Atlas Copco Compressors, LLC

Areas de Oportunidad para Mejorar un Sistema de Aire Comprimido, y Obtener Ahorros de Energia

Sustainable Productivity

Atlas Copco

Areas de Oportunidad para Mejorar un Sistema de Aire Comprimido, y Obtener Ahorros de Energia

- Fugas de Aire
- Usos Inapropiados del Aire Comprimido
- Drenes de Condensado Electronicos
- Compresores de Aire tipo Velocidad Variable

Fugas de Aire en un Sistema de Aire Comprimido

" Las fugas de aire pueden ser una fuente muy grande de consumo de energia en un sistema de aire comprimido, muchas de las veces entre un 20 y 30% del volumen total del aire de los compresores. Una planta tradicional que no mantiene un buen programa de correccion de fugas de aire, utiliza aprox. un 20% del total de la produccion de aire comprimido.

Por otro lado, estas fugas se pueden reducir hasta por debajo de un 10% del total de la produccion de aire comprimido, con un buen programa de correccion de fugas"

- Conectores, conectores rapidos, mangueras y tubos.
- Reguladores de Presion
- Trampas de Condensado y valvulas
- O'rings en mal estado, bridas

Fuga de Aire Atraves de un Orificio

- Algunos ejemplos sobre el costo “Anual Estimado de Fugas de Aire”

  - A 100 PSIG* (aproximadamente)

Orificio de 1/16” diametro	=	7 SCFM	=	$ 732
Orificio de 1/8” de diametro	=	25 SCFM	=	$ 2,933
Orificio de 1/4” de diametro	=	100 SCFM	=	$11,735*
Orificio de 3/8” de diametro	=	230 SCFM	=	$25,426

*** Basado en 8,760 horas de operacion / año @ $0.07 por kWh costo de la energia.**

(A 125 PSIG el factor de fuga incrementa un 20%, para un total de $14,082 / año)

Descarga de Aire Comprimido atraves de un Orificio…

Discharge of Compressed Air Through an Orifice in SCFM

GAUGE PRESSURE AT ORIFICE	1/32	1/16	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1
30	.633	2.53	10.10	40.50	91	162	253	365	496	648
35	.703	2.81	11.30	45.00	101	180	281	405	551	720
40	.774	3.10	12.40	59.60	112	198	310	446	607	793
45	.845	3.38	13.50	54.10	122	216	338	487	662	865
50	.916	3.66	14.70	58.60	132	235	366	528	718	938
60	1.06	4.23	16.90	67.60	152	271	423	609	828	1082
70	1.20	4.79	19.20	76.70	173	307	479	690	939	1227
80	1.34	5.36	21.40	86	193	343	536	771	1050	1371
90	1.48	5.92	23.70	95	213	379	592	853	1161	1516
100	1.62	6.49	26.00	**104**	234	415	649	934	1272	1661
110	1.76	7.05	28.20	113	254	452	705	1016	1383	1806
120	1.91	7.62	30.50	122	274	488	762	1097	1494	1951
125	1.98	7.90	31.60	126	284	506	790	1138	1549	2023
150	2.37	9.45	37.50	150	338	600	910	1315	1789	2338
200	3.10	12.35	49	196	441	784	1225	1764	2401	3136

Based on 100% coefficient of flow. For well-rounded orifices, multiply values by .97
For sharp edge orifices, multiply values by .65
This table represents approximate values

