At present, there are no industry standards for classifying pneumatic conveying systems. The systems shown throughout engineering literature and in equipment suppliers' brochures are described by various terms — vacuum, negative pressure, positive pressure, low pressure, medium pressure, high pressure, low velocity, high velocity, dilute phase, dense phase, and medium phase. Some terms describe the type of airstream the system uses to convey material, other terms describe the degree of material concentration in the system's conveying phase.

This two-part article discusses some basic terms used to describe pneumatic conveying systems. Part I classifies pneumatic conveying systems by system type. Part II, which will appear in the April issue, classifies pneumatic conveying systems by material conveying phase.

All pneumatic conveying systems can be classified into one of three system types, depending on the kind of airstream used to convey material — vacuum, pressure, or a combination of vacuum and pressure. The sections that follow define and describe each system type and further classify their operating components.

**Vacuum systems**

Vacuum systems, also called negative-pressure systems, use vacuum-generating devices to produce medium- to high-velocity airstreams in their conveying lines. These systems are generally used to pick up material from several sources for delivery to one discharge destination. Vacuum systems are also used to unload material from bulk transport vehicles such as railcars, barges, and ships.

In a typical vacuum system (Fig. 1), material is drawn directly into the conveying line from the pickup source, which is maintained at atmospheric pressure. The pickup source can be a bin equipped with a rotary airlock or a process device like a mixer or mill. The conveying air moves the material to a destination (filter receiver), which is maintained below atmospheric pressure. The filter receiver separates the material from the conveying air, discharges the material through a rotary airlock to storage or process, and passes the conveying air through a dust filter into the vacuum-generating device.

Vacuum systems can be further classified by the device used to generate the vacuum and by the vacuum level at which each system operates. Four common vacuum-generating devices are the low-pressure fan, the lobe-type blower, the screw-type blower, and the venturi.

**Low-pressure fan systems** generate vacuum with centrifugal fans or regenerative blowers and are generally used to collect fugitive dust; to vent silos, belt conveyors, or bagging operations; or to collect nuisance dust within a plant. Vacuum levels range from 2 to 60 inches water gauge. Capacities range from several pounds per hour to several hundred pounds per hour.
Lobe-type blower systems generate vacuum with positive-displacement lobe-type blowers and are generally used to convey material over short distances. Vacuum levels range from 3 to 15 inches mercury. Capacities range from 100 lb/h or less to 100 t/h or more.

Screw-type blower systems generate vacuum with positive-displacement screw-type blowers and are generally used to convey material over long distances; ship unloading is a typical application. Vacuum levels range from 16 to 26 inches mercury. Capacities range from several tons per hour to several hundred tons per hour.

Venturi systems generate vacuum with venturis, which use positive-pressure air supplies. These systems are generally used to convey abrasive or friable material over very short distances (up to 20 feet); a typical application is vacuum-loading a conveying vessel, which is then discharged by pressure. Vacuum levels range from 4 to 20 inches mercury. Capacities range from 1 to 50 t/h.

Several manufacturers have introduced venturi systems that convey material directly through the venturi bodies. These systems operate at very low capacities, but can convey material several hundred feet or more. Venturis used in this manner are commonly called eductors.

Pressure systems
Pressure systems, also called positive-pressure systems, use air discharged from pressure-generating devices to produce low- to high-velocity airstreams in their conveying lines. These systems are generally used to pick up material from one source for delivery to one or more discharge destinations.

In a typical pressure system (Fig. 2), material is conveyed from the pickup source, which is maintained above atmospheric pressure. The conveying air moves the material to storage bins or packaging silos, which are maintained near atmospheric pressure.

Pressure systems can be further classified by their equipment configurations and by the pressure levels at which they operate (low, medium, or high). Four common equipment configurations are rotary airlock/blower, pressure vessel/blower, screw feeder/compressor, and pressure vessel/compressor.

Each equipment configuration uses a mechanical device or pressure vessel to mix the air and the material to be conveyed. In addition, each system's blower or compressor has an atmospheric air inlet where filtered air is drawn in to be compressed. Unlike in a vacuum system, the conveyed material can't be drawn into the blower or compressor, even if the inlet's filter fails.

Rotary airlock/blower systems use low-pressure blowers to pressurize their conveying lines. Rotary airlocks (maintained at atmospheric pressure) separate the pressurized conveying lines from the material source. The airlocks continuously meter material into the conveying lines and control the mixing of air and material. Air leakage and wear can be a problem with these systems. Pressure levels range from 2 to 12 psig. Capacities range from less than 1 t/h to as much as 25 t/h or more.

Pressure vessel/blower systems use low-pressure blowers to pressurize their conveying lines after they are filled with material. These systems convey in batches and experience less air leakage and wear than rotary airlock systems. Pressure levels range from 10 to 15 psig. Capacities up to 50 t/h or more are possible.

Screw feeder/compressor systems use medium-pressure (single-stage reciprocating or rotary vane) compressors to pressurize their conveying lines. Mechanical screw feeders rotate the mate-

![Fig. 1 Vacuum system](image)
Fig. 2 Pressure system

Fig. 3 Combination vacuum/pressure system
rial, continuously forcing it into the pressurized conveying lines. High conveying rates are possible with these systems, but a great deal of horsepower is needed to turn the mechanical screws. In addition, these systems are unsuitable for conveying abrasive materials due the high maintenance needs of the screws. Pressure levels range from 20 to 45 psig. Capacities up to 200 t/h are possible.

**Pressure vessel/compressor systems** are available with either medium- or high-pressure compressors. Systems that use medium-pressure (reciprocating or dry screw) compressors convey material over longer distances and at higher rates than pressure vessel/blower systems. Pressure levels range from 30 to 60 psig. Capacities up to 200 t/h are standard.

Systems that use high-pressure compressors (or that operate from existing plant air supplies) convey material from a few feet up to several thousand feet. Pressure levels range from 50 to 80 psig. Capacities range from several hundred pounds per hour to several hundred tons per hour.

Some medium-pressure compressor systems and all high-pressure compressor systems require pressure vessels that meet the codes of the American Society of Mechanical Engineers (ASME). In addition, both types of systems can be designed with two pressure vessels. In medium-pressure compressor systems, two-vessel configurations achieve conveying rates similar to screw feeder/compressor systems, but with lower energy requirements and reduced component wear.

**Combination systems**

Combination systems, also called vacuum/pressure systems, combine vacuum and pressure operation. These systems are generally used to pick up material from several sources for delivery to several discharge destinations. Combination systems are also used where vacuum pickup is most desirable, but where pressure delivery is most suitable — for instance, when material is unloaded from bulk transport vehicles for delivery to several locations.

In a typical combination system (Fig. 3), both the material source and the material destination are maintained near atmospheric pressure. In operation, material is drawn from the pickup source into the conveying line and transferred to a filter receiver. The receiver separates the air and the material. The filtered air is discharged to a vacuum/pressure blower, which then discharges it into the pressure system. The material is simultaneously discharged through a rotary airlock into the pressure conveying line for delivery to its destinations.

The critical area in coordinating vacuum and pressure operation is the point where the material leaves the vacuum zone and enters the pressure zone. In many cases, an airlock is used to separate the two zones. A pressure pot, alternately placed under vacuum and pressure, can also be used.

**Next month:** Classification of systems by material conveying phase.

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