Compressors and Compressed Air Systems

An Online Continuing Education Course for Engineers

Course Number: M-6017

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Compressors and Compressed Air Systems

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Whether installing a new system or altering an existing plant, compressed air systems provide many opportunities to gain long-term dollar savings. The proper design and operation of air compression systems is very critical. It is important to have a complete understanding of the exact requirements for compressed air—i.e., how, when, and where it will be used. The purpose of this course is to present fundamentals and general information on compressed air systems. The course is divided in 30 sections:

1. System overview
2. Compressed air ratings
3. Types of compressors
4. System design considerations
5. Compressor controls
6. Compressor sizing
7. System configuration
8. Air quality
9. Components of compressed air system
10. Compressed air treatment
11. After-coolers
12. Dryers
13. Compressed air filters
14. Six levels of compressed air treatment quality
15. Receivers
16. Compressed air distribution network
17. Piping materials
18. Hose and tubing
19. Condensate control
20. Miscellaneous Elements
21. The cost of compressed air
22. Air compressor installation
23. Maintenance and servicing
24. Trouble shooting
25. Safety considerations
26. Handy rules of thumb
27. Myths and realities of compressed air

28. Planned program for energy efficiency
29. Industry codes and standards
30. Brief academic review

The course includes a glossary at the end.

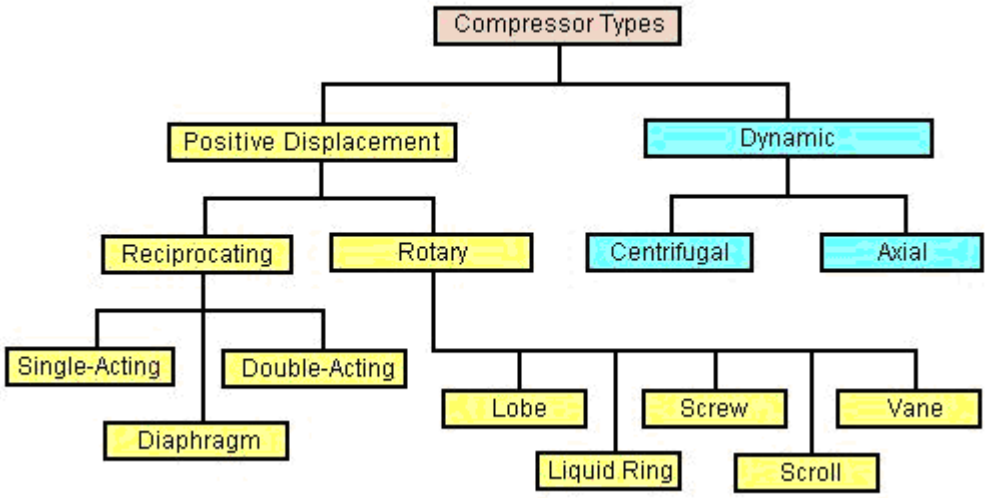
SYSTEMS OVERVIEW

The two broad categories of air compression equipment are dynamic and positive displacement machines.

1. Dynamic machines use axial and centrifugal impellers to impart velocity to the air, which is then converted to pressure. Centrifugal and axial compressors are dynamic machines that often operate at high speeds.

2. Positive displacement machines use reciprocating pistons, rotary screws, or vanes to produce air compression. Screw, reciprocating, lobe, and vane compressors are positive-displacement machines.

There are many different types of compressors on the market, each using a different technology to produce compressed air.



These types are further characterized by:

1. Compression stages:

   Air compressors are available in single or multiple stages of compression.

   Multiple staging is usually adopted when the discharge pressure is greater than 80 psig. Multiple stage compressors offer energy efficiency as air is cooled between compression stages and moisture is removed through cooling. Advantages of multistage compression are:

- Better mechanical balance and uniform torque of multi-crank machines and a smaller flywheel;
- Increased volumetric efficiency as a result of lower pressure in the IP cylinder clearances;
- Reduction of power to the drive;
- Possibility of operating at high speeds;
- Provisions for better lubrication due to the lower working temperature;
- Smaller leakage loss and lighter cylinders.

2. Type of Cooling:

   Air compressors can be air, water, or oil-cooled. Air-cooled compressors have either integrally mounted or separate oil or air coolers. These require adequate ventilation to perform reliably. Water-cooled compressors require an adequate pressure of quality water. Remember that air compressors typically reject about 2,000 - 2,500 Btu/hr for every hp. Water-cooled units are more energy efficient.

3. Type of Drive:

   The prime mover can be electric motor, engine, steam, or turbine driven. Electric motors are the most common type found in industrial operations. Engine or turbine driven machines are sometimes used for heavy-duty applications and in mobile units in remote locations where an electrical supply is not available. Such an example would be in a mining operation.

4. Lubrication (oil, oil-free):

   Air compressors are available as dry/oil-free and lubricated. The types of compressors are as follows:

Non Lubricated (Oil Free)	**Lubricated**
Rotary Screw and lobe	Rotary screw and lobe
Reciprocating	Reciprocating
Centrifugal	

In general, oil-free compressors are preferable in clean air applications such as the food industry, electronic manufacturing, controls and instrumentation, and hospital services. Lubricated compressors for utility air services are acceptable if a proper coalescing filtration system is included.

5. Packaged or custom-built

- Usually compressors are packaged items; units are custom built when heavy-duty machines for the mining industry or large energy projects are required.
- Most reciprocating and dry screw air compressors are shipped as self-contained packaged items requiring minimum tie-in conn
- The centrifugal air compres ally not shipped as a self-contain

6. Operating

Pressure is the lly expressed in the units psi or bar (psi = po psi).

- Low (0 t
- Medium
- High (ov