FMC Technologies and
Our Measurement Solutions
Legacy Brands

FMC Technologies, Inc. is a global leader providing mission-critical technology solutions for the energy industry. Its Measurement Solutions business unit excels in process systems, measurement technologies, transportation, and custody transfer of gases and liquids in the oil and gas industry. FMC Technologies employs approximately 12,500 people and operates 27 production facilities in 16 countries.

FMC Technologies Measurement Solutions sets the standard for global Best Measurement Practices by designing, manufacturing and servicing the precision products and systems used to measure and control liquids and gases in industrial applications. The Smith Meter® brand is known worldwide for its ability to produce reliable, accurate and consistent measurement results. Similarly, our Sening® brand tank truck components and systems are trusted to provide safety and environmental protection while ensuring accurate measurement during the transport and transfer of liquid products. Both Smith Meter® and Sening® are trademarks owned by FMC Technologies, Inc.

We put you first.
And keep you ahead.

FMC Technologies, Inc.
500 North Sam Houston Parkway West, Suite 100
Houston, Texas 77067 USA
+1 281 260 2190

USA Operation
1602 Wagner Avenue
Erie, Pennsylvania 16510 USA
+1 814 898 5000

Germany Operation
Regentistrasse 1
25474 Ellerbek, Germany
+49 4101 3040

www.fmctechnologies.com

Guide to Marketing Terminals
Reputed Product Loading and Unloading
Ethanol and Biodiesel Blending
Asphalt Loading
LPG Loading
FMC Technologies is the leading supplier for terminal measurement equipment with:

**Experience** – Over 70 years of experience in terminal applications worldwide; more than any other supplier.

**Worldwide sales and service** – Local support before and after the sale.

**The right meter** – FMC Positive Displacement, Turbine, and Proline Coriolis Meters.

**Accessories** – Mechanical or electronic controllers, control valves, temperature compensators, transmitters, strainers, and air eliminators.

**Worldwide approvals** – Our equipment meets (or exceeds) most weights and measures, electrical and mechanical design code requirements – worldwide.
LPG Loading

Condensing tanks can be used to ensure the meter will always have a liquid head pressure. The tanks provide for the condensation of vapors during product flow. As an alternative, differential back pressure control can be accomplished by continually monitoring temperature and pressure during transport loading and adjusting valve position to ensure product is always metered above vapor pressure. This can be accomplished using electronic presets with temperature and pressure inputs.

Odorant injection is extremely critical. Typically between 1 to 1.5 pounds of odorant per 10,000 gallons is required by law. Also, some means of detecting and reporting odorant activity is required.

The preset control device must be able to handle all the loading considerations that regulate product delivery, ensure data integrity, provide security and safety, and act as an interface to peripheral devices.

Considerations for the preset include:

- Pump control
- Valve and back pressure control
- Accurate delivery of the preset amount
- Monitoring of all critical functions
- Volume plus mass accumulation (meter error correction, temperature, pressure, and density correction)
- Record keeping (transaction data, display information)
- Communications with terminal automation systems (status, transactions, events, and authorizations)
- Proving software
- Safety interfaces (overfill and ground, vapor connections and others)
- Condensing tank controls or alternative vapor pressure valve control
- Odorant injection, control, and monitoring

Refined Product Loading

Overview

Refined product loading at a marketing terminal loading rack involves the safe, accurate delivery of product on board the truck. While there are many facets involved in loading a truck, this guideline concentrates on procedures, considerations, and solutions from the time the truck arrives at the terminal gate until the truck completes all transactions and leaves the terminal.

The state-of-the-art terminal today requires a number of functions to ensure truck loading is completed according to industry requirements. These requirements may be stipulated by the oil company, by the government, or by the demands of environmental regulations, requiring different types of equipment and systems be put into place.

Typical Truck Loading Sequence

The truck arrives at the terminal gate where a Gate Card Security and Authorization system is in place to allow the driver to identify himself and/or the truck. This information is sent to a computerized Terminal Automation System (TAS) that contains all the necessary files to identify the request and either authorize or deny entry.

The terminal will have multiple loading bays where a number of trucks can load simultaneously. Once at the appropriate loading bay, the driver will typically be required again to use some identification by means of either a card or badge reader. Here the products are selected and, if allocated in the TAS, the driver will be authorized to load. Whether loading only one product into all compartments of the truck or loading several different products into different compartments, the basic loading procedure is the same. Much of today’s loading requires systems to be able to deliver single products or a combination of products simultaneously to obtain various blends.

