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PROCESS INSTRUMENTATION

Midstream Pipelines 4.0 - **Meeting new challenges with speed and digital precision**

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Production from both conventional and unconventional oil and gas plays across North America continues to rise to record levels. However, for companies across the supply chain to capitalize on the economic benefits afforded by these resources, midstream infrastructure – most notably pipeline networks – will have to grow immensely.

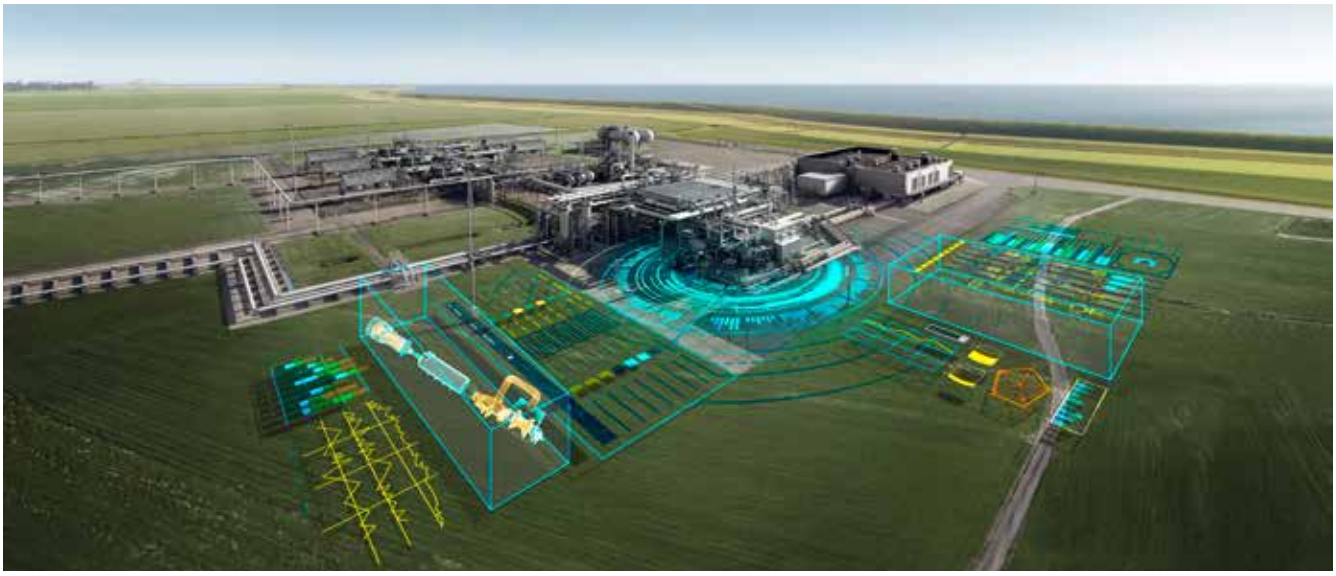
The American Petroleum Institute (API) estimates that, in order to meet production growth through the year 2035, the U.S. alone will need up to 45,000 miles of transmission lines with 10-12 million horsepower of compression and up to 240,000 miles of gathering lines with 22-29 million horsepower of compression [1].

Given the sheer magnitude of the coming build out, the conundrum facing midstream operators is how they can bring new capacity online rapidly and sustainably, while at the same time cost-effectively maintaining the integrity of existing infrastructure. Once new infrastructure becomes operational, they are then faced with the challenges of maximizing utilization and reducing total cost of ownership (TCO) in order to generate returns on these enormous capital investments.

With an extensive portfolio of products and technologies spanning the entire midstream value chain, Siemens is helping operators address these challenges with an integrated approach that we call Pipelines 4.0.

Pipeline Market Challenges

The immense volume of oil and gas production coming from shale plays represents a tremendous opportunity for operators and suppliers alike. However, the supply bonanza has quickly outstripped the established transportation infrastructure – particularly pipelines, which have been the primary means of moving oil and gas. As a result, producers are having to utilize more flexible but significantly more costly transportation methods, including rail, truck, and waterways.



