Quantity data flow in the oil & gas supply chain

How can we ensure that our quantity data values are correct?

Version History

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Contents

1. Introduction

From the well head to end consumers, oil and gas supply chains are amongst the most complex in the world.

This paper focuses on a single important aspect within all this complexity - the measurement and subsequent calculations of product quantity data.

What sort of quantities are we talking about? Considering only the oil supply chain, more than 99 million barrels of crude oil and products are traded every day on our planet. At every point in the chain where crude oil and its products are produced, stored, and transferred, exact measurements are taken to determine how much product is being transferred.

Pricing of natural gas, crude oil, and products such as gasoline, LPG, diesel, jet fuel, heating oil etc. depends on exact standardized product quantity values. E.g.:

- "How many barrels at 60 °F (NSV) of my crude have I sold to my customer?"
- "How many Gigajoules at 15 °C and 101,325 kPa (metering & combustion) of natural gas are transmitted in a single day to my utility company customers?"

These are important questions, since the dollar value your organisation obtains for "your product" is, in a simplified way, the "standardized product quantity" times "the price per unit" (e.g., 68 $ per barrel at 60°F).

Historically, these quantity values have been calculated via spreadsheets by many experts using table data printed in large impressive-looking books for all possible products.

However, with the advent of modern ERP systems, oil and gas business processes are highly automated and it is possible for IT systems to perform these tasks. Unfortunately, the focus of most ERP system implementations has been on supply chain process optimization and not on the intrinsic complexity of quantity calculations.

The new dynamics of increasing market volatility now demands concentration on the quantity data flow within the supply chain and how this data is being controlled and enriched while being passed through IT landscapes.

Bulk products are at the heart of every oil & gas company. Unfortunately, exact and transparent quantity conversions along with good quality quantity data have been neglected as product availability was not

an issue. ROI from increased operational excellence through process automation and process transparency was large and readily achievable. There is undoubtedly still potential for the industry in this area. However, the level of detail and complexity has been raised – now these processes' technical contents must be examined as well.

Within the SAP Oil, Gas, & Energy Solution system, SAP provides a flexible, open interface for complex quantity conversions (Quantity Conversion Interface - QCI), which customers can utilize to integrate their own calculations or third-party solutions. The aim of typical implementations has tended to be to "get some numbers returned back from the calculations" thereby ensuring uninterrupted process flows. Thus, if we now examine this process in detail, a massive cost optimization potential in becomes apparent.

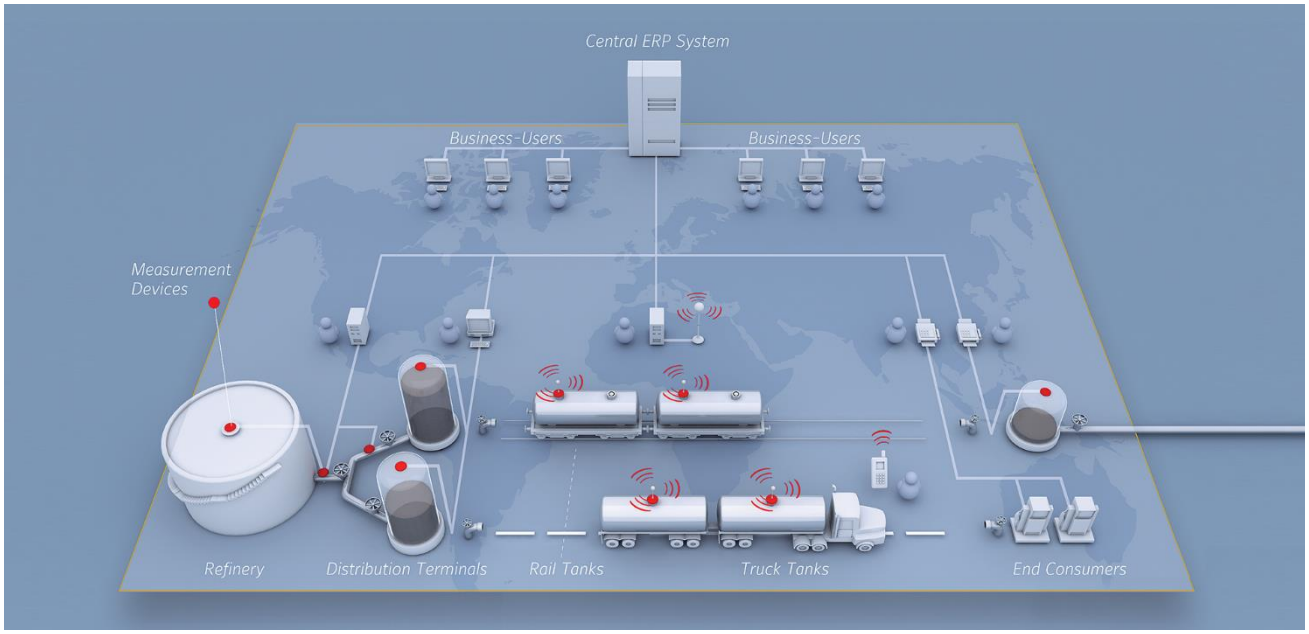
To put it simply - the reason for QuantityWare's existence is this formula:

