The term Industry 4.0 goes back to the 2011 high-tech strategy of the German government and was meant to be a possibility for promoting the computerization of and in the manufacturing industry. Besides this, Industry 4.0 is sometimes also said to represent no more than the 4th industrial revolution (Fig. 1).

The idea of Industry 4.0 consists of six principles:

- Inter-Operability: Humans, Smart Factories and Cyber Physical Systems (CPS) communicate via the Internet of Things
- Virtualization: virtual plant and simulation models
- Decentralization: CPS within Smart Factories can make decisions on their own
- Real-Time Capability: collect and analyze data immediately
- Service Orientation: offering of services via an Internet of Services
- Modularity: flexible adaptation of Smart Factories to changing requirements.

The connected factory, also known as the smart factory, is supposed to enable innovation, increase process efficiency, reduce and handle risks and boost agility of workers and infrastructure. Typical industries where Industry 4.0 is already or meant to be applied are Aerospace, Automotive, Civil Infrastructure, Energy, Healthcare, Manufacturing, Transportation and Entertainment.

Some experts see Industry 4.0 as something which is paving the way for a worldwide evolution in connectivity, automation and artificial intelligence (Sahil Deva; Feb 5, 2016). The process of bringing the relevant technologies to the desired plateau of productivity has already started. Other studies confirm that also the process industry and the heavy/industrial machinery area will be getting strongly influenced by the cluster of Industry 4.0 technologies (Fig. 2).

The main question that puzzles the thermoprocess community is whether the ingredients of Industry 4.0 especially with regards to sensor technology, data-processing devices, interconnectivity and data safety can also work in the rather tough environment of the typical thermoprocess industry.

In other words: are there sufficient solutions from the more IT-related technology which can reliably work in the technically challenging environment of the thermoprocess industry (Fig. 3)?

VDMA metallurgy initiated in 2014 a workgroup consisting of experts from different metallurgical and IT-industries, which presented in 2015 the results of a SWOT-analysis regarding the thermoprocess industry and Industry 4.0 (Table 1). It is interesting to see that several opportunities based on the existing strengths of the thermoprocess
industry are identified. When reflecting about Industry 4.0, although the existing weaknesses and threads cannot be neglected. Especially the omnipresent topic of data-safety is – at this time of the discussion – the peak argument against anything which is related to an open-data-exchange world. And data-safety can be considered not only to be a fuzzy anxiety of managers or IT-specialists. Almost every week the news and media have coverage on various cyber-attacks on a global base. The thermo-process industry is well aware of the fact that cyber-attacks can also happen beyond gov-

Table 1: SWOT analysis by VDMA metallurgy

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Opportunities</th>
<th>Threads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Know-how</td>
<td>Data collection and exchange</td>
<td>New business models</td>
<td>Data safety</td>
</tr>
<tr>
<td>Automation</td>
<td>Standards</td>
<td>Service business</td>
<td>IP safety</td>
</tr>
<tr>
<td>Resource efficiency</td>
<td>Interfaces</td>
<td>Extensive modernization</td>
<td>Acceptance/ Readiness of customers</td>
</tr>
<tr>
<td>Data processing</td>
<td>Cost control</td>
<td>New markets</td>
<td>Lack of specialists</td>
</tr>
<tr>
<td>Simulation</td>
<td>Digitization of empirical process knowledge</td>
<td>Maintenance/ Retraceability</td>
<td>Boundary conditions of metallurgical plants</td>
</tr>
</tbody>
</table>
ernment, military, banking or civil-engineering facilities.

Despite the risk situation related with online data-exchange and cyber-attacks, the German thermoprocess industry can already show some interesting cases where industrial players have established a first level of Industry 4.0 within their own organization and production.

The benefits for production/manufacturing are:

- Savings in energy demand
- Improved capacity utilization
- Higher flexibility: heat treatment on demand
- Early indication of maintenance requirements: the model is validating actual values with set values
- Efficient control during the entire production process
- Exploration of interaction in the process chain and optimization of the overall process
- Feedback of the gained analysis for the layout and design of similar products
- Optimization of Overall Equipment Effectiveness (OEE) including all system parameters.

In a study by McKinsey and Company, several value drivers from Industry 4.0 have been identified (Fig. 4). Given the opportunities for new and additional business models, Industry 4.0 and its related technologies can be a very interesting field of activity for the thermoprocess industry. Different to earlier technological revolutions, this 4th industrial revolution shows a certain need for speed. In comparison to other technologies of the 20th century it becomes obvious that reaction and adaption time for the relevant industries is no longer within decades or years.

One of the most important questions for open-minded decision makers in the thermoprocess industry is how to approach this fast-moving and potentially game-changing technology. A simple blue-print solution is not available, but a basic roadmap can be offered, although especially for small and medium sized companies the way to Industry 4.0 can be challenging:

- Step 1: Information and awareness about the necessary change
- Step 2: Create an environment of readiness for change
- Step 3: Digitization in several steps
- Step 4: Live and use of new markets and business models related to Industry 4.0.

### SUMMARY

Summarizing the discussion about Industry 4.0 for the thermoprocess industry, the following statement can be given:

- Industry 4.0, Internet of Things, Big Data are more than only technological challenges for society and industry
- The term "next industrial revolution" is justified because of the speed of this technological development and its possible implications on existing industrial processes
- Top management – especially in small and medium sized companies – is today not always aware enough of the importance of Industry 4.0
- Leadership, labor law and work habits also need to be adopted to a future industrial world in which everything is connected to everything.

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