# PEFTEC 2015

# Icon Scientific Ethanol Blender

## Optimising Ethanol Gasoline Blendstocks Through Addition of Ethanol to Blending Analyser Sample Lines

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# Introduction

- Refineries now often need to manufacture a BOB (Blendstock for Oxygenates Blending) with product quality properties such that it produces a final on-specification gasoline when the required amount of ethanol for the specific grade is added at the marketing terminal
- The ethanol has an impact *(boost or suppression)* on a number of the critical gasoline product quality specifications which is dependant on the specific sample matrix and has to be modelled
- BOB's have to be conservative in respect to final product quality property give-away to cope with the worst case boost prediction
- For conventional gasoline blending, there are large incentives to use on-line analysers for on-line control and certification of the blend
- However there are more limited incentives for using on-line analysers for BOB blending if they are only measuring the neat BOB

# Introduction

- ***Icon Scientific has developed and demonstrated a unique patented system*** to mix a combined BOB/ethanol sample flow to the analysers in the required ratio with a very high precision (better than± 0.05%).
- The system will eliminate the uncertainty of the boost models for BOB blending control and release and enable the recapture of the full economic benefits of on-line analyser control and analyser on-line certification of the final product
  - ***$1M-$15M for analyser control of the blend and $2M-$25M+ for online analyser certification depending on the size of the refinery and gasoline volumes blended***

# Control and Release Issues with Blendstocks for Ethanol Addition

- An added complication arises when manufacturing gasoline containing ethanol for biofuels production because the ethanol needs to be added at the marketing terminal not at the refinery
- As noted above, refineries now need to blend a BOB (Blendstock for Oxygenates Blending) with product quality properties such that it produces a final on-specification gasoline when the required amount of ethanol for the specific grade is added at the marketing terminal
- The ethanol has an impact (boost) on a number of the critical gasoline product quality specifications; most importantly octane, vapour pressure and distillation properties
- Boost models need to be developed to predict this boost effect when developing the blend recipes and blend targets for the BOB's

# Control and Release Issues with Blendstocks for Ethanol Addition

- The boost effect is sample matrix specific
  - i.e. depends on the specific component compositions and their proportions used to blend the BOB. It also depends on the base property value of the BOB and can be non-linear
- An allowance needs to be made for the precision (uncertainty) of the boost model in addition to the normal targeting and release limit considerations
- The uncertainty of the boost models can be quite high significantly increasing the giveaway
- Therefore the BOB's need to have even more conservative targets in respect to the final product quality property give-away than conventional gasoline to cope with the worst case boost
- Benefits from analyser control ***and release*** are significantly reduced (can only blend release to BOB target/spec)

# Capture Significant Added Benefits from On-line Analysers When Blending BOB's

- A solution is to precisely add the required amount of ethanol into to the final sample flows to each analyser
  - The analysers will now measure and control to the exact boost effect for that specific blend matrix and property
- The boost model uncertainty no longer needs to be included when setting the blend targets as the boost is directly measured by the analysers
  - Targets can be set and controlled closer to speciation significantly reducing giveaway
- This also enables recapturing the added benefits of using analysers for on-line certification if this approach is used
  - In this case blend targets can be set and controlled to final specification values not BOB values

