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The Art of Blending
Accuracy and Efficiency

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Blending grades of petroleum products to produce products of specified quality is a skill. The ability to accurately blend to precise quality and volume can give a supplier a valuable competitive edge.

The Basic Blending Process

The process of batch blending has been in use by bunker suppliers for decades. Using this process, the supplier prepares the blend in a designated holding tank. Prior to the delivery of the product the supplier prepares the blend by adding a number of different products together and analyzing the mix. As a result, the batch blending process wastes both time and storage facilities, and these costs are passed on to the consumer, reducing the supplier's competitive edge.

In more recent years, advancements in technology have introduced a technique called in-line blending. This has revolutionized the blending industry. In-line blending is defined as: The controlled proportioning of two or more component streams to produce a final blended product of closely defined quality from the beginning to the end of the batch, thus permitting the product to be used immediately or loaded directly to the customer. In-line blending has several important technical and economic advantages over batch blending:

- Reduced Process Time
- Increased Flexibility of Fixed Assets
- Improved Quality
- Reduced Waste and "Give Away"
- Simplified Planning
- Lower Production cost
- Reduced Capital Cost
- Lower Labor Cost
- Simplified Process Plant

An in-line blending system will typically comprise two or more component streams, each with a strainer, flow metering device, temperature element, flow control valve and a check valve. The blend header will consist of a mixing device and possibly a sampler and / or analyzer.

In-line blending systems may be supplied in many different configurations, ranging from skid-mounted units installed at a terminal, to barge or trailer mounted units providing mobility. *Figure 1* showsa typical skid-mounted in-line bunker blending system installed on a marine loading dock.

Ratio Blending

Ratio blending is the normal technique of blending two or more products together by volume or weight. The accuracy of a ratio blending system is dependent on the accuracy of the flow meters and flow transmitters used. It follows that if the quality parameters of the base components are known and consistent, then a high quality final product can be produced.

Mixing

Mixing the component streams together is critical when blending in line. Unlike batch blending the mixing of an in-line blend has to be performed dynamically as the component streams converge to ensure that the blend is continuous and homogeneous. The degree of mixing in a blend header depends on the rate of energy dissipation. In nearly every in-line bunker blending application, natural turbulence is inadequate to ensure a homogenous blended product throughout the blended product flow range.

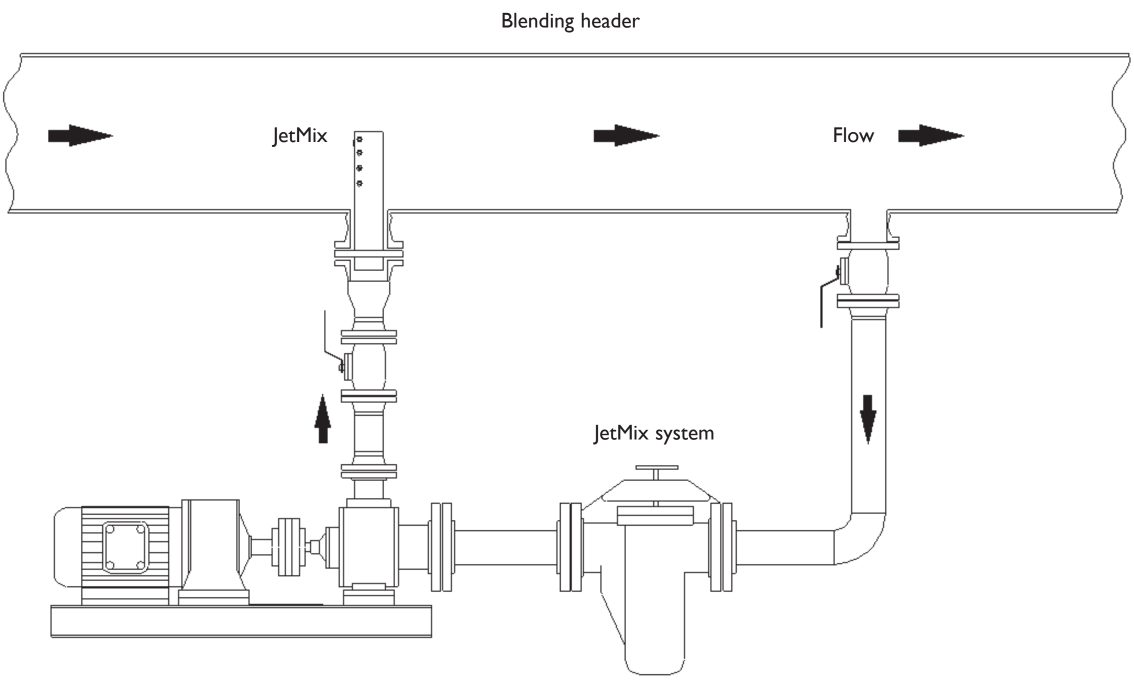
Traditional mixing devices such as in line static mixing elements divide and turn the fluid, increasing the rate of energy dissipation through pressure loss. The pressure loss provided by a static mixer is generally proportional to the square of the flow rate/velocity. If the flow turndown ratio of the blended product is small, then a static mixer might provide acceptable mixing without excessive pressure drop. However, if the flow turndown ratio is large, which it normally is for in-line blending applications, the static mixer will provide an excessive pressure drop and is likely to be unsuitable for the application. A solution to this problem is a dynamic Jet Mix® mixing system which is a powered mixing loop that produces sufficient energy to blend components together at zero flow up to and well above the point at which natural turbulence occurs.

