EMERSON

Paradigm k

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Unprecedented operational efficiency through automation

The oilfield - reservoir, wellbore and surface facilities - is modeled mathematically with situational physics as one entity.

- Paradigm k™ is a native cloud-based application capable of monitoring, processing and interpreting large volumes of data “at rest” (archived) and “in motion” (live data from sensory devices) in real time
- Autonomous history matching in real time without human intervention (built-in Artificial Intelligence) by honoring all measured data from permanent and episodic sensors, in particular, from a Multiphase Flow Meter
- The oilfield model evolves in real time, garnering predictive capacity with each update from history matched data
- At any point in time, Paradigm k may be triggered to run in predictive mode to act as virtual flowmeter or give the oilfield production forecast.
- Data history: the user may select a point in time (past or future), causing display of production data corresponding to that time

Harnessing the Internet of Things for unconventional oilfield automation

The oilfield consists of three constituents: reservoir, wellbore, and surface facilities. The primary objective of k is Unconventional Oilfield Automation by harnessing Internet of Things (IoT) solutions. The k IoT, in this context, consists of four horizontal layers of core services: permanent and episodic sensing, archival in a data history, cloud computing and oilfield simulation. These services are vertically combined to achieve solutions that create a digital twin of the oilfield.

Paradigm k seamlessly connects real time data from sensors to simulation and analytics. It anticipates events to immensely enhance the operational efficiency of an oilfield comprising hundreds of wells, while optimizing asset performance across the full lifecycle of a well.

k is a fully automated system in the cloud that offers a holistic solution encompassing a myriad of activities that are central to oilfield operational efficiency. The system also includes an optional Edge-component that connects directly to a Multiphase FlowMeter (MPFM)

Incomparable simulation performance

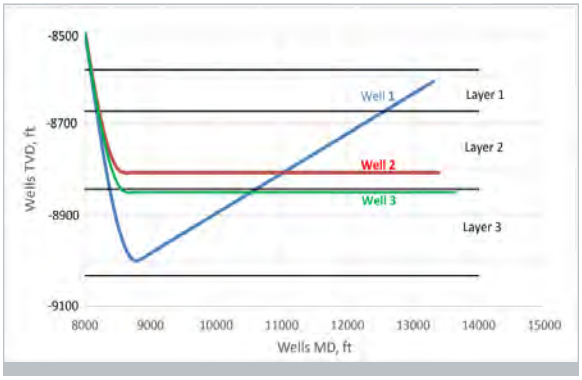
A key automation enabler is Phoenix, a hybrid oilfield simulator central to k, that offers incomparable performance. Taking advantage of the situational physics of the formation, Phoenix mathematically models the oilfield as one entity on economical cloud and Edge computational systems. Combined with built-in Artificial Intelligence (AI), Phoenix enables the automation of optimization and history matching, leading to diagnosis and prognosis. The model of the oilfield evolves in real time, garnering predictive capacity with each update from the history-matched data.

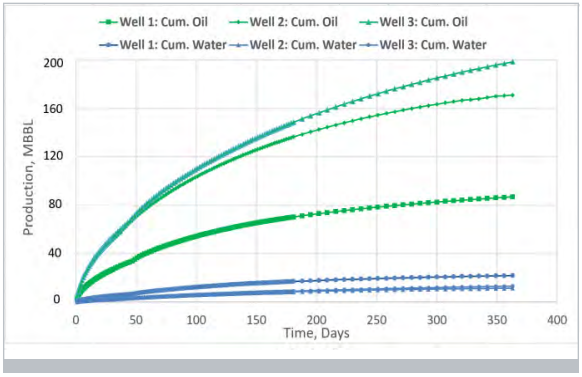
Phoenix is coupled with a resourceful and efficient IoT system that is capable of reading from sensory devices, processing and analyzing large volumes of data “at rest” (archived) and “in motion” (live data). k continuously receives, interprets and diagnoses data “in motion” to anticipate and identify events.

