"Automated Truck Loading Systems"
Class # 2030.1

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Introduction

Bulk storage facilies, often refered to as distribution terminals, must load and unload liquid product between storage tanks, railcars, tank trucks, and barges. The transfer of petroleum products has become a concern in areas such as safety, security, measurement accuracy, and regulatory requirements. Due to the advancement of electronic systems, improvements have been made in these areas. This report will focus on useful preset features and the types of blending that are available using an electronic preset. Blending configurations that will be covered include the sequential blender, the ratio blender, the side stream blender, and the hybrid blender.

Overview

The loading of petroleum products at distribution terminals has undergone a great deal of renovation since the early 1970's. These changes, for the most part, have taken place due to the introduction of electronic instrumentation and control devices. These electronic devices replaced what was traditionally mechanical equipment at the load rack. Through the 1980's and into the early 1990's this equipment has been refined and its features expanded to meet the needs of modern distribution facilities. The electronic preset is responsible for much of this improvement. While product accountability, reduced operating cost, and improved inventory control continue to be one of the significant benefits of the electronic preset, government regulations have also had a large impact on the upgrading effort. The Clean Air Act requires that gasoline must be blended with a specified percentage of oxygenates for a particular geographic area. Basically, these regulations prohibit the petroleum products from being directly delivered in their refined form, and do require that they be blended with products such as Ethanol (gasoline) or Biomass (diesel). Combining this with the requirements of high performance gasolines for today's fuel efficient automobiles, the blending requirements become more complex. Today, an electronic preset device can control multiple products and can store different blending percentages all while simultaneously controlling valves, monitoring meter pulses, and keeping necessary activity logs. In the future, the preset device offers great flexibility at the load rack to accommodate new blending regulations.

Electronic Preset

When a blending process is being planned, a decision on the type of blender required will first need to be made. The types of blending options available may depend on the features available on the electronic preset. There are some common features available on many preset devices which are necessary for proper blend operation and delivery accuracy.

1. Recipes

The blending of two or more liquid products requires a recipe. A recipe is the definition (by percentage) of each individual product amount which is required to produce the desired blend product. The number of available recipes and the recipe settings will vary with the preset. The selection of a defined recipe is common at a truck terminal. Many of today's electronic presets are capable of storing many different recipes.

2. Product Flow Profile

Individual product flow parameters indicate to the electronic preset how a product will flow. Flow parameters would include details such as flow rate settings and meter accuracy settings. Each of the products' flow settings are independently programmed, which allows the system to be fine tuned to the characteristics of

each product's flow stream. Meter accuracy settings generally require adjustment as the meter experiences normal wear. A prove process should be periodically performed to make sure that the meter accuracy settings are correct.

3. Volume Compensation

Some presets are capable of volume compensation which is a process by which measured volume is corrected to a desired reference temperature. This is an extremely valuable feature because temperature changes can cause measured volumes to be slightly inaccurate since the product density has changed. The preset device should allow an operator to program the type of product in order to accurately compensate for temperature based on a product's characteristics. It is recommended to choose a preset device that uses industry standard compensation algorithms which comply with API standards (API Chapter 11.1 Refined Products, Chapter 11.2.4 Light Products).

4. Clean Line Start

When two or more products are flowing through a common load arm, it is often desirable for the terminal operator to ensure that the product left in the common section is of his choosing. This is done to avoid contamination and/or quality of the next recipe delivered. Typically the product left in the common section is the highest quality product delivered. Leaving this product is accomplished by ensuring that it is always the last product to be delivered in a recipe. The method by which this is accomplished will vary with blender types. It can be done by volume or as a percentage of the recipe.

5. Configurable Inputs and Outputs

An electronic preset device is required to deliver a varying number of products either simultaneously or sequentially. Some load racks may have four products while others may only have three products. Therefore, it is desirable that the inputs and outputs be configurable to meet the needs of a particular application and to easily accommodate upgrades or modifications in the load rack.

Sequential Blending

Sequential Blending is a blend configuration which individually controls more than one product with block valves. There is a common pipeline which sends product through a meter and flow control valve, and then delivers the product one at a time until the required preset volume is complete. Because this method only delivers one product at a time, actual blending must take place when the products have been delivered to the destination. A sequential blender configuration is illustrated in Figure 1.