As the loading process begins, safety devices must be engaged. Overfill detectors are connected to prevent the truck from being overloaded. Since the loaded products are flammable, a grounding device is connected to eliminate the possibility of static discharge. Because a good portion of today’s loading is done by the bottom loading method where the truck is not vented to the atmosphere, trucks that have returned from a delivery will contain vapors. These vapors need to be dealt with as they are both hazardous and valuable. Therefore, typically the truck will connect to a vapor recovery hose prior to loading. The new incoming product pushes the vapors to the top of the truck and out the hose to the vapor recovery system for processing. While these are the primary safety devices, there may be more depending on user requirements.

After all safety requirements are met, the driver will connect the loading arm and open the appropriate compartment valves on the truck. At this point, the metering system becomes the central control for the primary functions of accurate and safe product loading. One component of the metering system is the Preset Control Device. This device is the interface where the driver configures the products and the amounts to be loaded.

(Continued on next page)
Refined Product Loading

Once the driver has set the load, the preset takes control of the entire process. The safety devices are connected and the preset controls all aspects of flow and volume accumulation from the meter. The preset is also responsible for data integrity and transfer of the transaction information to the Terminal Automation System (TAS). This will generate a Bill of Lading for the truck showing all products loaded and other information. Once loading is completed, the driver will disconnect the load arm(s) and safety devices, retrieve the Bill of Lading and exit the terminal.

Considerations

The major consideration for the metering system at a terminal load rack is the type of meter chosen. Viscosity is the primary factor for selecting a meter for truck loading when choosing a positive displacement meter, turbine meter or Coriolis meter. Certain other influences need to be considered when selecting the appropriate meter such as piping, vibrations, electrical installation, flow conditioning, chemical compatibility, system hydraulics, and past experience.

The choice of equipment to be used involves not only the meter, but also the strainer, control valve and preset device, as well as the interface to necessary peripheral devices. The meter, control valve, and strainer can be selected following sizing guidelines. These are the primary considerations when choosing a metering system solution for refined products loading. There may be additional company-specific requirements to consider.

Preset Control Device

The preset control device needs to be able to handle most of these considerations and more. The preset control device is primarily used to regulate product delivery, ensure data integrity, provide security and safety, and act as an interface to peripheral devices.

The following are some considerations for the preset:

- Pump control
- Valve/flow control
- System security
- Accurate delivery of the preset amount
- Monitoring of all critical loading functions
- Volume accumulation (meter error correction, temperature, pressure, density correction)
- Record keeping (transaction data, display information)
- Communications with Terminal Automation Systems (status, transactions, events and authorizations)
- Proving software
- Safety interface (overfill and ground, vapor recovery and others)
- Additive control and reconciliation

Additional considerations for designing the metering portion of a truck loading system include:

- Products required to be loaded or blended
- Recipes and percentages
- Pumping capabilities
- Pressure loading profiles
- Product delivery rates
- Meter and control valve sizing
- Number of arms per product
- Piping configurations
- Contamination
- Product accountability
- Safety
- Equipment protection
- Load rack utilization (arrangement of products and arms to support rack throughput)

LPG Loading

Overview

The truck loading of LPG, while similar to refined products loading, has unique requirements. LPG is more volatile than gasoline or distillates and special care must be taken to ensure safe and accurate loading. This overview concentrates on procedures, considerations, and solutions pertaining to truck loading of LPG.

As with refined product terminals, the typical LPG terminal will have a security and terminal automation system. The loading procedure is much the same as it is for refined products. The driver identifies himself and perhaps the truck. They receive authorization to load and proceed to connect loading arms and safety devices.

Once again, the most important part of the loading process is the metering system and much of the equipment is the same as other loading processes such as the choice of meter, strainer, and electronic preset. There are a few significant differences in LPG loading, including the fact that flow parameters and system pressures play a major role in the loading process. This requires additional considerations for the control valve, additives, and means of ensuring accurate measurement by maintaining the product in a liquid state at all times.

Considerations

Unlike refined products loading, LPG loading has a number of major concerns. One of the obvious considerations is the meter, where certain properties of LPG come into play. LPG is quite non-lubricating, and therefore, care must be taken in the selection of the meter to account for this issue. Because LPG has a low vapor pressure, attention must be given to ensure the product remains in a consistent liquid state. Finally, one of the major concerns is that LPG is colorless and odorless and requires an odorant to be injected without fail.

The choice of equipment to be used involves the meter, strainer, control valve, odorant injector, preset device, and condensing tank, if required. Once design flow rates have been established, the sizing of the meter, strainer, and control valve can be completed. Note that special care is needed in sizing the meter for performance and durability. Also, the control valve will need attention to ensure adequate system back pressure.

