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Challenges in blending of Biofuels in Terminals

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Abstract

Bulk storage petroleum facilities are often referred to as supply and distribution terminals are used to receive, store, load or transfer petroleum product into tank trucks or rail wagons or barges. Such transfer of petroleum product has become a concern in areas of safety, security, measurement accuracy, hazardous area approval and other regulatory requirements

With the advancement of electronic systems, improvements have been made in this area

This paper will focus on the salient features of the batch controller which is an integral and most important part of the metering system and the types of blending that are available in an electronic microprocessor based Batch controller

KEYWORDS:

Ratio Blending, Batch controller, Renewable fuels, Ethanol

1.0 Introduction

The loading of petroleum products at depots and terminals have undergone tremendous changes since the early 19080's. These changes, for the most part, have taken place due to the introduction of electronic instrumentation and control devices. In earlier days traditional mechanical equipment used to find place in the gantry for loading purposes. Because of the features of the electronic batch controller many of the changes could be made possible to meet the needs of modern day loading facilities

The modern day batch controller is designed to be modular and scalable to fit the needs of virtually any loading application..

They are designed to improve the traditional preset model by offering a number of key benefits, such as: ease of use, powerful stand-alone operation, seamless integration with automation systems, near limitless scalability, and powerful features. They save time and money and have a reduced cost of ownership with anytime, anywhere access and remote control. This helps the users to access the batch controller via internet anywhere in the world via the internet with appropriate authorisation to view the real-time meter activity, logs, alarms, and configurations.

While product accountability, reduced operating cost and improved inventory control continue to remain one of the major benefits of the electronic batch controller, government regulations have also had a large impact on the upgrading effort. Primarily these regulations have meant that across the geography of India the petroleum products be blended with Ethanol or biodiesel to be delivered to the retail outlets from the terminal facilities

Combining this with the requirements of premium grade petrol & diesel for today's fuel efficient automobiles, the blending requirements have become more complex. The electronic batch controller, today, can load multiple products, additives, main desired blending percentages all while simultaneously controlling preset valves, monitoring meter pulses and keeping necessary activity logs

2.0 Why blend

Figure 1.0 Rudolf Diesel

2.1 Background.

The concept of using vegetable oil as a fuel dates back to 1895 when Dr. Rudolf Diesel developed the first diesel engine to run on vegetable oil. He demonstrated his engine at the World Exhibition in Paris in 1900 and described an experiment using peanut oil as fuel in his engine

In 1911 Rudolf Diesel stated: "The diesel engine can be fed with vegetable oils and would help considerably in the development of agriculture of the countries which use it."

In 1912, Diesel said "the use of vegetable oils for engine fuels may seem insignificant today. But such oils may become in course of time as important as petroleum and the coal tar products of the present time

2.2 Why are renewable fuels used?

A) Domestic production.

- Energy security
- Renewable

B) Functions in existing engines.

C) Utilizes current distribution

D) Social benefits

i) Strengthens agricultural base

ii) Reduced carbon monoxide emissions

E) Effects on Fuel Properties / Performance

i) Improves Thermal stability of fuel

ii) Enhances octane number of petrol thereby improving ffuel economy

Iii) Better Lubricity of diesel fuel and detergency

iv) Higher Cetane number for diesel

v) Lowers Emissions

2.3 What are renewable fuels?

Ethanol

Ethanol is a chemical compound that is also called ethyl alcohol or grain alcohol (CH3CH2OH). It is a clear and colourless liquid at room temperature.

Ethanol can be manufactured from..

- Sugar based crops
- Starch based crops
- Forest industry waste
- grasses or straw

Common sources are…

- Corn
- Wheat
- Sugar Cane
- Sugar Beet

Bio-Diesel

Alternative fuel comprised of mono-alkyl esters of long chain fatty acids derived from renewable biological resources

Bio-diesel can be manufactured from..

