Best practices of production accounting & data reconciliation
How to create time and use high-quality data for better opportunities

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Abstract

Figuring out whether your company is following Best-In-Class Production Accounting is not hard, there are a few questions that may help figure that out:

· Is your Production Accounting an admin task only?
· Is your Production Accounting run as a set of mandatory tasks for monthly balance closure?
· Does your company create new operations and business value out of the reconciled balance results?
· How many "pieces" does your full Production Accounting process have?
· Is your paper accounting getting in the way of your physical accounting and operations?

The cost of ignoring this missed opportunity is large whereas the latest technology, VM-PA, automates the impediments in achieving and sustaining the value. This work will cover how VM-PA upgrades Production Accounting processes to achieve engineering best-in-class production accounting that creates new value.

Introduction

The content of this work has been built based on the large KBC's and Soteica Visual MESA's experience collected over more than 20 years implementing these types of solutions worldwide. Basically what we have seen is that production accounting is usually treated by average actors as an admin task, only used to comply with the mandatory part of the accounting business which is basically the monthly reporting of stocks, production, consumption, and so on for performance monitoring purposes. However we believe, and we've actually seen it in some of what we call best actors, that there is a best in class production accounting approach which ultimate goal is for these types of systems to become the unique version of the truth that can be used to support many decision making processes in an industrial environment. For this to be possible production accounting has to be much more than just an admin task for monthly reporting, it has to be the collection of methodologies that pursue the generation of high quality data by introducing state-of-the-art techniques and engineering knowledge. As for the latter, there's the possibility to create production accounting models capable to track hydrocarbon losses in detail and support loss reduction initiatives for example, or to trace crude oil batches across the entire supply chain to troubleshoot some distillation issue, to mention a few examples.

But quality costs time, so these techniques must focus on minimizing the time required for doing accounting, which in turn also guarantees that these procedures will be sustained over time creating sustained opportunities for improvement.

In summary we believe that production accounting has to be delivered in a way that is capable to cover both the mandatory part as well as the engineering part, so the best in class production accounting approach is one that creates time for you to use the generated high quality data for better opportunities, moving away from an admin task.

So, how is your production accounting business, are you doing your best?

To what extent does your Production Data get formally used within a company's procedures?

Let us begin by putting together all the data that is usually relevant to PA, the intrinsic functionalities of this business process and some of the not intrinsic but additional functions that PA data could be an input to.

At the bottom of the page references can be observed, red is relevant data, blue is intrinsic functionalities (understanding by intrinsic functionalities those that a production accounting methodology cannot do without, from our point of view, and if it does it's a questionable methodology with a lot of room for improvement), and green for those extra functions with PA data as an input that help get closer to that idea of PA data to be the unique version of the truth

