical and pharmaceutical processes may treat water vapor and other gases as contaminants, requiring a very high level of purity.

5. What is the typical range of dewpoint temperatures to be found in compressed air?

Dewpoint temperatures in compressed air range from ambient down to -112˚ F (–80˚ C), sometimes lower in special cases. Compressor systems without air drying capability tend to produce compressed air that is saturated at ambient temperature. Systems with refrigerant dryers pass the compressed air through some sort of cooled heat exchanger, causing water to condense out of the air stream. These systems typically produce air with a dewpoint no lower than 23˚ F (5˚ C). Desiccant drying systems absorb water vapor from the air stream and can produce air with a dewpoint of -40˚ F (–40˚ C) and drier if required.

6. What are the standards for the quality of compressed air?

ISO8573.1 is an international standard that specifies the quality of compressed air. The standard defines limits for three categories of air quality:

- Maximum particle size for any remaining particles
- Maximum allowable dewpoint temperature
- Maximum remaining oil content

Each category is given a quality class number between 1 and 6 according to the reference values shown in the table below. As an example, a system that conforms to ISO8573.1 and is rated for class 1.1.1 will provide air with a dewpoint no higher than -94˚ F (–70˚ C). All remaining particles in the air will be 0.1 um or smaller, and the maximum oil content will be 0.01 mg/m^3. There are other standards for compressed air quality, such as ANSI/ISA-7.0.01-1996 for instrument air.

ANSI/ISA-7.0.01-1996 FOR INSTRUMENT AIR.

QUALITY CLASS	PARTICLE SIZE (UM)	DEWPOINT ° C	DEWOINT ° F	OIL CONTENT (MG/M^3)
1	0.1	-70	-94	0.01
2	1	-40	-40	0.1
3	5	-20	-4	1
4	15	3	37	5
5	40	7	45	25
6	—	10	50	—

7. How is dewpoint in compressed air measured reliably?

Some principles of dewpoint measurement apply to all types of instruments, regardless of manufacturer:

- *Select an instrument with the correct measuring range:* Some instruments are suitable for measuring high dewpoints, but not low dewpoints. Similarly, some instruments are suitable for very low dewpoints but are compromised when exposed to high dewpoints.
- *Understand the pressure characteristics of the dewpoint instrument:* Some instruments are not suitable for use at process pressure. They can be installed to measure compressed air after it is expanded to atmospheric pressure, but the measured dewpoint value will have to be corrected if pressure dewpoint is the desired measurement parameter.
- *Install the sensor correctly:* Follow instructions from the manufacturer. Do not install dewpoint sensors at the end of stubs or other "dead end" pieces of pipe where there is no airflow.

Vaisala manufactures a family of instruments that are ideal for measuring dewpoint temperature in compressed air. DRYCAP® sensor technology provides fast dewpoint measurements from ambient temperature down to -76˚ F (–60˚ C) with an accuracy of ±3.6˚ F (±2˚ C) over the entire range. In addition to the general principles given above, consider the following when selecting and installing a Vaisala dewpoint instrument:

A. The best installation for a dewpoint sensor isolates the sensor from the compressed air line. This is accomplished by installing the sensor in a "sample cell" and connecting the cell to a "T" in the compressed air line at the point of interest. A small amount of compressed air is then bled past the sensor. The cell should be made of stainless steel and connected to the "T" with tubing (¼" or 6mm). It is useful to install an isolation valve between the cell and the air line. This enables easy installation and removal of the sensor.

B. A flow-regulating device is necessary to control to airflow past the sensor. The desired flow rate is only 1 slpm (2 scfh). The regulating device can be a leak screw or a valve. To measure pressure dewpoint, the regulating device is installed downstream of the sensor, so that when the isolation valve is opened, the sensor is at the process pressure. To measure dewpoint at atmospheric pressure, the regulating device should be installed upstream of the dewpoint sensor.