# Capture Significant Added Benefits from On-line Analysers When Blending BOB's

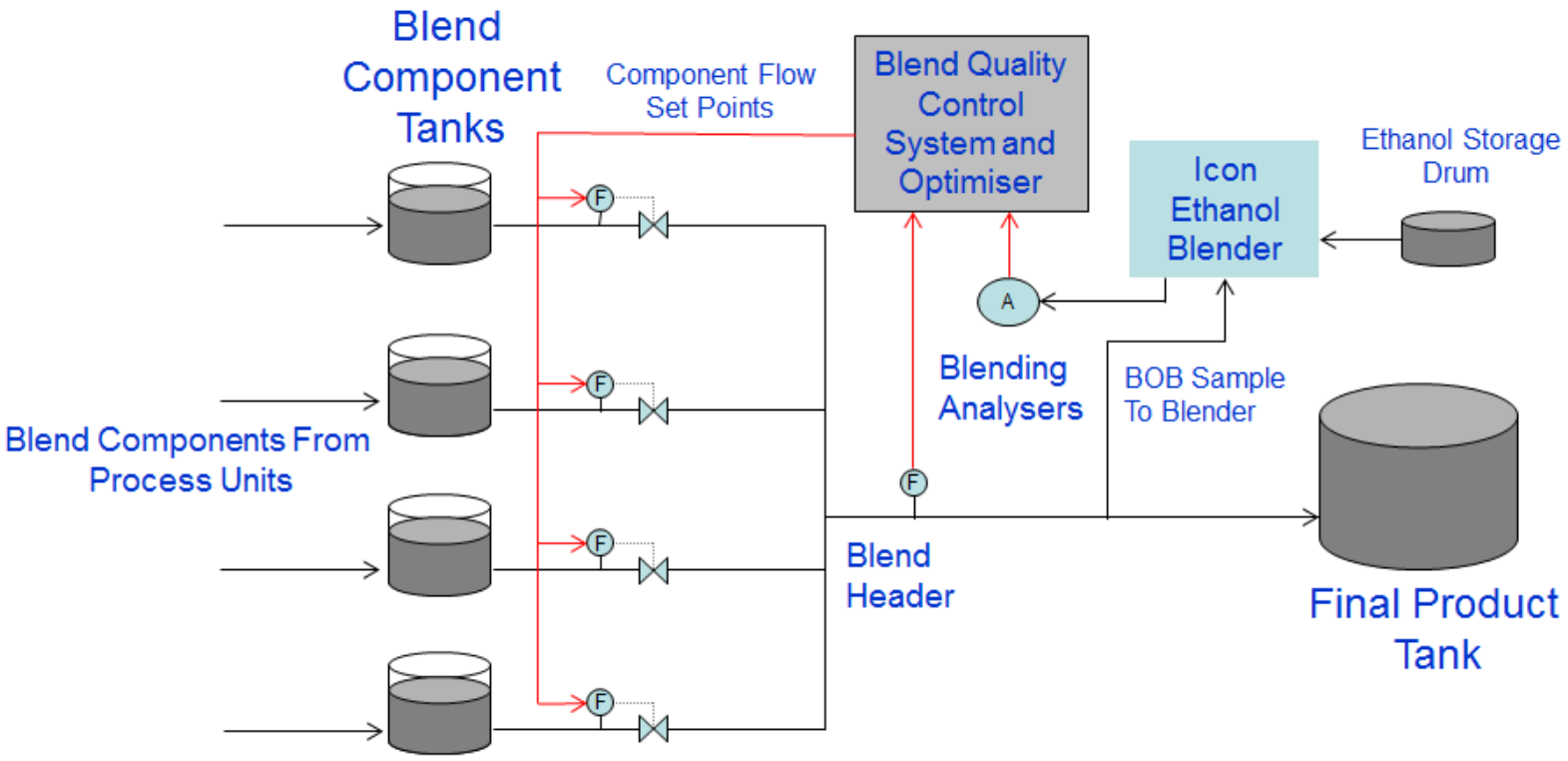
- ***Icon Scientific has developed and demonstrated a unique patented system*** that uses precision manufactured piston cylinders to mix a combined BOB/ethanol sample flow to the analysers in the required ratio with a very high precision (± 0.05%) so the uncertainty of the mixing system is virtually eliminated
- The precision of the Icon Scientific mixer system is independent of the flow rate and the flow rate is automatically set by the actual instantaneous demand from the analysers
- It only continuously mixes the small final sample flows to the analysers. This minimises the ethanol use to only exactly the amount required by the individual analyser sample flows.

# Capture Significant Added Benefits from On-line Analysers When Blending BOB's

- Alternatives to the Icon Scientific piston cylinder approach are either to use coriolis or turbine flow meters and a small flow control valve(s) or metering pumps to continuously control the ethanol addition to the sample.
  - In both cases the fundamental precision will be in the range of ±0.2% similar to a terminal tanker loading system which is not as good as the fixed volume precision piston cylinder approach. This is an added uncertainty for the blend target setting increasing the giveaway
- These systems will also not be able to mix just the small volume flow required by the analysers due to turndown and hysteresis effects on varying demand flows from e.g. cyclic analysers further potentially reducing the mixing precision
  - Will need to mix the constant full analyser fast loop or a bypass loop flow so they will use a significantly greater volume of ethanol

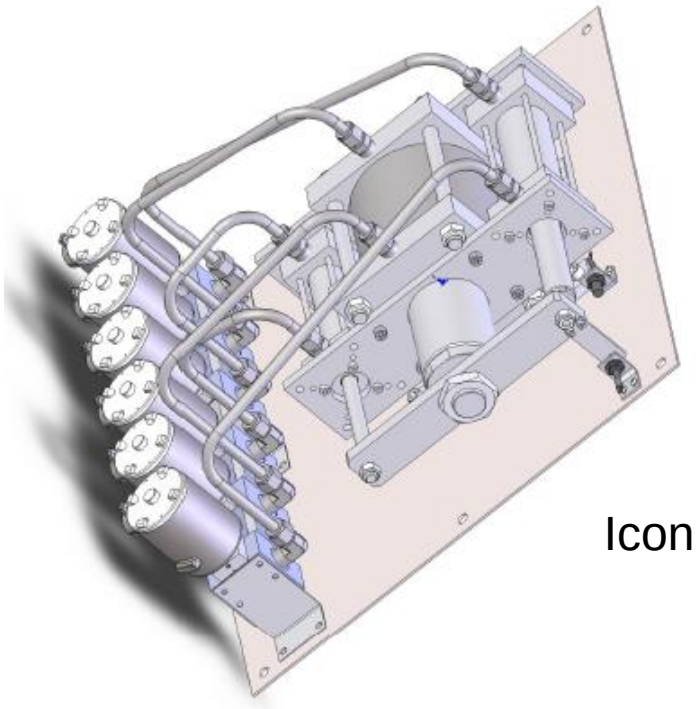
# Capture Significant Added Benefits from On-line Analysers When Blending BOB's