Vegetable oils

Recycled cooking oils

Animal fats

Tall oil from wood pulp waste

Common sources are …

Soybeans

Rapeseed

Jatropha nuts

Coconuts

Palm trees

2.4 What are their properties?

- Standard Specification for "Denatured fuel ethanol for blending with gasoline, for use as automotive spark-ignition engine fuel",

  EN 228:2004.

- Defines properties for unleaded fuel to be sold in the EU.
- Allows up to 5% Ethanol

Fuel Grade Ethanol is not defined based on the feedstock.

Exx refers to the percentage of

Ethanol blended with fuel.

a)E5 = 5% Ethanol

b)E10 = 10% Ethanol

c)E85 = 85% Ethanol

ASTM D 6751 – 03a

- Standard Specification for Bio-diesel Fuel Blend Stock (B100) for Middle Distillate Fuels

  EN590:2000

- Defines properties for diesel fuel to be sold in the

EU, Czech Republic, Iceland, Norway or Switzerland

- Allows up to 5% FAME

ASTM D 4806-98

Based on the feedstock, bio-diesel may be referred to…

- SME or SOME – Soybean methyl ester
- RME – Rapeseed methyl ester
- CME - Coconut methyl ester
- FAME – Fatty acid methyl ester (collective term for bio-diesel)

Bxx refers to the

percentage of

FAME blended with diesel

fuel.

a)B2 = 2% FAME

b)B20 = 20% FAME

c)B100 = 100% FAME

2.5 What are the Asia-Pacific trends?

Demand for biofuel is projected to be strong

Asia Pacific region relies heavily on imported crude oil

Many countries are concerned about energy security

Pollution from transport sector is a serious problem in many large cities

Several Asian nations are introducing bio-diesel policies

Asia pacific has available land and ideal climate for growing vegetable oil crops

- Palm
- Coconut
- Jatropha…

2.6 India trends:

Ethanol blending is the practice of blending petrol with ethanol. Many countries, including India, have adopted ethanol blending in petrol in order to reduce vehicle exhaust emissions and also to reduce the import burden on account of crude petroleum from which petrol is produced. It is estimated that a 5% blending (105 crore litres) can result in replacement of around 1.8 million Barrels of crude oil. The renewable ethanol content, which is a byproduct of the sugar industry, is expected to result in a net reduction in the emission of carbon dioxide, carbon monoxide (CO) and hydrocarbons (HC). Ethanol itself burns cleaner and burns more completely than petrol it is blended into. In India, ethanol is mainly derived by sugarcane molasses, which is a by-product in the conversion of sugar cane juice to sugar.

■ 2.7 Renewable fuel issues at the storage/loading terminal.

a)Ethanol Water Tolerance

- If ethanol blended fuel becomes contaminated with too much water, phase separation can occur.
- When phase separation occurs, the blend separates into two layers: fuel on top, ethanol/water on bottom.
- Phase separation is more likely to occur with:
  - Higher amounts of water contamination
  - Lower temperatures
  - Less alcohol

B) Ethanol Blending Growth

- When you mix Ethanol with fuel there is growth factor that occurs.
- 90 liters of fuel and 10 liters of Ethanol equal 100.+ liters of blended product.
- The factor varies with Ethanol quality and type.
- Resent test results by some of the major oil companies indicate 0.2% to 0.4% growth.

Originally when Ethanol was first introduced as a component to Motor spirit (MS) the curiosity of its Exothermic and Endothermic (Expansion and contraction) when combined with MS was identified.

This expansion and contraction is so inconsistent a true correction table has yet to be developed since pressure, temperature and delivery rate seem to impact this growth factor. Most customers use Table 6B as a reference at this time. But customers were still trying to identify why they were having losses and yet seeing gains at some point. They have identified a rise in complaints from their customers on volume discrepancies, why?