The critical considerations for LPG loading include:

- Pressure Design Codes – Understanding and applying design codes and safety standards, such as those established by the Department of Transportation (DOT), the American National Standards Institute (ANSI), the American Petroleum Institute (API), and the National Fire Protection Agency (NFPA), are the first steps in planning a successful installation.
- Design flow rates are typically derived from the size and type of fittings on the truck. Truck internal piping for liquid and vapor connections will also affect the flow rates.
- Temperature measurement is also critical. Both ambient and product temperature can affect the liquid state of LPG and therefore must be monitored and maintained.
- Supply lines from storage to the metering system should be sized to allow for minimum volume to prevent any accumulation of vapors should the temperature change significantly. Buried lines should be considered.

(Continued on next page)
Asphalt Loading

Overview
Asphalt loading involves the accurate and safe delivery of products. Asphalt loading is comparable to refined product loading with some notable differences. In the past, asphalts were blended in the tank farm to conform to Department of Transportation standards. Metering was primarily used as a general indication of volume and a safe loading method for truck overfill. The real measurement was done by weigh scales.

Typical Truck Loading Sequence
Asphalt is typically sold by weight with various blended grades depending on the particular requirements. A driver pulls on to a scale empty to obtain a gross vehicle weight, selects a specific meter dedicated to a blended product with an associated tank, then controls the loading of the truck through the use of a top-loading, manually operated valve. After loading, the truck "weighs out" and a Bill of Lading is produced based on weight.

Some terminals today use meters as the measurement standard in lieu of scales. By experience, the driver, noting the temperature and density of the blend, can preset the truck by volume. The actual loading is basically the same, controlled through a top-loading, manually operated valve. When the load is complete, the gross volume and gross at standard temperature volume, along with calculated weight, are printed on the Bill of Lading.

Terminals being upgraded today can improve the process even further with new technology. The use of Coriolis meters now allows for weight or volume loading with recording of each, without manual intervention. Electronic presets allow for site selection of blend recipes and eliminate the need for tank farm blending and tankage to store finished blends. Going one step further, by fully automating the terminal, drivers can now simply card in and allow the Terminal Automation System to select the blend and command the preset to set up and load the blend components on a per preset basis.

Considerations
The major considerations for the metering system at an Asphalt Loading Terminal are selection of the measurement standard, method of loading (weight or volume), and the data needed to produce a Bill of Lading for the truck. With regard to metering systems, either PD or Coriolis meters can be used. Turbine meters are not recommended due to viscosity. PD meters are volumetric devices and can load by volume or inferred mass by density. Coriolis meters measure mass and live density or inferred volume without other devices.

Regardless of the meter to be used, additional considerations include the strainer, control valve, and preset device.

The strainer should be selected based on desired flow rates and filter needs. Strainers in viscous applications will have high pressure drop with clean or dirty baskets.

The control valve will most likely be externally powered rather than using the flow media, primarily due to temperature and viscosity. The meter, control valve and strainer can be selected following sizing guidelines.

These are the primary considerations when choosing a metering system solution for asphalt truck loading. There may be additional company-specific requirements to consider.

Additional considerations for designing the metering system portion of an Asphalt Loading Terminal include: products to be loaded or blended, recipes and percentages, pump capabilities, pressure loading profiles, product delivery rates, temperature, viscosity, safety and equipment protection.

The preset control device must be able to handle these considerations and more. The preset control device is primarily used to regulate product delivery but can also be used as the primary measurement recording device for accurate, secure data, operator and driver safety, and as an interface to peripheral equipment.

Asphalt Unloading

Overview
There are three applications for truck unloading at a marketing terminal. On occasion, undelivered product can be off-loaded to storage. In a case where a needed product cannot be pipelined into a terminal, such as ethanol or biodiesel, product is delivered by truck, rail or barge and is off-loaded to storage. Most smaller bulk plants are not connected to main pipelines and take all delivered product by truck, rail or barge. In all cases, the application is quite similar.

Typical Truck Unloading Sequence
The driver connects the ground plug for static protection and the unloading hose to the inlet side of the metering system. The truck compartment valve is opened and the driver turns on the truck pump and pumps the compartment dry. Because the hose is full of air, both at the beginning and at the end of the unloading procedure, the metering system must contain devices to prevent air from being metered as well as to prevent possible damage to the meter.

During the process, the metering system becomes the central control for the primary functions of accurate and safe unloading of the product. The metering system typically includes a strainer, meter, control valve, and an air elimination device to handle the air at the beginning and the end of the unloading.

In the case of returning undelivered product, a preset device is not normally used unless there is information, transaction and events data required by the terminal. This is not always the case for unloading at bulk plants. Sometimes preset devices are used because the entire compartment may not be delivered to the location and a specified preset amount must be delivered.