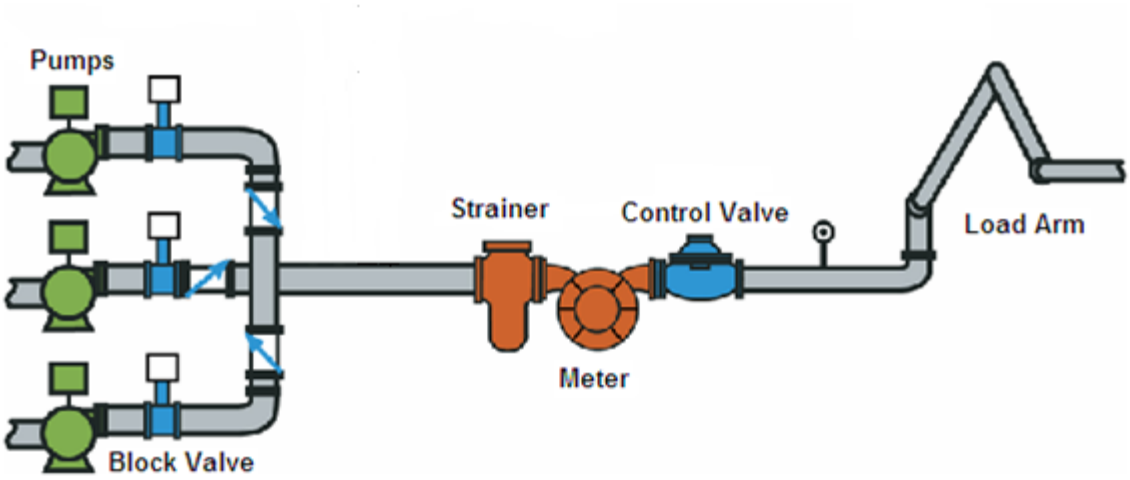

Figure 1 Sequential Blender

The block valves are an important part of this type of blend configuration. A sequential blender operates by first turning on the pump to create a pressure in the line and then individual block valves are opened or closed. Block valve feedback inputs should be provided to assure proper block valve sequencing during recipe delivery. When the feedback has been received showing that the block valve is opened, then the control valve can be opened. The preset device should expect feedback input from each block valve and if the feedback is showing undesired valve activity, then the appropriate alarm will be activated and flow will be stopped.

Advantages of Sequential Blending	**Disadvantages of Sequential Blending**
1. Cost - This type of blender requires a lower cost than a ratio blender because there is only one meter and temperature, pressure, or density is not being monitored for each individual product line. There is less equipment required for this configuration.	**1. Blend Quality -** The biggest disadvantage resulting from sequential blending is that the quality of the final product is dependent on the proper preset and delivery. A preset terminated early will result in an off-spec blend producing an inferior product.
2. Hydraulic Sensitivity - This type of blending is very insensitive to hydraulic variations. This is because the product is controlled through a single meter and control valve.	**2. Product Mixing -** Since the products are delivered one at a time, the actual mixing of the product must be accomplished at the delivery location. If the individual products are delivered to a tank truck, then the actual blending must occur while in transit.
	3. Delivery Time - The delivery time of a recipe is increased because only one product at a time is being delivered. There is also additional time involved with each transition from one product to another since there is more valve activity (opening and closing block valves and control valve).

Ratio Blending

Ratio blending is a blend configuration that controls two or more different products simultaneously through individual flow control valves. Each product has a meter and a control valve so the preset device can deliver them ratio metrically until the required preset volume is complete. This method will blend products in the load arm prior to loading. A ratio blender configuration is illustrated in Figure 2.