So, for example relevant data is inventory and material movements, as well as all movements coming in and out of the site's fence, process flow meter data and so on. As for intrinsic functionalities any PA system must deliver the reconciled balance, its analysis and reporting, in an audited environment, with integration skills to reduce manual data entry and double work. And as for the additional functions, there some quite popular ones like crude composition tracking or support for utilities balances and some others, less popular but with huge added value like support for hydrocarbon loss, tank emissions, plan vs actual tracking, crude oil batch tracking and son on.
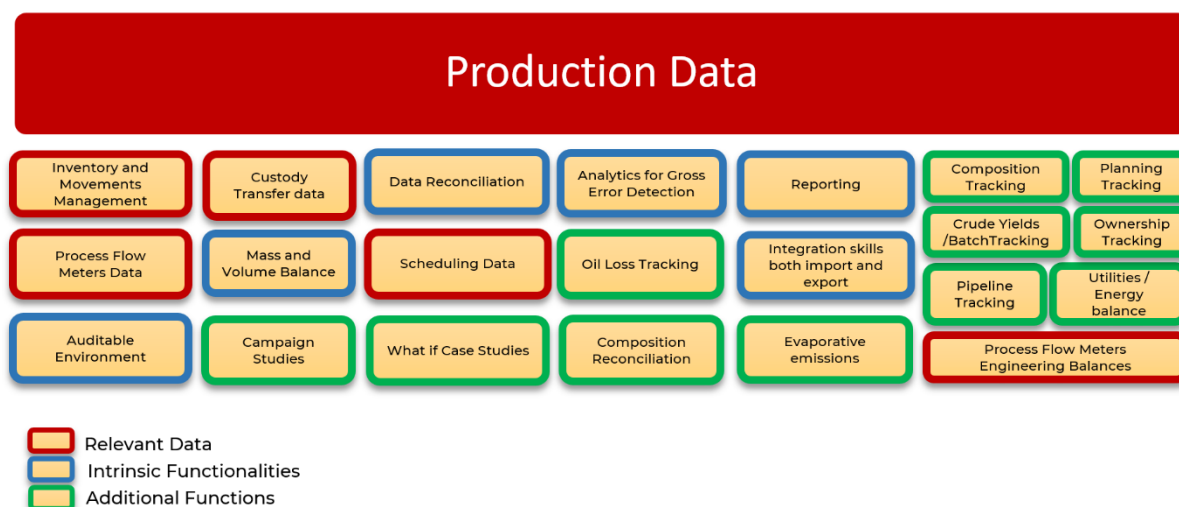
High Quality Data is Expensive

Within a best in class approach, the purpose of any production accounting methodology should be to obtain high quality data and in a timely fashion to support for the unique version of the truth to be used for further decision-making processes.

But high quality data is expensive as it requires many pieces to be put together, kept synchronized and maintained in an integrated workflow to guarantee data consistency, easy and high visibility across the entire process, with information flowing at the end of the day of course mainly from left to right but allowing also internal workflows where information can flow both directions to support a collaborative environment as all these pieces can usually be taken care by different groups of people.

So, from a comprehensive approach, three big groups of functions can be identified within a PA process, data collection, validation, and data exposure. First-hand experience shows us that a good system is one that can cover the production accounting process end–to-end. Our understanding is that end-to-end is key here to achieve best-in-class procedures, and this means for the PA system to have visibility and control of the data from

the origin through the whole process until the data is released.
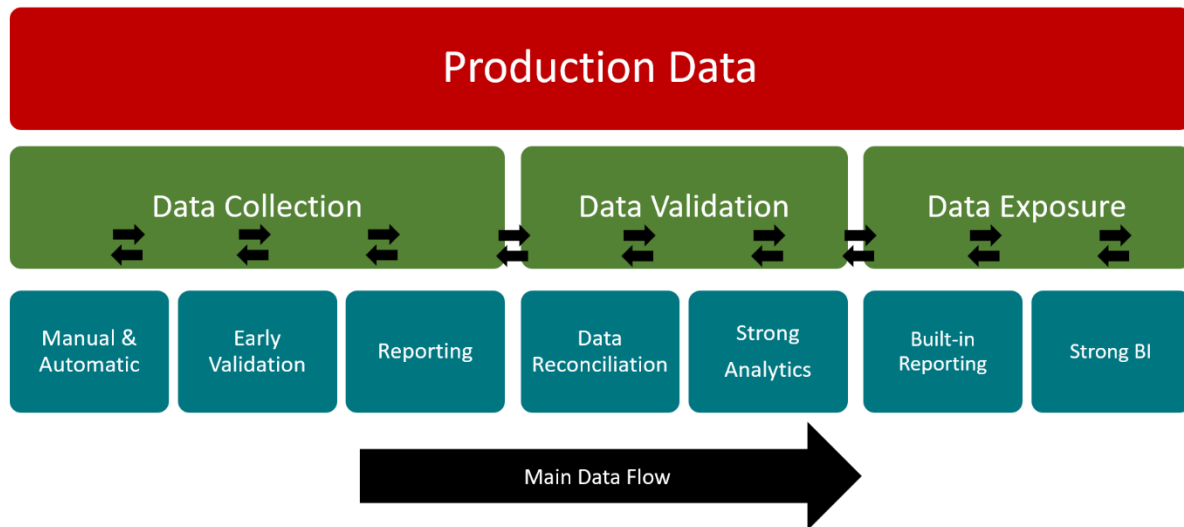
Continuing with the idea that the best in class production accounting methodology is one that takes ownership and control from the very first moment when the raw data is generated as opposed to getting involved at later stages when many things have already happened to the data, here comes the topic of the scope of the production accounting model.
The model can be:

· As simple as inventory and battery limits operations, also known as off-site balance, usually used for performance monitoring purposes through calculations such as net production and overall losses,
· While there could be process plants models as well, typically isolated from the off-site balance carrying out parallel balances in near real-time basis, for unit monitoring purposes, since process data is normally tied to other external procedures in the real-time domain, such as simulation, APC, and so on.
· Or it could be all of the above at the same time. And this would be best in class production accounting in terms of the visibility of the data, where each individual part of the model scope is handled at the particular time basis that makes sense according to the type of data covering from hourly through daily to monthly.
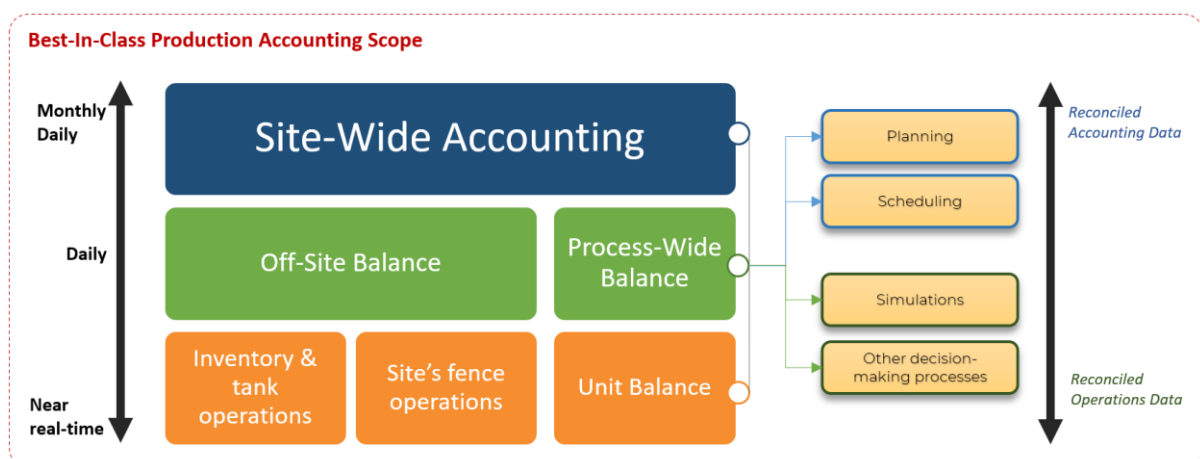
With the concept of high quality data in mind, having the process plants added to the PA scope, adds the possibility to cross check all measurements at the same time and in the process improving bad measurements

while monitoring the good ones. To achieve high quality data based on data reconciliation, measurements redundancy must be maximized and this pushes the idea of promoting site-wide models, but keeping a balance between data quality, model complexity and the knowledge of the sites assets in terms of the accuracy of the measurement devices. In any case, site wide data reconciliation is a good approach to observe and improve the quality of the measurement devices, but that's material for a whole other discussion.

When the previously mentioned scope is accepted in the company's culture as a sustained methodology, there are some key goals that can be achieved. These goals span both business and operations.

<table>
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• Mandatory auditable Production Site-wide balance closure

• Produce reliable baseline for decision making processes (i.e. scheduling)

• Produce consistent and verifiable data for LP models, ERP systems

• Hydrocarbon loss reduction

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• Produce more reliable data to be used for simulation an optimization.

• Detect errors at early stages, improve data quality and operating procedures to produce better data.

Manage and sustain a focused instrument maintenance program through the systematic analysis of plant custody transfer and measurement errors.

