Automated Truck Loading Systems
Class# 2030

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1 Introduction

Terminal Management Systems (TMS) are used at bulk marketing storage facilities (terminals) to support distribution of liquid products from storage to vehicle. Terminals are downstream from the refinery and owned and operated by major oil or independent terminal companies. Products are generally stored in fixed tanks and include refined, gasoline, and chemicals.

The TMS is a PC based terminal management software application to provide security using driver data validation, automated printout of bills of lading, and product inventory management together with the load rack products responsible for measurement and control of product loading.

Each terminal may include any number of load racks with communications from the load rack electronics to the TMS located in a main terminal building.

2 Automated Loading Products

Common loading requirements have resulted in the availability of standard products to support automated operations. These products include the required features and approvals and can be installed and configured by terminal operators with the minimum of training.

Flow Meter

Loaded product is measured by weight or volume and measurement devices must include Weights and Measures approval if the loaded product is considered a custody transfer (point of sale). For weighed product loading it is standard practice to use a mass flow meter or weigh scale and for volumetric loading a positive displacement meter or turbine meter is normally used.

Control Valve

A digital flow control valve, wired to an electronic preset, provides flow control. The electronic preset is configured to support the particular product loading requirements. Care must be taken to select a valve that will close quickly in an emergency situation with loss of power and possible reduction in line pressure. For blending operations additional control valves and meters will be required.

Electronic Preset

The electronic preset is a batch controller developed specifically to control load rack operations and be mounted at the load rack to reduce wiring costs. This device can operate in either standalone or automated mode where it is wired to the TMS using serial RS-485 or RS-232 communications. Each electronic preset can be multi-dropped on a single communications line and includes a second serial communications port wired to a shared load printer to provide standalone mode bill of lading printouts. The electronic preset can be configured to support ratio, sequential or straight product loading and includes a staged flow

profile required for truck loading. Multiple products can be blended at the load rack as required with or without additive and reduce tank storage requirements.

Net temperature compensation is provided with the addition of a RTD temperature probe installed in the main product line. This compensates for volumetric changes in product due to changes in product temperature. Standard API temperature conversion tables are used for the particular products.

Pressure and density can also be measured in real-time, if required. The electronic preset includes 4-20mA inputs to support these inputs.

The electronic preset supports meters and valves common to the industry. Once installed the meter is calibrated against a Weights and Measures approved proving device to ensure accurate product measurement. The electronic preset includes write protected Weights and Measures registers for the meter calibration factors. The electronic preset can also perform calibration monitoring of the meter and alarm during the load if calibration changes for any reason.

Additive Injector

Additive injection is used to dispense the required brand of additive to the base product during the load. This is commonly achieved by the use of a "dumb" injector, consisting of a simple meter and solenoid design, controlled by the electronic preset.
The electronic preset activates the correct additive injector based upon the product recipe selected by a pull-down menu. The electronic preset includes the functionality to support multiple additives at the same load arm, essential for terminals supporting multiple suppliers.
Configurable I/O is available for the additive pump and solenoid outputs, and high resolution additive meter inputs. No conflict can exist between the electronic preset and the "dumb" injector and the exact required dose of additive can be dispensed at all times during the load, with the option to clean line flush. If for any reason additive amounts become out of tolerance during loading, the electronic preset will try to compensate to bring amounts back into specification by over or under additizing, and will terminate loading if additive amounts cannot be corrected.

Typical Load Rack Configuration

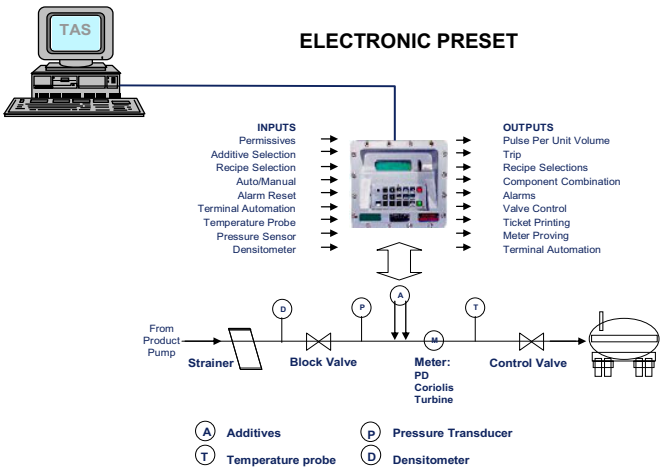

Figure 1

Terminal Management System

The TMS is used to manger product distribution at the terminal. Product is tracked separately for each supplier, and product throughput is reconciled over a configurable period, usually every 24 hours. Reports are automatically generated for each supplier with access to information fully password protected.
Automatic tank gauging systems can be connected to the TMS to provide a comparison between physical tank inventory versus calculated inventory based upon throughput. Any differences are reported as gain/loss amounts for that period.
The TMS can support both order driven operations with the preset automatically downloaded to the electronic preset, and allocation based operations where drivers enter a customer number and the required preset amount of product on the electronic preset. This amount is checked against the customer's product allocation before the load is authorized. The TMS should be capable of supporting unmanned operations at all times. Messages displayed at the load rack should be simple and easy to understand to help reduce loading times.