- The figure below shows how the Icon Scientific Ethanol Blender will be used within the overall blending control system



# Icon Scientific Ethanol Blender

- The Icon Scientific Ethanol Blender System for analyser samples uses precision engineered piston cylinder assemblies that are rigidly mounted together and mechanically linked to deliver a mixed ratio of ethanol and BOB sample with a precision of better than ± 0.05%



Icon Scientific Ethanol Blender
Operating Principle

# Icon Scientific Ethanol Blender

- The larger central cylinder delivers a precise fixed amount of the conditioned gasoline BOB sample and a smaller second cylinder delivers the precise amount of ethanol needed to produce the required mixing ratio
- As the two cylinders are mechanically linked, the ratio of the flows is permanently fixed by the ratio of the diameters of the cylinders as the piston speed and relative displacement is always identical in both cylinders. The gasoline BOB sample and ethanol flows are mixed in a static mixer before delivery to the analysers
- For flexibility, two of the smaller cylinders are provided either of which can be selected for use for a specific blend to provide two different blend ratios e.g. 4.8% and 9.8% for E5 and E10 grades
  - If in future it is necessary to blend other ethanol grades, the smaller piston cylinders can be replaced with other cylinders of the required size

# Icon Scientific Ethanol Blender

- A second set of check cylinders are provided so that the flow from the operating cylinders can be periodically validated to confirm correct operation.
- At the end of each stroke, position sensors and switching solenoid valves automatically reverse the direction of flow to provide a continuous smooth flow of sample to the analysers.
- The motive force is the BOB sample pressure on the side of the piston that is connected to the BOB inlet sample line.
- The speed that the pistons move will automatically self-adjust based on the actual flow demands from the analysers so only the exact amount required by the analysers is mixed at any time.
- Safety features include leak detection in the bottom of the cabinet that automatically isolates the BOB sample and ethanol inlet lines.

# Icon Scientific Ethanol Blender

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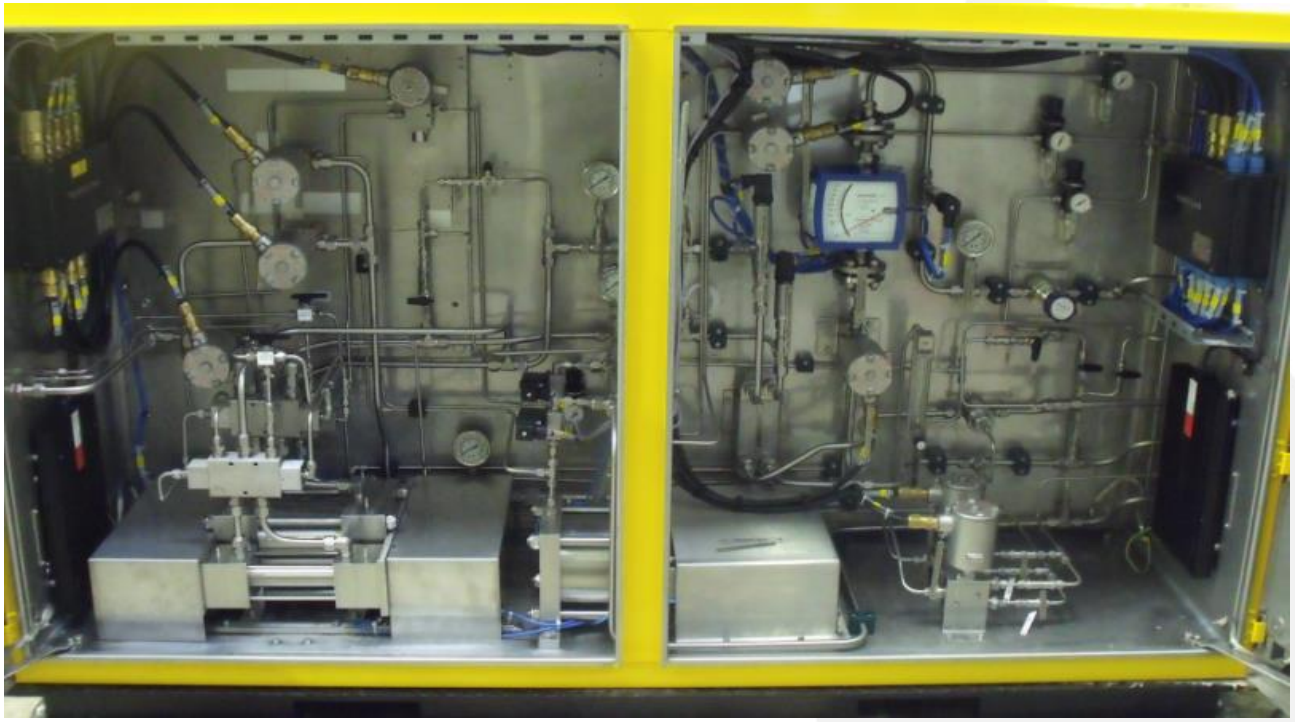
- The motive force is the BOB sample pressure on the side of the piston that is connected to the BOB inlet sample line.
  - The speed that the pistons move will automatically self-adjust based on the actual flow demands from the analysers so only the exact amount required by the analysers is mixed.
- The complete system is mounted in a temperature controlled cabinet and a concurrent heat exchanger and pressure control is provided on the inlet BOB sample and ethanol flows to ensure they are the same temperature and pressure before mixing to maintain the best possible accuracy.