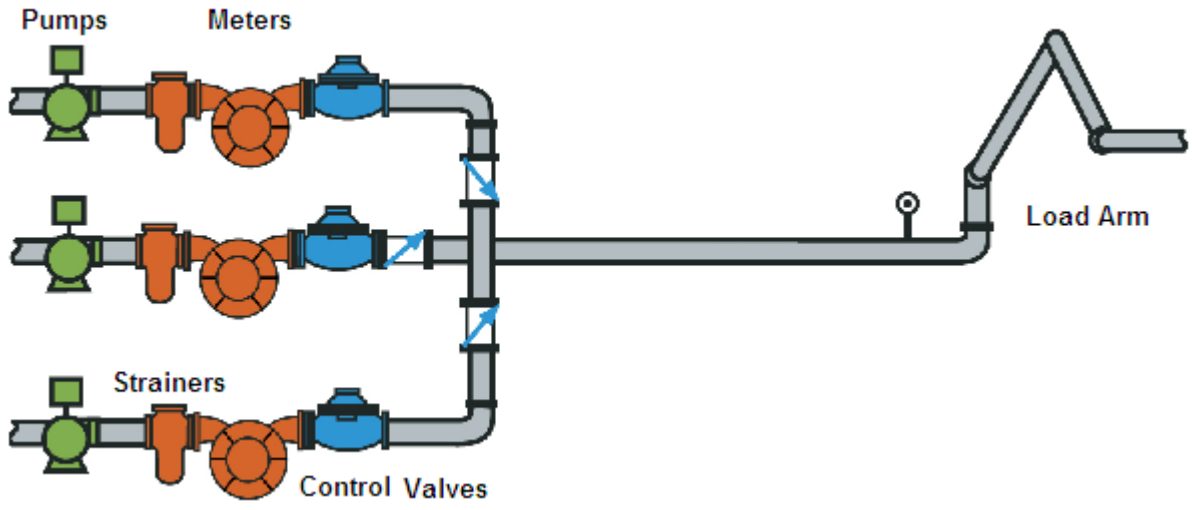

Figure 2 Ratio Blender

Advantages of Ratio Blending	Disadvantages of Ratio Blending
1. Blend Quality - The delivered blend is rarely out of blend specification at any time. This means that premature termination of a batch will typically not affect the quality of the delivered product. **2. Product Mixing -** The mixture of products that form a recipe is taking place during delivery. **3. Delivery Time -** Simultaneous delivery of all the products means shorter delivery time. This eliminates the need to stop any single product in order to transition to another product during delivery.	**1. Cost -** The initial equipment cost and the maintenance costs for a ratio blender is typically higher since a meter, a control valve, and possibly a temperature probe or other analog inputs are required for each individual product. **2. Complex Electronics -** Since each product line is metered separately, the electronics required to control and monitor each line are increased accordingly. This factor often means higher costs as well.

Side Stream Blenders

Side Stream Blending is a form of two product Ratio Blending where the minor product is metered and is controlled by a valve, while the main product is free flowing. Another meter and its corresponding control valve are located downstream of where the two products merge. A side stream blender configuration is illustrated in Figure 3.

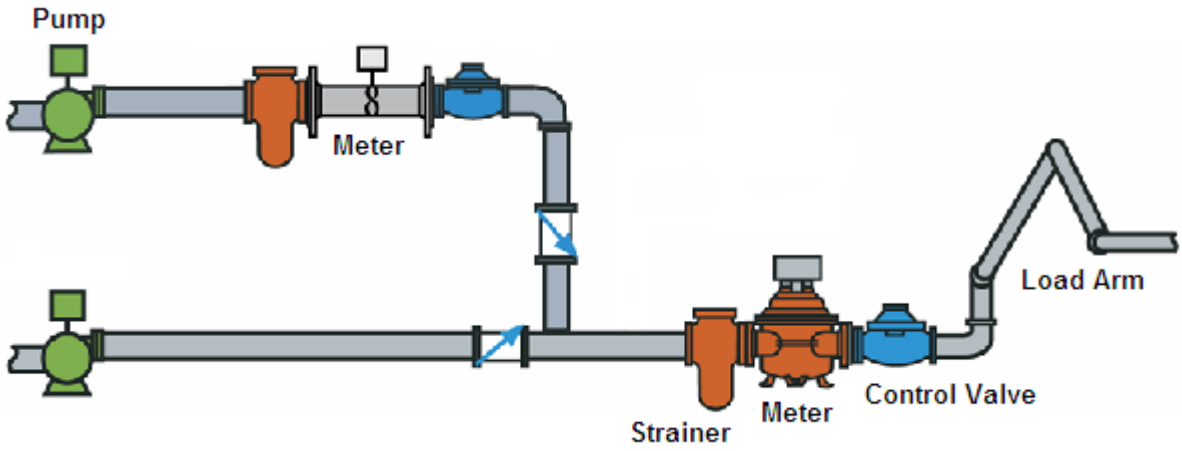

Figure 3 Sidestream Blender

The quality of the blend is strictly determined by controlling the flow rate of each product in the recipe to achieve the pre-assigned ratio. It is important to remember that using standard flow control methods will not control the product flow rates close enough to maintain a 0.5 percent or better blend tolerance. The preset device for a sidestream blender must be capable of controlling combined outputs based on any combination of products. The preset device should be capable of automatic flow optimization on the blend using the flow rate**.** When one of the blend products being delivered cannot achieve its programmed flow rate because an additional load arm is being used for the same product, the preset should be capable of adjusting the flow on the product lines in order to maintain the blend quality.

