

Many manufacturing plants employ compressed air systems in one capacity or another, and, for the most part, these systems provide similar output. While all compressed air might be the same, the engineering of that air is not. The needs of a petrochemical plant are quite different from those of an automobile manufacturing plant. Application-specific engineered air addresses those different needs.

Engineered air describes compressed air tailored to meet specific industry needs—100 percent oil-free, particulate filtered, and reliable. It goes beyond the simple output of compressed air at a specified pressure pounds per square inch. Engineered air provides the right type of air for the right application. A good example of this concept put into practice is work done at a North American ethylene plant.

Customized configuration

Ethylene processing plants use compressed air systems in a number of ways. Air powers pneumatic tools used in general maintenance, and it is employed for other plant operations, such as blow-down and dry-out. Blow-down uses compressed air to clear pipes and vessels of debris and blockage, while dry-out uses compressed air to remove moisture from pipes prior to ethylene processing.

Ethylene plants also use compressed air combined with steam to remove the coke build-up in the cracking furnaces. Scheduled periodic removal of this solid build-up allows the overall ethylene processing operations to run more efficiently.

Recently, a world-scale North American ethylene plant was undergoing a major expansion project that required a specially designed compressor system to handle the additional requirements. With this major expansion underway, it was vital that this new system provide absolutely reliable engineered air.

In order to ensure the most dependable compressed air source possible, the compressor package included a custom-designed compressor with a high-tech control system, meeting requirements for durability and reliability, accessibility and maintainability, and high level of control ([Fig. 1](#)).

Compressor Configuration Supports Maintenance and Reliability Needs

Written by MT Staff
Friday, 01 July 2005 00:00

The base design for this customized system also had to meet stringent API 672 standards for packaged, integrally geared centrifugal air compressors for petroleum, chemical, and gas industry services.

Durability and reliability

A baseload ethylene plant is the lynchpin of any petrochemical manufacturing complex. Ethylene is the building block and feedstock for all the downstream feeder plants. A baseload plant is expected to run continuously, maximizing efficiencies and minimizing costs. Downstream plants totally rely on the plant to provide a continuous supply of feedstock—in this case ethylene.

This is one of the key reasons the compressor system had to be designed to be extremely durable. To ensure this durability, the customized air compressor features self-adjusting tilting pad journal bearings that can adapt to load changes, providing stability, as well as double-acting thrust bearings to accommodate all load conditions. In addition, the system features stainless steel impellers, resistant to corrosion and erosion.

All of the compressor systems had to run reliably also. An unplanned shutdown would have an adverse impact on the entire petrochemical complex manufacturing capabilities. The compressor was built with a redundant oil system, helping eliminate the possibility of system failure, allowing the ethylene plant to meet its availability targets ([Fig. 2](#)).

Within an air compressor, the oil pump is the heart of the lubrication system; it is what keeps the machine running smoothly. If the pump breaks down, the machine comes to a grinding halt. To avoid this, we included not one, but two full capacity, full pressure pumps in the design—one motor-driven auxiliary and the other a shaft-driven main.

During regular operations, the shaft-driven main is operating, while the motor-driven auxiliary is on perpetual standby for emergency situations, providing additional overall package protection. Without this redundant system, in the event of an oil system malfunction, the entire compressor system needs to be shut down. The redundant system eliminates downtime and provides a reliable source of engineered air.

Accessibility and maintainability

Compressor Configuration Supports Maintenance and Reliability Needs

Written by MT Staff
Friday, 01 July 2005 00:00

In order to keep the plant's compressor system running efficiently and reliably, it was essential to design the unit for maximum accessibility and maintainability. While requiring additional time and attention from plant engineers, scheduled cleaning and maintenance are a sound investment. As with all other plant operating systems, compressed air systems that have a planned maintenance program are less likely to have unexpected breakdowns. Simply put, less downtime allows for more production. In addition, consistent cleaning and maintenance practices help keep wear and tear to a minimum. This ultimately saves money in replacement parts.

The intercooler design is an example of the ease-of-maintenance design philosophy. Within a compressor intercooler, both U-shaped and straight intercooler tubes are industry practice. However, straight tubes are easier to clean than those with a U-bend design. An engineer can simply remove the water piping, unbolt the water box, and rod the tubes in place. Rodding is not possible with U-bend tubes found in some compressors.