Algunos Usos Inapropiados del Aire Comprimido

- SOPLETEO
  - cuando se utiliza para enfriamiento, secado, limpieza general, limpieza personal y barrido pisos, etc.
- GENERACION DE VACIO
  - Es cuando el aire comprimido es usado en conjunto con un venturi, para generar presion negativa y volumen en masa. Como alternativa se puede utilizar una bomba de vacio. Si el vacio con aire comprimido es necesario, se debera instalar una válvula solenoide en la línea de suministro de aire comprimido, para apagar esta aplicación cuando no sea necesaria.
- ENFRIAMIENTO DE GABINETES
  - Controles programables, cabinas de control en linea, paneles c/relays, sistemas NC/CNC y gabinetes de computadoras, son algunos de los ejemplos tipicos.
- TRANSPORTE DE DILUIDOS
  - es utilizado para transportar sólidos como material en polvo en un formato diluido con aire comprimido. Una alternativa es utilizar blowers, que son equipos de baja presion y alto caudal.
- ATOMIZACION
  - Atomizacion es cuando el aire comprimido es usado para dispersar o entregar liquidos a un proceso en aerosol. Un ejemplo es atomizar combustible hacia dentro de un boiler. La presion fluctuante puede afectar la eficiencia de la combustion. Como alternativa se puede utilizar un blower.
- SPARGING
  - Sparging es el hecho aerear, oxigenar, agitar liquidos con aire comprimido. Como alternativa se puede utilizar un blower.

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Drenes de Condensado

Dren convencional controlado por timer:

- Tiempo de apertura 5 seg. cada 5 minutos (1 min. por hora) = 146 h/año

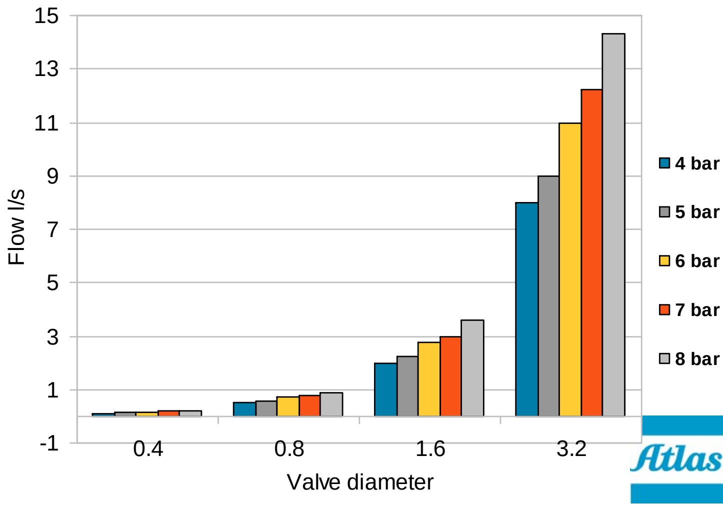
- Diametro tipico del dren 3,2 mm (0.125”) = 12 l/s o 25 cfm
- 7 bar/102 psi presion de trabajo

COSTO TOTAL: 146hrs x 4kW x $0.10 = $58 por dren, por año

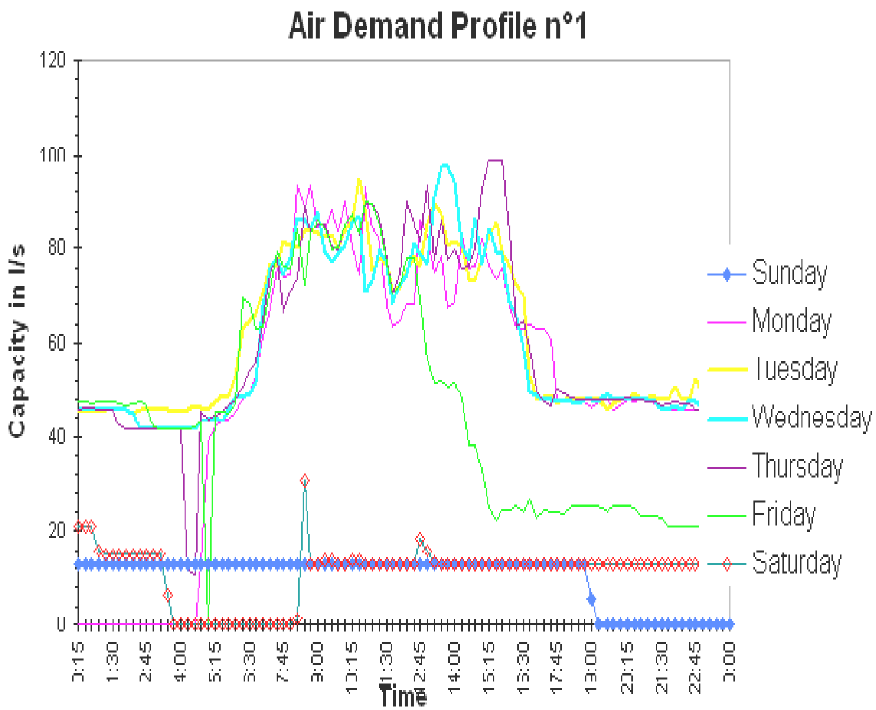
Drenes de Condensado Electronicos:

- Cero gasto de aire comprimido

- $58 de ahorro por año por dren



Ahorros de Energia con Compresores de Velocidad Variable



En el 92 % de todas las instalaciones, la demanda de aire comprimido muestra importantes fluctuaciones.

En el 70 % de todas las instalaciones , el ciclo de carga/descarga es entre el 40...80%

Como consecuencia de esto, existe un potencial muy grande de ahorros de enrgia si se utilizaran compresores de de velocidad variable!

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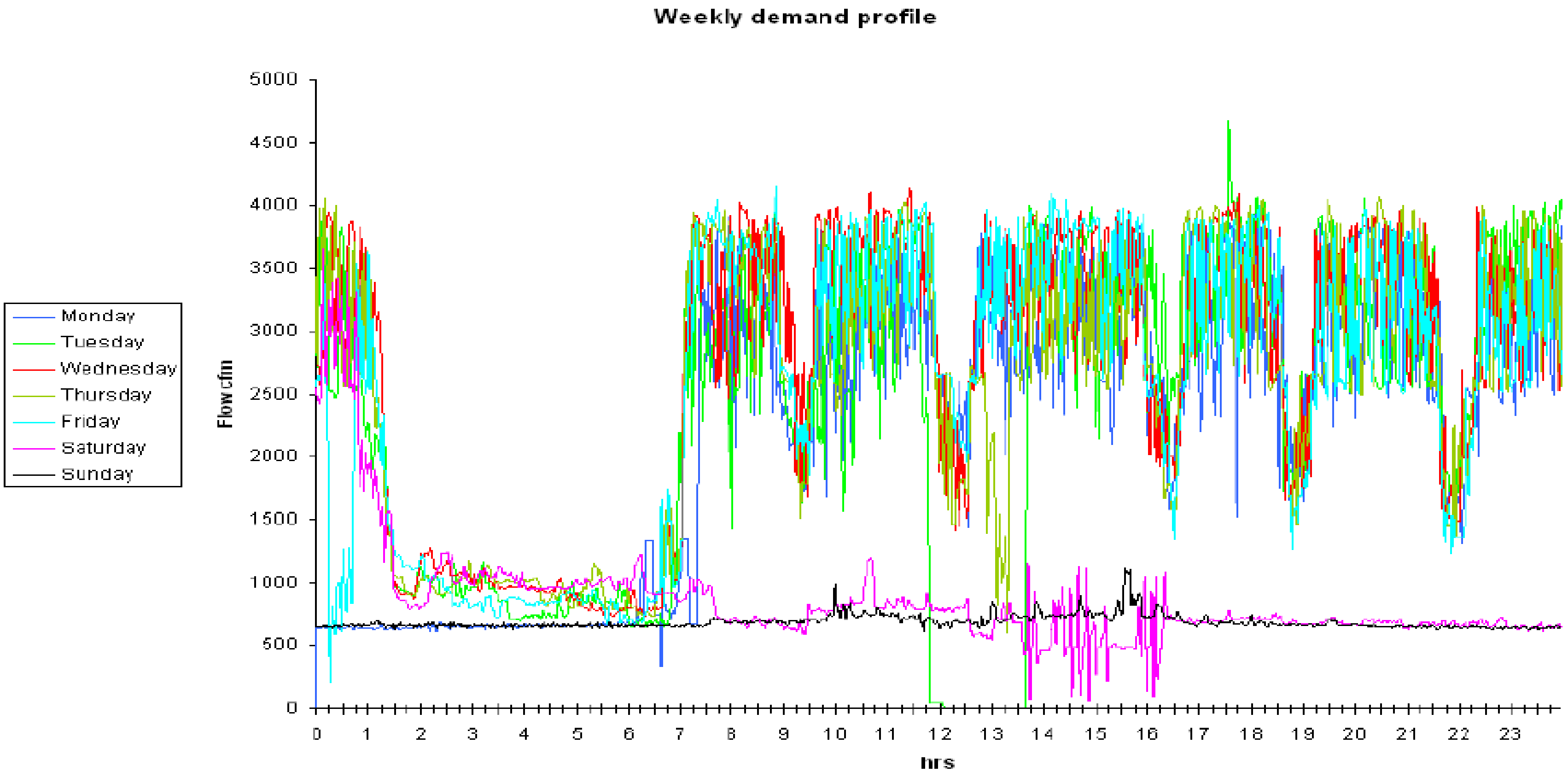
Ejemplo Real de Ahorro de Energia con Compresores de Velocidad Variable