Once the unloading is complete, the driver will disconnect the hose and ground and collect any required documentation.

Considerations
The major consideration for the metering system is the meter type for the application, with the primary factor for selecting a meter being viscosity and air vulnerability. Other influences need to be considered such as piping, vibrations, electrical installation, flow conditioning, chemical compatibility, system hydraulics, and past experience. A complete list of equipment choices includes the meter, strainer, control valve, and an air elimination system, which requires significant consideration as it must prevent any air from entering the metering system.

These are the primary considerations when choosing a metering system solution for refined product unloading. There may be additional company-specific requirements to consider.

Considerations for the preset include:

- Products to be unloaded
- Pump control
- Valve/flow control
- Accurate delivery of the preset amount (weight/volume)
- Monitoring of all critical loading functions
- Mass, volume and density calculation
- Record keeping (transaction data, delivery information)
- Communication with terminal automation system (status, transactions, events and authorizations)
- Safety interfaces

Normal considerations for designing a truck unloading metering system include:

- Products to be unloaded
- Pumping capabilities and type (PD Pump or self-priming centrifugal)
- Product unloading rates
- Meter and control valve sizing
- Piping configurations
- Air prevention and elimination system
- Product accountability
- Safety
- Equipment protection
Ethanol and Biodiesel Blending

Overview

The blending of either ethanol or biodiesel has many considerations. The primary concern in either case is the accurate proportions of each product blended into any given recipe. This blend accuracy depends on many variables within the system. The primary measuring device determines the overall system accuracy, thus meter selection is of great importance. The system hydraulics can have an effect on measurement as well as valve control, blending tolerance, repeatable shut-off, and safety. The type of blending chosen will require different or specific considerations to ensure proper hydraulics. In summary, the three most critical issues are: type of meter, method of blending, and system hydraulics.

FMC Technologies Measurement Solutions has published a complete Technical Paper for Renewable Fuels Blending (Publication Bulletin TP0A015) and can be found on the FMC Technologies web site www.fmctechnologies.com/measurementsolutions.

Major Considerations with Respect to the Top Three Critical Issues:

Meter Selection Technology – PD, Turbine, and Coriolis Meters

• Flow Range – Minimum to maximum flow rate varies from meter to meter depending on product characteristics.

• Viscosity – PD and Coriolis meters have a much broader range than small turbine meters; typically a small turbine meter is only accurate to a viscosity in centistokes (cSt) equal to its diameter.

• Temperature – Is not normally an issue for the meter as much as its effect on viscosity. The exception is biodiesel (B100), which will need to be maintained at 50° F (10° C) minimum to prevent crystallization. This normally means the tanks and all piping will be heat traced and insulated.

• Pressure – Is not normally an issue as long as adequate back pressure is maintained on metering devices to ensure accurate measurement.

Hydraulics of the System – Effects on Control Valves

• Flow Range – Minimum to maximum – A control valve has a range over which it can accurately and repeatedly control flow rate and maintain stability of the flowing system. Valves trying to operate outside their range will result in cyclic operation of the entire loading system causing surges, meter instability, non-repeatable shut-down, inaccurate blends, wear on the equipment, and safety issues.

• Viscosity – This is not normally an issue with the viscosities associated with refined products blending; however, it can affect control valve pressure loss due to viscosity increase and rate decrease.

• Temperature – Effects are related to changes in viscosity.

• Pressure – The operating pressure range is very critical for control valve functions. Consideration must be given to low flow rates at high pressure, as well as high flow rates at lower pressures. A rule of thumb is 60 - 80 psi meter inlet pressure. However, a complete pressure profile analysis should be done with both the fewest arms operating and the maximum number of arms operating.

Type of Blending – Sequential, Ratio or Combination Ratio/Sequential (Hybrid)

• Flow Range –
  Sequential: Since this method uses a single meter, it is required that all products in the recipe flow within the range of the meter. This can be an issue for the minor components in the recipe. When loading small compartments, the minor component may run for a very short period of time and can create issues of inaccurate blends and shut-off.
  Ratio: Since each product in a ratio blender has its own meter, it is critical for each product to run within the limits of both the meter and the control valve. The low flow start rate is of great importance, especially for the minor components of the recipe.
  Hybrid: Considerations are the same for both Sequential and Ratio.

• Viscosity – Consideration only as it affects Flow Range regardless of the type of blending.

• Temperature – Consideration only if one of the components in the recipe has an issue with its ability to mix well with the products and stay mixed.