In doing so, it enables evocative decisions such as reduction of the number of surface separators through virtual metering. In addition, it enables optimal completion design, automatic calibration of the subsurface model, and maintenance of optimal production conditions such as the best gas lift injection schedule.

Example Applications

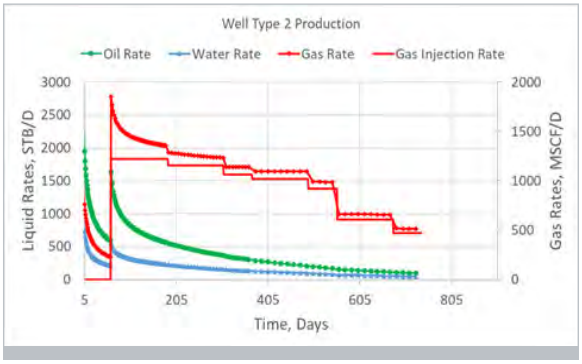
Completion design and optimization: Fast, forward simulations may be performed to optimize completion design, such as number, position and properties of hydraulic fractures, based on reservoir quality and economics.





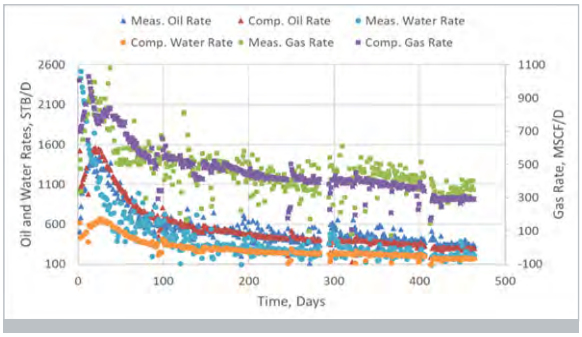
SPE 196071 (ATCE 2019)

Gas lift planning and optimization: The oilfield simulator Phoenix, which takes into account both the wellbore and reservoir behavior, enables gas lift optimization at any time during the life of the well.



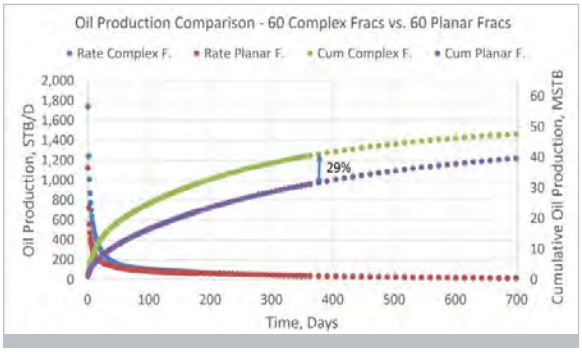
SPE 192716 (ADIPEC 2018)

Assessing the true nature of the subsurface model throughout the life of the well: Having obtained a mere 30 days of production data, k will start to provide information on the subsurface characteristics via AI-boosted automatic history matching, highlighting any substantial changes to the oilfield, e.g. fracture or reservoir property changes due to neighboring well activity.

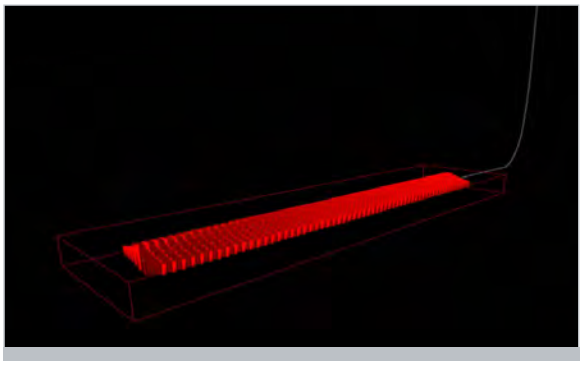


SPE 191444 (ATCE 2018)

Modeling complex fractures: The novel mathematical solution in k enables fast and efficient production predictions from complex fracture configurations. The graphics below illustrate a simple example involving 60 main planar fractures and 1200 branch fractures.