In addition, intercooler tubes with a water-in-tube design are easier to clean and maintain than those with an air-in-tube design that require wire brush or chemical bath cleaning. This compressor features straight intercooler tubes with water-in-tube design for this very reason. The longer it takes to clean the intercooler, the longer engineered airflow is down.

Another example of important compressor components that benefit from diligent inspection and maintenance are journal and thrust bearings. These bearings help provide a stable and near frictionless environment to support and guide the rotating shaft. Properly installed and maintained, these bearings can last for extended periods of time. However, regularly scheduled inspections and maintenance keep them running reliably. The ethylene plant's compressor features horizontally split bearings, which are easy to maintain, inspect, and replace. An engineer simply removes the top half of the gear case to service. No other disassembly is required.

Interchangeability of parts is another factor taken into consideration when designing the ethylene plant's compressor system. Interchangeability contributes heavily to ease of maintenance. Interchangeable parts save time and money. Multiple stage air compressors use a bull gear and pinion system to power the impellers at each stage of air compression. The quality of the bull gears used directly determines whether they are interchangeable. The customized compressor uses high precision AGMA Quality 13 gears.

Compressor Configuration Supports Maintenance and Reliability Needs

Written by MT Staff
Friday, 01 July 2005 00:00

The American Gear Manufacturers Association (AGMA) provides established gear quality ratings, ranging from 3-15. These numbers signify the quality levels, or standards, developed by the AGMA that differ per application. AGMA Quality Level 13 gears, otherwise known as aircraft-quality gearing, are generally regarded as high-precision gears. They provide lower noise levels and, under normal operating conditions, have a longer performance life. More importantly, though, they provide interchangeability.

If the gear is AGMA Quality Level 12 or below and any one of the three pieces needs to be replaced, all three pieces—one gear and two pinions—need to be replaced. However, with Level 13 gears, rather than remove and replace all three pieces, the plant engineer needs to swap out only the component in question. This saves time and money in unnecessary replacement parts.

High level of control

The operation of multiple compressors feeding into a single plant air system needs to be coordinated, monitored, and controlled in order to accommodate various applications. An initial investment in innovative monitoring technology can ultimately pay for itself.

With that in mind, the customized compressor can be accommodated with a PLC-based automatic sequencer, which permits up to eight compressor units to communicate with one another and operate in sequence according to a programmed schedule. High-tech PLC-based automatic sequencers are capable of monitoring and matching compressor supply to demand. For example, they can select which compressors to use at any given time, shutting down those compressors not necessary to plant operations, even choosing back-up units if needed. By turning multiple compressors into one, an automatic sequencer can ensure stable system pressure, which allows the entire operation to run as efficiently as possible, saving both time and money.

In addition, a PLC-based modular control system allows for remote monitoring and diagnostic checks on the compressed air systems, helping to predict and prevent any systems malfunctions that could result in stoppage of engineered air. This can save money on repairs and replacements, as well as lost production time.

The most cost-effective systems, like the FS-Elliott Regulus control system, provide state-of-the-art technology and ease-of-use. The ideal control system should feature an easy-to-operate touch screen with a graphic color display. These features allow operators to

Compressor Configuration Supports Maintenance and Reliability Needs

Written by MT Staff
Friday, 01 July 2005 00:00

view easy-to-understand graphics while monitoring the plant engineered air systems. An advanced system also provides easy adjustment of set-points and control mode changes using the touch screen. These flexible controls are fully adaptive, changing to meet the plant's application-specific needs.

The control system also stores and logs operating data used for trend monitoring and preventive maintenance. This feature permits engineers to monitor and predict trends in their engineered air systems and act before problems arise. Extended monitoring of vital parameters is important for equipment protection, saving money in maintenance and avoiding repairs.

Ethylene plants are extremely energy conscious. A systems operation closer to surge lines saves power and minimizes wasteful unloading, while lower set-points and precise control minimizes energy usage. The advanced control system is able to make more efficient use of the ethylene plant's manpower. With easy-to-use remote control and monitoring capabilities, this system can reduce the tasks of the ethylene plant operators, allowing them to shift focus to other plant responsibilities.

An engineered air system is created with specific plant applications in mind, to increase reliability and efficiency. The custom-engineered compressor we installed at the ethylene plant was designed with the following key points in mind:

- Durability and reliability—A robust engineered design combined with key system redundancies.
- Accessibility and maintainability—Moving parts designed with ease of access and maintenance in mind.
- High level of control—High-tech control systems provide for efficient operation and allow plant operations to predict and prevent possible problems.