C. Do not exceed the recommended flow rate. When measuring pressure dewpoint, an excessive flow rate will create a local pressure drop at the sensor. Because dewpoint temperature is pressure sensitive, this will create an error in the measurement.

D. The best tubing material is stainless steel (SS). Non-metallic tubing can absorb and desorb water vapor, creating a lag in measurement response. If SS tubing is not available, consider using PTFE or other materials that do not absorb water. Avoid the use of clear plastic tubing or yellow rubber tubing.

E. It is possible to reduce installation costs for permanent dewpoint instruments by installing the sensor directly in the compressed air line. In these cases it is important to choose a location where the sensor has adequate airflow and where the temperature of the compressed air is at or near ambient temperature.

8. What are the telltale signs of a malfunctioning dewpoint sensor?

- An instrument that displays one value all of the time, as if the output or display were locked.
- An instrument that is "bottomed out," always reading its lowest possible value.
- An instrument that is erratic, changing rapidly or randomly over a wide range of values.
- An instrument that displays impossibly dry or wet dewpoint values.

DEWPOINT IN COMPRESSED AIR

9. How often should a dewpoint sensor be checked or calibrated?

It is best to follow the manufacturer's recommendation. Vaisala suggests a one or two year calibration interval, depending on the instrument. Sometimes a simple field check against a calibrated portable instrument is sufficient to verify correct operation of other instruments. Vaisala provides detailed calibration information in the User's Manual that is shipped with each instrument. Any time that you have doubts about the performance of your dewpoint instruments, it is wise to check their calibration.

10. How do I choose the right sensor for my requirements?

When selecting a dewpoint transmitter, the accuracy and dewpoint measurement range are important factors to consider. Long term stability, ease of calibration, and ability to withstand condensation are also key performance features to keep in mind.

The three most common types of sensors for measuring dewpoint are chilled mirrors, metal oxide and polymer sensors. Chilled mirror technology can offer the highest accuracy over a wide range of dewpoints. However, due to its optical measurement principle, the sensor is very sensitive to dirt and dust. Accurate chilled mirror devices tend to be expensive and are used when absolute accuracy is essential and frequent maintenance can be performed.

Metal oxide, including aluminum oxide technology, is designed for low dewpoint measurement in industrial processes. It provides very good low dewpoint measurement but offers poor low long-term stability. This drift in the output reading means frequent calibration which typically must be done only at the manufacturer's calibration lab. Metal oxide sensors can also be easily destroyed by higher moisture levels and condensation.

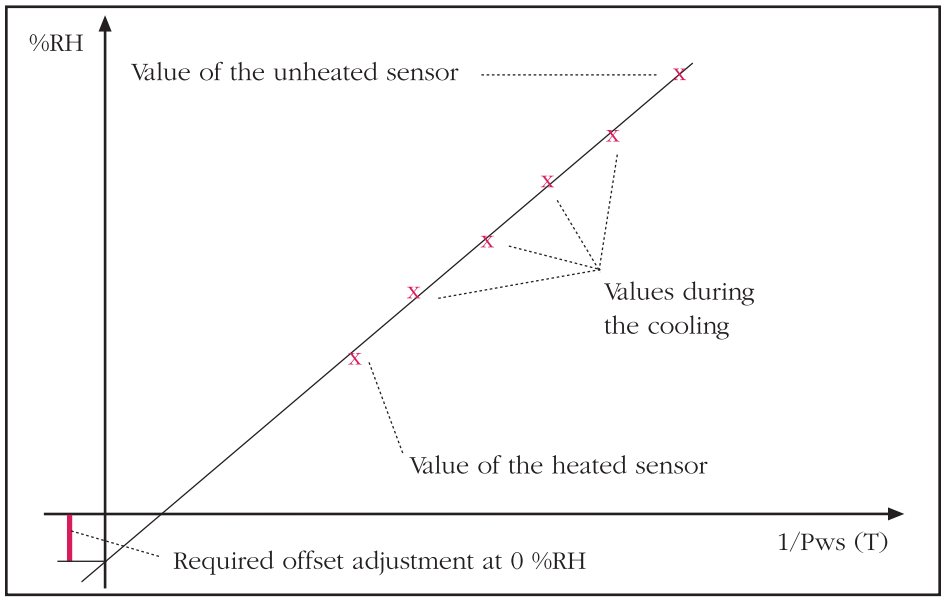
Polymer sensors are immune to condensed water and can measure over a wide humidity range. For decades polymer sensors have been used in a wide variety of industrial and meteorological applications. Newer technologies now allow polymer sensors to be used in low dewpoint applications as well. The main advantage of the technology is improved long-term stability. Polymer technology combined with intelligent electronics offer a high-performance solution for applications where minimal maintenance is needed for the dewpoint transmitter.