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Business

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Operations

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On the business side, for example, there will be more reliable and more timely available high quality data to feed LP models and scheduling models and in general any other decision-making process at the business level. If better data is more timely available, the operation can more closely follow the plan since both the schedule and the plan can more quickly react and adjust.

Hydrocarbon loss tracking to support loss reduction initiatives appears as one of the most attractive reasons for implementing production accounting at this level of scope and on a daily basis. The HM-31 standard by the Energy Institute, an accepted standard for hydrocarbon management, in its material balance chapter it says *"Daily balances require a lot of effort and commitment if the data are to be meaningful, as this type of balance sees substantial variation in the percentage loss…[] Daily balances may however help to identify problems and allow the early rectification of any defects."*[1] So, it is accepted that, though losses must be observed on a monthly basis, it is good practice to track it on a daily basis to be able to react more quickly. Then the key is to reduce the effort required to do accounting and to adopt these shorter accounting time periods.

On the operation side, production accounting has proved to be the source of reliable data for meter maintenance, process simulation and optimization tools for those processes to use adjusted data rather than purely raw data. In this area, it's worth mentioning that, though process simulation may apply some data reconciliation over the raw data sometimes, its scope is typically on the process side only, while the adjusted values based on production accounting are based on site-wide reconciliation so they are likely to be better as they has been cross checked against all the best actors in the site, which are usually located at the off-site.

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[1] HM 31. Guide to hydrocarbon management in petroleum refinery operations.
https://publishing.energyinst.org/topics/hydrocarbon-management/loss-control/hm-31.-guide-to-hydrocarbon-management-in-petroleum-refinery-operations

Integrated, automated, complete production data

Now let us describe the interactions between production accounting and other businesses and systems. Having in mind the end-to-end concept that I mentioned before, there are some functions that are recommended to be intrinsic part of the production accounting process and system as opposed to be handled by external tools, for several reasons like visibility and control over the whole life cycle of every piece of information that takes part in the balance for auditing and troubleshooting purposes, for example, or for model maintenance reasons. Having separate systems imply that separate models have to be maintained and synchronized and this is clearly against the best practice as this introduces unnecessary complexity and additional efforts to sustain the process.

So, activities like inventory and movements managements or process units' balances should be delivered by the production accounting system itself and be connected to all external sources of data.