Information supplied by [Addison W. Kelley](#) , vice president global customer support, [FS-Elliott Co., LLC](#) ;
(626) 855-7515

Typical Compressor Operation

Compressor Configuration Supports Maintenance and Reliability Needs

Written by MT Staff
Friday, 01 July 2005 00:00

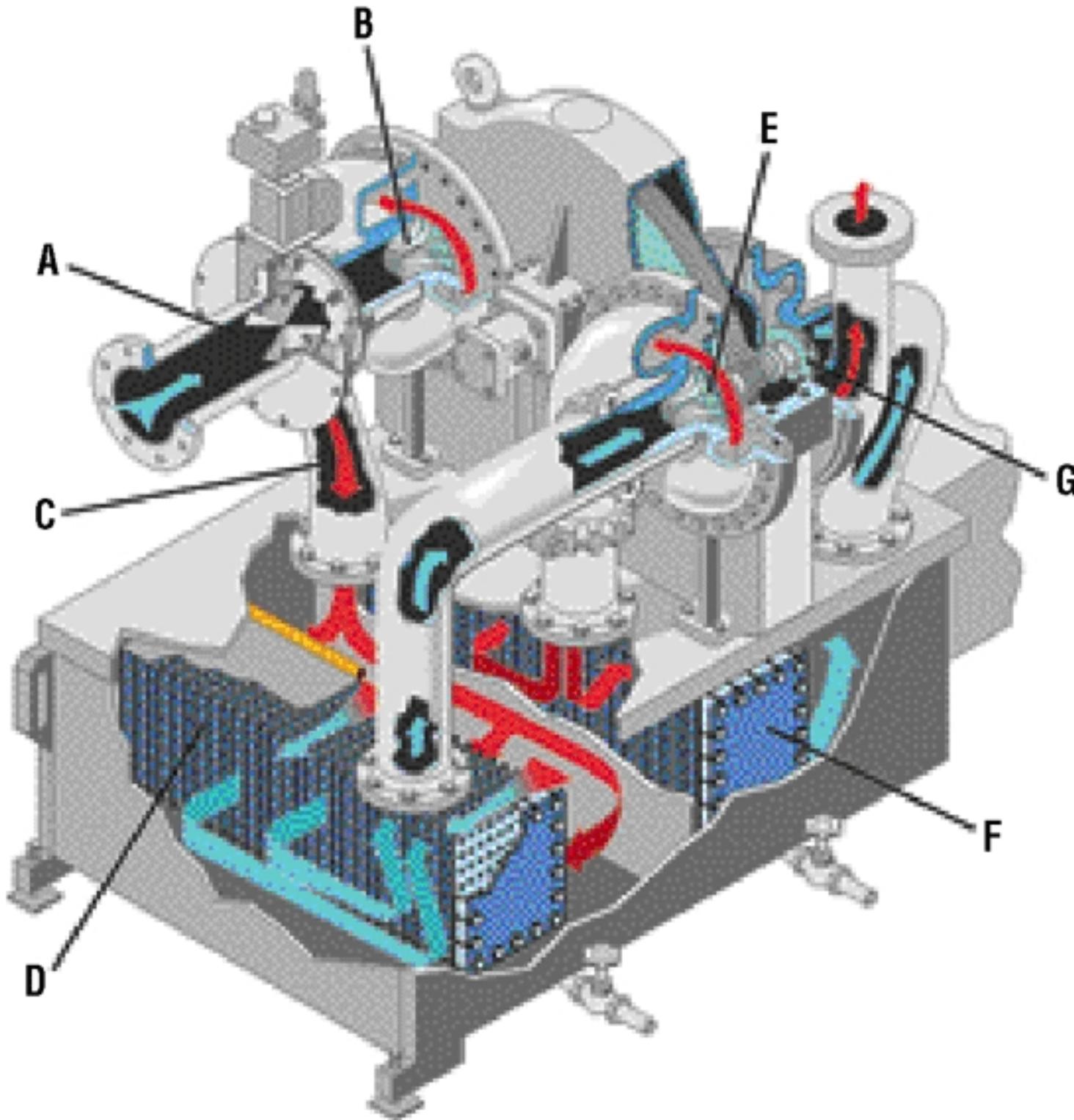


Fig. 1. Ambient air enters the first stage through the inlet control device (A) where it is accelerated by the

