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Data handling of process plants

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Purpose

The purpose of this paper is to document the current Red-Bag philosophy on the handling of data in the process industry, emphasizing on the mechanical data. This paper does not pretend to be complete or to present the ultimate solution, it is a recording of thoughts that will be changed or mature in due time.

Introduction

Process plants such as the (petro-)chemical industry are dealing with a wide range of data. The range of data handled includes for example contractual commercial data during the EPC (Engineering, Procurement and Construction) phase of a plant and operational technical data during the production phase of a plant.

Due to the overall amount of data in the life cycle of a plant in the process industry, the efficiency of handling the data is an important issue. Some data will be necessary real time but other data can be stored in a cabinet and is probably never to be used again. This is also the case with technical data. For example: data like the operating temperature in a pipeline will be used during the real time operation of the plant. However the certificate of a welder who has welded a vessel can be stored in a cabinet and will probably only be necessary to reproduce when the inspection authority will request for a copy of the certificate.

The process industry is working already some years to standardize or actually to automate the data of process plants. The background for the automation is consisting of different reasons. Some of the reasons are to improve the data hand-over with suppliers such as Engineering Contractors at project completion or to automate the Material Management System to support the working process in the procurement or purchase departments. The automation for the procurement or purchase department have been done by many plant owners but also at Engineering Contractors. These automation efforts have resulted in many occasions in large data bases with well defined components and materials usually will suited to support the procurement and purchase department. Unfortunately further use by other departments of this data has been cumbersome or not possible at all and sometimes slowed down the work process in those departments rather than improved the work efficiency. Also the procurement database in many cases was organized different from how for instance the technical department would like to see or use the data.

It can be concluded that the organization of data can not be successful for all stakeholders of the data (such as the procurement and the engineering departments) without considering the way these stakeholders would like to use the data. If the technical departments had been involved in the development of the original procurement database, the structure of the database would have probably been completely different but would have served both departments' purposes.

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Data structure philosophy

Red-Bag has chosen to follow a different route in order to structure the data and to include the requirements for data of different stakeholders. It is important to understand that in this route the requirements for the technical departments have been considered first before the requirements of other departments or stakeholders. This choice has been made because the technical departments need more basic details of process plant components and equipment than most other departments.

At first the Red-Bag FMDI principle was selected to define the component in its most bare-bone form. The data of this bare-bone form is the minimum required data necessary to define a component, based on the definition of the Function, the Material, the Dimension and the Interface of the component. As a consequence, if any of this data is changed the component will be a different component. All stakeholders will therefor use this minimal data when defining the component and therefor the data is necessary in all databases when defining the subject component. It is important to understand that components can consist of various other components to fully define the component, for example a centrifugal pump will consist of the casing, the impeller and various other components. An elbow however can be considered to be just one basic component to make its definition complete. For background of the Red-Bag FMDI principle refer to the relevant paper on the Red-Bag web site.

As a second issue the data transfer between stakeholders was considered. There is a vast amount of data necessary to fully describe a process plant. But not every stakeholder uses all of this data and different stakeholders use only a part of their own data in their communication with others. The communication between a plant owner and an engineering contractor is usually about different data than a fabricator with its sub-suppliers. This differentiation in ‘communication’ data makes that the databases can be made specific for each stakeholder with only the relevant data. The databases per stakeholder are lighter and easier to use than if all data of a plant is to be stored and understood by all stakeholders. Also the discussion about standardization of the overall data can be split into separate discussions with only the relevant stakeholders participating. For example: the standardization of a part of all a process plant data can be done in a discussion between the engineering contractor and the plant owner. This discussion will be about data such as process conditions and materials to be used. Standardization of other data such as weld details will only be done for example between the fabricator and its sub-suppliers.

The third aspect considered in the Red-Bag approach is the time line or life cycle of the process plant. Some data is very important during the design of a plant but will not be important when the plant is in operation. This means that data of that sort needs to be accessible during the design but can be stored further back when the plant is in operation. For example the project planning for the construction of the plant is important during project execution but is of virtually no value during the operation of the plant. The significance of data can also change. For example the design pressure and temperature during the design phase of plant will determine the required wall thickness of a column but when the plant is in operation the wall thickness is a given fact and will more or less determine the allowable design pressure and temperature combination.