Patented Auto-Calibration

Auto-calibration is used to measure accurate dewpoint values in very dry conditions with the polymer sensor. This is because when relative humidity approaches zero very small changes in humidity result in large changes in dewpoint readings. For example, dewpoints of -40˚ C and -50˚ C in room temperature correspond to relative humidities of 0.8 %RH and 0.3 %RH, respectively. With the typical ±2 %RH accuracy specification of polymer sensors, an accuracy of ±2˚ C dewpoint can be achieved down to -9˚ C. Auto-calibration extends this accuracy +/- 2˚ C down to -60˚ C.

During auto-calibration, the DRYCAP® sensor is heated and the humidity and temperature reading of the DRYCAP® sensor are monitored as it cools down to ambient temperature. This data is analyzed and used to adjust the reading of the humidity sensor.

The key is that the sensor's output is equivalent to relative humidity (%RH) which changes when temperature changes. This known physical dependence allows the auto-calibration to evaluate if the low humidity reading at 0%RH is correct. Any possible drift is the automatically corrected by the microprocessor. The result is accuracy better than ±2 °C even at low dewpoints.



Vaisala DRYCAP® Sensor

The Vaisala DRYCAP® Sensor consists of two parts: a capacitive polymer sensor bonded together with a resistive temperature sensor. The polymer sensor measures the humidity (amount of water molecules in the measured gas) in terms of relative humidity (%RH). The temperature sensor measures the temperature of the polymer sensor. From these two values the microprocessor in the transmitter electronics calculates dewpoint temperature.

Key Advantages of the Vaisala DRYCAP® Sensor

The performance advantage of the DRYCAP® sensor is its unique combination of accuracy, stability and wide measurement range from dry to wet. The DRYCAP® sensor is immune to condensing water making it ideal for systems where there is a risk of condensation if a dryer malfunctions. In addition, the excellent chemical tolerance of the DRYCAP® sensor makes it suitable for use in a wide variety of demanding environments including applications with chemical impurities in the air.

For more information, please contact Steve Jiroutek, Vaisala Application Engineer, Vaisala Inc., Steve.jiroutek@vaisala.com, Tel: 1-888-VAISALA (824-7252)

DOCTOR

BY DAN BOTT

Some doctors do make house calls. These are not the kind of doctors that most people know but the doctors that are required for under-the-weather vacuum systems. These professionals don't wear surgical masks and are rarely seen in the O.R. but they do spend a lot of time in the equipment room performing complicated surgery on ailing vacuum systems. Just like in anything else, some vacuum doctors are great and some are, well, not so great.

How do you know if you have a problem? Let's say your vacuum system has been in place for many years, even decades and there have been the usual aches and pains but in general things seem to be running just fine. What makes you call the good doctor for a checkup? There are several symptoms that will indicate a problem worth calling in a professional to help resolve.

> "Just like in anything else, some vacuum doctors are great and some are, well, not so great."

