WHITE PAPER

Gardner Denver

ENGINEERING PROJECT SOLUTIONS

API Standards for Air Compressors

A Guide for purchasers, EPC companies and end-users

Introduction

Manufacturers of compressed air systems and nitrogen packages must ensure that their products meet the enhanced requirements of applicable regulations and standards defined by legislation in addition to optional recommendations.

A thorough understanding of API standards and how their relations with air compressors is therefore indispensable when choosing the compressed air supplier to achieve the customer air technical requirements. The API (American Petroleum Institute) has been leading the effort to establish and maintain quality and performance standards for the oil and gas industry. The API sets three such standards, API 618, 619, API 681 & API 672. Which standards you should apply will depend on the specific application and the equipment you will rely on to do so.

Standards enhance the safety of industry operations, assure quality, help keep costs down, reduce waste, and minimize confusion. They help speed acceptance, bring products to market quicker, and avoid having to reinvent the wheel every time a product is manufactured.

Sometimes these standards become binding when they come into force through legislation. For instance, these standards can be quoted in contracts of complex projects including EPC contractors (Engineering Procurement and Construction). In that cases these standards are binding if they are related to safety for people and property. In other cases, they are optional if they are used to facilitate working with specifications, quality, documentation, manufacturing drawings, etc.

This white paper outlines:

- API (American Petroleum Institute) explanation.
- The relation between types Compressors and API Standards
- Explanation of API 618, API 619, API 681 and API 672
- Typical Industries served with API Compressors
- Customised air compressors for API Standards
- Simple Guidelines for equipment purchasers, EPC companies and end-users

API Institute

The goal of the API (American Petroleum Institute) is establishing and maintaining standards for the worldwide oil and natural gas industry. Their work helps the industry invent and manufacture superior products consistently, provide critical services, ensure fairness in the marketplace for businesses and consumers alike, and promotes the acceptance of products and practices by industry and governments globally.

Since 1919, the API (American Petroleum Institute) has been leading the effort to establish and maintain quality and performance standards for the oil and gas industry. API has developed more than 700 standards to enhance operational safety, environmental protection and sustainability across the industry, especially through these standards being adopted globally. API standards have provided a consistent means for companies to advance and evaluate technical knowledge and skills based on individual certification programs.

API standards are developed under API's American National Standards Institute accredited process, ensuring that the API standards are recognized not only for their technical rigor but also their third-party accreditation which facilitates acceptance by state, federal, and increasingly international regulators.

Benefits of Utilizing API Standards

By understanding the value of participating in API industry standardization efforts, not only does the industry as a whole benefit, but your organization will receive tangible benefits, too. There are very important advantages to using API standards. Here is just some of the most important ones:

End-User Operational Safety
Operators can minimize hazards to their safety through the use of equipment designed and built to API specifications and recommended practices. API standards add value to the equipment or materials by reducing the operator's risks.

Production Reliability
API standards for the industry also lead to greater reliability. This approach allows companies to leverage their engineering resources by providing technical input for documents that can be regarded as best practices and true industry standards.

Operational
API standards provide a clear structure to operating processes, with an emphasis on continual improvement of working systems. This new working implementation process is an investment that leads to better methods, reduction of risks and better management control.

Environmental Safety
Nowadays eliminating potential damage to any ecosystem and possible safety hazards is a top priority. Using API standards is not only critical to the success of a project, but also to the environment and the public.success but also critical to the environment and public.

API Standards for Air Compressors

There are a wide variety of API Standards that may be included in contractual agreements to specify and control the quality of air compressors for the oil & gas, petrochemical, chemical and power generation industries. It is necessary to be familiar with the codes and standards related to compressors that can be specified in the contract. In the following sections, those standards are enumerated and explained.

Types Compressors and API Standards

- COMPRESSORS TYPES
  - POSITIVE DISPLACEMENT
    - RECIPROCATING API 618
      - SINGLE ACTING API 618
      - DOUBLE ACTING API 618
    - DIAPHRAGM API 618
    - ROTARY API 619
      - LOBE API 619
      - SCROLL API 619
      - VANE API 619
      - LIQUID RING API 681
    - SCREW API 619
  - DYNAMIC
    - AXIAL API 617
    - CENTRIFUGAL API 672

CompAir Compressor, Dryer and N2 Generation (PSA type) Packages

API 618, API 619, API 681 and API 672. Key in EPC Contracts

API 618, 619, API 681 and API 672 are effective tools to guide the specification, manufacturing, and quality control of rotary, liquid ring and centrifugal air compressors. These APIS can be encounterd frecuently in complex and EPC projects that need engineered air compressed packages.