[back to text](#)

Compressor Oil system

Compressor Configuration Supports Maintenance and Reliability Needs

Written by MT Staff
Friday, 01 July 2005 00:00

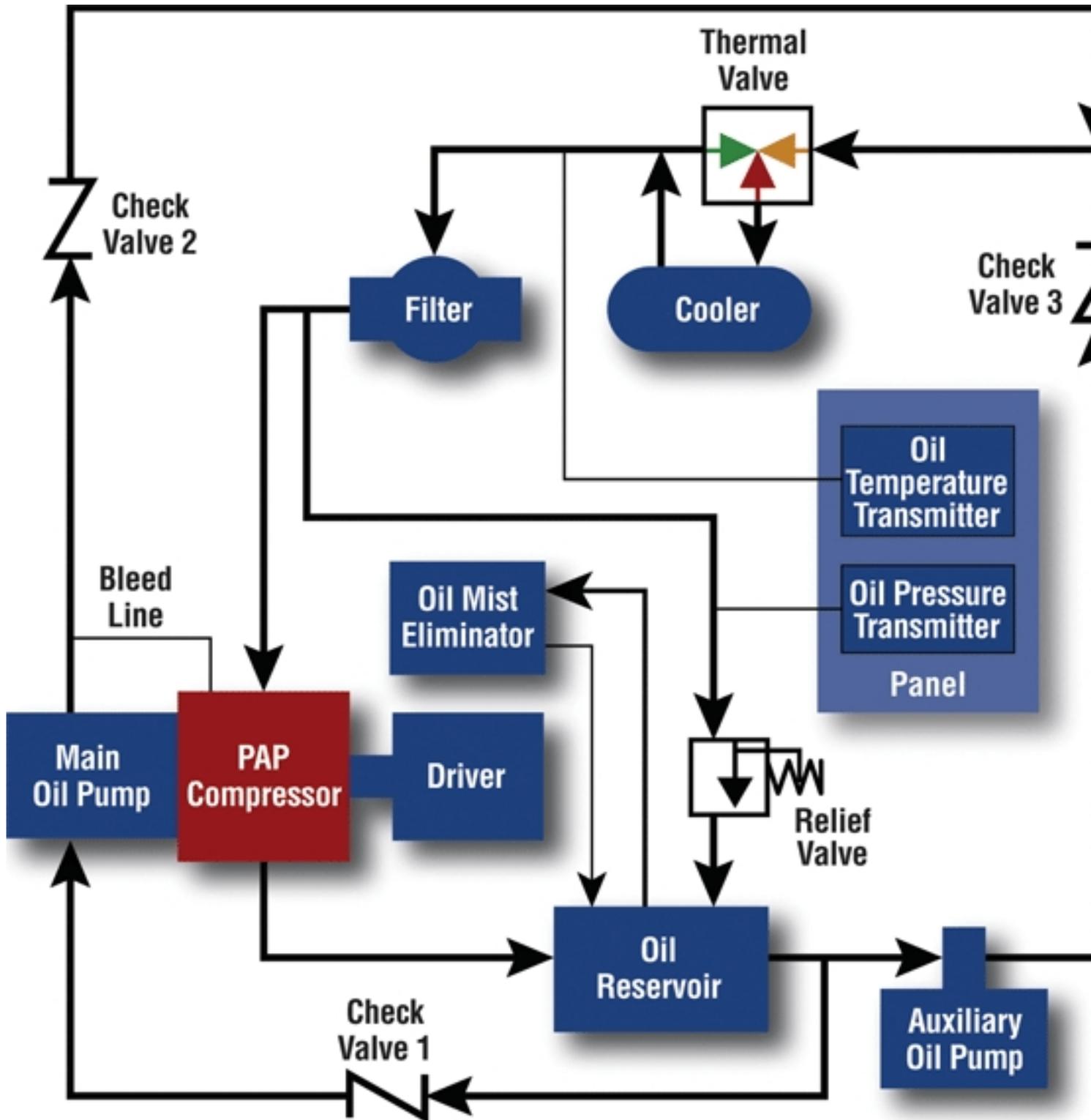


Fig. 2. The compressor was designed with a redundant oil system. During regular operations, the shaft-