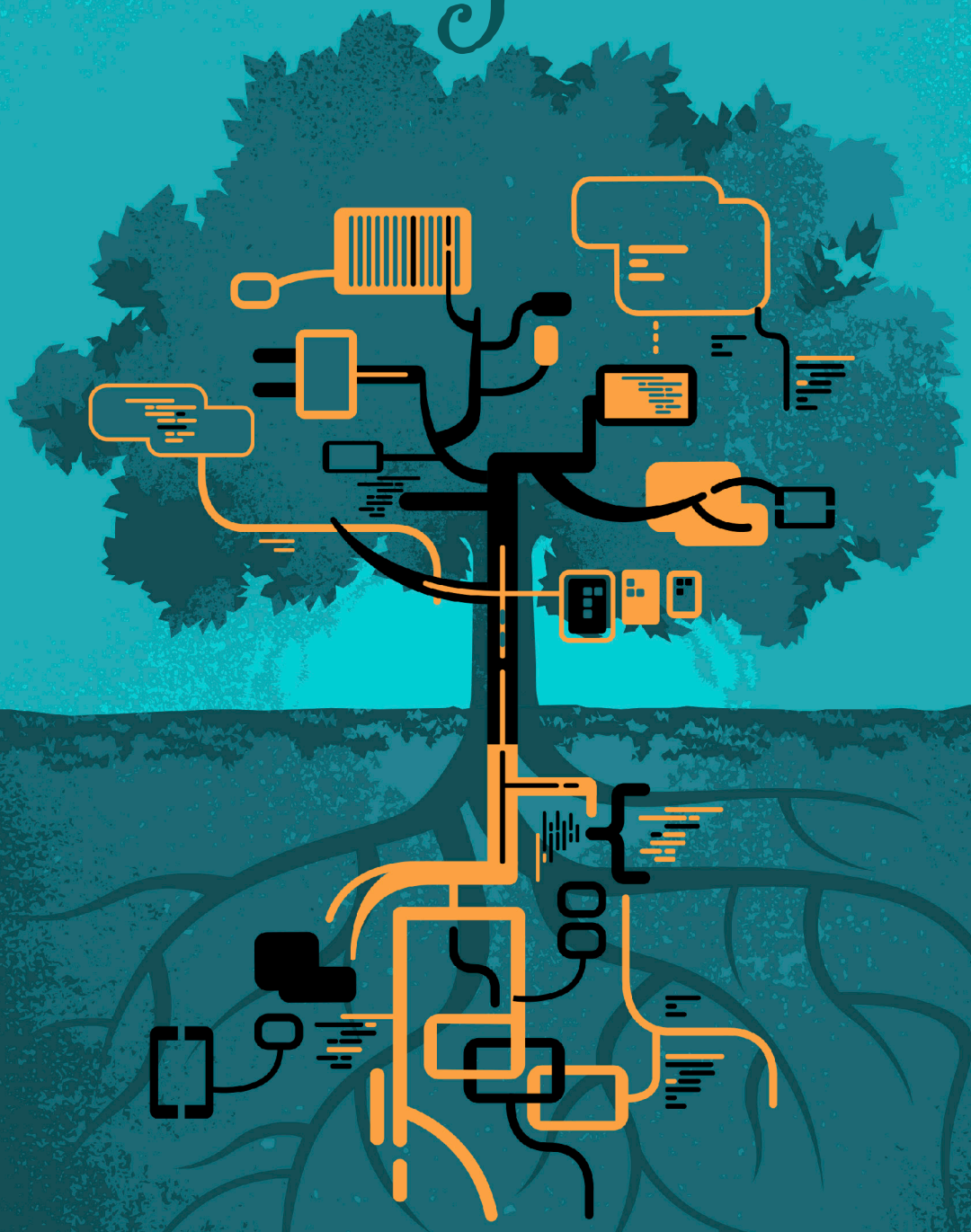
Simulation software ecosystems



Whether used for traditional products or emerging energy transition solutions, pipeline design and analysis software provides value from engineering to operations, says Paul Dickerson and Dr. Jon Barley, Emerson.

