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## Components for Safe Combustion Systems

### Overview

Combustion systems are an integral part of every industrial furnace. Advances in component technology, combined with soaring fuel prices, have made efficiency improvements attractive investments. As industries slowly recognize that there can be a significant return on investment by upgrading the combustion system, it is important to recognize the basic components that comprise the typical pipe train.

Most system flaws have been determined to be the result of the improper design and handling of the fuel. The most likely causes have been:

- ◆ The equipment supplier reduced the quality of the pipe train by using inferior components or by exceeding safe design criteria.
- ◆ The company offering a “total package” subcontracted the pipe train to a third party unqualified in fuel systems.
- ◆ The end user attempted to save money by building the pipe train in-house, without understanding the complexity of a fuel delivery system and the criteria to be followed.

Thousands of fuel pipe trains have been put into service, supplying gas, oil, propane and other fuels to industrial furnaces in a safe, reliable manner. When solid design criteria are followed, proper components are selected, and good assembly practices are followed, the combustion system should be trouble-free.

This article will review the types and functionality of the fundamental components of the typical fuel pipe train.

### Proper Design Characteristics

**General:** Whenever delivering fuel to an industrial process, it is imperative that all components and piping are compatible with the fuel being delivered. Attention should be given to ensure that all components are rated well above the pressure that the system will operate. Precautions must still be taken during the assembly of the pipe train to make sure that the system is free of filings, pipe dope, weld spatter, and foreign objects. Attention should also be given to any local and industrial codes to make certain that the system meets the customer’s insurance requirements.

Unfortunately, too often a company will cut corners when building or purchasing a combustion system only to find out after an inspection (or worse yet a problem) that the system does not meet their insurance carrier’s requirements. Modifications in the field can lead to costly downtime, which most often will cost more than purchasing a properly designed pipe train in the first place.

# ***Fundamental Components***

## ***Isolation Valves***

Ball valves and gas cocks are most commonly used on smaller pipe sizes (3" or less) and positive shutoff wafer valves are usually used on lines greater than 3". There are two key features with isolation valves. First, the valve must be rated for positive shutoff of flow so that no fuel can pass when the valve is in the fully closed position. Second, the valve should contain a lockable handle so that vibration or accidental bumping cannot inadvertently open it. The best valves also contain a means for adding an external lock to readily comply with lockout / tagout procedures.



## ***Strainer***

All pipe trains carrying fuel must have a filter or fine mesh strainer, typically 40 mesh, at the beginning of the main section of the pipe train. This strainer will prevent any solid foreign objects from passing into the rest of the pipe train and compromising the seats on downstream valves. The strainer screen should be made either stainless steel or monel to prevent rusting. An optional "blow down" valve may also be installed on the strainer base at the request of the customer to allow partial cleaning of the strainer screen

without disassembling the pipe train.

## ***Regulator***

The function of the regulator is to decrease and stabilize the delivery pressure to a value that is acceptable at the burner for proper operation. All pressure drops in the piping system after the regulator must be calculated first, then added to the pressure needed at the burner in order to size and select the proper regulator.

Many users choose to have a bypass line around the strainer and regulator, sometimes with redundant components, to ensure that fuel delivery is not interrupted if one of these components should fail or require maintenance. This is acceptable in most safety certifications and guidelines.



*This article, written by Dan Ertl, has been published in several magazines and presented at several conferences.*

## Pressure Switches

High and low pressure switches must be incorporated into every pipe train design. The function of the pressure switch is to ensure that the line pressure is within an acceptable range for safe operation.

The low-pressure switch is a 'normally open' switch that relies on the gas pressure in the line to move it to, and hold it in, the closed position. If the line pressure drops below the set point, the switch reverts back to the open position, triggering the shut-off valves to close.

The high-pressure switch is a 'normally closed' switch. When the line pressure exceeds a certain set point, the switch opens, triggering the shut-off valves to close.

In the simplest configuration, the switches are electrically set up in a closed loop series arrangement with the shut off valves, so that if either of the switch set points is violated, power is removed from the shut off valves and the valves close. Although automatic reset switches are available, manual reset pressure switches are recommended in most cases to assure that the problem is addressed before operation can be resumed.



## Shut-off Valves

The function of the shut-off valves is to interrupt the flow of fuel whenever preset safety conditions are not met, whether pressure, temperature or flow. There are two basic types of shut-off valves available: electromechanical and pneumatic. Both are acceptable in most codes if properly installed. Each should be a “fail closed” valve, using a spring return mechanism to force the valve to a closed position when safety permissives are not met.

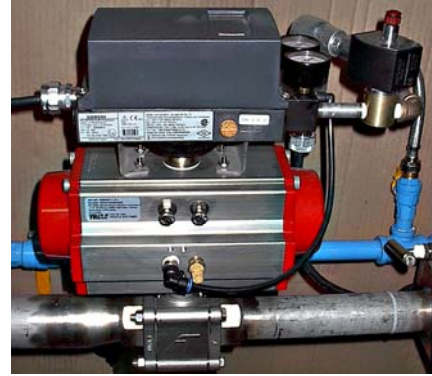
According to the NFPA code, any pipe train carrying fuel must incorporate two shut-off valves in the system, known as a double block arrangement. Furthermore, some codes require a venting arrangement that incorporates the use of a pressure relief valve between the two shut off valves. A qualified pipe train supplier should be well versed in the specific codes and design considerations necessary for a given application.

**IT IS NEVER ACCEPTABLE, UNDER ANY CIRCUMSTANCES, TO INSTALL A BYPASS LINE AROUND SHUT-OFF VALVES, UNLESS REDUNDANT SHUT-OFF VALVES ARE ALSO INCLUDED IN THE BYPASS LINE.** This holds true for all codes, safety certifications and approvals.

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## **Flow control**

Historically, an arrangement whereby the fuel and air valves are mechanically linked was common practice for some installations. The ratio of air to fuel was set up via the linkage, or by means of a ratio regulator. As the evolution of sensing equipment has progressed, the ability to control the fuel and air independently has given some users the capability to compensate for process changes that affect the fuel/air ratio. This “mass flow” concept has given the user the ability to avoid the inefficiencies inherent in the linked method.



## **Flow monitoring**

There are two basic types of flow monitoring: metering, using an in-line or turbine meter, and differential pressure, using orifice plates with a manometer or transmitter. Both methods are effective and widely used. The decision as to which should be implemented is usually based on weighing the accuracy required in a specific situation against the cost.

There are a wide variety of other optional components that can be incorporated into the basic pipe train design. Usually necessity and cost are the two determining factors in the selection of any other components. Typical options include thermometers, pressure gauges, pressure transmitters and temperature transmitters. A qualified supplier should be capable of explaining the function of any additional equipment and should also be able to provide guidance on whether any of these options are necessary in a specific application.



## **Conclusions**

Properly designed and assembled combustion systems can be a safe, reliable and trouble free system, provided it is designed, assembled and installed by qualified personnel. Any company which designs and assembles pipe trains as part of its core business should be able to provide the necessary expertise and resources to guide a user through the process of sizing, selecting and integrating the necessary pipe train components for a specific combustion application. An educated consumer looking for value, working with a proven quality-driven supplier, can produce a safe, trouble free and cost-effective combustion system.

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