GASOLINE IN LINE BLENDING SYSTEM

A survey by Valero of US refineries indicated a range of giveaway performance, as follows:

Octane giveaway (AKI octane): US Average=0.5 ON; min=0.1 ON, max= 1.2 ON

RVP giveaway (psi): US Average=0.3 psi; min=0.1 psi, max= 0.6 psi

With best available technology, how much practical reduction in giveaway can we achieve, recognizing that we cannot measure values with "zero error"?

Do those numbers change if in-line blending is used?

MANUAL BLENDING

Most of the Refineries in the US and Latin America, either don't have or use inoperable in-line blending technology, and consequently they are still blending "manually" using blending operator "eye-ball" property control.

This means that if a refinery is blending 4 components (Butane, naphtha, alkylate and reformate), the operators need to open the valves one at the time for each blend component. Also, they need to follow a correct order to avoid stratified blends with the possibilities of splitting phase.

MANUAL BLENDING

As we can see here, there are many weak points using this procedure, with high chances of human error (open the wrong valve or blending the wrong component, or incorrect blend component properties).

This procedure can take up to days or weeks to be completed and if the wrong recipes is used, it is very difficult to find the error right away, since there are no on-line analyzers that measure real time blend properties to make corrections.

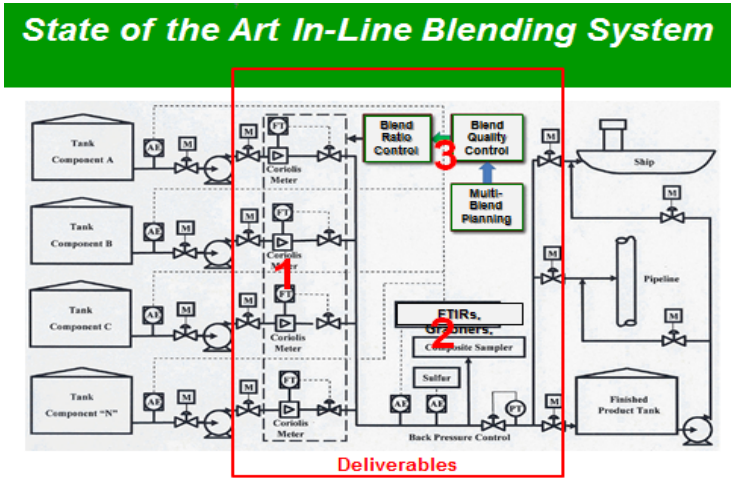
This forces blenders to be very conservative and deliberately produce either high giveaway and occasionally off-spec recipes.

IN-LINE BLENDING

The inline blending technology introduced in 1965 has many advantages compared to the "cheap" sequential manual blending technique.

- **With an inline blender you can reduce the blending time by at least 50%, which requires less inventory on hand, and frees tanks for other purposes;**
- **No off-specs or re-blends; Blend properties are measured real time and corrections are made right away**
- **Much smaller octane and vapor pressure property giveaway, pushing the limit of error of measurement;**
- **Minimize demurrage charges or missed pipeline shipments.**
- **Fewer/less testing of blend samples (saving $);**

IN-LINE BLENDING



An Inline blender uses on-line analyzers to check and control simultaneously many properties. All the main properties are measured: RON, MON, RVP, D-86 Distillation, Aromatic, Benzene, Olefins, Density, Sulfur, VLI, etc.

The measurement precision tolerances are the one described in ASTM test methods for in-line blend release, generally 0.59 X Reproducibility of the test method.

In reality, we do much better than this with our technique of "site precision" standards. We use on-line analyzers proven in the field with much better precision than ASTM lab test methods.

ACHIEVABLE MEASUREMENT PRECISION

When we account for the limit of error of measurement based on ASTM repeatability (r) and reproducibility (R) of a measurement, what matters for blending is the REPRODUCIBILITY of measurement, so we get the following results depending on the technology.

For Octane

- **Using octane knock engines in the Lab, AKI ON r=0.2 ON R=0.8 ON for ASTM tests using D-2699 for RON (R=0.7) and D2700 for MON (R=0.9). The repeatability is 0.2ON for both RON and MON**

- **If we use a spectroscopic analyzer calibrated and validated per ASTM WG61371 and ASTM site precision, e.g. FT-IR spectrometer for in-line blending of octane, we get an R=0.1ON**

ACHIEVABLE MEASUREMENT PRECISION

For RVP

- **RVP for ASTM D5191 r=0.21 psi R=0.4 psi**
- **RVP for on-line Grabner based on ASTM D6378, r=0.04 psi R=0.1 psi**

Using those systems, with proper maintenance and calibration, will make "Valero" standard of reproducibility 0.1 achievable for both octane and vapor pressure.

Practical Improvement in Giveaway Reduction

ILB giveaway performance with conventional on-line analyzers in 1996 [4] was 0.3 ON and 0.24 psi for RVP.

With technology improvements (2019), we have AKI giveaway of 0.2 ON (falling level engines) and 0.1psi with Grabners. If using FT-IR spectrometers, AKI giveaway is 0.1 ON.