The above three items advocate data differentiation data in to:

- Component basic definition data such as the FMDI principle
- Distinction of data as per the stakeholder requirement
- Life time of data during the life cycle of the plant

It must be noted that for the component definition all international standards are considered and used that facilitate the definition data. For example piping components are well defined in documents such as the ASME and EN code.

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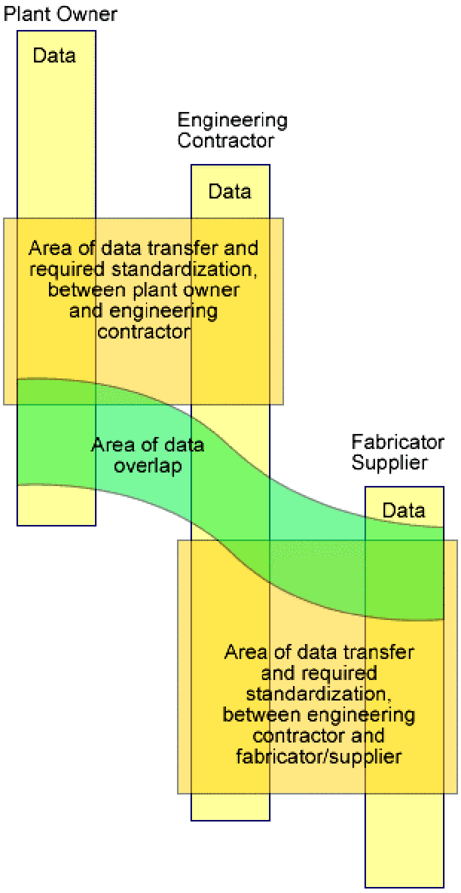

With the figure at the left the difference in data is explained that is being handled between three example stakeholders, the plant owner, the engineering contractor and the fabricator/supplier.

At the very left the column of data for the plant owner is indicated. The top of the column represents data like legal and commercial data that is of no interest to an engineering contractor. Further down in the column in the orange area the data like overall plant cost, plant capacity and plant lay-out is indicated. This data is of interest to both parties, the plant owner and the engineering contractor.

If we look at the column of the engineering contractor, we see the similar approach. There is at the top some data that is not of interest to the fabricator and further below some data that is in the orange area that is of interest to both parties.

The green area indicates that there might be a data overlap, that is data that is of interest to all three parties.

The figure clearly demonstrates in this example that it is not necessary for the plant owner to be involved in all minute detail of all the plant data. It is possible to leave certain detail data to the other parties involved in the process of building and maintaining the plant.

Figure - Data areas and transfer areas

Example

The design temperature and pressure is of importance to both the plant owner and the engineering contractor. The design parameters dictate the wall thickness of all vessels and heat exchangers. This data remains important to the plant owner in case vessels or pipe lines need to be replaced. This is an example of data in the area of data transfer and required data standardization (orange) between plant owner and engineering contractor.

The design pressure and temperature can also be important to the vessel fabricator, if the vessel is to be calculated by the fabricator. (If the vessel is completely designed by an engineering contractor this data is not that important anymore since the wall thickness and the design is fixed by the engineering contractor.)

The above example indicates an area for data transfer and required standardization applicable between all stakeholders of a process plant. It is obvious that the areas need to be identified before starting with the standardization of data structures and data transfer. With the identification of these areas the applicable stakeholders who need to be involved in the standardization can be assigned to take the lead in the standardization. We explicitly mention ‘to take the lead’ because these parties knows best the boundaries of the requirements for the data.

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Other example

The fabricator of a vessel needs to provide the welders certificates with the vessels documentation. The data on this certificate will not be handled other than as part of this certificate document. In this case the data will remain part of this certificate and not used anywhere else. The only purpose for this data is to be reproduced as a document when for instance an inspection body would like to see whether all paperwork is in order and all procedures have been followed. With this example it is demonstrated that, in general, data can not be handled as one sort of data. Some data needs to be available as figures such as the design temperature and pressure to be used for additional calculations and some data can be stored as part of a document and need to be retrieved as a document only in a document database.