The resulting "backup" at the wells and subsequent erosion of margins is an issue the entire industry is contending with. As the price of oil continues to hover in the $40-$70 range, producers are being forced to find new ways to minimize costs, increase profits, and maximize safety. As far as hydrocarbon transportation goes, pipelines remain the most efficient means of achieving those goals.

In addition to limited pipeline capacity, producers and midstream operators must contend with the state of aging infrastructure. Approximately half of the nation's ~2.5 million miles of pipelines in operation today were commissioned more than 50 years ago. Many pipeline networks are in desperate need of upgrading to ensure safe and cost-efficient operation. This comes at a time when most of producers' and operators' capital budgets are constrained amidst the "lower for longer" price environment.

Another challenge relates to digital transformation and connectivity. Most of the industry has now realized that digitalization is not a passing trend and that it will need to be a core pillar of operating strategies moving forward. Considering this, operators must learn how to utilize and maintain the vast volumes of new data they are generating to positively impact their bottom line. They must also take measures to properly secure their data networks and prevent malicious cyberattacks from disrupting operations, which could have significant safety and cost implications. If that was not challenge enough for the industry, there is also evolving regulatory frameworks and the inevitable loss of the legacy knowledge from experienced personnel moving into retirement.

All these hurdles create a compelling case for producers and pipeline operators to consider adopting an integrated approach that brings all the tools and services required to develop, operate, and maintain pipelines under one umbrella. This was the primary motivation behind the development of Pipelines 4.0.

What is Pipelines 4.0?

Pipelines 4.0 is an integrated approach to the engineering, supply, and life cycle optimization of pipeline assets. All components — including motors, drives, turbines, compressors, e-shelters, process instrumentation, and digital solutions — are tailored to meet the evolving needs of North American midstream operators.

Siemens is one of the few companies in the world that can deliver such complex functionality as a fully integrated solution. The approach builds on our extensive pipeline experience, breadth of product portfolio, and rich domain expertise in rotating equipment, electrification, automation, process instrumentation, and digitalization to simplify the development, operation, and maintenance of capital-intensive midstream projects.

Some of the key areas Pipelines 4.0 addresses include:

1. Rotating Equipment for Pumping and Compression

A multitude of factors must be considered when selecting rotating equipment for compression and pumping stations. Reliability, efficiency, CAPEX, OPEX, and emissions (among others) will all play a role in determining the type of compressor and associated mechanical driver that delivers the most value over the life of the asset. While no two pipeline stations are the same, one strategy that can yield several benefits for any project is to source as much of the equipment scope – from the power module to the discharge flange of the compressor – from one supplier. Doing so greatly simplifies interface management and reduces the level of coordination required during design and execution, thus minimizing the chance of costly project delays.

Pipeline projects can also benefit by utilizing fully integrated and pre-tested compression packages. The primary advantage here is that a great deal of engineering work is performed offsite prior to delivery, which shortens lead times and reduces the likelihood of delays in the field during installation.

2. Digitalization

"Lower for longer" oil prices are forcing the industry to step back and re-evaluate the way that they do business. In the process, one thing is becoming clear: digitalization is here to stay. It will forever change how companies work internally and how they engage with suppliers and customers. It is also fundamentally transforming business and operating models, putting data at the center of the decision-making process.

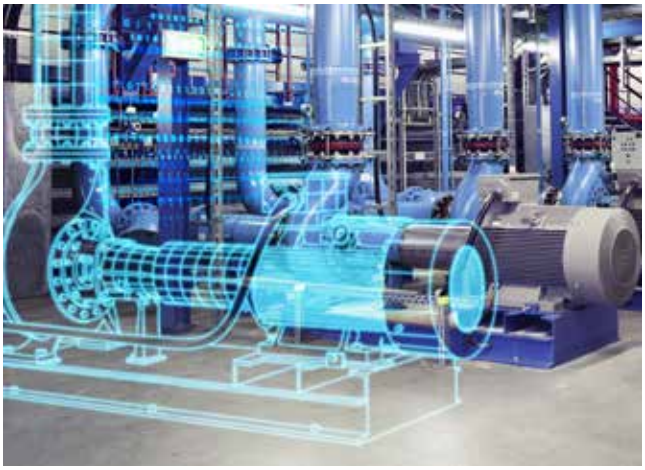
In the context of midstream today, there are many applications where digitalization can be leveraged to reduce costs, improve efficiency, and drive competitive advantage. Some of these include:

• Smart Pumping - Energy optimization in a pipeline involves complex, multi-variable equations that must be continuously solved. Factors such as individual pump efficiencies, pump station energy consumption, varying energy costs between stations, and the delicate balancing of the cost/benefit of expensive drag-reducing agent (DRA) concentrations must all be considered.