The graph of ethanol- gasoline volume expansion is highlighted in the chart as

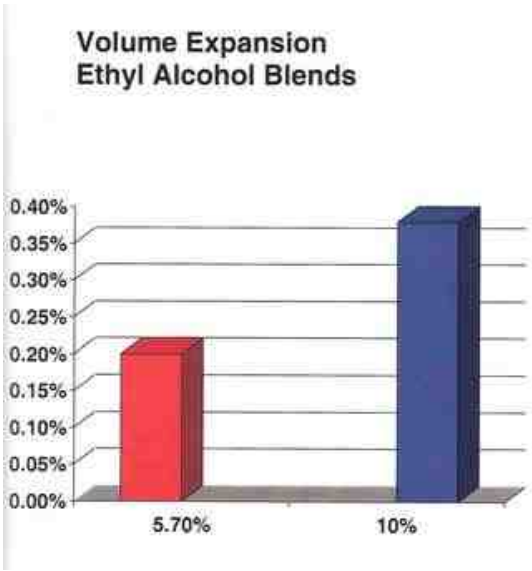

Figure 2.0 Volume expansion of ethanol in gasoline

3.0 Blending types

3.1 RATIO BLENDING

Ratio blending is a blend configuration that controls two or more different products simultaneously through individual control valves. (refer Figure 3.0)

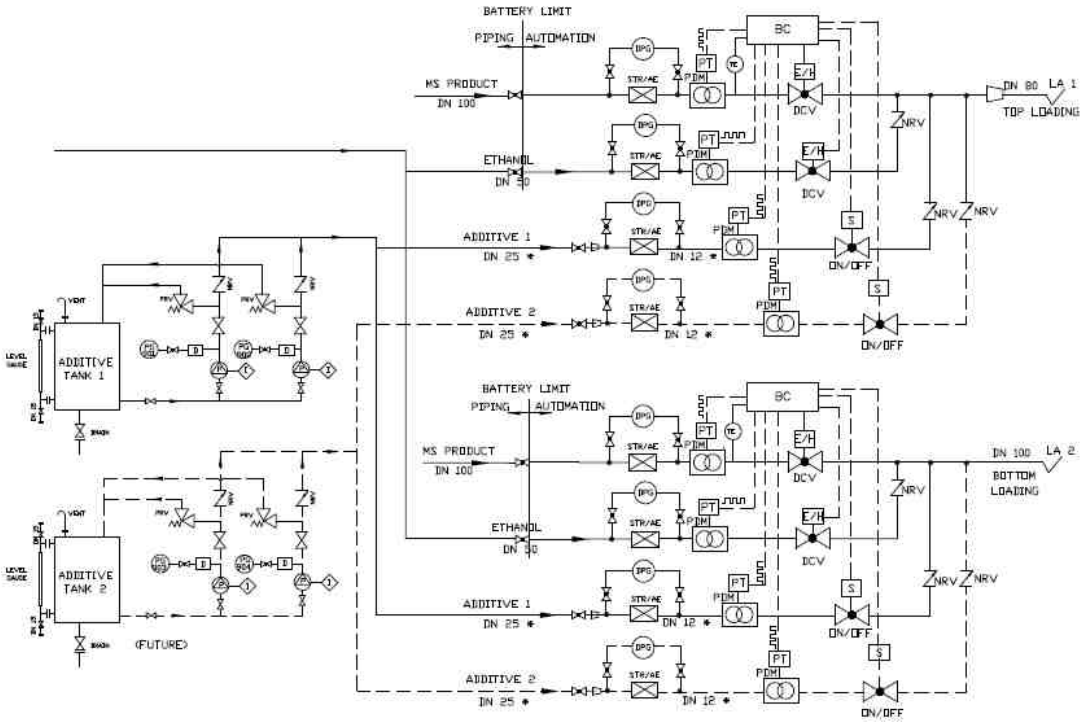

Fig 3.0 Typical P&ID of the loading of gasohol with Ratio blending

3.2 HOW RATIO BLENDING IS ACHIEVED IN A TERMINAL

In the above schematic(Fig 3.0), the batch controller controls the ratio of gasoline and ethanol and helps achieve the blended gasohol

The ratio of gasoline and ethanol is set in the batch controller. The quantity to be preset for each compartment is set in the batch controller. For example if the quantity to be loaded is 4000 litres and ethanol is 10%; the batch controller computes the quantity to be loaded for gasoline as 3600 and for ethanol as 400 litres and thereby controls and operates the loading sequence