The world is rapidly trying to adjust to an era of uncertainty. Supply chain snags, personnel shortages, and the need for more sustainable operations are impacting nearly every industry, including pipeline operators. Ensuring that pipelines operate at peak efficiency is no longer a goal; it is a requirement to stay competitive.

Operating a pipeline at peak efficiency requires the right digital tools, including pipeline design and analysis software. Using a robust software tool helps teams design, prepare, evaluate, and adapt their pipeline operations to meet the shifting needs

of a new era of pipeline use and development. But not all tools are created equal; choosing the right solution to help meet the needs of modern operations means finding one that is designed for ease of use and provides value at every stage.

Making a move to modern operations

Today's most innovative pipeline solutions are neither built nor operated as they would have been twenty years ago. Modern pipeline operators have a variety of needs, and the tools they use should offer corresponding capabilities. Engineers require reliable tools to model the way the pipeline will react to specific changes. For example, their software should be able to simulate a flow decrease in one part of the pipeline to show how that change will impact pressures and flow in other areas.

For liquid transport systems, engineers also need systems capable of performing surge analysis to ensure they are designing safe networks. Their simulation software should be able to demonstrate what happens if a valve is closed

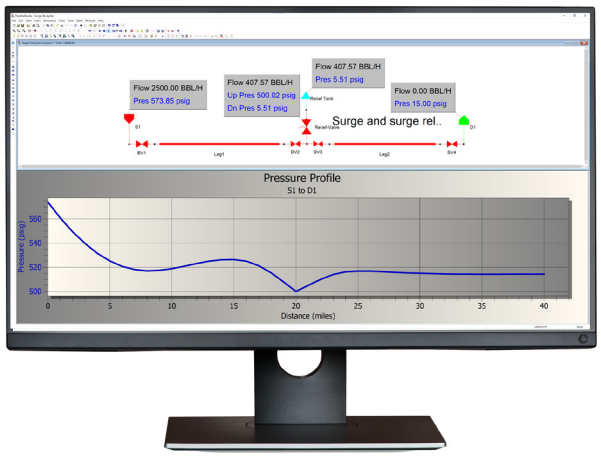


Figure 1. The safe design of liquid pipeline networks requires software capable of accurately modelling surge to ensure relief valves are properly sized.

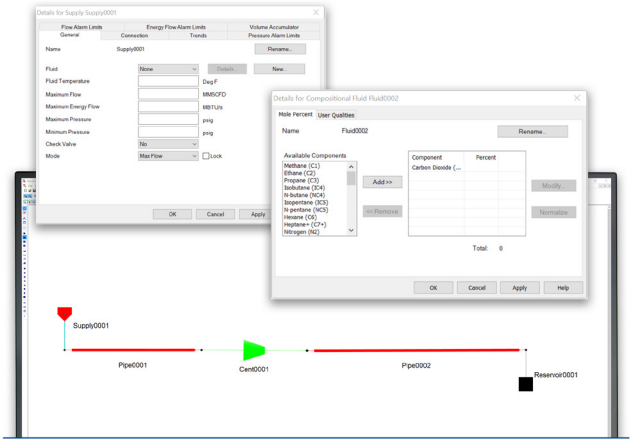


Figure 2. Problematic contaminants in CO_2, such as methane, can be accounted for in pipeline design software, allowing for safer transport of the gas.

suddenly, and it should offer tools to help the engineer size the surge relief valves.

In addition, many engineers will need access to models for tracking batches of different products moving through the pipeline. Using these tools, the team can model batch schedules to help determine the sequencing of offtake and routing valve opening and closing, which is required to deliver the right quantity of product to the right location.

But those functions are just the basics. Today, as markets are moving toward more sustainable products, many engineers need extended functionality in their digital tools. For example, as operators introduce hydrogen into natural gas, this change can significantly impact pipeline operations.