Air Compressors Technology	API Standards
Reciprocating Compressors	**API 618** Covers the minimum requirements for reciprocating compressors and their drivers used in petroleum, chemical, and gas industry services for handling process air or gas with either lubricated or nonlubricated cylinders. Reciprocating compressors covered by this standard are of low to moderate speed and in critical services. Also covered are related lubricating systems, controls, instrumentation, intercoolers, aftercoolers, pulsation suppression devices, and other auxiliary equipment.
Rotary Compressors	**API 619** Describes requirements for dry and oil-flooded, helical-lobe rotary compressors used for vacuum or pressure or both in petroleum, petrochemical, and gas industry services. It is intended for compressors that are in special-purpose applications. It is not applicable to general-purpose air compressors, liquid-ring compressors, or vane-type compressors. This edition of Std 619 is the identical national adoption of ISO 10440-1:2007, petroleum, petrochemical and natural gas industries - Rotary-type positive displacement compressors: Part 1: Process Compressors Part 2: Packaged Air compressors (oil-free)
Liquid Ring Compressors	**API 681** This standard covers the minimum requirements for liquid ring vacuum pump and compressor systems for service in the petroleum, chemical, and gas industries. This includes both vacuum pump and compressor design and system design. The design of the system is critical to the successful operation of the liquid ring vacuum pump or compressor. Close attention must be paid not only to the design of the ring liquid system but also to how it is integrated into the user's process. Although this standard covers minimum requirements appropriate for petroleum refinery service, purchasers may wish to consider pumps, compressors, and systems that do not meet all the requirements of this standard, based on specific nonflammable, nontoxic service conditions.
Centrifugal Air Compressors	**API 672** This standard covers the minimum requirements for constant-speed, packaged, general purpose, integrally-geared centrifugal air compressors, including their accessories for use in the petroleum, chemical, and gas industry services. This standard is not applicable to machines that develop a pressure rise of less than 0.35 bar (5.0 psi) above atmospheric pressure, which are classed as fans or blowers.

Typical Industries served with API compressors

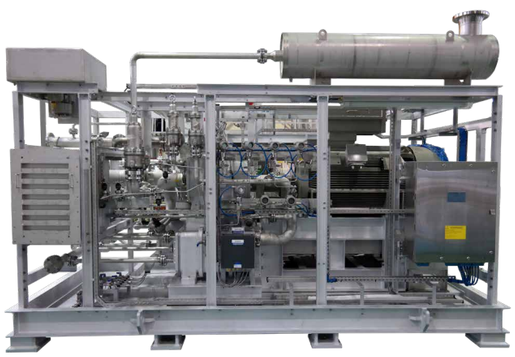
Through API standards, the American Petroleum Institute provides effective tools to guide the specification, manufacturing, and quality control of air compressors used within a variety of industries and applications. The industry more important is Oil & Gas but other like chemical & petrochemical, power generation and fertilizer use these standards to ensure that the products are manufactured committing the best practices.

- **Onshore**
- **Offshore**
- **Chemical & Petrochemical**
- **Power Generation**
- **Fertilizer**

Customised Air Compressors for API Standards

For compressors manufacture API Standards mean a way to be recognized for product quality. Also, it is a way to demonstrate their capabilities to manufacture products that meet API specifications.

Thanks for API and other international quality standards the compressors suppliers have implemented a management system that provides assurances that processes have been implemented to provide consistent, conforming products. The compressors suppliers that are able to provide customized engineered packages, are able to identify and address customer requirements, product issues and face the most demanding technical specifications.



Gardner Denver centrifugal compressor

Simple guidelines for equipment purchasers, EPC companies and end-users

When evaluating compressed air packages, you can best serve the customer specifications by emphasizing the following criteria:

Analysis of specification
Typical project documents include, but are not limited to, contractual agreements (purchase orders and/or subcontracts), source ITP, project specifications, engineering or fabrication drawings, data sheets, applicable codes, references, or standards.

Study API specifications and be sure that the compressor manufacturers have verification that the products meet the requirements of the API specifications and standards.

It is also very important to pay special attention to project description and the environmental conditions. Site altitude, ambient temperature, typical weather or humidity among other things, have a direct impact on machine selection and the technical requirements.