Costo de operacion (energia), instalacion existente:	Dollar	$ 462,121
Costo de loperacion (enegia), instalacion recomendada:	Dollar	$ 362,634
Ahorros con el sistema propuesto:	Dollar	$ 99,488
Costo estimado del sistema propuesto:	Dollar	$ 144,300
Retorno de inversion del sistema recomendado:	Años	1.4

El Aire es Gratis, pero no el Comprimido

We are committed to your superior productivity through interaction and innovation.

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Handout: Inappropriate Uses of Compressed Air

Compressed air is probably the most expensive form of energy available in a plant. Compressed air is also clean, readily-available, and simple-to-use. As a result, compressed air is often chosen for applications in which other energy sources are more economical. Users should always consider more cost-effective forms of power before considering compressed air. Inappropriate uses of compressed air include any application that can be done more effectively or more efficiently by a method other than compressed air. Examples of inappropriate uses of compressed air include:

- Open blowing,
- Sparging,
- Aspirating,
- Atomizing,
- Padding,
- Dilute phase transport,
- Dense phase transport,
- Vacuum generation,
- Personnel cooling,
- Open hand held blowguns or lances,
- Cabinet cooling,
- Vacuum venturis, and
- Diaphragm pumps.

Each is inappropriate use and suggested alternatives are described below.

Open Blowing

Open blowing is using compressed air applied with an open, unregulated tube, hose, or pipe for one of these applications:

- Cooling,
- Bearing cooling,
- Drying,
- Clean-up,
- Draining compressed air lines, and
- Clearing jams on conveyors.

The alternatives to open blowing are vast. Some are listed below:

- Brushes,
- Brooms,
- Duct collection systems,
- Non-air loss auto drains,
- Blowers,
- Blowers with knives,
- Electric fans,
- Electric barrel pumps,
- Mixers, and
- Nozzles.

Sparging

Sparging is aerating, agitating, oxygenating, or percolating liquid with compressed air. This is a particularly inappropriate application as liquid can be wicked into a dry gas increasing the dew point. The lower the dew point of the compressed air the more severe the wicking effect. This can occur with oil, caustics, water rinse materials, etc. Alternatives to sparging include low-pressure blowers and mixers.

Aspirating

Aspirating is using compressed air to induce the flow of another gas with compressed air such as flu gas. An alternative is a low-pressure blower.

Atomizing

Atomizing is where compressed air is used to disperse or deliver a liquid to a process as an aerosol. An example is be atomizing fuel into a boiler. Fluctuating pressure can effect combustion efficiency. An alternative is a low-pressure blower.

Padding

Padding is using compressed air to transport liquids and light solids. Air is dispensed over the material to be moved. The expansion of the air moves the material. The material is usually only moved short distances. An example is unloading tanks or tank cars. Molecular diffusion and wicking are typical problems with padding. An alternative is low to medium pressure blowers.