The digital control valve(refer Fig 4) is the key component of the meter run. The batch controller makes adjustments to the valve opening, closing and control based on the feedback from the flow meter

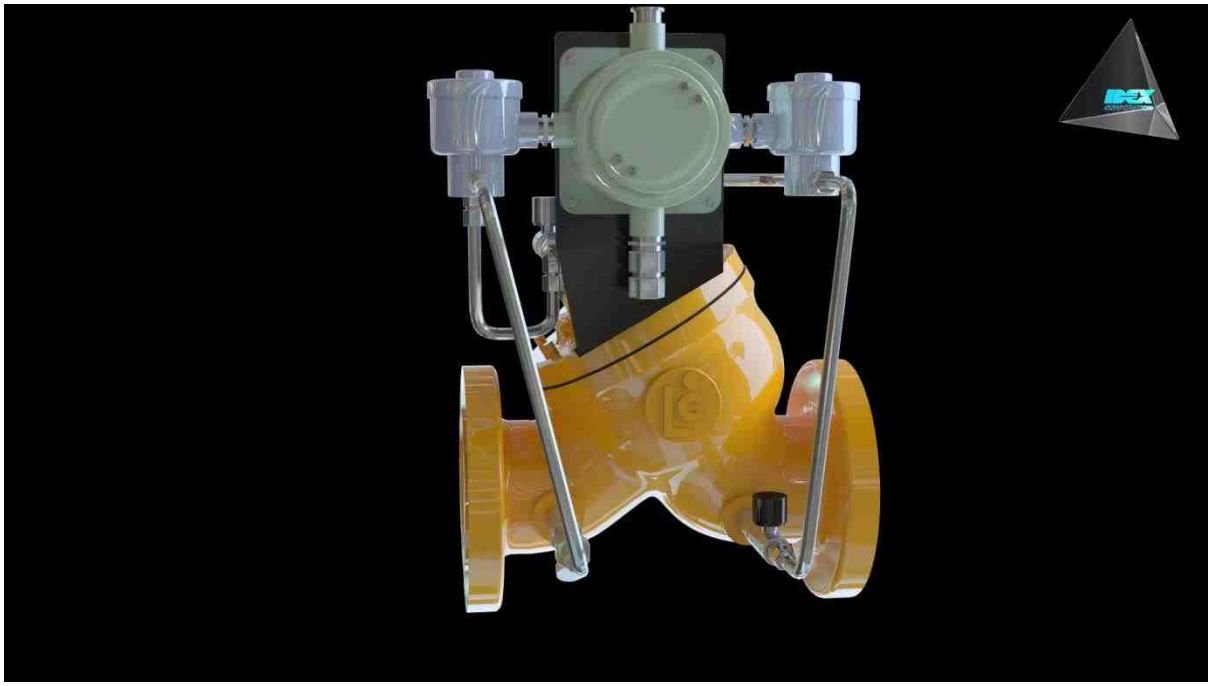

Fig 4.0 Digital control valve

3.3 Process of Ratio blending

The flow profile illustrated below(Fig 5.0) shows each stage progresses throughout a load

When the start button on the batch controller is pressed, the gasoline digital control valve opens and the flow rate ramps up from zero to Low flow start. At this stage both the normally open & normally closed solenoids of the gasoline digital control valve are energized. Once the low flow rate is achieved the batch controller makes periodic adjustments within the dead band to ensure that the Low flow start volume has been delivered

As soon as the low flow volume in the gasoline digital control valve is attained, the ethanol digital control valve opens and ramps up from zero to low flow

The high flow rate will commence on the gasoline digital control valve. As the high flow stage begins, it energizes both of the digital valve's solenoids. Once the High flow rate is achieved the NC solenoid will be de-energized. This is done in an attempt to lock the valve in a position to maintain the desired flow rate. Product flow will continue at the high flow rate until the 1st stage trip volume is achieved