# Icon Scientific Ethanol Blender

- The piston cylinders provide a very wide flow rangeability that is not available with other mixing techniques
  - The maximum flow can be up to 300 l/hr which is useful when filling octane engine protofuel tanks without disrupting the flows to the analysers (if octane engines are used for blending, the protofuels must also contain the correct amount of ethanol for the grade being blended)
  - Minimum flow can be as low as 1-2 litres/hr if required for testing a single analyser between blends with the same precision
- The ethanol used for the mixing is stored in a tank located close to the mixing system sized (typically 10 m3) to give a reasonable operating period between refills based on the frequency of blending.
  - The denatured ethanol quality should be the same quality as that as used in the marketing distribution terminals and should use the same type and amount of denaturant.

# Icon Scientific Ethanol Blender

- A view of the blender system with the cabinet doors open



- The main mixing cylinders can be seen in the above photo mounted in the bottom left hand side of the cabinet. The validation cylinders are mounted on the floor in the middle of the cabinet

# Icon Scientific Ethanol Blender

Close Up of the Piston Cylinder Assemblies

# Icon Scientific Ethanol Blender


Complete Icon Scientific Ethanol Blender System Including Control Unit

# Icon Scientific Ethanol Blender

- The control system uses the same Explosion Proof (Eexd IIB+H2 T6) PC with 17” touch screen as the main Icon Scientific analyser range.
  - It features a multi-language display and has the same look and feels as the standard Icon analyser software and shares many common features.
  - The control system touch screen provides the full operator interface to operate and monitor the system performance including diagnostic alarms and managing the validation checking.
  - The control system also includes all interfaces to monitor and control the ethanol storage tank based on sensors mounted on the tank including level and nitrogen overpressure. The control system provides a continuous indication of the status of the ethanol storage tank (see following screen snapshots).
  - Modbus, digital and analogue inputs and outputs can be provided.
- The system is suitable for operation in a wide ambient temperature range (-10 to + 55° C) and is third party certified to IP 66 and 67

# Incentives for Using the Icon Scientific Ethanol Blender

- If the Icon Scientific Ethanol Blender system is implemented at a site, it should be possible to achieve the same volume weighted giveaway as for conventional gasoline blending as indicated in the table below:

| Type of Blending | Typical Example Volume Weighted Giveaway Ranges For E5 | | | |
|---|---|---|---|---|
| | RON (ON) | MON (ON) | Vapour Pressure (kPa) | Added Benefit From Ethanol Blender |
| **BOB Blending (No Analysers – Batch Recipe)** | 0.7 – 1.0 | 0.7- 1.0 | 10.0 – 20.0 | - |
| **BOB Blending Without Ethanol Blender (Analyser Control only)** | 0.6 – 0.7 | 0.6 – 0.7 | 5.0 – 15.0 | - |
| **BOB Blending With Ethanol Blender (Analyser Control)** | 0.3 – 0.5 | 0.3 – 0.5 | 1.5 – 2.5 | $1M-$15M |
| **Type 3 BOB Blending With Ethanol Blender (Analyser Control and Release)** | 0.05 - 0.1 | 0.05 - 0.1 | 0.5 – 1.0 | $2M-$25M+ |

# Additional Information

- White paper with full details of hardware, application and how to estimate incentives available to download from the Petro Industry News website or direct from Icon Scientific

- Or Contact
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