Dilute Phase Transport

Dilute Phase Transport is used in transporting solids such as powdery material in a diluted format with compressed air. Molecular diffusion and wicking are typical problems with dilute phase transport. An alternative is a low to high-pressure blowers or a low-pressure air compressor designed for 35 psig. The pressure required depends upon the moisture content and size of the material being transported.

Dense Phase Transport

Dense Phase Transport used to transport solids in a batch format. This usually involves weighing a batch in a transport vessel, padding the vessel with compressed air, forcing the batch into a transport line, and moving it in an initial plug with a boost of compressed air at the beginning of the transport pipe. Once the material is moving in a plug, you may fluidize the material in a semi-dense or moderate dilute phase using fluidizers or booster nozzles along the transport path. The material is typically transported to a holding vessel that dispenses it on an as needed basis using pad air from the secondary transport vessel to move it to the use location. A typical application would be the dense phase transport of carbon black. There are typically four compressed air elements to the transport. They are control air for the equipment, pad air for the initial transporter, transport air to move it in the piping, and fluidizers or booster nozzles along the transport piping. Most dense phase manufacturers specify 80-90 psig with one single line supporting the entire process. The control air and booster nozzles typically use pressures in the 60-70 psig range. The actual article psig required for the pad air and the transport air is typically 30-45 psig. Because of the lack of capacitance in most of these applications and the high volume-short cycle transport times, the original equipment manufacturers request 80-90 psig and uses the entire supply system as the storage tank. As this usually negatively impacts the plant air system, separate compressors, filters, and dryers are applied to this process at the elevated pressure.

Alternatives include supporting the control air, pad air, and boosters with regulated plant air plus metered storage and using a two-stage positive displacement blower (28 psig) or single stage compressor (40-50 psig) for the transport air. Another alternative is to use metered storage for both the pad air and transport cycle. This necessitates providing the entire requirement from storage and metered recovery per cycle, with a metering adjustment to refill the vessel just before the next transport cycle. The storage should be sized to displace the required air first for the pad and then for the transport cycles within an allowable pressure drop to terminate the transport cycle pressure at the required article pressure. This will flatten the volumetric load on the system, eliminate any impact on other users, and reduce the peak energy required to support the process.

Vacuum generation

Vacuum generation is those applications where compressed air is used in conjunction with a venturi, eductor, or ejector to generate a negative pressure mass flow. Typical applications are piabs, hold-downs, or 55-gallon drum mounted compressed air vacuum cleaners. This is by far the most inefficient application in industry with less than 4% total efficiency, although for very intermittent use (less than 25% load factor), compressed air can be a reasonably efficient solution. An alternative is a vacuum pump. If a compressed air generated vacuum is required, install a solenoid valve on the compressed air supply line to shut this application off when in is not needed.

Personnel Cooling

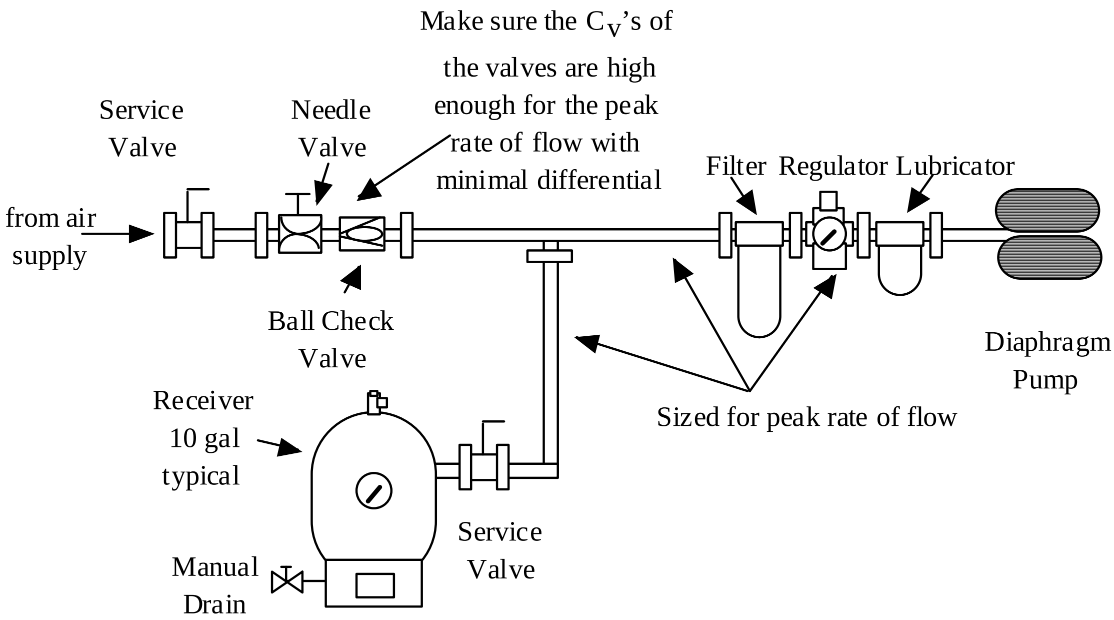
Personnel cooling is operators directing compressed air on themselves to provide ventilation. This is dangerous because it can shoot particulate into the skin. A 1/4" tube blowing air on an operator can consume 15-25 bhp of compressed air. An alternative is fractional horsepower fans of 1/4 bhp or less.