Hydrogen has different physical properties than natural gas, and pipeline pressures must change to achieve the correct flow rates. Moreover, consumers taking gas out of the system are likely calculating their requirements based on energy content rather than volume of gas. Because the volumetric energy content will be lower with hydrogen, teams will need best-in-class design and analysis software to identify the correct increase, and to automatically determine the correct flow and pressure needed to meet those energy contracts.

Carbon capture operations also need simulation software to help design systems for transport to depleted reservoirs for sequestration, or to storage tanks for reuse. These operations collect captured carbon dioxide (CO_2) from various plants and transport it to the designated sequestration sites. Transporting CO_2, however, is different from transporting gas. CO_2 transporters must keep the pressure and temperature at a level to maintain the fluid in a single phase, and this and other requirements present unique challenges. The solutions chosen must help these teams build the models they need to keep the pressure high and the temperature low from end-to-end.

Some carbon capture groups are even collecting CO_2 from many different sources. As the CO_2 from different facilities is combined, contaminants can become an issue. Due to environmental and operational risks, there may be limits regarding how much of each contaminant is present in certain parts of the network. Modelling software provides tracking of contaminants – such as nitrous oxides, sulphur oxides and methane – and it then computes the comingling at junctions in the network to provide the analysis needed for staying within necessary limits.

Successful organisations are finding these digital tools within fit-for-purpose pipeline design analysis and simulation software ecosystems. Today's most effective pipeline simulation software solutions contain everything engineering teams need, often all from a single provider to help ensure seamless operation.

Pipeline design and analysis software

Pipeline design analysis and simulation software is used by engineers to design pipeline systems, and to help them perform short and medium-term planning for their pipelines before they start operations. The software enables steady state and transient hydraulic analysis of pipelines for both

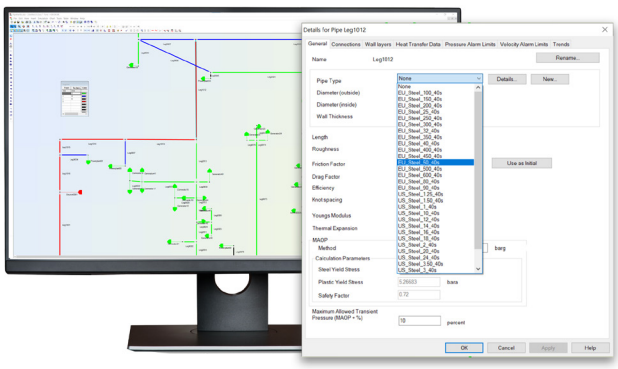


Figure 3. Pipelines can be quickly configured with minimal mouse clicks using the sensible default data in Emerson's PipelineStudio modelling software.

liquids – such as crude oils, refined products, biofuels, and LNG – as well as for gases, such as dry and enriched natural gas, regasified LNG, CO_2, and hydrogen.

During greenfield design, engineers use pipeline design and analysis software to determine how much piping and other material is needed, how much product volume they need to move through a system to meet contractual obligations, and the required pipe sizes needed to meet specific shipping volumes.

Pipeline simulation software can also be used for pipeline systems already in place. Engineers can enter the specifications for an existing pipeline into the software to identify bottlenecks in the system, determine how the system will respond to specific upsets, or identify where they may need additional compressor stations.

Advanced users also turn to pipeline simulation tools for planning and analysis of their existing systems. Using powerful modelling tools, they can plan and analyse activities, such as the best ways to shut down their pipelines, and the safest and most efficient ways to start them back up again.

Select for ease of use

Pipeline design can be a complex and time-consuming process. Today's engineers are busy, however, and few have the spare time to spend learning, navigating, and transitioning between software packages to get the reliable results they need. The best solutions are feature-rich but also easy to use. To find such a solution, organisations should look for a few key features that set the most user-friendly and intuitive systems apart from the pack.

First, users should be able to go from zero to design in a single software package. The best pipeline simulation software allows users to go directly from steady state simulation to transient simulation without having to move to a different application or purchase additional modules.