Life Cycle of the Plant

As last differentiator we would like to mention the data's significance during the life cycle of the plant. The life cycle of a plant has an influence on the use of the data. As an example: the design temperature and pressure are important data that will determine the wall thickness of the vessels. On the other hand when the plant is in operation the wall thickness is a given fact and will in turn determine the allowable design pressure and temperature combinations. This aspect has an effect on which data will be on the foreground determining other data or vice versa. As a result the data's significance during the life cycle of a plant has an important influence on the structure of the databases and the software dealing with the data.

It can be concluded that the structuring of data is depending on number of related data aspects. This document indicates three related issues that partly determine the way the data should be organized to fulfill its requirements for most of the users of the data. The previous conclusions are repeated below:

The data handling and transfer requires a bare-bone approach for the definition of components in a plant. For the bare-bone definition the Red-Bag FMDI principle can be used as a guideline.

The stakeholders handling a discrete set of data will need to establish the data structure, the standardization and the functionality required handling the data. Functionality in this context means also the calculations performed with the data. The data can be separated in data that will be used as individual data and data that is for the record only. An example was given with the design pressure and the certificate of the welder of a vessel.

The significance of data during the life cycle of a plant needs to be considered. Certain data will have importance during the EPC phase of a project but can lose its importance during the maintenance and operation phase of the life of a plant.

Development of application in the engineering toolbox at Red-Bag

Red-Bag is developing software for various parties or stakeholders in the process industry. Most of our software needs to communicate with each other and/or needs to use other databases and/or needs to use other application's functionality. The first software applications are built with the purpose to provide an engineering toolbox. This toolbox is supposed to work like a normal engineering department works. The toolbox will therefore consist of for example an electronic line table (LDT), a pipe class calculation tool (PCC), an electronic equipment list (EQL) and a vessel and heat exchanger calculation tool (VES).

The general philosophy is that all applications can work stand-alone. This enables users to work at different locations even when a connection to the main system is not available. This implicates that all applications have their own working database. The overall engineering toolbox system will have a database controller that maintains the separate database the systems master databases.

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The engineers and designers use the data of components to the deepest level of detail and because of this detail the software is developed from the bottom up. This bottom up approach has an advantage but also disadvantages. The advantage is that from the start of the application development all details are considered, the disadvantage is that it is difficult to maintain the overview of the overall structure of the software application at the start of the development. The data considered in the engineering toolbox is data that is used by the plant owner and the engineering contractor. Fabricators and suppliers will use some of this data. The data therefor fits in to the left top orange box and some in the green overlap area.

The user of the software application will only select the basic (definition or bare-bone) data to define his selection of the component. Further component details are separated from the basic data. The detail data is data that is used only by the software to perform for instance a calculation. Example: for a pipe component calculation the user selects only the nominal OD, the schedule, the material and the dimensional standard. The software will collect all the necessary detail data for the calculation from the database such as the wall thickness and other sizes. The separation of basic and detail data handling is also used in the software according to this approach. The so-called objects in the software consists of a general part to be shown to the user and child member objects that contain the details for the calculations.

Data and instruction communication by software applications

When the applications are communicating with each other the detail data will not be transferred to other software applications since that data is already fixed in the dimensional standards such as the ASME B16.9. The software applications need only to transfer basic data to define the subject components and that are necessary to perform their task. In some exceptional cases a software application can ask the other application to inform about detail data of the component which is not available in the first application.

The databases and the structure of the data will have obvious similarities. This document will only discuss the structure of the data, the database structure is outside the scope of this document.