Advantage of Side Stream Blending	Disadvantage of Side Stream Blending
The advantages of side stream blending are similar to Ratio Blending (see Ratio Blending advantages).	**1. Hydraulic Sensitivity -** The delivery of the minor component of the blend is dependent on the pressure of the minor product being at least 20 PSI higher than the pressure in the main product. If this pressure is not higher, the minor product will not blend into the major product stream causing bad blends. The higher pressure must be maintained at all times. **2. Measurement Accuracy –** The measurement of the main product is not directly measured; instead it is inferred. Other disadvantages of side stream blending are similar to ratio blending (see ratio blending disadvantages).

Hybrid Blender

Hybrid blending is a combination of sequential blending and ratio blending. A typical hybrid blender may include two or three sequentially blended products with one or two ratio blended products. The sequential products flow one at a time and in most cases one of the ratio products would flow simultaneously with each of the sequential products. The ratio product(s) can be plumbed either upstream (side stream blending) or downstream (ratio blending) of the sequential product meter. The hybrid blenders have been developed to blend products in existing installations that may not mix well in a sequential loading profile (i.e. Biomass and Diesel). A hybrid blender is illustrated in Figure 4.

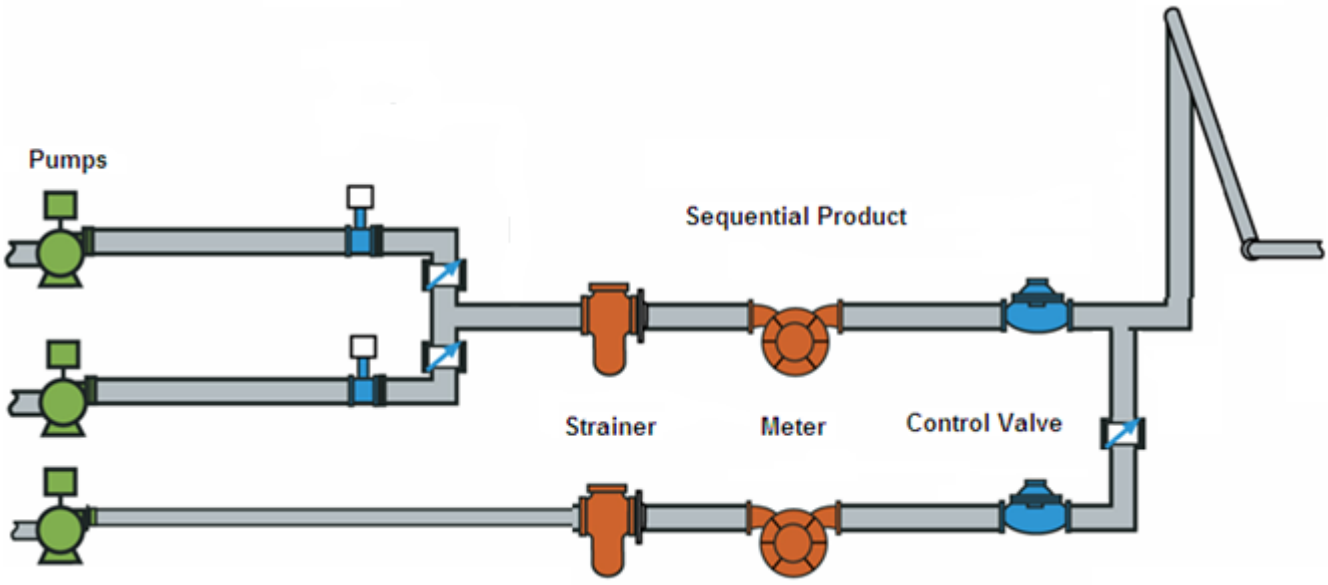

Figure 4 Hybrid Blender

Advantages and disadvantages of the Hybrid Blender are similar to those previously defined for Sequential, Ratio and Side Stream blending depending on the configuration of the products.