Open Hand Held Blowguns or Lances

Unregulated hand held blowing is not only a violation of most health and safety codes, but is also very dangerous. Hand held blowing guns that conform to all occupational health and safety standards should be used. There are different styles of blowguns that deliver various airflow, velocity, and concentrations. Selecting the proper gun for the application. Pipes installed in the end of hose and unregulated non-approved guns must not be used. Blowguns must have no more than 30-psig discharge nozzle pressure. The nozzle should be constructed to relieve backpressure if the nozzle is plugged or blocked. The blowgun must also have a spring-operated throttle mechanism so it shuts off automatically if it is dropped.

Diaphragm pumps

A common error is to not size diaphragm pumps to the maximum viscosity, highest-pressure required and highest volume. The result is poor performance and an increased supply pressure requirement. Diaphragm pumps are commonly found installed without regulators and speed control valves. Those diaphragm pumps that are installed with regulators are found with the regulators adjusted higher than necessary. The higher than necessary setting of the regulator increases the demand on the compressed air system and increases the compressed air system operating costs. With higher than necessary pressure settings, the amount of compressed air admitted into the diaphragm chamber is increased above that which is actually required to move the product. The amount of product actually transferred remains the same, but the amount of air required increases with the increased pressure. Diaphragm pumps must have generously sized diaphragm regulators installed in the supply line and generously sized supply piping or hose. The regulator must be adjusted to equal the maximum head that the pump is required to provide. A flow control valve installed up stream of the regulator will accomplish the required speed control. Operating the diaphragm pump without a speed control increases the rate of compressed air consumption by increasing the strokes per minute of the diaphragm pump. The speed control should be adjusted to pump product in the maximum allowable time. As a general rule the regulator and flow control valve are not included with the standard pump package. Also, when the pump has no liquid or slurry to pump it will rapid cycle, wearing out the diaphragm. The pump controls must be configured to turn the pump off when there is nothing to pump. The following drawing shows the proper installation of a diaphragm pump.



The air operated diaphragm pump is designed to pump a wide variety of liquids. The low initial cost of the pump in conjunction with the ease of installation makes this an "universal pump". While the convenience and safety of these pumps is acknowledged and makes them an obvious choice for a chemical facility, they are extremely expensive to operate. It requires 7 to 9 times the energy to operate a pump with compressed air as it does to operate an electric pump of the same capability. The pumps are usually installed with a combination filter-regulator-lubricator (FRL). From the (FRL) a piece of hose is then connected to the pump. If the operator requires more flow the regulator is adjusted to deliver more pressure. This is an incorrect assumption. When the regulator is completely open -- there is no regulation. Do not confuse pressure with flow. One way to reduce the operating costs is to install the pump as shown above. The regulator setting is directly proportional to the discharge pressure of the pump. If the pump is required to provide 100 gallons per minute at a total dynamic head of 115 feet, the corresponding regulator setting will be: 115/2.31 = 50 psig. The needle valve is used to control the rate of flow. Adjust the pressure at the regulator and then set the needle valve to a corresponding rate of flow. The small receiver is used to store air and the check valve insures that the stored air will be available for this dedicated application only.