Digital solutions are increasingly being utilized to address these variables and maximize overall energy efficiency. "Smart Pumping," as it is sometimes referred to, uses continuous, real-time energy monitoring to optimize the output and overall operating profile for each pump station and across the pipeline – providing intelligent analysis for station-to-station load balancing and proper handling of transient operations. It also can contribute to emissions reductions, helping to boost an operator's environmental reputation, if not also providing potential carbon offset credits to sell. In one use case, an operator found that a 1 percent reduction in power usage could potentially translate to 70,000 metric tonnes of CO2 savings.

• Drive Train Analytics – Reliably performing drive trains are key to efficient and cost-effective pipeline operations. It should come as no surprise that an increasing number of midstream operators are leveraging analytics to derive new paths forward from the data they generate.

By deploying a Drive Train Analytics (DTA) solution, an operator can be alerted to the growing potential for a fault or trip in a drive train component (e.g. motor, VFD, transformer, etc.) so that its root cause can be addressed before it leads to a shutdown. This type of predictive capability reduces both planned and unplanned maintenance and enables operators to more efficiently allocate important resources, such as labor and spare parts inventory. The benefits of DTA can be further magnified by connecting entire fleets of drive trains. In such cases, data can be leveraged to identify long-term performance trends and alter the way equipment is operated, contributing to less energy consumption and laying the groundwork to develop new drive train specifications.



• Digital Twins – In recent years, one concept that has garnered a great deal of attention in the oil and gas industry is the "digital twin" and how it can be harnessed to add value to midstream operations.

An intelligent digital twin is a virtual, digital model that coexists with its physical counterpart, whether a single component, subassembly, or complete system such as a turbine. It's possible because manufactured products evolve from initial concepts via advanced 2D and 3D software tools, such as computer-aided design (CAD) and computer-aided engineering (CAE). Likewise, other software tools are used to design and simulate production processes in virtual form. By adding real-time pipeline performance data to process models, a performance digital twin can also be created. This can serve as a baseline for monitoring performance and developing what-if simulation models for improvements and decision support. With this performance digital twin, midstream operators can not only drive operational efficiency, but also compare simulation and test results with real-world observations.

• Operations Intelligence - Every pipeline facility is characterized by a cumulative data evolution – with massive quantities of raw data being aggregated throughout all phases of the project lifecycle. The problem many operators face is that this data is spread over a multitude of software applications, databases, and hard files, both at their facilities and corporate offices. As a result, the information available to decision-makers is often inaccurate, out-of-date, and incomplete.

Operations intelligence software solutions can solve this problem by providing visibility into operational and business systems such as ERP, MES, production databases, process historians, and more. Many companies in refining and chemical processing have used these platforms to support complex operations by aggregating operational and business data in a dashboard. An increasing number of pipeline operators are also reaping the benefits, which range from improvements in process visibility and control, to reduced downtime, to greater predictivity of operational results.

3. Process Instrumentation and Automation

Process automation continues to emerge as a powerful lever for midstream and pipeline companies who are increasingly facing pressure to reduce operational costs. However, in order to benefit from automating the transportation and storage of hydrocarbons, companies need process transparency. An array of high-performance field instruments is required to monitor the health and efficiency of midstream infrastructure – from pumping/compressor, valve, and metering stations, to above- and below-ground storage tanks. This includes digitally-enabled flow, pressure, temperature, level and positioning products, as well as corresponding control and communication solutions – all of which must meet stringent standards set by the oil and gas industry.