• Pressure –
  Sequential: Not normally an issue as long as typical pressures are maintained.
  Ratio: Standard Ratio Blending where the product streams are blended in a common manifold, downstream of each product’s control valves, is not normally an issue as long as typical pressures are maintained. For Side-Stream Ratio where the minor component is plumbed in upstream of the main delivery meter, the minor component must have sufficient pressure to get into the mainstream under all flowing conditions.
  Hybrid: Both Sequential and Ratio considerations apply.
Overview
The blending of either ethanol or biodiesel has many considerations. The primary concern in either case is the accurate proportions of each product blended into any given recipe. This blend accuracy depends on many variables within the system. The primary measuring device determines the overall system accuracy, thus meter selection is of great importance. The system hydraulics can have an effect on measurement as well as valve control, blending tolerance, repeatable shut-off, and safety. The type of blending chosen will require different or specific considerations to ensure proper hydraulics. In summary, the three most critical issues are: type of meter, method of blending, and system hydraulics.

FMC Technologies Measurement Solutions has published a complete Technical Paper for Renewable Fuels Blending (Publication Bulletin TP0A015) and can be found on the FMC Technologies web site www.fmctechnologies.com/measurementsolutions.

Major Considerations with Respect to the Top Three Critical Issues:

**Meter Selection Technology – PD, Turbine, and Coriolis Meters**
- **Flow Range** – Minimum to maximum flow rate varies from meter to meter depending on product characteristics.
- **Viscosity** – PD and Coriolis meters have a much broader range than small turbine meters; typically a small turbine meter is only accurate to a viscosity in centistokes (cSt) equal to its diameter.
- **Temperature** – Is not normally an issue for the meter as much as its effect on viscosity. The exception is biodiesel (B100), which will need to be maintained at 50° F (10° C) minimum to prevent crystallization. This normally means the tanks and all piping will be heat traced and insulated.
- **Pressure** – Is not normally an issue as long as adequate back pressure is maintained on metering devices to ensure accurate measurement.

**Hydraulics of the System – Effects on Control Valves**
- **Flow Range** – Minimum to maximum – A control valve has a range over which it can accurately and repeatedly control flow rate and maintain stability of the flowing system. Valves trying to operate outside their range will result in cyclic operation of the entire loading system causing surges, meter instability, non-repeatable shut-down, inaccurate blends, wear on the equipment, and safety issues.
- **Viscosity** – This is not normally an issue with the viscosities associated with refined products blending; however, it can affect control valve pressure loss due to viscosity increase and rate decrease.
- **Temperature** – Effects are related to changes in viscosity.
- **Pressure** – The operating pressure range is very critical for control valve functions. Consideration must be given to low flow rates at high pressure, as well as high flow rates at lower pressures. A rule of thumb is 60 - 80 psi meter inlet pressure. However, a complete pressure profile analysis should be done with both the fewest arms operating and the maximum number of arms operating.

**Type of Blending – Sequential, Ratio or Combination Ratio/Sequential (Hybrid)**
- **Flow Range** – Sequential: Since this method uses a single meter, it is required that all products in the recipe flow within the range of the meter. This can be an issue for the minor components in the recipe. When loading small compartments, the minor component may run for a very short period of time and can create issues of inaccurate blends and shut-off.
  Ratio: Since each product in a ratio blender has its own meter, it is critical for each product to run within the limits of both the meter and the control valve. The low flow start rate is of great importance, especially for the minor components of the recipe.
  Hybrid: Considerations are the same for both Sequential and Ratio.
- **Viscosity** – Only as it affects Flow Range regardless of the type of blending.
- **Temperature** – Consideration only if one of the components in the recipe has an issue with its ability to mix well with the products and stay mixed.
- **Pressure** – Sequential: Not normally an issue as long as typical pressures are maintained.
  Ratio: Standard Ratio Blending where the product streams are blended in a common manifold, downstream of each product’s control valves, is not normally an issue as long as typical pressures are maintained. For Side-Stream Ratio where the minor component is plumbed in upstream of the main delivery meter, the minor component must have sufficient pressure to get into the mainstream under all flowing conditions.
  Hybrid: Both Sequential and Ratio considerations apply.
Asphalt Loading

Overview

Asphalt loading involves the accurate and safe delivery of products. Asphalt loading is comparable to refined product loading with some notable differences. In the past, asphalts were blended in the tank farm to conform to Department of Transportation standards. Metering was primarily used in a general indication of volume and a safe loading method for truck overfill. The real measurement was done by weigh scales.

Typical Truck Loading Sequence

Asphalt is typically sold by weight with various blended grades depending on the particular requirements. A driver pulls on to a scale empty to obtain a gross vehicle weight, selects a specific meter dedicated to a blended product with an associated tank, then controls the loading of the truck through the use of a top-loading, manually operated valve. After loading, the truck “weighs out” and a Bill of Lading is produced based on weight.