Terminal Automation

A Terminal Automation System (TAS) is often used in conjunction with an electronic preset. Traditionally, the TAS is responsible for process monitoring, process control, and safety control. An automation system can have a positive impact on product quality since it is offering additonal control over the process.

This type of system operates by communicating between preset and the automation system. If product blending will be occuring, then the system must be properly designed to handle the blending process. A preset device which controls a blending rack must have the ability to recognize and control the flow of several products and then communicate this data back to the automation system. The preset should be able to report the exact quantity of each product delivered in a blend so this information can be recorded and then product inventories can be updated accurately.

The TAS can ensure notification of the product quality by checking delivered volumes against the expected volumes based on recipe definitions. This can be done through communications between the TAS and the preset device. In this type of system, where a TAS is present, it is essential that the preset device can communicate blend data to the TAS.

If a TAS communications failure occurs, then the preset device should have the ability to temporarily enter a mode where it can operation entirely on its own and save necessary information for when the TAS returns. Then when the TAS is back online, the preset device will share all of the information received while TAS communications were down. This is a reassuring feature to have and might want to be considered a necessity if data cannot be lost during a communications failure.

Blend Configuration Selection

The choice of which blending method to use will vary with the type of operation and the conditions experienced at the load rack. Take into careful consideration the required quality of the blend, the delivery flexibility desired, and the cost. The ratio blender assures blending quality as the finished product reaches its destination and this is true even if the batch is stopped early. Of course, cost is always a factor and must also be considered. A sequential blender is cheaper because it requires less equipment and therefore might be a better solution for those searching for a more economical system. If product load times must be kept to a minimum, then a Ratio Blend configuration might be the best choice.

Communications and Auxiliary Equipment

A preset device must communicate with other auxiliary equipment. Commonly the preset must communicate with a terminal automation system (as mentioned) or with a meter such as a coriolis meter. Communications are transmitted through a serial connection or an ethernet connection. Some of the information that can be polled from the preset is not only the past and present loading information (current batch information, archived batch logs, transaction logs, etc.) but operating information as well (I/O states, and program parameters). Some Ethernet equipped preset devices have an embedded web server that provides web pages that can also be useful for monitoring information. This allows for remote monitoring through a web browser. This monitoring includes preset diagnostics, delivery data, and many other processes to all be viewed from anywhere in the world. Network capabilities also allow for the preset to act as a PC by printing to network printers, and enabling alarm notifications to be sent to an email address. Now operators can be notified about potential problems at the load rack regardless if they are at home or at the load rack. Notifications can be received through email, on a cell phone, or on any other email capable electronic device.

Another device that the preset can work in conjunction with is a card reader. Card readers are used for driver identification and authorization. Card readers are either magnetic stripe or proximity based; either type of card reader can be captured or momentary readers. When used, the driver must “card in” for validation. The card in sequence can be tied directly into the preset as a security permissive to allow or deny product delivery. A legal operator list (valid card numbers) is stored in the preset and can be managed by someone with sufficient security privileges. This allows the terminal managers to know exactly who is loading and authorizes each individual to operate the preset.

Equations

Some preset devices also offer an equation feature which provides extreme flexibility for a variety of situations. With general digital outputs, facility engineers can design customized solutions by using equations to access the internal preset data. Equation syntax is much like a computer programming language and can be written to make decisions and set digital outputs as desired. Equations could also be used to copy certain data into different registers or to archive data in a log that is not normally archived.

For instance, one common use for equations is when double precision (64 bit) information needs to be access by a communication protocol that only supports single precision (32 bit) information. The conversion can be handled internally by the preset by creating an equation. The equation can set a single precision general user register equal to the double precision register and the preset will handle the conversion (with a minor loss of precision). This is just one example of a use for equations.

When writing equations, some previous computer programming experience may be helpful. Those who have difficulties creating such an equation can contact the technical support center for their preset device and the tehnicians there will often provide the custom equation for the given situation.

Conclusion

A distribution terminal needs to take into careful consideration the type blend configuration that is needed, the preset device that is needed, and the terminal automation system that is needed.

Electronic presets and blender configurations at the load rack will continue to advance, especially as today's fuels must be made to burn cleaner. There are many new features that can be expeceted in the future, and many new problems that will be encountered. Electronic presets, terminal automation systems, and different blending configurations are expected be the major parts to the solution of future blending challenges.