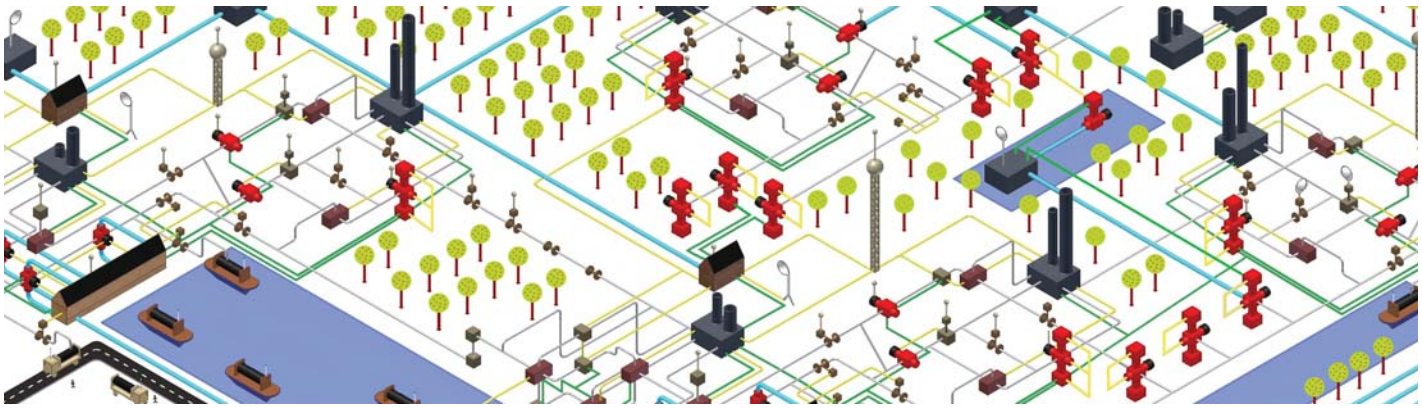

Innovative smart plant engineering

Population growth and rising standards of living are driving up the consumption of energy and raw materials. To minimize environmental impact, strategies are needed that ensure the careful and sustainable management of our limited resources. Plant engineers can play an important role in this respect, developing facilities that are considerably more efficient when compared to today's processes. They should focus on the following four requirements high safety, high recycling, higher efficiency and a much higher degree of automation.

By Dr. -Ing. Ingo Bruchhold, rapidea

When looking to develop future supply and production plants, it is important for engineers to properly balance strategies relating to concepts such as smart products, Industry 4.0 and smart products plant engineering. These terms can be described as follows:

The **smart products strategy** includes intelligent, self-monitoring, self-adjusting, user-friendly, resource-saving, energy-saving and communications-capable products: Examples in supply or production plants include the following: a) drives that can be automatically optimized to meet the different operating mode requirements and in the case of damaged fittings will automatically move to their safe positions whilst simultaneously informing other plant sections of the relevant emergency [03], [04]; b) sealing systems that automatically set-up for different operating modes and change the temperature of their matrix advantageously, can be partially self-repairing and can request other aggregates to undergo a controlled plant shut-down in an emergency [07]. and c) fittings that automatically optimize themselves to meet the requirements of the different operating modes and whenever necessary, automatically reducing any leaks that occur through self-repairs [02].

The **Industry 4.0 strategy** includes digitalization and networking along the entire added value chains. In supply and production plants this could include: a) intelligent production systems, such as factories and products as well as services, can be permanently interlinked via an IT network and data, information, control commands and software can be exchanged over this network (vertical networking) and b) business partners and customers, who are active in the IT network can also be linked together (horizontal integration).