The first symptom is anemia. Are your vacuum pumps sluggish? Are they coughing, sputtering or otherwise misaligned? Prescription: one of the best action items you can take is to have your supply equipment evaluated by a qualified service technician. The key word here is "qualified". Hiring someone without the proper experience with YOUR vacuum pumps will only lead to more issues. Having an expert go over the mechanical workings of supply equipment is critical to solving vacuum delivery issues. They are able to troubleshoot, identify and repair pump related failures or weaknesses so that the supply system is operating at its peak. A well-trained and experienced service technician will provide you with peace of mind and excellent running equipment.

The second symptom is smoking. The Vacuum General, a very distant cousin to The Surgeon General, has determined that smoke from a vacuum pump is one of the leading indicators that something is seriously wrong. Smoke or mist from the discharge of oil sealed packages is an indication that the separation system is not in good working order. Separation systems can be tricky to evaluate as problems can be related to particulate contamination, oil type/condition, operating vacuum level, discharge temperature and many other factors. Calling your service technician will be the first step in resolving the issue although sometimes further engineering support will be required.

Next is chronic tapping. Are you continually tapping the vacuum gauges in surgery to see if you can get higher vacuum? Chronic tapping is a signal that there may be a problem in the pipes and is typically one of three issues. First is design. If your facility has expanded, either by adding a new wing or adding high demand areas such as surgery and you are using the same vacuum distribution system, there may be restrictive diameters in the supply header. This will cause excessive

VACUUM

pressure drop between vacuum pumps and use points. Second is overload. If the system is incapable of attaining adequate vacuum, it may be due to the excessive demand that is limiting the capability of the vacuum system. If this is the case, higher capacity vacuum pumps are in order. Finally, there may be other restrictions in the header. This could be the result of loaded vacuum filters, partially closed isolation valves, debris inside the header itself or a variety of other issues. Obviously, the recommended course of action is to locate the problem and eliminate the restriction.

The final symptom is spinning meters. If your electrical meters are walking off the wall during peak demand periods, chances are you are running too much horsepower to supply demand. Operating at excessive header vacuum levels will significantly increase energy consumption and keep trim vacuum pumps online artificially. Lowing site vacuum level will allow for pumps to cycle less frequently and keep trim pumps offline for longer periods of time during peak demand periods. Also, if the supply configuration is set up so that trim vacuum pumps do not time out and shut down quickly, there may be controls issues that can be modified to allow for lower energy consumption.

When your vacuum systems are in need of a checkup, there are a number of different problem-solvers who can show up at your doorstep. First, there are solid professionals who can get right to the issue, identify and solve the problem. These pro's are worth the money. Next are the good hearted and well-intentioned individuals who are bent on fixing your system with the solution of the week. They may not be exactly what you need but they usually get the job done. Then there are the techno-doctors who try to fix your system with the latest gadget or electronic widget or the doctors who are fresh out of vacuum med school who will learn their trade by practicing on your system. Look out for these guys. Worst of all are the good old boys who are not doctors at all but pose as doctors so you will buy their solution.