"Product A" Profit = ("quantity data of product A" X "price") - "costs".

SAP helps you to define and manage "product A", as well as optimize the complex "price" and "cost" variables. QuantityWare ensures good quantity data.

2. Simplified Example Supply Chain

As a basis for our “quantity data flow in an oil &gas supply chain” discussion, a graphical representation of our simplified supply chain is depicted down below. In this example, we focus on a liquid product supply chain. Since we discuss the implications on the IT infrastructure qualitatively, the results gathered in the following chapters can also be taken as a basis for a natural gas supply chain.



In the upper part of the graphic, business users are assumed to operate business transactions within a highly integrated, central ERP system (central box).

Our simplified supply chain in the lower part describes the distribution of diesel, gasoline, and LPG. The products are produced in a refinery and stored in large tanks. Via a pipeline system these liquids are transmitted to a distribution terminal (truck-based) and an intermediate depot for transfer to rail tank cars. From the terminal, the diesel, LPG, and gasoline is transported via truck loads to various gas stations. The intermediate depot is responsible for the transfer of diesel via rail cars to large industrial consumers – typically for energy production.

At the refinery, product is stored in large tanks which are constantly monitored. Tank dip measurements - which are often automated (e.g., radar gauging) or taken manually - result in product volumes at fluctuating ambient temperatures. Additionally, quality data (e.g., sulphur content, LPG composition) and density values are measured.

The measurement systems used to collect such data are typically “real time” (i.e., fast) whose primary design is oriented around ensuring maximum operational safety.

Via pipeline systems, product is pumped to the terminal and the intermediate depot. Pipeline batch quantities are measured and quantity data (temperature, pressures, volumes etc.) is retrieved by other measurement systems along the entry and exit points of the pipeline - guaranteeing operational excellence and highly automated processes.

In the depot, tank levels are again controlled by the operating company in the same way as in the refinery.

Railcar and truck loading also require exact determination of product quantity data (volumes, temperature, masses/weights via weigh bridges, etc.), while discharge from the railcars and trucks to end consumer storage tanks is also accompanied by measurements.

Thus, at each custody transfer point, as well as each point where the mode of transport changes, sophisticated measurement devices (flow meters, gauging systems, weigh bridges, density meters, etc.) are in use. Such devices may be manufactured by one or more suppliers, who all incorporate more-or-less sophisticated quantity calculation procedures, typically based on measurement standards, allowing the determination of several product characteristics. Exact quantity data is necessary to determine this transfer of ownership throughout the supply chain – price, taxes, and tariffs are based upon this data.

3. Quantity Data Flow - Simplified Supply Chain

If we now take a closer look at the simplified supply chain, we can identify two distinct data flow models which are still in discussion within the industry:

- The more historical model - the “distributed quantity data flow model”,
- The modern ERP based model - the “integrated quantity data flow model”.

3.1. Distributed Data Flow - Simplified Supply Chain

This model assumes that the relevant measurement data from all measurement points (required by an ERP backbone solution for the orchestration of the complete business process) is simply “dumped” into the ERP system via technical interfaces. Business users working with the ERP system obtain only the minimum data required for business documents (e.g., contract updates, nominations, metering tickets, invoices etc.). With this approach, no state-of-the-art quantity conversion is assumed to be available or required within the ERP system. The business depends on the operational world to deliver reliable data.