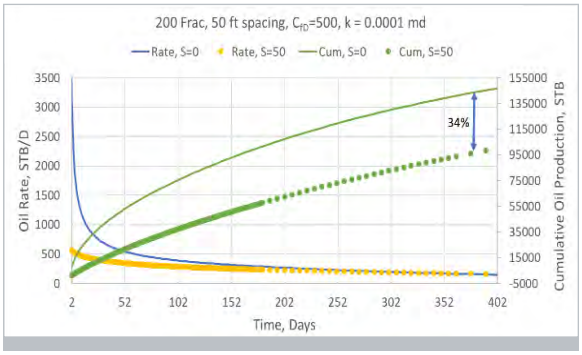


SPE 191444 (ATCE 2018)



SPE 191444 (ATCE 2018)

Estimating production loss due to near-wellbore fracture restrictions: Over-flushing during fracture treatment and/or applying an overly aggressive drawdown during early production can result in fracture restrictions near the wellbore. Paradigm k quickly calculates the production loss due to such restrictions that are further aggravated by the small contact areas between the transverse fractures and the wellbore.

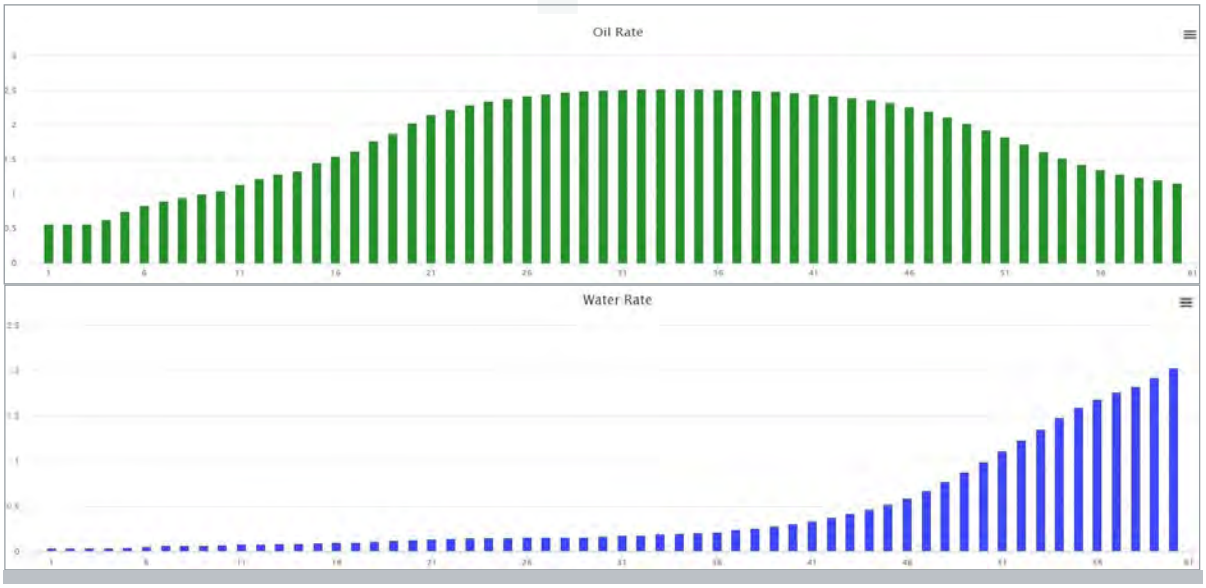


SPE 191444 (ATCE 2018)

System Requirements

Paradigm k is a native cloud solution and can be run on any cloud, whether private, public or hybrid. The system requirements can be satisfied with an economical cloud instance with any vendor, e.g. generic compute-optimized instances in Azure, AWS, GCP or any mid-sized cloud vendor. It can also be tailored to provide an in-house private cloud solution.

Enhanced Virtual Metering (k-VM™) and Virtual Production Log (k-VPL™): Paradigm k provides enhanced Virtual Metering and unique capabilities such as Virtual Production Log, that covers the full horizontal well length from heel to toe, in addition to its ability to visualize flow conditions deep into the formation.



▲ Perforation clusters from heel to toe

SPE 196071 (ATCE 2019)

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