Vacuum venturis

When compressed air is forced through a conical nozzle, its velocity increases and a decrease in pressure occurs. This principle, discovered by 18th century physicist G. B.

Venturi, can be used to generate vacuum without a single moving part. Vacuum generators are used throughout industry. Some applications for vacuum generators are listed below:

- Shop Vacuums,
- Drum Pumps,
- Palletizers,
- Depalletizers,
- Box makers,
- Packaging Equipment, and
- Automatic Die cutting Equipment.

Vacuum generators are selected for safety, ease of installation, physical size of the generator, the fact that no electricity is required, and low first cost. Vacuum generators are not normally selected because they are more economical to operate. As a rule of thumb, in a base load situation, if the vacuum generator is operating less than 25% of the time, it will be more economical to operate than a dedicated vacuum pump. Otherwise, vacuum generators are, in general, less effective in pulling a vacuum and cost as much as five times more to operate than a dedicated vacuum pump. Using vacuum generators to generate the vacuum for shop vacuums and drum pumps, which are typically peak load applications, could cause another compressor to turn and stay on until it times out. Having to operate a second compressor because of the added demand associated with a vacuum generator eliminates any apparent savings associated with a vacuum generator, even if it operates only once a day for a short period of time. In the cases where vacuum generators should be more economical to operate they are installed without an automatic shutoff solenoid or the automatic shutoff solenoid is wired into the stop circuit and not the run circuit. When the machine stops the vacuum generator or the control valve exhausts compressed air because of the position at which the equipment stops. Again, the first cost may be cheaper, but the operating cost is four to five times greater. A dedicated vacuum pump, or the use of central vacuum system will provide more suction force at a fraction of the cost of vacuum produced by compressed air. In this case, it is significantly more cost effective to provide a system that is designed into the machine from the beginning than it is to try to retrofit a piece of equipment. This can accomplished by being proactive at the time the machine specifications are prepared and the purchase orders issued. Vacuum generators must be applied properly and only after taking life cycle costs into consideration. Even then, if there is remaining capacity on a central vacuum system, the additional vacuum requirements may be added to it for such a small additional energy cost that there is no possible economical justification for a vacuum generator.

Cabinet Cooling

Cabinet cooling should not be confused with panel purging. The following are typical applications where cabinet cooling is found:

- Programmable controllers,
- Line control cabinets,
- Motor control centers,
- Relay panels,
- NC/CNC systems,
- Modular control centers, and
- Computer cabinets.

When first cost is the driving factor, open tubes, air bars (copper tube with holes drilled long the length of the tube) and vortex tube coolers are used to cool cabinets. When life cycle costs are taken into consideration these choices prove to be expensive. It is not uncommon to find an open tube or air bar consuming 7-1/2 hp of compressed air to cool a cabinet. Vortex tube coolers can be an improvement over open tubes and air bars because they are often cycled with a thermostat control, which reduces air consumption. However, air to air, air to water and refrigerated cabinet cooler are available that only use 1/3 hp to accomplish the same task.

Other Inappropriate Uses

Other improper uses of compressed air are unregulated end-uses and supply air to abandoned equipment, both of which are described below.

Unregulated End-Uses

A pressure regulator is used to limit maximum end-of-use pressure and is placed in the distribution system just prior to the tool. If a tool operates without a regulator, it uses full system pressure. This results in increased system air demand and energy use, since the tool is using air at this higher pressure. High pressure levels can also increase equipment wear, resulting in higher maintenance costs and shorter tool life.

Abandoned Equipment

Many plants undergo numerous equipment configuration changes over time. In some cases, plant equipment is no longer used. Air flow to this unused equipment should be stopped, preferably as far back in the distribution system as possible without affecting operating equipment.