The ethanol digital control valve follows the same sequence of attaining the low flow volume and achieving the higher flow rate. The ethanol digital control valve then achieves its first stage trip when approaching its target delivery and the batch controller de-energizes both solenoids till the 1st stage flow rate is achieved. As soon as the 1st stage trip flow rate is achieved, the batch controller will energize the normally open solenoid. This is done in an attempt to lock the valve in a position to maintain the desired flow rate. Product flow will continue at the high flow rate until the 2nd stage trip volume is achieved. As soon as the 2nd stage trip volume is reached the batch controller will de-energize both solenoids until the 2nd

stage flow rate is reached. This permits the line pressure to reduce the valve opening. When the 2nd Stage trip flow rate is reached ; the batch controller will energize the normally open solenoid to control the flow rate until the final trip volume is reached. Once the Final trip is reached and the preset ratio volume delivered both the solenoids are then de-energized. The ethanol digital control valve will close much before the gasoline digital control valve. The ethanol batch will get over just prior to the gasoline valve commencing the ramp down process

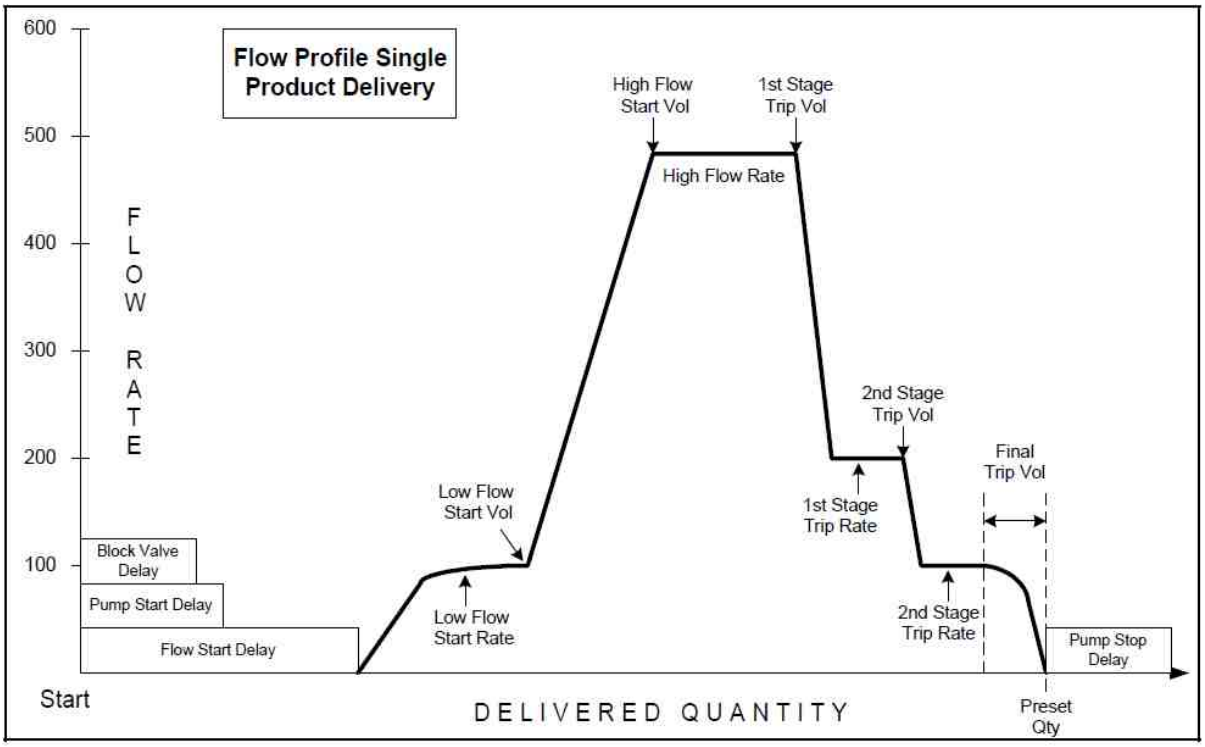

Fig 5.0 Flow profile