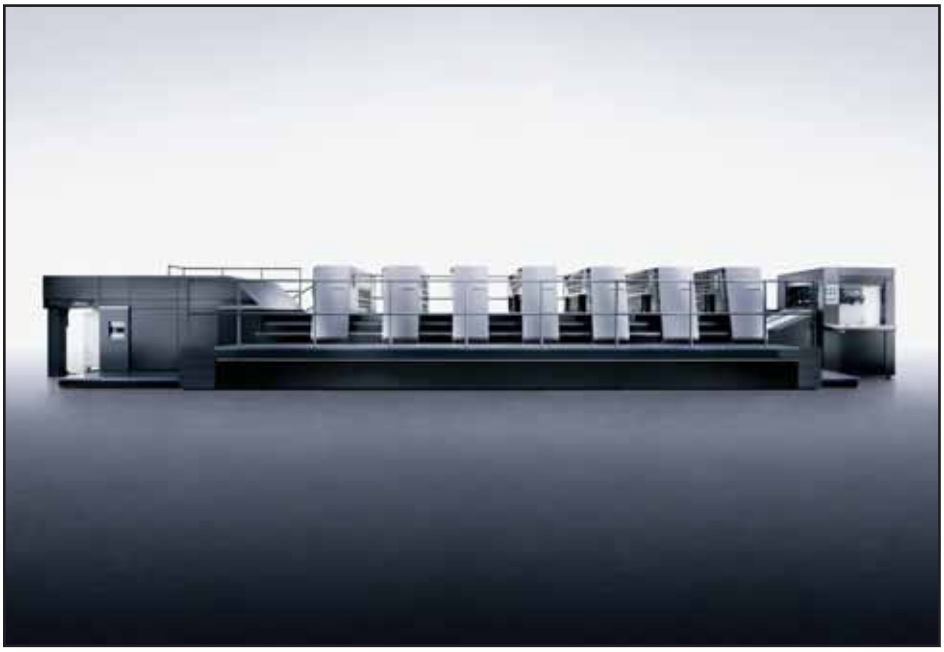
Remember what the good doctor says about vacuum system costs: when you pay for vacuum, you are paying for nothing and the more nothing you want, the more you have to pay. While some systems only require a checkup, many systems are in need of major surgery. Knowing the existing parameters along with future considerations will prepare you well for any upcoming changes and will keep your operating and purchase costs as low as possible.

For more information please contact Dan Bott, Dan Bott Consulting, tel (251) 960 – 1026, email: dan@dbott.com or visit www.danbottconsulting.com

OEM:

HEIDELBERG PRINTING PRESSES

Compressed Air Best Practices spoke with Mr. Steven Arndt from the Engineering Department of Heidelberg USA.



Heidelberg Speedmaster XL 105

What printing presses use the Scrollstar® air compressor and dryer systems?

We have two main product lines offering the Scrollstar® compressed air system, the Speedmaster (SM) Series and the new XL Series. The Speedmaster Series is designed for packaging printers or commercial printers looking for high speeds, high quality, and large-scale production. It prints on normal paper stock for commercial printing purposes. We offer a "CD" model of the Speedmaster Series which can print on board stock.

The new XL Series printing presses can print on both normal and board stocks. The new XL Series has a top speed of 18,000 impressions per hour. This matches the fastest sheet-fed printing presses in the world. Prior to this, Heidelberg's fastest press delivered 15,000 impressions per hour. The specific models using Scrollstar® are to the right.

MODEL	CONFIGURATION
SM74	Optional for 4 & 5 colors, standard starting with 6 color
CD74	Standard for up to 8 colors, Plus II version standard with special presses 8 color and above
SM/CD102 with Preset delivery	Scrollstar® Plus standard
SM/CD102 with PPD delivery	standard up to 8 colors, Plus II version standard with special presses 8 color and above
XL105	standard 2 – 7 colors, Plus II standard 8 colors and above

What is the compressed air being used for on the press?

Compressed air is used both on the press and in peripheral systems. On the press, compressed air engages and disengages many critical function systems listed below. On the peripherals, the same is true. The ink-line dispensing system, for example, uses air to automatically dispense ink from tubes and into the printing units — on an on-demand basis. Air pressure is in the 2-6.5 bar range — depending upon the viscosity of the ink. An in-line varnish, with low viscosity, requires significantly less air pressure. Another example is the ink-move agitators used on printers using UV inks. These types of inks are stiff. A pneumatically powered ink agitator is used to keep ink up against the ink fountain roller and to keep it evenly mixed. The air pressure is normally fixed at 4 bar.