Using Compressed Air

As a general rule, compressed air should only be used if safety enhancements, significant productivity gains, or labor reductions will result. Typical overall efficiency is 10-15%. If compressed air is used for an application, the amount of air used should be of minimum quantity and pressure and used for the shortest possible duration of time. Compressed air use should also be constantly monitored and re-evaluated.

Leak Load

Leak load should be estimated periodically. On a well-maintained system, leakage should be less than 10% of full system flow. Tests should be undertaken quarterly as part of a leak detection and repair program. A simple methodology estimating leak load is described below.

Estimating Leak Load for Systems with Load/Unload Controls

For compressors that use load/unload controls, there is an easy way to roughly estimate the amount of leakage in the system. This method involves starting the compressor when there are no demands on the system and bringing the system to normal operating pressure. All air-operated end-use equipment should have the supply valves and/or solenoids open with the equipment electronics off to account for internal leaks. Open blowing applications should be isolated through shutoff valves. A number of measurements are taken to determine the average time it takes to load and unload the compressor.

The compressor will load and unload because the air leaks will require the compressor to cycle on as the pressure drops from air escaping through the leaks. Total leakage (percentage) can be calculated as follows:

Leakage (%) = [(T x 100)/(T+t)]

where: T = loaded time (seconds)
t = unloaded time (seconds)

Leakage will be expressed in terms of the percentage of compressor capacity lost. The percentage lost to leakage should be less than 10% in a well-maintained system. Poorly maintained systems can have losses as high as 20-40% of air capacity and power.

Estimating Leak Load

Directions: *Using the data provided below, please estimate the percentage of compressor capacity lost to leaks for the following system. Measurements were taken using the method described previously that involves starting the compressor when there are no demands on the system. A number of measurements were taken of determine the time it takes to load and unload the compressor. The compressor will load and unload because the air leaks will require the compressor to cycle on as the pressure drops from air escaping through the leaks. The following table shows the measurements that were taken:*

Time loaded	2 min 10 sec	2 min 5 sec	2 min 15 sec	2 min 10 sec
Time unloaded	5 min 20 sec	5 min 10 sec	5 min 15 sec	5 min 5 sec

Use the following equation:

Total leakage (percentage) can be calculated as follows:

Leakage (%) = [(T x 100)/(T+t)]

where: T = total loaded time (seconds)
t = total unloaded time (seconds)

Calculations:

Leak Load for Systems with Other Controls

Leakage can be estimated in systems with other control strategies if there is a pressure gauge downstream of the receiver. This method requires an estimate of total system volume, including any downstream secondary air receivers, air mains, and piping (V, in cubic feet). The system is then started and brought to the normal operating pressure (P_1) and the compressor is turned off.

Measurements should then be taken of the time (T) it takes for the system to drop to a lower pressure (P_2), which should be a point equal to about one-half the operating pressure. Leakage can be calculated as follows:

Leakage (cfm free air) = $[V \times (P_1 - P_2)/(T \times 14.7)] \times 1.25$

where: V is in cubic feet
P_1 and P_2 are in psig
T is in minutes

The 1.25 multiplier corrects leakage to normal system pressure, allowing for reduced leakage with falling system pressure to 50% of the initial reading. Again, leakage of greater than 10% indicates that the system can likely be improved. These tests should be carried out once a month as part of a regular leak detection and repair program.

When to Baseline

Data should be collected by measuring: (1) under normal operating conditions, (2) other significant conditions (different production levels, seasonal variations, etc.), and (3) after changes to system operation. For maintenance purposes, testing should also be performed at full-load rated conditions. In addition to power and pressure measurements, flow and temperature data can be vital.

To ensure that performance actually improves and to re-establish the baseline, be sure to re-measure after performance enhancements are made. Remember to always correlate to production levels. The expectation is that energy use will go down, assuming of course that production did not rise with a corresponding increase in the compressed air loads. If production did not rise, and the pressure went up, adjust controls appropriately.

For more detailed baselining of your compressed air system, consult with your compressed air system specialist or contact an instrumentation expert if you are going to invest money in measuring equipment.