Receipts and shipments data, on the other hand, have an extra level of complexity. Though they could also be handled by the production accounting system up to a certain point, this data usually comes with some additional commercial information that is typically generated on commercial or operational tools like truck or ship loading or unloading systems that generate information ticket numbers and so on and this justifies the use of those systems that are specially designed for those particular purposes. But in any case, if data is already in one place it should never be required to be manually enter the same information in other systems.
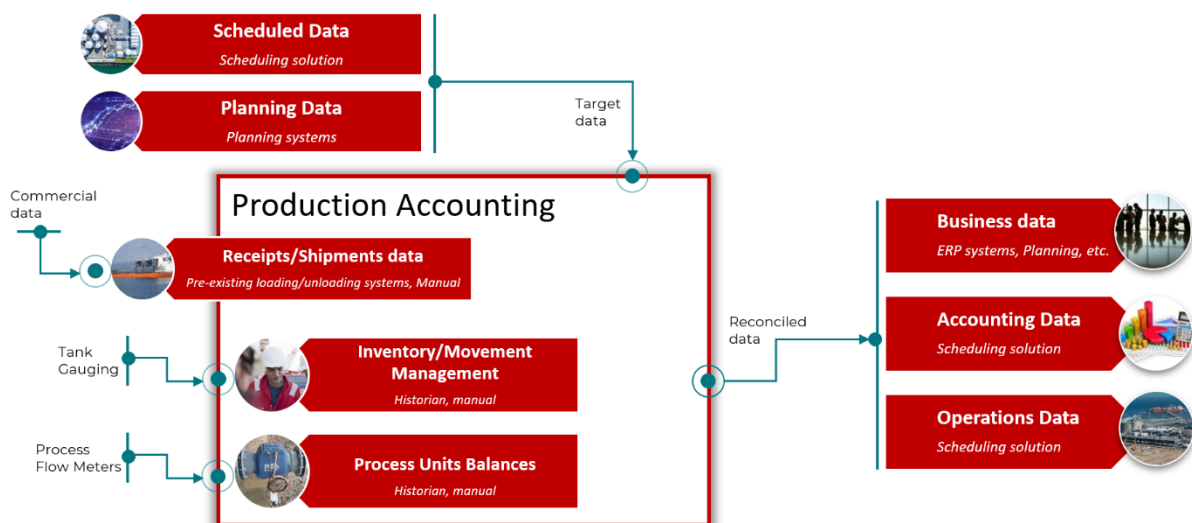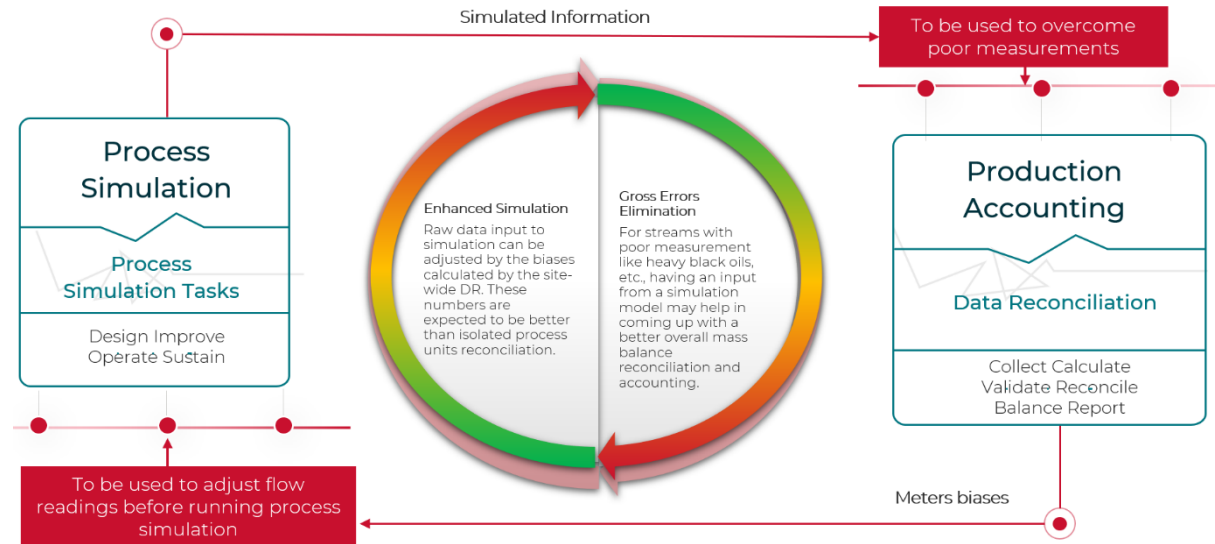

Three types of data can be identified as relevant to the production accounting process:

- · Actual data, which is the main input that will be processed and subject to validations and reconciliation,
- · Target data which refers to both planning and scheduling data. Planning data is typically used for plan versus actual tracking in the back-casting activities associated to the accounting. The scheduling data, particularly the scheduled operations, is used to establish a collaborative workflow with the oil movement management capability of the production accounting system. So actual operations are logged according to those that have been scheduled for the day, which simplifies the movements management significantly and operators will be grateful for that.
- · And finally, the generated reconciled data is exposed to be consumed by whoever needs this data for their own business processes.

One other topic that helps to bring more sense and consistency among businesses that are related to each other is to establish a workflow between accounting and process simulation.

Process Simulation — Process Simulation Tasks — Design Improve Operate Sustain

Simulated Information

To be used to overcome poor measurements

Enhanced Simulation
Raw data input to simulation can be adjusted by the biases calculated by the site-wide DR. These numbers are expected to be better than isolated process units reconciliation.