The JetMix® mixing system is particularly useful when an analyzer such as a viscometer (see Trimming below) is installed in the blend header.

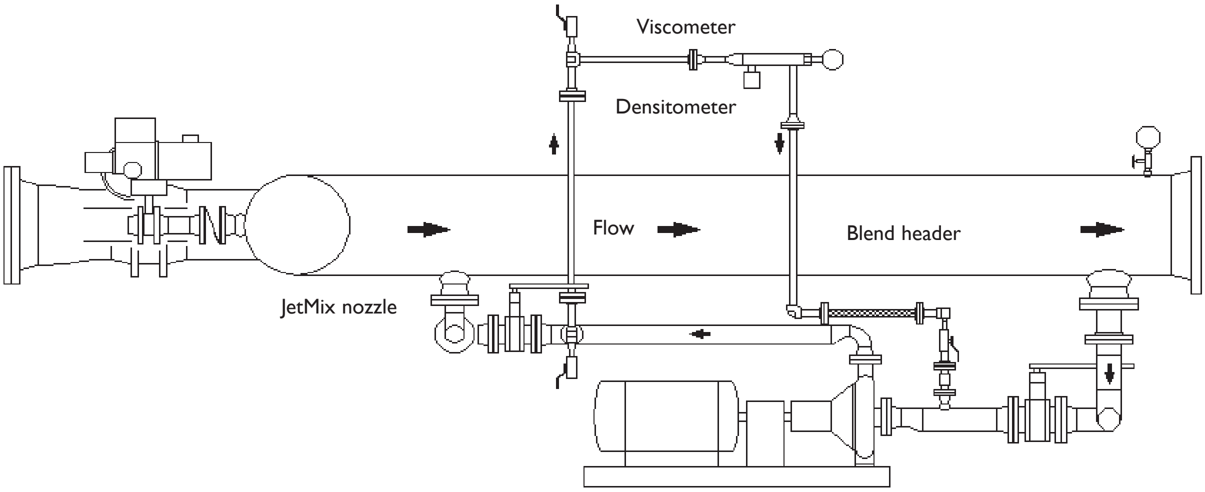
Trimming

Volumetric ratio blending systems produce consistently good results when the quality of the base components is known and constant. If one of the components varies in quality, as they often do, then the blended product will be affected. A solution to this problem is to incorporate an analyzer in the mixed output of the blender and introduce this measurement as part of the closed loop trim control system. A trim set point such as viscosity now becomes a part of the blend recipe, which is used to dynamically trim the volumetric ratios as the blend is in progress. This gives increased accuracy to the overall blended product plus a flow-weighted average of batch viscosity. However, great care must be applied when designing and installing an analyzer trim or it may have adverse effects on the accuracy of the blending system. Considerations must include:

- The analyzer should be installed in the mixed section of the blend. If it is not then the analyzer will NOT give representative measurements.