The gasoline digital control valve then achieves its first stage trip when approaching its target delivery and the batch controller de-energizes both solenoids till the 1st stage flow rate is achieved. As soon as the 1st stage trip flow rate is achieved, the batch controller will energize the normally open solenoid. This is done in an attempt to lock the valve in a position to maintain the desired flow rate. Product flow will continue at the high flow rate until the 2nd stage trip volume is achieved. As soon as the 2nd stage trip volume is reached the batch controller will de-energize both solenoids until the 2nd stage flow rate is reached. This permits the line pressure to reduce the valve opening. When the 2nd stage trip flow rate is reached, the batch controller will energize the normally open solenoid to control the flow rate until the Final trip volume is reached(refer Fig 6.0 for the Automated process for ratio blending)

Once the Final trip is reached and the volume delivered both the solenoids are then de-energized

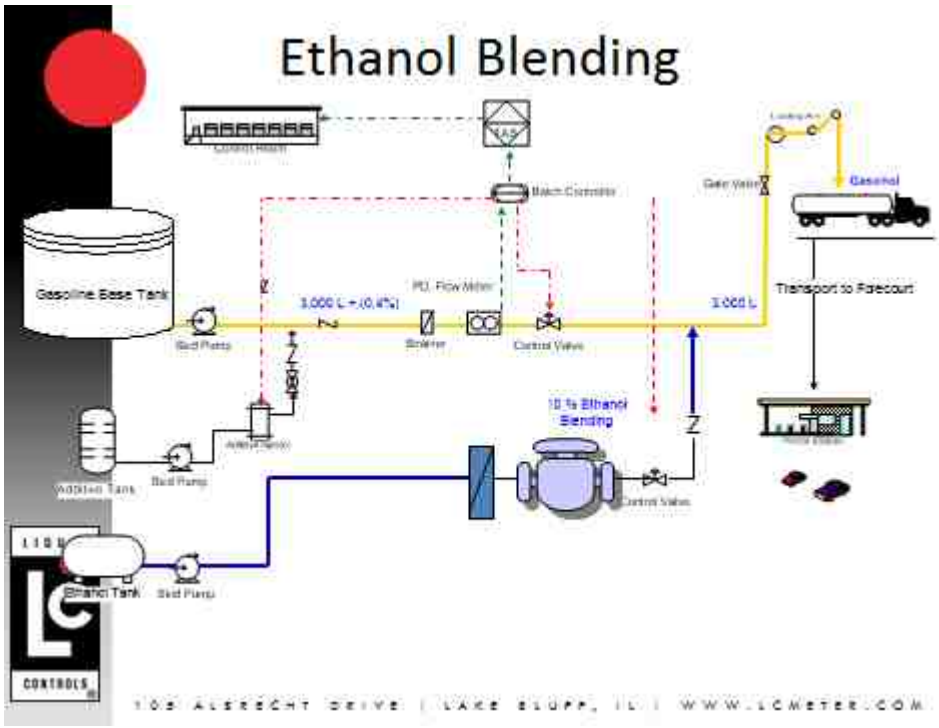

Fig 6.0 Ethanol blending process

3.4 Advantages of Ratio Blending

The delivered blend quality is rarely out of blend specification at any time. Any premature termination of the batch will not affect the quality of the delivered product

Simultaneous delivery of all the products means shorter delivery time

The overall impact of proper and precise ratio blending can be ascertained with the primary effect on fuel and the engine performance