Some terminals today use meters as the measurement standard in lieu of scales. By experience, the driver, noting the temperature and density of the blend, can preset the truck by volume. The actual loading is basically the same, controlled through a top-loading, manually operated valve. When the load is complete, the gross volume and gross at standard temperature volume, along with calculated weight, are printed on the Bill of Lading.

Terminals being upgraded today can improve the process even further with new technology. The use of Coriolis meters now allows for weight or volume loading with recording of each, without manual intervention. Electronic presets allow for site selection of blend recipes and eliminate the need for tank farm blending and tankage to store finished blends. Going one step further, by fully automating the terminal, drivers can now simply card in and allow the Terminal Automation System to select the blend and command the preset to set up and load the blend components on a per preset basis.

Considerations

The major considerations for the metering system at an Asphalt Loading Terminal are selection of the measurement standard, method of loading (weight or volume), and the data needed to produce a Bill of Lading for the truck. With regard to metering systems, either PD or Coriolis meters can be used. Turbine meters are not recommended due to viscosity. PD meters are volumetric devices and can lead by volume or inferred mass by density. Coriolis meters measure mass and live density or inferred volume without other devices.

Regardless of the meter to be used, additional considerations include the strainer, control valve, and preset device.

The strainer should be selected based on desired flow rates and filter needs. Strainers in viscous applications will have high pressure drop with clean or dirty baskets.

The control valve will most likely be externally powered rather than using the flow media, primarily due to temperature and viscosity. The meter, control valve and strainer can be selected following sizing guidelines.

These are the primary considerations when choosing a metering system solution for asphalt truck loading. There may be additional company-specific requirements to consider.

Additional considerations for designing the metering system portion of an Asphalt Loading Terminal include: products to be loaded or blended, recipes and percentages, pump capabilities, pressure loading profiles, product delivery rates, temperature, viscosity, safety and equipment protection.

The preset control device must be able to handle these considerations and more. The preset control device is primarily used to regulate product delivery but can also be used as the primary measurement recording device for accurate, secure data, operator and driver safety, and as an interface to peripheral equipment.

Refined Product Unloading

Overview

There are three applications for truck unloading at a marketing terminal. On occasion, undelivered product can be off-loaded to storage. In a case where a needed product cannot be pipelined into a terminal, such as ethanol or biodiesel, product is delivered by truck, rail or barge and is off-loaded to storage. Most smaller bulk plants are not connected to main pipelines and take all delivered product by truck, rail or barge. In all cases, the application is quite similar.

Typical Truck Unloading Sequence

The driver connects the ground plug for static protection and the unloading hose to the inlet side of the metering system. The truck compartment valve is opened and the driver turns on the truck pump and pumps the compartment dry. Because the hose is full of air, both at the beginning and at the end of the unloading procedure, the metering system must contain devices to prevent air from being metered as well as to prevent possible damage to the meter.

During the process, the metering system becomes the central control for the primary functions of accurate and safe unloading of the product. The metering system typically includes a strainer, meter, control valve, and an air elimination device to handle the air at the beginning and the end of the unloading.

In the case of returning undelivered product, a preset device is not normally used unless there is information, transaction and events data required by the terminal. This is not always the case for unloading at bulk plants. Sometimes preset devices are used because the entire compartment may not be delivered to the location and a specified preset amount must be delivered.

Once the unloading is complete, the driver will disconnect the hose and ground and collect any required documentation.

Considerations

The major consideration for the metering system is the meter type for the application, with the primary factor for selecting a meter being viscosity and air vulnerability. Other influences need to be considered such as piping, vibrations, electrical installation, flow conditioning, chemical compatibility, system hydraulics, and past experience. A complete list of equipment choices includes the meter, strainer, control valve, and an air elimination system, which requires significant consideration as it must prevent any air from entering the metering system.

These are the primary considerations when choosing a metering system solution for refined product unloading. There may be additional company-specific requirements to consider.
Refined Product Loading

Once the driver has set the load, the preset takes control of the entire process. The safety devices are connected and the preset controls all aspects of flow and volume accumulation from the meter. The preset is also responsible for data integrity and transfer of the transaction information to the Terminal Automation System (TAS). This will generate a Bill of Lading for the track showing all products loaded and other information. Once loading is completed, the driver will disconnect the load arm(s) and safety devices, retrieve the Bill of Lading and exit the terminal.

Considerations

- The major consideration for the metering system at a terminal load rack is the type of meter chosen. Viscosity is the primary factor for selecting a meter for truck loading when choosing a positive displacement meter, turbine meter or Coriolis meter. Certain other influences need to be considered when selecting the appropriate meter such as piping, vibrations, electrical installation, flow conditioning, chemical compatibility, system hydraulics, and past experience.