Typical JetMix installation - schematic



Typical mix system trim analyser loop

- The blend mixing system should be efficient throughout the complete flow range of the blend and not create too much pressure drop to inhibit the high flow rate.
- If the analyzer incorporates a referral process in conjunction with line measurement and line temperature, such as referring viscosity at line conditions to 50° Celsius, then:

  (i) The referral method should suit the temperature and dynamic measurement RANGE being taken. Most analyzers only employ one ASTM or matrix curve to refer the line measurement to a standard temperature. This method is normally unacceptable as it assumes that the viscosity is constant and that only the temperature is varying.

  (ii) The blended product should be as close to the referral temperature as possible. This will decrease the "referral error".

  (iii) The temperature measurement at the analyzer should be as accurate as possible. Any temperature measurement error will significantly affect the referral accuracy. (For example, it is well known that the viscosity of cool bunker fuel changes dramatically with temperature.)

- The analyzer should not be affected by sunlight (temperature change). Thermal insulation around the analyzer and temperature elements is always a good idea
- The analyzer should not be affected by hydraulic or mechanical "noise". Most analyzers use frequency / vibration techniques for analysis.
- The trimming stream should be selected by the stream with the most effect on the blended product.
- The accuracy of the trim is dictated by the accuracy of the analyzer. Great care must be used in selecting the right analyzer for the job.

To maintain quality, the effect of analyzer trim and the possibilities of stream starvation must be considered. This phenomenon often occurs during blending when one or both of the component tanks are stratified. It is normal to allow a small drift in trim adjustment before raising an alarm and/or reverting to ratio control or shutting down.

Recent developments in Jiskoot blending control systems have included dual trim control that allows two different analyzers such as viscosity and density to be installed on the same blender. The blending control system has a hierarchy of control that eliminates the obvious problems of the analyzers fighting each other. This is particularly useful for suppliers who tightly control more than one parameter such as sulphur content.

Sampling

Sampling the quality of blended product is an important but controversial subject and there are a number of international standards that can be applied. The sample of a blend must be representative, which means that small sample "bites" should be taken at flow proportioned intervals from the mixed homogeneous section of the blend header.

Cut Back and Cut Up

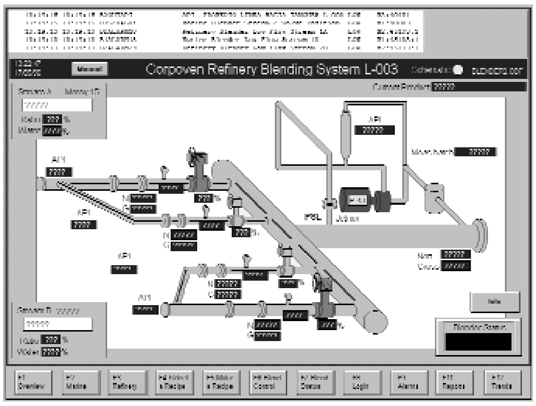
During the blending process, it is often difficult or impossible for the in-line blender to maintain the requested blended product flow rate (operator set point) because of restrictions placed upstream or downstream of the blending system. The Jiskoot InSight blend controller combats this problem by monitoring the position of the control valves in each stream. If any of the control valves open beyond a defined position then the system will "cut back" and maintain control.

Jiskoot InSight Blend Controller.

Cut back refers to the system reducing the requested product flow set point to a position at which the stream control valve is open at its optimum position (typically 50 – 70% dependent upon the valve type used). The Jiskoot blend control system will continue to monitor the product flow rate and track the control valve position so it can increase or "cut up" the product flow to attain the originally required operator set point.

Supervisory Control and Data Acquisition (SCADA)

A SCADA system installed on a PC or on a customer based control system in a control room can be a great addition to a blending controller. The SCADA system can be configured to show realistic graphical screens of the blending system that displays all the dynamic features as they happen. The SCADA system will allow remote operation and can hold unlimited amounts of



The picture above illustrates an example of a single SCADA screen.

information including recipes, audit trails, alarm history, operator identification, blend reports and logs. The blending control system should communicate to the SCADA via a high speed, industry standard protocol network such as MODBUS.

The Author

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