Gross Errors Elimination
For streams with poor measurement like heavy black oils, etc., having an input from a simulation model may help in coming up with a better overall mass balance reconciliation and accounting.

Production Accounting — Data Reconciliation — Collect Calculate Validate Reconcile Balance Report

To be used to adjust flow readings before running process simulation

Meters biases

This workflow improves both sides, the accounting balance will benefit from replacing systematic bad measurements with simulated quantities improving the overall quality of the balance, while all processes tied to simulation will benefit from using site-wide validated data as opposed to purely raw data.

How VM-PA delivers

VM-PA is KBC's solution for mass balance, production accounting and data reconciliation.
VM-PA delivers Best-In-Class Production Accounting by integrating engineering knowledge with yield accounting techniques creating the single version of the truth serving as the foundation of the facility's hydrocarbon allocation and loss control initiatives by automating the capture, balance, and tracking of complex-wide systems to increase efficiency and reduce operating costs. All this is achieved expeditiously and in an auditable and flexible environment. All VM-PA current users are running daily accounting, some of them have been doing this for more than 20 years now and they can provide testimony on how we have helped them improve their business. VM-PA is covering the most varied situations, from very small plants with simple operations to multi-site operations with both local and remote facilities, even sites with complex paper accounting implications that get in the way of the physical accounting. All this proves that VM-PA is flexible and can easily scale according to the requirements.
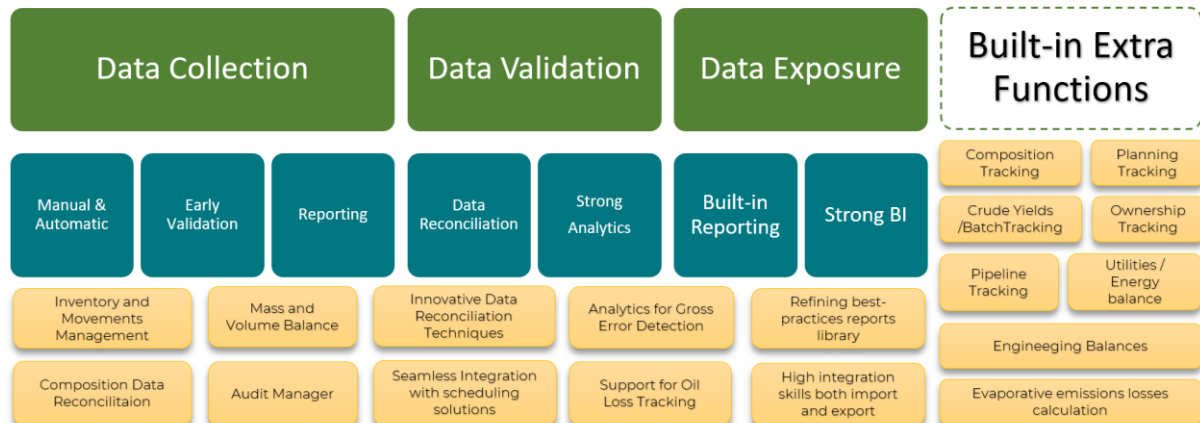
All the functionalities that are listed in this slide are meant to solve the issues we have been mentioning and help to achieve best-in-class accounting by creating time and the context to use the high-quality reconciled balance data for better opportunities. How we do it:

- By providing a holistic solution (end-to-end) for the whole production accounting business process from data capture, through validation and data exposure. All in one is always better for visibility and model maintenance reasons.
- By delivering expeditious accounting procedures that guarantee refinery-wide daily long-term sustainability. This creates time for other tasks on top of the time required for the accounting itself.
- By providing those additional analytical scenarios as built-in functionalities to guarantee that the extra time is better spent on analysis rather than on building the analytical context.
- By integrating engineering knowledge as built-in functionalities to maximize the value of the reconciled balance data.

Take a moment for you to review this list and ask yourself how your facility is doing in those areas.