Data structure of pipe components for PCC (and for other applications) as example

The components to be used in a piping system are usually defined in a pipe specification. The pipe specification consists of different pipe classes for the various process and utility services. The pipe class lists a number of components that can be used in the pipe class. Components are items such as pipe, elbow, reducer, weldolet, valves and flanges. Most of these components are well defined in the national and international codes such as the ASME and EN codes. For these components the definition is complete when referring to a component from these codes and the applicable material. An elbow can be defined as:

ASME B16.9 - 3” XS LR (=dimension), ASME SA106 gr.B (=material)

In some recent publications other subjects have been added to complete the definition of the component such as the material certificate. In the structure as propagated in this document the certificate is not part of the bare-bone data of the component. The material certificate is part of the pipe class or a requisition tool. For instance for the stress calculation of the components it is not necessary to know the presence of the material certificate, for the 3D design it is also not necessary. The material certificate is necessary to order the material as per the owner’s or authority requirements as an additional safety to track the origin of the material.

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The PCC application uses only the above example to transfer data about a component. All dimensional details and all material details (in combination with the selected design temperature and calculation code) are extracted from the application database for the stress calculation of the component. The separation of the basic (input) data and the detail data makes also the maintenance to software efficient. If a material code is changed only the applicable figures need to be changed and no software code needs to be updated.

The software applications and the data are separated as they are in the real world. The line table is standard engineering document, fulfilling an important function in engineering but also during operation of a plant. Red-Bag is developing an electronic line table that will fulfill all the functions of the paper version of a line table. The LDT (line designation table) is an electronic line table that contains the data throughout the life cycle of the plant. It starts with a lot of process data, engineering and design data, operation and maintenance data and custom fields for the user to define. The LDT uses line numbers to identify the process and utility lines. The lines are constructed according a certain pipe class.

The applications are designed such that the LDT can ask the PCC software questions that an engineer would do, like “This line has a design pressure and temperature indicated does this pressure and temperature correspond with the pipe class?” The PCC application needs to understand the question and the associated data and needs to respond accordingly. This example is especially useful if an engineer is supposed to check a few hundred lines that in this case can be done by the application.

PCC and LDT will communicate like real engineers. The pipe class determines the components and the pressure and temperature limits. The line table lists the lines with process conditions and test conditions that are built from the pipe components in the pipe specification. The data transfer between LDT and PCC needs to be such that related data can be transferred between the applications. The data that both applications have in common are such as the pipe class name, the pressure and temperatures and the line size. In the software objects and the data structures both application need to have corresponding members to transfer the data and to execute the required instruction. The philosophy of separating functions as per the real paper documents and engineering tasks will be continued in most other applications. During the development of these applications many of these functions and interfaces are considered. On top of that the general structure is developed to be able to add additional interfaces if required.

Method selection of data and instruction transfer

The software instruction and data transfer needs to be designed to cope with the above example actions. Red-Bag has followed the developments and has concluded that XML is the preferred language to transfer data and instruction. Recent publications show that the OpenSource community as well as MicroSoft will support this development. Red-Bag will use the XML technology to communicated between their applications and to communicate over the Internet with webservices. It is Red-Bag’s vision that only the applicable engineers will have to use the full functionality of the applications but that much more persons will like to have the possibility to look in the databases with limited functionality via an ordinary web browser such Netscape, Opera, Mozilla and Explorer. Some first attempts of this Internet access are visible on the Red-Bag website under ‘free engineering tools’.

The line table is a typical example where the responsible engineer will use the application and many others will only access the data via a web browser. A responsible engineer will fill the database with the relevant data and updates the data when required. This responsible engineer could be a project engineer, systems engineer or a process engineer that would handle the line table. Other engineers such as instrument engineers, piping engineers and designers will frequently access the line table just to review the line table data via a web browser.

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This similar approach will be followed for the VES and the EQL application. The VES (vessel and exchanger calculation software) will be used to calculate the vessel and to determine the main dimensions. The EQL (equipment list) will contain the equipment general data that is part of the mechanical data sheet. Between the VES and EQL certain functions can be performed as in the PCC and LDT combination. Further in the future the LDT and EQL will be able to communicate with each other for example to check connections or to compare process conditions.

Red-Bag will continue to develop software following this general approach. The engineering toolbox shall consist of applications made by engineers for engineers and eventually fulfilling all stakeholders' requirements. Further future developments please contact our development department.

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