Another example of a peripheral system using compressed air are the coating pumps. Coating pumps are used to circulate an aqueous or UV coating from barrels to the coating tower and back. An example of this is the cover of Compressed Air Best Practices Magazine. Compressed air is used to reposition the flow valves in the coating pumps for presses which have a coating tower. A final example of a peripheral system is our Wash-star system. The Heidelberg Wash-star system is a solvent collection facility (tanks). You do not want electrical components around solvents. We therefore use air to reposition a 8-position pneumatic valve — as well as to control the direction of the solvents. This pneumatic system collects the solvents and rinses out the pans to make sure no debris is left in the pans.

On the press:	*Peripheral systems:*
• Ink rollers	• Inkline ink dispensing system
• Dampening ductor	• Ink-move agitators
• Impression pistons	• Coating pump valves
• Feeder blast and suction air	• Washstar valves
• Vacuum belt air	
• Infeed sheet stops	
• Sheet de-curler	
• Delivery sheet gate	
• Non-stop delivery	
• Modular blanket wash	
• Ink roller wash-up blade	
• Autoplate feature	
• Impression cylinder washer	

Please describe the Scrollstar®

The Scrollstar® uses an Atlas Copco SF4 scroll air compressor to provide oil free, dry air for all pneumatic systems in Heidelberg Speedmaster and XL Series presses. Scrollstar® is powered directly by the press' electrical distribution and is fully integrated into the pneumatic system and electrical controls of the printing press. There are three versions of Scrollstar® available for Heidelberg presses. The three versions are as follows:

1. **Scrollstar® —** consists of an Atlas Copco SF4 compressor modified and specially configured for Heidelberg sheet-fed presses.
2. **Scrollstar® Plus —** consists of the same modified Atlas Copco SF4 compressor mounted in a cabinet. The upper section of the cabinet contains an additional blast-air blower, that is speed controlled, to provide a blanket of air over the delivery-sheet guide plate. The Scrollstar® Plus is used exclusively on SM102 and CD102 presses built after Drupa 2000 with a Preset Delivery.

Heidelberg Scrollstar®

OEM: HEIDELBERG PRINTING PRESSES

Compressed Air Best Practices spoke with Mr. Steven Arndt from the Engineering Department of Heidelberg USA.

3. **Scrollstar® Plus 2 —** consists of the same modified Atlas Copco SF4 compressor mounted in a cabinet. The upper section of the cabinet contains 6 additional reservoir tanks for added capacity during high demand situations. This compressor configuration is standard for special presses where the potential exists for high air demand during specific operations.

Why did you select a scroll technology?

"Compressed air is used to reposition the flow valves in the coating pumps for presses which have a coating tower."

The scroll compressor provides a quiet, nearly maintenance-free source of compressed air. We had three main criteria when we selected the scroll compressor:

1. The scroll is contact-free with few friction points. We saw that the kW/scfm ratio is very good
2. Few pulsations: The scroll provides a very even flow of air to the press. Sheet-fed printing places a dot, on-top of another dot, to achieve a specific color. A press cannot have vibrations due to uneven air pressure. Stable air pressure, with no pulsations, provides smooth and even strokes of all the pneumatic pistons, in the application rollers, which are engaging the impression cylinders.
3. Noise level, with the cabinet, is very quiet at 56 dba

At what pressures does Scrollstar® operate? What air supply (in cfm) is provided?

Scrollstar® cycles between 7.8 bar and 9.8 bar. Maximum pressure is 10 bar (145 psig). The product supplies 9.1 cfm (4.3 l/s) at 7.8 bar and 8.8 cfm (4.15 l/s) at 10 bar.

What type of air treatment does the system provide?