VM-PA and Scheduling solutions

In the latest VM-PA release a seamless integration with scheduling solutions has been developed. This integration establishes a collaborative workflow with VM-SCS, KBC's solution for Supply Chain Scheduling but the same technology can be used to integrate to any other system, as long as a Restful web service is available to provide the list of scheduled operations. We are using a state-of-the-art approach to map the model elements based on an ontology-based semantic technology which allows a much more flexible way to map different models as opposed to plain mapping tables.
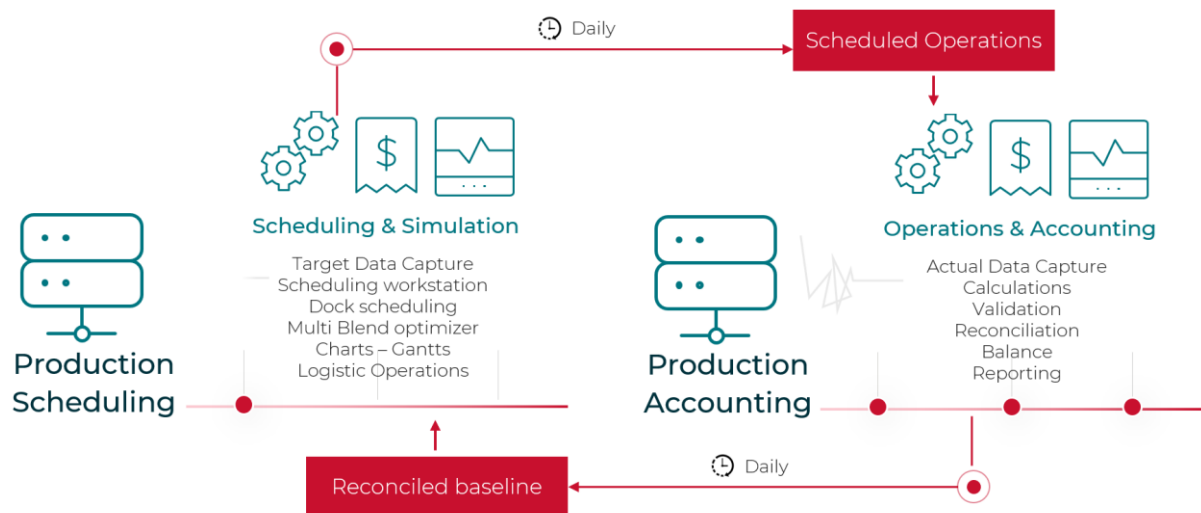
This development is expected to significantly decrease the amount of data that operators have to enter, changing their role from creating movements with all the details to simply updating them from scheduled to actual operating details.

VM-PA Hydrocarbon Loss Management

As said before, hydrocarbon loss management is one of the most attractive topics related to the benefits that can be obtained with a best practice accounting. In the image below, most of the main components that take part in the total loss calculation are shown. This list is also consistent with the HM-31 standard by the Energy Institute mentioned before. This standard explicitly describes how to account for losses and makes some recommendations on how to keep them under control.

