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; 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; and c) fittings that automatically optimize themselves to meet the requirements of the different operating modes and whenever necessary, automatically reduce any leaks that occur through self-repairs.

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 ongoing 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 for changing function modules as well as b) pipeline networks, consisting of primary, secondary and tertiary pipeline systems for transporting media and function modules; and c) 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
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.

**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

**Reference literature**

[01] Bruchhold, I.: Schnellwechselsystem zum Austausch von Aggregaten und Komponenten; 3R International 7/2003; Vulkan – Verlag GmbH; Essen (D) 2003; ISSN 0340 - 3386

[02] Bruchhold, I.; Grote, K.-H.: Developing a ball valves with high...
sealing force and low operation torque; Valve World; Ausgabe April 2004; KCI Publishing B.V.; Zutphen (NL) 2004; ISSN 1383 - 8113


[04] Bruchhold, I.: Druckgesteuerter Schwenkantrieb mit Sicherheitsvorrichtung; DP 10 2007 061 868.0; Deutsches Patent- und Markenamt; Bundesdruckerei, Berlin (D) 2009

[05] Bruchhold, I.; Warwel, M.: Modular quick-change system reduce production downtime and failure; Valve World, Volume 16; Issue 1; Jan/Feb 2011; KCI Publishing B.V.; Zutphen (NL) 2011; ISSN 1383 - 8113


[07] Bruchhold, I.: Dichtungssystem für heiße Medien sowie Verfahren zum Betreiben eines solchen Dichtungssystem; Deutsche Patentanmeldung 10 2011 055 032.1; Deutsches Patent und Markenamt; Offenlegung, Berlin (D) 2013


[09] Bruchhold, I.; Grote, K.-H.; Warwel, M.: Steigerung des Automatisierungsgrades in intelligenten Anlagen durch Einsatz von innovativen Wechselsystemen; Fachbeitrag auf der Homepage des VDMA für seine Mitglieder; VDMA Veranstaltung Technik Forum Industriearmaturen Februar 2014; Frankfurt (D) 2014


About the author
Dr. -Ing. Ingo Bruchhold studied Mechanical Engineering and graduated from the TU in Berlin and his subject was recycling-favourable connection technology. He subsequently held leading positions in the development and design departments in 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. For info: www.rapidea.de