In Figure 2 below, improved network communications now offer the potential to manage multiple terminals from a single TMS server, offering reduced costs for companies managing multiple terminal operations.

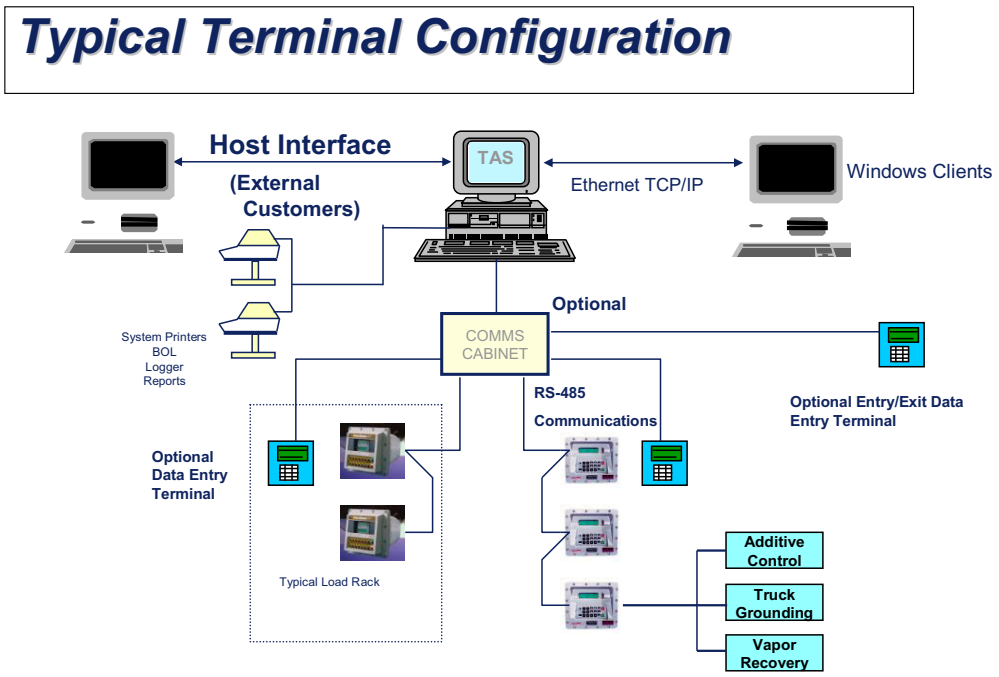

Figure 2

3. Additional Requirements.

Safe Loading Practices

Although vapors may not be present at all times the potential always exists and devices should be supplied as explosive proof.
Flow rates for truck loading should follow API publication 2003 recommending safeguards against ignitions from static electricity. Flow rates should be limited to around 600. Gallons Per Minute for 4" pipe for gasoline products.

An Emergency Shut Down (ESD), switch should be provided at each load rack which, if activated, should remove AC power from all field devices and terminate all loading operations.

A grounding system must be connected to the vehicle at all times during loading to dissipate any static electricity built-up on the vehicle. This connection is made using a standard multi-pin low-voltage plug to a mating receptacle fitted on the vehicle. A contact closure is used to signal a good ground connection which is wired to the electronic presets at the load rack. The electronic presets are configured to detect this input before allowing any load to start.

Security of Operations

The TMS must validate loading information before loading can begin. The driver is prompted by messages from the TMS displayed on the electronic preset to enter the required load information. Once approved, the electronic preset extends power to the field devices and loading can begin.

A data entry terminal can be provided at the main gate in the case of unmanned operations. The driver enters his driver and pin number and after verification the TMS signals the automatic gate control circuitry to open the gate.

Environmental Requirements

Bottom Loading is mandatory in the USA for gasoline products and provides a self-contained system where gasoline vapors cannot reach the atmosphere, being returned to a Vapor Recovery System.
A truck overspill system can be installed to sense product level in the compartment using an optical sensor.
If triggered this system will remove power from the flow control valve and immediately shut down the load. The electronic preset will display an overspill alarm message signaled by a contact closure from the overspill system.

Efficient Loading Operations

Efficient loading operations are best achieved by selecting cost-effective products that meet operational requirements and reduce loading times.

Use of electronic presets to support additive accounting with "dumb" injectors rather than "smart" injectors greatly reduces cost. An electronic preset can be used as the driver interface with the TMS and further reduce costs.
Electronic preset meter calibration monitoring can alert the terminal operator of potential problems with the metering device at an early stage and prevent product losses between meter proving cycles.

For weighed product-loading, use of a mass flow meter and electronic preset combination eliminates the cost for the weigh scale and improves loading times by eliminating the need to weigh trucks after each compartment is loaded.

4. Conclusion.

A well designed Terminal Management System will offer a flexible, scalable solution that will meet the individual needs of the terminal.
It will improve throughput, help insure safe operations and can now be provided as multi-terminal solutions with load rack products as part of the solution.