Sounds simple? Unfortunately, a fully optimized supply chain production and product flow relies on passing trading, planning, and scheduling results back from the ERP system to different operational units; if this does not happen the different units (tank farms, refineries, pipeline operators, trucking companies) operate in a “blind” silo mode, where business process disruptions will occur.

To minimise negative effects, ERP systems such as the SAP Oil, Gas, & Energy ERP solution have been introduced since the early 1990’s with the aim of seamlessly integrating complex oil & gas processes in a single business model. With this level of integration, more complex factors must be taken into account in a single system running supply chain scheduling activities, as well as mid- to long-term trading activities, excise duty requirements, or exchange business processes between partner companies.

At present, a high degree of automation has been achieved within the industry and data flows between the operational world and the ERP process world have steadily increased. During this process, it has become clear that an ERP system cannot just “accept” quantity data from operations; it needs to be able to monitor the data and have an opportunity to perform its own data validation and calculations.

The oil and gas industry operates on a global scale across many organisational, political, and national boundaries. Different countries utilize different standards, especially with respect to so- called “base conditions” (to which quantity data values are normalized) and unit of measure systems, with the SI system (often called metric system) and the U.S. customary system being the most well-known.

Modern local measurement systems are probably accurate (the validation and verification of such data relies upon manual procedures and is therefore not often performed), but simply do not provide the flexibility to calculate all required data for contracts, invoices, excise duty payments or sophisticated product pricing engines. In addition, updates for new measurement standards to hundreds of real time measurement systems, typically provided by more than one supplier, can become extremely costly, cumbersome and time consuming.

To avoid such costs and risks, the SAP Oil, Gas, & Energy ERP system provides a sophisticated Quantity Conversion Interface (QCI), which allows a centralised quantity conversion tool to be implemented. SAP itself does not provide any measurement-standards based quantity conversion tool that can be used in conjunction with the QCI, however based on such an interface, a new model has emerged during the last decade - the integrated quantity data flow model.

3.2. Integrated Quantity Data Flow Model

The integrated quantity data flow model does not rely on a simple one-way quantity data flow from the operational measurement world, but requires a single, state-of-the-art, secure, and reliable calculation engine within the central instance (e.g., ERP system), that can perform all kinds of calculations for all:

- unit of measure systems
- calculation measurement standards

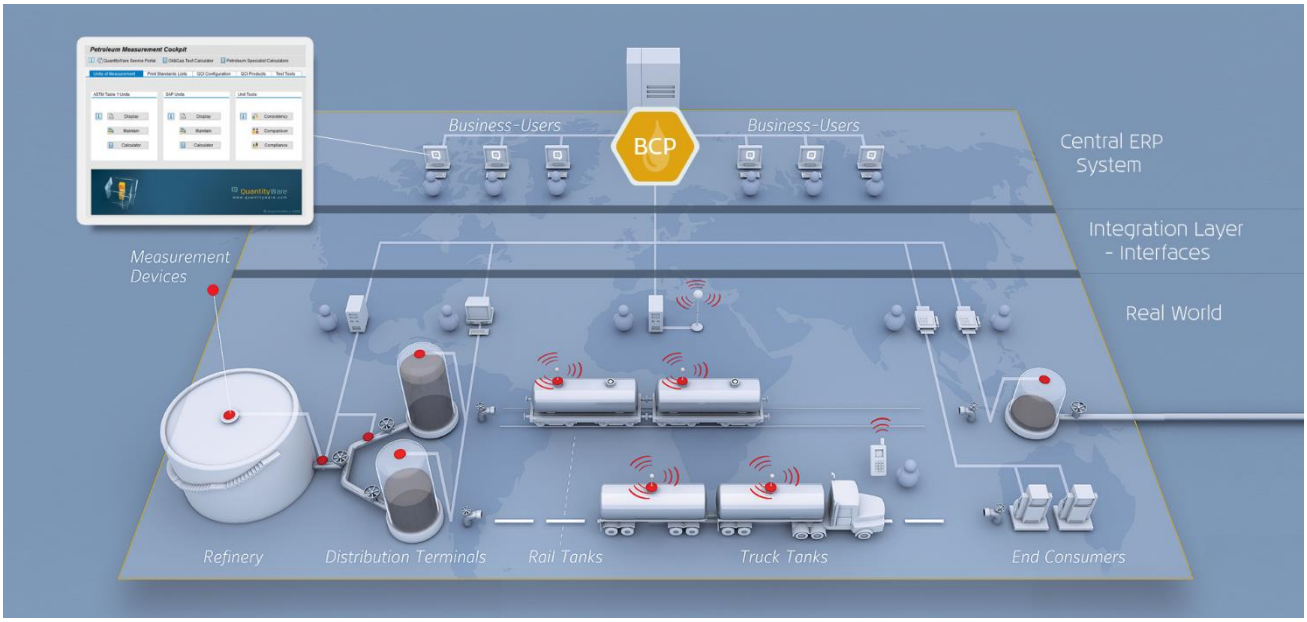
Within this model, data passed from an ERP “external” system such as a tank gauging system, can easily be checked and enriched with additional data in a transparent and secure manner. Business users (inventory managers, schedulers, tank farm managers, sales specialists, to name but a few) should have this data at their fingertips within an integrated system to work with maximum efficiency e.g.:

- invoices are based on good quantity data
- excise duty is calculated with high accuracy
- transparency is achieved throughout the supply chain

One of the most important aspects of such integration is the capability to check the data being passed from external measurement systems to the ERP system. It is extremely important to reduce the risk of false calculations through a simple double-check (“gate keeper”) within all implemented business transactions.

Based on our current experience within the industry, many ERP implementations have (correctly) focused on optimized process orchestration and are still working on closing important process gaps. The quality of the quantity data, which is the basis for the ultimate financial success of any company participating in supply chain business processes, has not been in focus - so far.

The following graphic visualizes the integrated quantity data flow model, by overlaying three main IT layers over our simplified supply chain:



The ERP system manages complex business processes and feeds results (e.g., schedules, forecasts, nominations) to the operational world. These results are based on data from the “real world”, where the physical flow measurement of crude oil, products and natural gas takes place. From a quantity data flow perspective, the relevant measurement data is passed via an integration layer to ERP systems, enriched in the ERP world, and checked, controlled, and utilized in all business processes that deal with real quantity values, i.e., all non-long term planning process parts.

If an ERP system with SAP Oil, Gas, & Energy is in use in conjunction with QuantityWare solutions, select ERP system users can configure, monitor and adjust all quantity conversion & calculation procedures if necessary. This is possible through usage of the Petroleum or Gas Measurement Cockpit – a user-friendly management tool included in the two "SAP Certified Integration" solutions from QuantityWare - Bulk Calculations – Petroleum (BCP) and Bulk Calculations – Gas (BCG). Owing to the degree of integration with SAP Oil, Gas, & Energy, centrally, securely managed quantity conversion procedures are easily defined and seamlessly integrated into all ERP processes.

Example:

Let's assume that in our simplified supply chain you are selling truck loads of commercial propane. The loading rack measurement system was manufactured in 1997. This system utilizes a built- in calculation routine for LPG temperature corrections based on an extended ASTM D1250-80 standard, which was the only solution available for this calculation in 1997.

You load 100 000 gallons on to trucks or railcars. The volume calculation at 60 °F, with loading temperatures deviating around +/-20 °F from 60 °F, results in a nominal difference of 1 000 gallons when compared to the current GPA 8217 / TP-27 standard calculation for that product load.

This difference in standardized volume (the quantity value) results in an invoice value loss of between 1 000$ to 2 000$ (depending on the current market price).

Only if your central measurement system is constantly checking such "operational world" calculations, will you be able to prevent massive negative financial impact to your organisation.

In business terms, whenever quantity data is passed from the operational "real world" into the "ERP system world", it is checked and enriched, ensuring high quality quantity data, transparency, and fully optimized business processes.

4. Increase Operational Excellence - Minimize Financial Risks

Based upon the model description in the previous chapter, an integrated IT landscape which can adapt to changing business processes, brings real business benefits. This flexibility is required for the intrinsically complex quantity conversion area – which is why QuantityWare created its BCP and BCG solutions - to simplify the issue and let business managers gain control of a complex technical risk area.

4.1. The Integrated IT Landscape – Quantity Data Flow Control

The issue:

From a quantity data flow perspective, business organisations need to be able to implement and if required, rapidly change the quantity calculation and conversions for all products, based on any potentially given measurement standard. The standard to be used is typically agreed between buyer and seller of a product and specified in contract terms and/or regulatory bodies.