The **smart products plant engineering strategy** covers technologies that are able to change the components, modules and aggregates integrated in the plants during on-going production as necessary due to pending operating pressures and these components, modules and aggregates as well as the materials can be transported over long distances to different stations in the plants and systems that are networked together: For example, in supply or production plants it is possible to use: a) module change systems [01] [05] for changing function modules as well as b) pipeline networks, consisting of primary, secondary and tertiary pipeline systems for transporting media and function modules [08], [09], [10]. These pipeline systems perform various tasks, such as handling (transporting of media from the producer to the consumer), testing (transporting pigs, sensors and transmitters into the sections to be tested), sealing (sealant transported for emergency sealing of sections following a blowout or leak), change (function modules transported to or from module change systems), etc

Advantages of smart plant engineering

The further development and implementation of smart plant engineering could make a strong contribution to the life cycles of plant components, modules and aggregates as well as the supplied or manufactured products, ranging from procurement and production up to the hand-over to the customers. Natural resources, materials, energy, services and processing times that apply to the relevant process can be pre-calculated relatively accurately, set-up and implemented and quickly corrected as necessary in the event of a deviation. Specific aggregates in these plants can be intelligently coordinated with each other and optimized to meet the current requirements without human intervention. During the servicing, maintaining, repairing and cleaning of the plants, aggregates and components can be regularly removed and refitted remotely and fully automatically by using the module change systems without reducing the high operating pressures and without interrupting production. Moreover, the function module can be supplied to different stations in the plant through the

primary and secondary pipeline systems as required. Components can be used differently and plant structures can be extended to optimize the processes and to adapt them for new production lines.

The manufacturers of components and aggregates can optimize their existing proven technologies to the geometrically standardized function modules used in the module change systems. This will facilitate the interchangeability of the same function modules from different manufacturers as well as the changing of modules with different functions becomes possible. Aggregates can exchange data, information and control commands over the IT network in parallel to this as well as being updated with the latest software. See Figure 1.

Criteria	Advantages of smart plant engineering
Time	Automatic interim testing => longer maintenance intervals Automatic conversions => faster production change Changes during ongoing production => shorter standstill times Automatic maintenance and repairs => longer service lives
Costs	Automatic testing and exchanges => lower maintenance costs Automatic testing and exchanges => lower repair costs High degree of automation => lower personnel costs Automatic conversions => lower conversion costs Universal compatibility => lower spare parts inventory costs Fast sealing => lower costs resulting from damage Higher safety => lower insurance costs
Technology	Conversion of "non-piggable aggregates" into "piggable aggregates" Regular updates for components, modules, aggregates and software Automatic change-overs / transporting of parts over long distances Changing-over of aggregates under full operating pressure Automatic withdrawal of samples and transporting them over long distances Provision of lubricants and additives over long distances as well Risk-free repairs and conversions even in contaminated sections Increases the degree of automation through intelligent global networking
Risks	Lower downtime risk due to faster or automatic repairs Damage risk reduced by automatic emergency controlling Human errors eliminated through a higher degree of automation
Markets	Entry into new markets possible from the fulfilling of additional requirements Increased market share due to using innovative and sustainable technologies Improved competiveness through faster optimisation to meet the requirements
Innovations	Standardised system parts / interfaces => easy integration of the latest technologies Quick part change options => shorter testing times for new technologies Quick conversion and testing of line sections
Safety	High fire safety through automatic provision of coolants and extinguishing agents Automatic closing of all lines through the provision of sealing media Shutting down of line sections through the rapid fitting of shut-offs Low reaction times due to sensors, IT networking and intelligent controlling
Resources	Material savings made through optimum controlling of the production processes Fewer personnel due to increased automation Energy savings through optimum and global networking of the production plants

Fig. 1: Advantages of smart plant engineering

Application areas

Smart plant engineering delivers high efficiency, uses less raw materials and energy and ensures sustainable management of resources and less environmental pollution. The increase in the degree of automation will also increase plant engineering and processing safety: The savings made with regard to human resources can improve the quality of life for other people by creating better jobs. The networking of plants along the entire added value chain as well as the interlinking of service providers, customers and business partners can shorten throughput times. Work that normally has to be carried out "manually" and directly "on-site" can be undertaken automatically over long distances and without direct intervention by anyone with the help of smart plant engineering. This innovative technology is particularly suited for application areas with very high health risks or those that can only be accessed with high technical expenditure. The following list shows some examples:

- Plants in which toxic, acidic or basic materials are used or produced as intermediate stages or end products
- Plants with extreme temperatures, pressures or radioactive contamination in the surrounding areas
- Plants with critical pollution of the surrounding areas, such as fungi, viruses, bacteria, cell structures or nanoparticles
- Plants in which possible contamination by external materials has to be fully eliminated
- Plants in which equipment or components only have short service lives due to them being very highly stressed

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