Quality Standards
In general, design, manufacturing and testing methods of plants have to conform to different codes and standards. A thorough understanding not only of API standards but also other international standars programs of compressed air quality and testing standards is therefore indispensable when designing your system to achieve the purity levels your application requires.

The international standards you should apply will depend on the specific contaminants the client needs to remove and the purification equipment you will rely on to do so. In addition, you should take into account the local / international regulations for manufacturing, materials, etc.

Here you can find other important quality standards:

Other International Standards	
ASME (American Society of Mechanical Engineers)	Important in tanks receivers
ISO (International Organization for Standardization)	Important to evaluate compressed Air quality
ATEX directive - European regulatory framework	For the manufacture, installation, and use of equipment and protective systems intended for use in potentially explosive atmospheres
IECEX Certificate	Facilitate international trade in equipment and services for use in explosive atmospheres, while maintaining the required level of safety

Engineered Air Compressors Packages
The best option to address API customer requirements is to choose a manufacturer that is able to provide engineered air compressors packages. It means that the compressors packages are custom designed and engineered by the supplier to perform client and/or EPC project-specific function.

The importance of project management
A thorough understanding of the project management process of compressed air in EPC contracts or complex projects is indispensable when EPC contractors or engineering companies are awarded contracts from important end-users for engineering, procurement, and construction management services.

As mentioned, engineered compressors packages is the option more suitable because it permits the compressors face the exact customer technical specifications and API standards. Choosing a supplier with a dedicated project management is key for leading to improved productivity as there is no ambiguity when quality specification defines what a particular compressor system should be doing at any given time.
The project management team is critical in analysing all technical requirements to deliver projects efficiently.

Coordination of Inspection Events
The EPC or the end user should be design an inspection plan to be ensure all the compressors are manufactured according to strict standards, and that the company's products and processes are evaluated according to designated testing levels.

Not only EPCs but also end-users should identify dates for source inspection scheduled work process events. Some of them are the pre-inspection meeting (kickoff with compressors manufacturer), key inspection events (factory acceptance, performance testing, and final inspection), and anticipated shipping date to allow coordination with other project members involved in the activity.

Source inspection reports are important and it should be reviewed for content, completeness and to eliminate the technical doubts.

Safety Training
Users must be trained on the relevant equipment and should not work alone. Safety of the individual performing source inspection is a key factor.

The EPC/user should provide a safety program that identifies specific safety hazards associated with the job. Source inspectors should be adequately trained and knowledgeable in these safety. Ensure only trained personnel audits compressed air equipment.

The source inspector must observe the safety procedures and policies of the compressors manufacturer while on their premises or, if more stringent, their own company safety requirements.

Testing of Rotary Screw Compressors and Auxiliaries
API organization enumerates in their Study Guide for Source Inspection and Quality Surveillance of Rotating Equipment the following points that should be verified in the final inspection of the rotary- (screw) type compressors:
— Dimensions are as shown on the compressor general arrangement drawing;
— Compliance with standards;
— Instrument and connection tagging;
— Piping compliance to P&ID;
— Proper piping support;
— Electrical and instrumentation wiring is installed per the approved drawings and area classification;
— Junction/terminal boxes are correctly mounted per the approved drawings and area classification;
— Nameplates contain correct information and are in compliance with API 619;
— API 619 specifies procedures and requirements that should be followed in preparation for shipment.

And the following points for centrifugal compressors:
— Performance test;
— Mechanical run test, including vibration data collection, sound level test, and oil temperature monitoring;
— Impeller overspeed test;
— Control panel factory acceptance test (FAT);
— Coupling fit test;
— Gas leakage test;
— After-test disassembly inspection;
— Unbalanced rotor response verification test (per API 617; 672 for centrifugal air compressors).

References & Futher Readings

- American Petroleum Institute webite - https://www.api.org/
- Guide for Source Inspection and Quality Surveillance of Rotating Equipment - https://www.api.org/~/media/Files/Certification/ICP/ICP-Certification-Programs/SI_Suite_Documents/SIRE/SIRE_StudyGuide_Final_10-24-2015.pdf
- API Standards - http://www.rotating.equipment/
- API's integrity management standards mean increased safety and reliability as offshore production is poised to grow, by Offshore Energy Today - https://www.offshore-energy.biz/apis-integrity-management-standards-mean-increased-safety-and-reliability-as-offshore-production-is-poised-to-grow/
- Top Benefits of Utilizing API Standard & ISO Certified Pipe Protection, by MSI - http://msipipeprotection.com/top-benefits-of-utilizing-api-standard-iso-certified-pipe-protection/

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