Innovative smart plant engineering

Towards future-oriented plant engineering

Population growth and rising standards of living are driving up the consumption of energy and raw materials. To minimize environmental impact, it is necessary to develop and implement strategies that will ensure careful and sustainable management of our limited resources and the affected environment. Plant engineers can play an important role in this respect, developing facilities that are considerably more efficient when compared to today's processes. Four requirements are essential in this respect: 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.

Smart products

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: a) drives that can be automatically optimised 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 optimise themselves to meet the requirements of the different operating modes and whenever necessary, automatically reducing any leaks that occur through self-repairs [02].

Industry 4.0

The Industry 4.0 strategy includes digitalisation 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).

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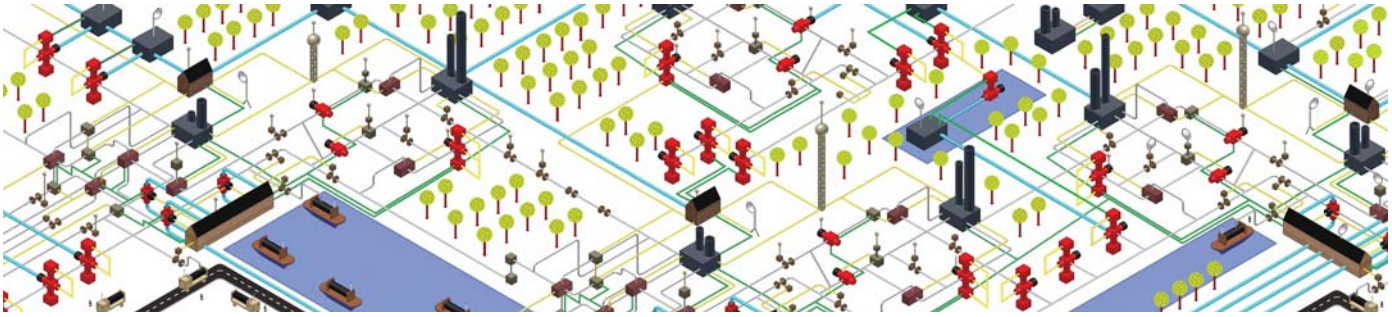
Smart products plant engineering

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), or change (function modules transported to or from module systems).

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 the 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.

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Specific aggregates in these plants can be intelligently coordinated with each other and optimised 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 optimise the processes and to adapt them for new production lines. The manufacturers of components and aggregates can optimise their existing proven technologies to the geometrically standardised 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. 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 A.

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

Figure A

Application areas

Smart plant engineering delivers high efficiency, uses less raw materials and energy than conventional plant engineering and ensures sustainable management of resources as well as 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. See figure B.

Smart plant engineering application areas	Examples of relevant plants
Plants, which are difficult to access due to chemical pollution of the surrounding area	Plants in which toxic, acidic or basic materials are used or produced as intermediate stages or end products
Plants that are difficult to access due to physical surroundings	Plants with extreme tremperatures, pressures or radioactive contamination in the surrounding areas
Plants, which are difficult to access due to biological pollution of the surrounding area	Plants with critical pollution of the surrounding areas, such as fungi, viruses, bacteria, cell structures or nanoparticles
Plants that are difficult to access due to the long distance	Deep water plants, without a finished infrastructure or are a long way from the land
Plants in which an extremely high degree of automation is needed	Plants that are often and quickly converted, looked after by just a few personnel or have to be operated with very high safety
Plants with extremely high cleanliness requirements	Plants in which possible contamination by external materials has to be fully eliminated
Plants with extremely high safety requirements	Plants in which a very high risk of damage has to be eliminated
Plants with an extremely high requirements regarding the vertical and horizontal changing-over of function modules	Plants in which their parts and components only have short service lives due to them being very highly stressed
Plants with extremely high requirements with regard to exchanging data, information, control commands and software as well as the interlinking of customers and business partners	Plants where efficient process management of the network is needed between all of the plants involved in the processing, service providers, customers and business partners

Figure B

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About the author

Dr.-Ing. Ingo Bruchhold studied Mechanical Engineering and graduated from the TU in Berlin in 'recycling-favourable connection technology'. After graduating he held leading positions in the development and design departments of various plant and fittings companies. He founded Rapidea, a business consulting company, in 1996 to provide specialist support in the development and optimisation of product and service sectors with regard to plant engineering as well as the intellectual property rights sector. More info: www.rapidea.de.