The choice of equipment to be used involves not only the meter, but also the strainer, control valve and preset device, as well as the interface to necessary peripheral devices. The meter, control valve, and strainer can be selected following sizing guidelines. These are the primary considerations when choosing a metering system solution for refined products loading. There may be additional company-specific requirements to consider.

Preset Control Device

The preset control device needs to be able to handle most of these considerations and more. The preset control device is primarily used to regulate product delivery, ensure data integrity, provide security and safety, and act as an interface to peripheral devices.

The following are some considerations for the preset:

- Pump control
- Valve/flow control
- System security
- Accurate delivery of the preset amount
- Monitoring of all critical loading functions
- Volume accumulation (meter error correction, temperature, pressure, density correction)
- Record keeping (transaction data, display information)
- Communications with Terminal Automation Systems (status, transactions, events and authorizations)
- Proving software
- Safety interface (overfill and ground, vapor recovery and others)
- Additive control and reconciliation

Additional considerations for designing the metering portion of a truck loading system include:

- Products required to be loaded or blended
- Recipes and percentages
- Pumping capabilities
- Pressure loading profiles
- Product delivery rates
- Meter and control valve sizing
- Number of arms per product
- Piping configurations
- Contamination
- Product accountability
- Safety
- Equipment protection
- Load rack utilization (arrangement of products and arms to support rack throughput)

LPG Loading

Overview

The truck loading of LPG, while similar to refined products loading, has unique requirements. LPG is more volatile than gasoline or distillates and special care must be taken to ensure safe and accurate loading. This overview concentrates on procedures, considerations, and solutions pertaining to truck loading of LPG.

As with refined product terminals, the typical LPG terminal will have a security and terminal automation system. The loading procedure is much the same as it is for refined products. The driver identifies himself and perhaps the truck. They receive authorization to load and proceed to connect loading arms and safety devices.

Once again, the most important part of the loading process is the metering system and much of the equipment is the same as other loading processes such as the choice of meter, strainer, and electronic preset. There are a few significant differences in LPG loading, including the fact that flow parameters and system pressures play a major role in the loading process. This requires additional considerations for the control valve, additives, and means of ensuring accurate measurement by maintaining the product in a liquid state at all times.

Considerations

Unlike refined products loading, LPG loading has a number of major concerns. One of the obvious considerations is the meter, where certain properties of LPG come into play. LPG is quite non-lubricating, and therefore, care must be taken in the selection of the meter to account for this issue. Because LPG has a low vapor pressure, attention must be given to ensure the product remains in a consistent liquid state. Finally, one of the major concerns is that LPG is colorless and odorless and requires an odorant to be injected without fail.

The choice of equipment to be used involves the meter, strainer, control valve, odorant injector, preset device, and condensing valve/flow control. Truck internal piping for liquid and vapor connections will also affect the flow rates.

The critical considerations for LPG loading include:

- Pressure Design Codes – Understanding and applying design codes and safety standards, such as those established by the Department of Transportation (DOT), the American National Standards Institute (ANSI), the American Petroleum Institute (API), and the National Fire Protection Agency (NFPA), are the first steps in planning a successful installation.
- Design flow rates are typically derived from the size and type of fittings on the truck. Truck internal piping for liquid and vapor connections will also affect the flow rates.
- Temperature measurement is also critical. Both ambient and product temperature can affect the liquid state of LPG and therefore must be monitored and maintained.
- Supply lines from storage to the metering system should be sized to allow for minimum volume to prevent any accumulation of vapors should the temperature change significantly. Buried lines should be considered.

The following are some considerations for LPG loading:

- Pressure Design Codes – Understanding and applying design codes and safety standards, such as those established by the Department of Transportation (DOT), the American National Standards Institute (ANSI), the American Petroleum Institute (API), and the National Fire Protection Agency (NFPA), are the first steps in planning a successful installation.
- Design flow rates are typically derived from the size and type of fittings on the truck. Truck internal piping for liquid and vapor connections will also affect the flow rates.
- Temperature measurement is also critical. Both ambient and product temperature can affect the liquid state of LPG and therefore must be monitored and maintained.
- Supply lines from storage to the metering system should be sized to allow for minimum volume to prevent any accumulation of vapors should the temperature change significantly. Buried lines should be considered.

(Continued on next page)
Condensing tanks can be used to ensure the meter will always have a liquid head pressure. The tanks provide for the condensation of vapors during product flow. As an alternative, differential back pressure control can be accomplished by continually monitoring temperature and pressure during transport loading and adjusting valve position to ensure product is always metered above vapor pressure. This can be accomplished using electronic presets with temperature and pressure inputs.