For AKI octane= YOUR AVERAGE – Conservative 0.2ON;

Using US average octane giveaway of 0.5-0.2=0.3 ON giveaway reduction

For RVP psi= YOUR AVERAGE – Conservative 0.1psi

Using US average RVP giveaway of 0.3-0.1=0.2 psi giveaway reduction

PRACTICAL IMPROVEMENT IN GIVEAWAY REDUCTION

Using the prices before the COVID-19 Pandemic (Feb 2019) the value of 1 ON-bbl is $1.08 and 1 psi-bbl is $2.17.

If we blend 100,000 bpd of gasoline, the giveaway reduction is worth:

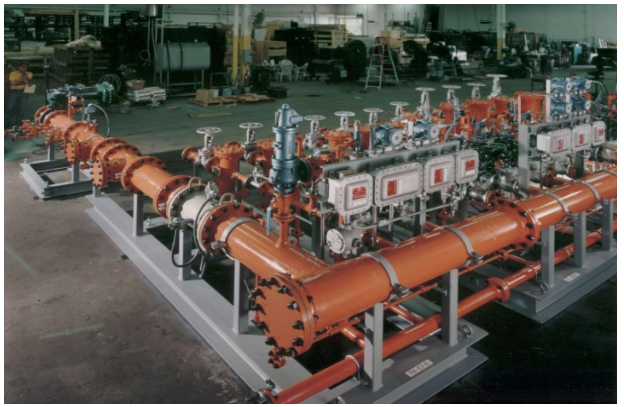
- **0.3 ON X $1.08 ON-bbl X 100,000 bbls X 365 days= $ 11.8 million/year**
- **0.2 psi X $ 2.17 psi-bbl X100,000 bbls X 365= $ 15,8 million/year**

Total giveaway reduction is worth ~ 27.6 million/year

This is just for a small batch of 100,000 bpd.

Costs and Benefits

The ILB is a pre-mounted, skid, turnkey and ready to use. The buyer needs to just prepare the concrete pad for putting and bolting the skid on it, and connect the skid to component and product lines.



The pricing of key elements (pumps, coriolis) is non-linear. Those represent the big pieces in the in-line blending system. RAI does this work on a daily basis. Please reach out to us to get going with the in-line blender.

COSTS AND BENEFITS

The following shows the benefit for typical refineries that makes 100,000 BPD of gasoline switching from manual blending (pumping one by one the blend components) to in-line blending.

Item No.	Benefit swtiching to an in-line blending technology	$/year
1	Property giveaway reduction using high precision on-line analyzers and blend property control optimizer (AKI octane, RVP)	27,600,000
2	Recipe giveaway reduction by synchronizing Refinerey LP plan with MBO planned recipe and on-line optimizer starting recipe	7,700,000
3	Maximizing gasoline gross profit ($/barrel) using off-line and on-line blend optimizers to maximize use of cheapest components	15,500,000
4	Reducing tank storage for finished gasoline	3,300,000
5	Reducing inventory of finished gasoline	1,000,000
6	Reducing downgrading of Premium line-fills to jetty	1,500,000
7	Increasing gasoline blending production throughput by reducing blending time by ~50% and 10% additional sales	5,500,000
8	Reducing demurrage and potential berth occupancy increase	500,000
9	Reduced ship tuenaround delay by 1 hr	600,000
10	Reducing laboratory manpower (e.g. grabbing samples, analysis, and documentation of result)	1,200,000
11	Reducing tank farm/field manpower for line-up through the use of MOV's	1,300,000
12	Reducing EPA Tier 3 Sulfur Credit Penalty	2,000,000
Total		**67,700,000**

REFINERY AUTOMATION INSTITUTE

RAI EXECUTIVES

- **Ara Barsamian – CEO, Director of Project Management/Engineering**

Mr. Barsamian has worked and consulted for the major oil companies, such as Exxon, Mobil, Chevron, Aramco, and PDVSA, in the area of refinery oil terminal automation, and gasoline and diesel blending automation. He has more than 30 years experience with blending, offsites automation, and project management. He has provided blending construction & automation work for HESS, BP, Motiva Port Arthur, Petro-Canada, Suncor, Sasol, etc. He has worked extensively in the development and implementation of a variety of on-line blending analyzers - particularly NIR types - and the associated shelters, sampling systems and sample recovery systems, specifically for gasoline and diesel blending and in-line blend certification. He participates in various standards and recommended practices bodies such as ISA and ASTM. jabarsa@refautom.com

- **Eliseo Lee Curcio – CFO/VP – Blending Management, Sales & Marketing**

Mr. Curcio is a blending expert, with over 10 years of experience working in advanced modeling and optimization for bunker, gasoline and diesel blending. He worked closely with traders and brokers in finding cheap components and blend them together to increase profitability. He designed the bunker blending software to predict easily compatibility and profitability. He is the Vice President and CFO at Refinery Automation Institute, where with his marketing and selling skills increased Company cash flow and brought new and fresh light to the business. Mr. Curcio has a M.S. in chemical engineering with high honor from University of Calabria, Italy and M.S. in advanced modeling and optimization from Catholic University of Leuven, Belgium. lee@refautom.com

REFINERY AUTOMATION INSTITUTE

THANK YOU

RAI is involved in many projects Worldwide building new gasoline in-line blender or refurbishing old one to increase profitability. Please reach out to us now, taking advantage of the situation with low costs.

We are World Expert and with us you will get the best in blending that you can get.

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