Oil loss constituents
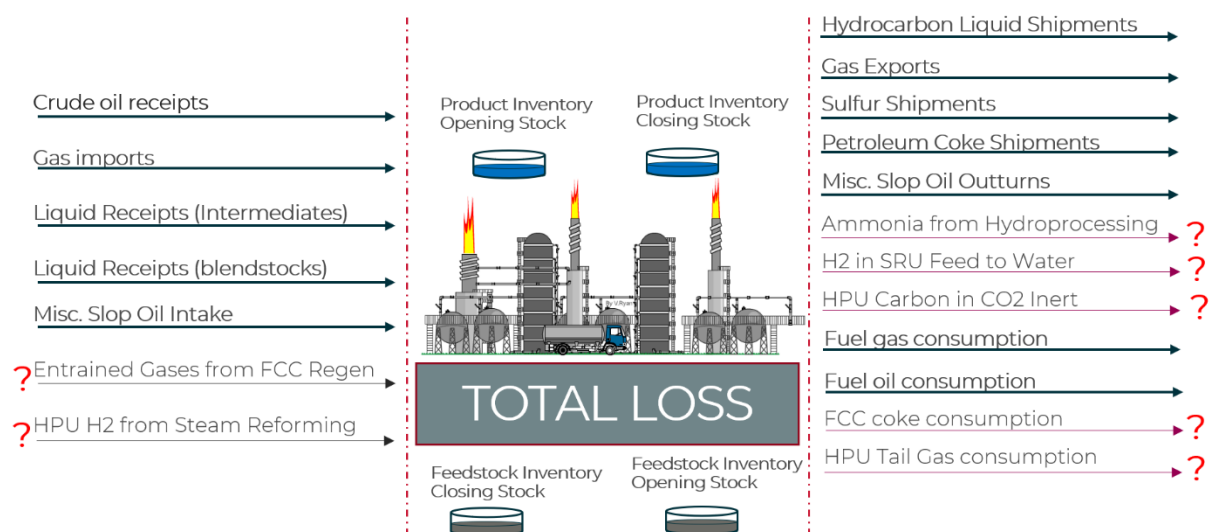
The items in bold fonts are the ones that represent the major components and the ones that can more easily be identified and measured. So those are the ones that are typically included in a regular production accounting model. Nonetheless that approach is not complete as normally the secondary components are skipped because of both their lower amount and the difficulty in have them measured or calculated. The best practice then, would be to have them included to measure the actual oil loss more accurately.

A similar thing happens with what is known as Accounted Loss. The accounted loss is basically that portion of the total loss that can be measured or calculated. By quantifying these elements, it serves to indicate areas of priority for loss reduction. The difference between the total loss and the accounted loss represents the unaccounted losses, and the importance of having all constituents included in the calculation is given by the fact that a large unaccounted loss could be an indication of problems in the measurement system, which compromises the quality of all the data that comes out the reconciled balance.

PA first class models should contain all losses sources

Total Losses Missing Constituents
- FCC coke consumption
- Entrained Gases from FCC Regen
- H2 in SRU Feed to Water
- Ammonia from Hydroprocessing
- HPU H2 from Steam Reforming
- HPU Carbon in CO2 Inert
- HPU Tail Gas consumption

Accounted Losses Missing Constituents
- Storage Tank Emissions losses
- Losses from API Separator Evap
- Losses from WWTP Water Outfall
- Miscelanea Losses

- Deep expertise
- Experience factors
- Empirical equations
- Engineering details

In summary, all the components that are shown in the previous image, which are not few, are usually skipped from accounting models. The best practice would be to have them all included for a better loss tracking. KBC's VM-PA can help with that as it has been conceived to provide support on all this items by integrating KBC's consulting engineering knowledge.

Conclusions

Integrating engineering knowledge with production accounting creates the single version of the truth. This best in class approach creates time to use the high-quality data for better opportunities. VM-PA delivers to business, accounting and operations, high quality data that is auditable, expeditious and flexible. So how can you begin to improve your accounting procedures? We propose that you begin by diagnosing your current methodology. Here are a few questions that can help you guide:
- How many "pieces" form your full production accounting / mass balance process and how expensive/hard is for you to keep them all aligned?

All about
EXCELLENCE

- Is your Production Accounting process run as a set of mandatory tasks for monthly balance closure and hence, more similar to an admin task only?
- How manual is your accounting/mass balance process? Which percentage of the accounting input data is automatically gathered and integrated to the models?
- Is your production accounting / mass balance process supported by statistical data reconciliation?
- Is your production accounting / mass balance process supported by automatic gross error detection?
- How long does it take to generate the official balance reports and all other tasks that concern to the production accounting process?
- Are your decision-making processes at all relevant levels (planning, finance, operations, etc.) based on the so called "unique version of the truth)?

KBC can further help with this diagnosis and provide real and proven solutions.