Odorant injection is extremely critical. Typically between 1 to 1.5 pounds of odorant per 10,000 gallons is required by law. Also, some means of detecting and reporting odorant activity is required.

The preset control device must be able to handle all the loading considerations that regulate product delivery, ensure data integrity, provide security and safety, and act as an interface to peripheral devices.

Considerations for the preset include:

- Pump control
- Valve and back pressure control
- Accurate delivery of the preset amount
- Monitoring of all critical functions
- Volume plus mass accumulation (meter error correction, temperature, pressure, and density correction)
- Record keeping (transaction data, display information)
- Communications with terminal automation systems (status, transactions, events, and authorizations)
- Proving software
- Safety interfaces (overfill and ground, vapor connections and others)
- Condensing tank controls or alternative vapor pressure valve control
- Odorant injection, control, and monitoring

**LPG Loading**

**Overview**

Refined product loading at a marketing terminal loading rack involves the safe, accurate delivery of product on board the truck. While there are many facets involved in loading a truck, this guideline concentrates on procedures, considerations, and solutions from the time the truck arrives at the terminal gate until the truck completes all transactions and leaves the terminal.

The state-of-the-art terminal today requires a number of functions to ensure truck loading is completed according to industry requirements. These requirements may be stipulated by the oil company, by the government, or by the demands of environmental regulations, requiring different types of equipment and systems be put into place.

**Typical Truck Loading Sequence**

The truck arrives at the terminal gate where a Gate Card Security and Authorization system is in place to allow the driver to identify himself and/or the truck. This information is sent to a computerized Terminal Automation System (TAS) that contains all the necessary files to identify the request and either authorize or deny entry.

The terminal will have multiple loading bays where a number of trucks can load simultaneously. Once at the appropriate loading bay, the driver will typically be required again to use some identification by means of either a card or badge reader. Here the products are selected and, if allocated in the TAS, the driver will be authorized to load. Whether loading only one product into all compartments of the truck or loading several different products into different compartments, the basic loading procedure is the same. Much of today’s loading requires systems to be able to deliver single products or a combination of products simultaneously to obtain various blends.

As the loading process begins, safety devices must be engaged. Overfill detectors are connected to prevent the truck from being overloaded. Since the loaded products are flammable, a grounding device is connected to eliminate the possibility of static discharge. Because a good portion of today’s loading is done by the bottom loading method where the truck is not vented to the atmosphere, trucks that have returned from a delivery will contain vapors. These vapors need to be dealt with as they are both hazardous and valuable. Therefore, typically the truck will connect to a vapor recovery hose prior to loading. The new incoming product pushes the vapors to the top of the truck and out the hose to the vapor recovery system for processing. While these are the primary safety devices, there may be more depending on user requirements.

After all safety requirements are met, the driver will connect the loading arm and open the appropriate compartment valves on the truck. At this point, the metering system becomes the central control for the primary functions of accurate and safe product loading. One component of the metering system is the Preset Control Device. This device is the interface where the driver configures the products and the amounts to be loaded.

(Continued on next page)
FMC Technologies is the leading supplier for terminal measurement equipment with:

**Experience** – Over 70 years of experience in terminal applications worldwide; more than any other supplier.

**Worldwide sales and service** – Local support before and after the sale.

**The right meter** – FMC Positive Displacement, Turbine, and Proline Coriolis Meters.

**Accessories** – Mechanical or electronic controllers, control valves, temperature compensators, transmitters, strainers, and air eliminators.

**Worldwide approvals** – Our equipment meets (or exceeds) most weights and measures, electrical and mechanical design code requirements – worldwide.
FMC Technologies and Our Measurement Solutions

Legacy Brands

FMC Technologies, Inc. is a global leader providing mission-critical technology solutions for the energy industry. Its Measurement Solutions business unit excels in process systems, measurement technologies, transportation, and custody transfer of gases and liquids in the oil and gas industry. FMC Technologies employs approximately 12,500 people and operates 27 production facilities in 16 countries.

FMC Technologies Measurement Solutions sets the standard for global Best Measurement Practices by designing, manufacturing and servicing the precision products and systems used to measure and control liquids and gases in industrial applications. The Smith Meter® brand is known worldwide for its ability to produce reliable, accurate and consistent measurement results. Similarly, our Sening® brand tank truck components and systems are trusted to provide safety and environmental protection while ensuring accurate measurement during the transport and transfer of liquid products. Both Smith Meter® and Sening® are trademarks owned by FMC Technologies, Inc.

Guide to Marketing Terminals

Refined Product Loading and Unloading

Ethanol and Biodiesel Blending

Asphalt Loading

LPG Loading