4.0 SIDE STREAM BLENDING

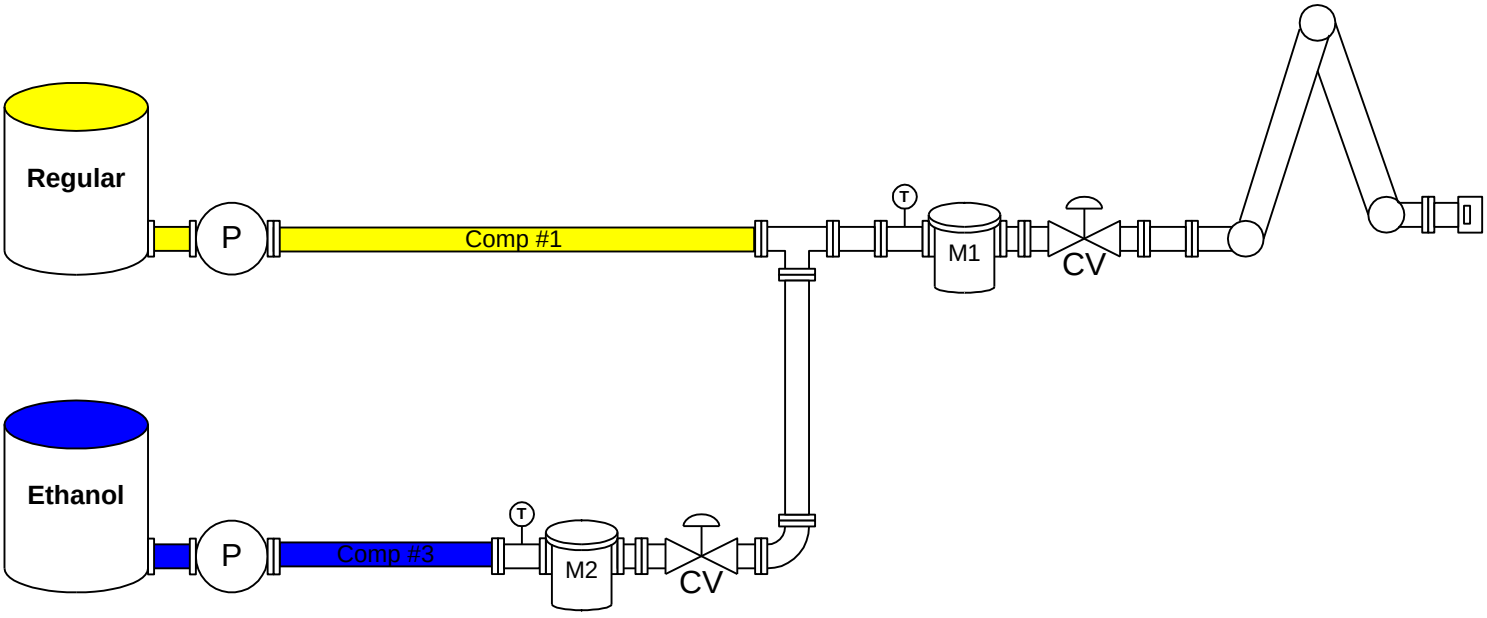

Fig 7.0 Side –stream blending schematic

Side stream blending is a form of two-product ratio blending where the minor product is metered and controlled by a valve

4.1 Advantages of Side Stream blending

The delivered blend quality is rarely out of blend specification at any time. Any premature termination of the batch will not affect the quality of the delivered product.

Another significant advantage with this method would be to capture the growth of ethanol and not give money away. It will ensure a stable product mix to the customer and help eliminate losses.

4.2 Pre-requisites for Side Stream blending

The delivery of the ethanol component of the blend is dependent on the pressure of ethanol being at least 20 psi higher than the pressure of gasoline. In case the pressure of ethanol is not higher then it may not blend properly into gasoline causing bad blends. Higher pressure of ethanol at all times is a pre-requisite for proper blending.

The volume correction for this blend is not available since no API table is available for ethanol-gasoline mix

5.0 Conclusion :

Advantages of precise

Automated blending

The significant advantage to the oil company which can be achieved by the automated and precise methodology of blending includes

- Avoiding Inaccurate Blend
- Ensuring zero Loss of products during the blending process
- No Human interference and therefore no Error in the blend percentage
- Ability to keep track of the blend in Real time
- Automated Recording & storage of data
- Monitoring the exact blend % and quantity even in the case of power outage or pump failure
- Achieving quality blend mix

6.0 Results

The major advantage to the automotive user/industry

- Better thermal stability of the fuel
- Better Fuel economy
- Better Lubricity
- Higher Cetane number for Bio diesel
- Lower emissions

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