The Scrollstar® air compressor, which has an inlet intake filter, features an integrated refrigerated dryer. The dryer is a standard feature and is not offered as an option. The dryer, like the whole Scrollstar® system, uses the same electrical

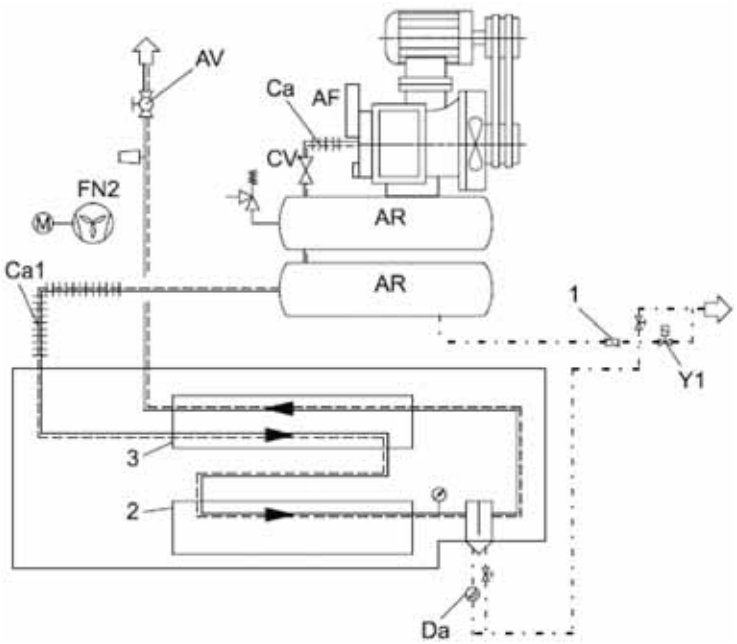
Version	Power required (1) [kW]	Cooling air outlet volume [m³/h] *([cu ft/min])*
ScrollStar	3,7	720 *(425)*
ScrollStar Plus II	3,7	720 *(425)*

Version	Maximum operating pressure [bar] *([psi])*	Volumetric flow [m³/h] *([cu ft/min])*	Noise emission [dB(A)]
ScrollStar	10 *(145)*	15 *(8.83)*	56
ScrollStar Plus II	10 *(145)*	15 *(8.83)*	56

Tab. 58 Maximum pressure, volume flow and noise emission

Supply at 7.8 bar	4.3 l/s
Supply at 10 bar	4.15 l/s

distribution system as the printing press. This runs the refrigeration compressor used to provide cold to the heat exchanger (air-to-refrigerant) where we extract the condensed moisture from the air. A mechanical separator provides a reservoir for the condensate, which is then extracted from the system by a timed electric solenoid valve. We also employ a second heat exchanger (air-to-air), which re-heats the air to eliminate the potential for condensation, along the tube exteriors, in the pneumatic circuits in the printing press. The system achieves a pressure dew point of 2˚ C (35.6˚ F) and will issue a high - dew point temperature warning at 15˚ C (59˚ F).



Thank you, Heidelberg, for your insights.

For more information please contact: Steven J. Arndt
Heidelberg USA, Engineering — Accessories,
Tel: (770) 419-6618, email: Steve.Arndt@heidelberg.com

JOB MARKET

Job Openings in the Compressed Air Industry

Compressed Air Best Practices

JOB MARKET ADVERTISING RATES

MAGAZINE ADS

For smaller classified-type ads use the following rates per column inch:

1x per year: $94.00* per column inch
3x per year: $90.00* (i.e., this is a 6 col. inch, reversed ad)
12x per year: $84.00*

*reversed ads = 1.5x normal price

Add $50.00 to post the job opening on www.airbestpractices.com when you purchase an ad in the magazine

Contact Patricia Smith for 4 color full page, 1/2 page and 1/3 page ad rates

ONLINE ONLY ADS

Each job posting is up on the site for 60 days. Postings can be purchased in bulk quantities per the rates below. The customer has twelve months to put the postings on the site. After twelve months, any unused postings will be charged at the minimum quantity.

Small Qty.	Price Per Posting	Bulk Qty.	Price Per Posting
1	$250	5-9	$185
2	230	10-24	170
3	210	25-49	150
4	195	50+	135

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