If businesses were to rely upon quantity data from the "operational world", they would have to enhance and update all operational systems whenever new standards became available or new contractual agreements were negotiated. This is, if not an impossible endeavour, an extremely costly one without end. In addition, data along the supply chain is typically based on different standards or standard conditions (e.g., base temperatures), and especially in international processes, many different units of measure are in use. This further complicates the situation and makes direct comparison of apparently similar quantity data values impossible.

The solution:

A unified approach is necessary. It is more efficient, cost-effective, and transparent to obtain the minimum required data from the diverse landscape of operational measurement systems and then centrally control and calculate all process relevant data, such as standardized volumes, weights, energies and masses. The realisation of such centralised complex calculations, their integration into existing ERP systems and accessibility to business managers and users is now possible thanks to QuantityWare. Central calculation engines such as the QuantityWare BCP and BCG can be configured within the SAP Oil, Gas, & Energy ERP systems to easily compare specific and mass external data with QuantityWare calculations with the following results:

- enabling “due diligence”
- preventing bad quality data from being passed to the ERP system
- controlling the results of field equipment exposed to hostile conditions
- thus, ensuring that both the “ERP” and “Operational” worlds are:
    - legally conform
    - contractually conform
    - …in an efficient and transparent manner.

4.2. Quality Assurance Guidelines - Quantity Data Flow

As described previously, back in the “good old days” human experts performed many of the calculations to obtain quantity value data. This process was limited in scope, as in its essence, it is a manual process which must be performed with a calculator – or at best, with a spreadsheet. Although this process is now logically being replaced by IT systems, it is important to realise the following “quality assurance” fact. Human experts can, if in doubt, double-check their results with a colleague; this natural, human “four-eyes principle” has been the standard “QA” method since measurements were first used.

If you are a supplier of a modern measurement system or calculation engine, a valid question always is: “The price I am paying is based upon the measurements you are giving me! How can you guarantee that your results are correct?”

That is a difficult question to answer…

Let us answer the question for them. Our recommendation to oil and gas companies consists of two parts:

- rely on a two-tier IT system, where operation measurement systems perform calculations but in turn, are checked and enriched by a central calculation engine.
- for any IT project where the QuantityWare solution is implemented, we strongly recommend that our Project Assessment & Implementation Guidelines are followed. These guidelines require that at least two human experts create independent "control" calculations of quantity conversion configurations, allowing the automated calculations to be validated. These test cases can then be stored in the system in a fully transparent manner and are ready to run on a regular basis (i.e., weekly, after critical system upgrades, support package actions, customer functionality go-lives, disaster recovery actions, etc.). In addition, QuantityWare BCP and BCG are shipped with our own internal automated test cases (accounting for approx. 35 % of the product code lines), which can be executed and inspected by every customer.

By following this recommendation, your organisation has the chance to:

- minimize extreme financial risks
- increase the quality of your quantity data in all organizational areas
- introduce flexibility to change quantity conversions to support new contracts or standards
- allow rare, specialized, measurements specialists to work more efficiently
- increase transparency
- honor "due diligence" more effectively by the centralization of management responsibility
- reduce contractual and legal conflict risk.

5. Conclusion

In this working paper we demonstrate why it is imperative for any quality and profit-orientated oil & gas company to focus on the overall quantity data product flow within their complex supply chain.

While there is still huge potential to leverage the dormant processing power of any ERP system (process redesign, utilization of new ERP based process capabilities, addition of missing process solutions e.g., in the trading area), any investments should be accompanied by a critical review of the existing quantity data flow capabilities. As noted in the introduction of this paper, the reason for review this can be expressed in a simple formula:

“Product A” Profit = (“quantity data of product A” X “price”) - “costs”.

- SAP ERP for Oil & Gas helps you to define and manage “product A”, as well as to optimize the complex “price” and “cost” variables.
- QuantityWare ensures good quantity data – the source of an oil and gas companies’ financial stability and health.
- if you do not have absolute transparency in your quantity data, your company is exposed to a massive financial, contractual, and legal risk. The financial potential alone for a company trading large volumes of product is in the region of “million US dollars per day”.

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