The most obvious benefit to such a solution is that it saves the user the time of exporting and importing files between software packages. However, another more critical value is consistency of the user interface. When a software package handles the full spectrum of simulation, users only need to learn one system to accomplish all their tasks. Working within a single package dramatically cuts training time with consistent, logical input at every stage.

The single interface should also be designed with the user in mind. Pipeline engineers need accurate answers quickly, and the more clicks they must perform to get to needed data, or to move data between solutions, the more time they spend on low-value tasks. Simulation software must therefore be intuitive to navigate and use. Typically, that user friendliness comes in software solutions that have been developed over many years, and tested and tweaked in the field to meet the needs of actual users.

Another key differentiator for best-in-class pipeline design applications is the presence of sensible default values. Often, pipeline engineers have scant data available for new builds. When their software solution contains well-designed defaults, they can avoid the complexity of starting from a blank page. Instead, engineers can use a starter configuration with sensible values to quickly begin the process of design and create a workable simulation, and they can then gradually refine from there as they gain access to more details.

Best-in-class software also offers parametric studies, which provide the ability to run sequentially through a set of different models with ranges of parameter values – such as different pipe diameters – to quickly identify the correct value to optimise the system, or to provide a range of operational scenarios. These parametric simulations can be performed for a whole pipeline system or individual pipes. Users simply create a matrix of parameters, and the software runs thousands of simulations against those parameters, outputting a matrix of optimal results. Automated parametric studies save significant time, often completing in just hours a process that takes days to perform manually.

Deliver value at every stage

Modelling a pipeline is typically a multi-stage project. In the earliest stages of design, an engineer might not have or need all the granular details. At that early stage, the goal is often to quickly rough-in an idea to see if it is even feasible. That type of simple model should be scalable and easy to create. Best-in-class design and analysis software provides the tools to use early models as a springboard to more complex engineering.

For example, an engineer starting a project might not be worried about temperature distribution across the network, so they simply perform a draft configuration to make sure pipe lengths and volumes look accurate but use isothermal simulation while testing those parameters. Instead of taking the time to set up detailed thermal parameters for the pipe, they simply set an average temperature for the whole system. However, once the lengths and volumes are settled, the engineer will need to come back and go into more detail, setting up detailed thermal parameters for the pipe and adjusting the thermal environment.

That same engineer might temporarily use generic compressors as placeholders in the first levels of configuration. When the system is coming together, they can add more detail around compressor modelling, such as head and efficiency

maps. The best tools do not force engineers to model every detail from the very first moments of design. Instead, they allow the engineer to easily jump right in, and to then begin refining and adding complexity where it is needed.

Best-in-class design and analysis software also instils value into operations, as was the case with a gas operation company serving a large area with varying natural gas demand. The company used a pipeline simulation system for short-term day-to-day planning. The simulation helped the operations team model how much gas they needed, how they were going to move it, and where it would be needed to satisfy customer demands in the face of fluctuating environmental factors, such as the weather.

The team now uses the models to quickly and easily decide how much to buy, how much to put into storage, and how much to put into the system. The team even does some load forecasting, taking information from load forecasting tools and entering them into the simulation to run tests. With the test results in hand, the team knows it is always prepared with enough gas in storage, even as extreme weather events occur and population centres change.

Critical evaluation is key

Whether a pipeline is designed to transport traditional materials or is navigating the uncertainty of the future with the addition of emerging energy solutions like hydrogen and carbon capture, utilisation and storage, its engineering team will need powerful design and analysis tools. But with a wide variety of available features and capabilities in different products, it is worth the time to carefully examine each application to determine if a given solution will deliver value across the entire chain.

Figure 4. Mapping systems can be integrated into Emerson's PipelineStudio software to achieve advanced GIS modeling capabilities.

Best-in-class software has typically been designed over decades and tested in the field by thousands of users over that time, an evolution that adds value at every step. Taking the time to properly evaluate design and analysis software adds the speed and flexibility teams need to make the fast decisions that lead to competitive advantage – a critical success metric in a constantly changing marketplace.