Measurement instrumentation must be designed with connectivity and IIoT in mind. It must also be capable of

withstanding the tough environmental conditions encountered by pipelines that traverse thousands of miles of harsh terrain. Serviceability is critical as well, since solutions located outside control rooms are usually in remote places – even buried or underwater. In such cases, technician service calls can be very costly, especially if system downtime is involved.

To address these challenges, instrumentation designed for midstream applications should incorporate features such as remote-mounted transmitters, heavy-duty dust-tight enclosures, and non-contacting sensors. Products must utilize solid-state components that are engineered, tested, and ruggedly built for reliability, complemented by built-in capabilities for preventive and predictive maintenance. This allows for remote diagnostics, which can help determine the root cause of a potential problem before a technician is dispatched. Once onsite, technicians' jobs are easier, and repairs can be completed quickly with replacement components that are self-configuring and easy to replace.

With pipelines, it is also important that operators utilize open and scalable automation solutions with uniform hardware and software interfaces to ensure consistent data management and compliance with global standards. Components must be interoperable with legacy systems and those from other vendors. Open systems facilitate "plug-and-play" designs for fast, flexible scalability, which is important as pipeline infrastructure grows and automation needs evolve over time.

4. Pipeline Integrity Monitoring

Approximately half of the nation's 2.5+ million miles of pipelines in operation today were commissioned more than 50 years ago. Monitoring the integrity of this infrastructure represents an immense challenge for operators, one that is made even more difficult when ineffective and often labor-intensive monitoring methods are employed, such as manual inspections. From malicious attacks to structural failures, pipelines today face many threats that traditional approaches simply cannot address.

The solution to this challenge is technology, and more specifically, the use of digital pipeline inspection services that utilize image-based data analytics and artificial intelligence to detect changes and intrusions within the pipeline corridor. Some of these technologies have their roots in areas such as healthcare imaging, 3D scanning and visualization, and power/energy technologies. By combining their capabilities to create a holistic monitoring solution, operators can drive toward a less costly approach to identifying compromised assets and assessing overall pipeline health.

5. Cybersecurity

The digital revolution is creating immense opportunities for midstream companies who harness the power of IIoT. However, in order to safely capitalize on the benefits afforded by connecting equipment like compressors and turbines, pipeline operators must be prepared to respond to an evolving security landscape in which cyber threats are the norm. While no industry today is safe from malicious cyber activity, pipelines represent an especially attractive target due to their distributed nature, as well as the high-impact outcome that can arise from a successfully executed attack. For this reason, the concept of "cybersecurity by design" is critical. Companies need intelligent, sophisticated operational technology that provides visibility across IT so that they can identify and act on sophisticated cyber threats, ensuring continued protection of midstream infrastructure.

Cybersecurity — Always a Top Priority

Because the oil industry is a critical infrastructure and cyber threats are always increasing in frequency and sophistication, it's key that oil delivery systems be monitored 24x7x365.

The Siemens industrial security concept is based on a multi-level "defense in depth" model based on the recommendations of IEC 62443, the leading standard for security in industrial automation. The cybersecurity concept protects all the relevant levels simultaneously — from the plant management level to the field level and from access control to communications security. It includes plant security as well as network security and system integrity, hardening plant security and reducing vulnerability risks.

Conclusion

Unconventional resource development has enhanced production in North America and made the U.S. the top oil and gas producer in the world. The unprecedented growth, however, has strained midstream infrastructure, namely pipelines — the safest and most cost-effective means to transport oil and gas to market. The resulting "bottleneck" poses an obstacle to the entire industry.

Pipelines 4.0 is Siemens' answer to this conundrum. From rotating equipment and process instrumentation to digital tools, cybersecurity, and more, Pipelines 4.0 brings together all the resources and disciplines required to build, operate, and maintain pipeline networks. Producers and pipeline operators who adopt this type of integrated approach will quickly benefit from reduced project lead times, minimize interface risk, a simplified development process, and lower pipeline total cost of ownership.

References:

1. "U.S. Oil and Gas Infrastructure Investment Through 2035" (American Petroleum Institute, April 2017), p3. http://www.api.org/~/media/Files/Policy/Infrastructure/API-Infrastructure-Study-2017.pdf

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