Mature Fields Optimisation

Production technologies for maximising well life
Advanced completions & production optimisation for your reservoirs

Tendeka is a completions technology provider focussed on increasing production from your well. Our best in class products and people ensure that our focus on your conventional or unconventional reservoir via monitoring, modelling and control gets you the maximum return on investment. Regardless of early life or mature fields applications, we provide you with the same quality products and the same assurance on increased productivity.

Tendeka is committed to delivering unique field-proven technologies to our clients, while ensuring the needs are fully understood and met to successfully execute all projects.

Our bespoke solutions for optimising mature fields focus on restoring and maximising production, reducing requirements for complex interventions, therefore saving the client time and money.

Our team of experienced engineers are ready to solve your global well challenges in existing wells:

- Water & gas control issues
- Poor well integrity
- High water cut
- Lack of downhole data
- Damaged seal bores preventing safety valve use
- No multi-lateral branch control
- Maximising oil recovery
- Costly interventions or inaccessible wells
- Limited value from fiber optic monitoring
- Leaking side pocket mandrels or gas-lift mandrels

These are only some of challenges Tendeka can assist you with, resulting in production optimisation and improved well integrity by using our advanced technologies.

80,000+ INSTALLATIONS GLOBALLY
Matching advanced completions with asset and well development challenges

Tendeka’s Subsurface Engineering Team is a globally deployed group of petroleum engineers and software developers with a vision to be the Operating Companies’ trusted advisor for the application of advanced well completion technology. The team’s mission is to create sustainable value for our customers and stakeholders by providing credible assessments and by creating innovative, sound recommendations for the application of advanced well completion technology. We do this by engaging our customers’ asset teams, developing an understanding of their reservoirs, their development challenges and their performance metrics.

The process of matching advanced completion solutions with asset and well development challenges is a multi-step workflow, beginning with a clear understanding of the asset objectives and key performance indicators.

   - Measure the value

2. Generate problem statements
   - Identify the obstacles

3. Generate opportunity statements
   - Present action + desired result

4. Evaluate possible advanced completions solutions
   - Detail how proposed solutions will deliver the desired results
   - Processes + feasible timescales

5. If decision is for go ahead, apply workflow analysis/findings to clarify
   - Design basis
   - Functionality requests + specifications
   - Required equipment

11 points of consideration for potential application of Tendeka’s advanced completions technology

- Asset objectives and challenges
- Reservoir recovery mechanism
- Reservoir heterogeneity
- Tendency for fluid coning or cusping
- Type of unwanted effluent production
- Produced fluid properties
- Evidence of unwanted effluent production/breakthrough
- Well type
- Well path, well architecture
- Economics framework
- Regulatory considerations
With 25 retrofit installations to date for 5 global operators, our Autonomous Inflow Control Device (AICD) technology continues to raise the bar, with a material increase in oil production across these installations ranging from 25% to over 50%.

**FloSure Autonomous ICD**

FloSure AICD placed across the reservoir reduces gas-oil ratio and delays early water breakthrough to increase oil production.

Our AICD is an effective solution for increasing oil production over the life of the field. The award-winning FloSure AICD has been deployed successfully across a range of oil viscosities to overcome water or gas breakthrough and ensure uniform production longevity. The device preferentially chokes unwanted produced fluids whilst promoting production of oil from the entire length of the well.

The valves are deployed with the sand face completion either as an integral part of Tendeka’s extensive range of sand screens, or within an independent sub.

The design includes a levitating disc that responds to fluid viscosity and density. FloSure uses Bernoulli’s theory of “sum of static pressure, dynamic pressure and friction loss along a streamline is constant”. Low viscosity gas reduces friction pressure and causes very high velocity, thereby “sucking” the levitation disc against the seat, restricting gas flow. Whereas high viscosity oil increases friction pressure pushing the disc away from the seat and increasing oil flow.

Our AICD is run with Tendeka’s zonal isolation products to compartmentalise the well, allowing zones with higher water cut or gas breakthrough to be autonomously isolated and choked.

**Case Study:**

**FloSure Autonomous Inflow Control Device (AICD) installed to increase oil production in Asia Pacific**

Tendeka provided a solution that reduced water cut, resulting in increased oil production and field recovery rates.

**The Challenge**

Wells in the field suffered high water breakthrough early in their life. These were completed with gravel-packed stand-alone screens and artificial lift. With short reservoir zones producing in the range of 280bbls/day, the application of inflow control was a challenge.

**Tendeka’s Solution**

Tendeka’s FloSure Autonomous Inflow Control Device (AICD) provides the ability to choke water in the producing zone based on the difference in viscosity between oil and water. The retrofit application consists of installing AICD subs within existing stand-alone screens along with packers for zonal isolation.

**Project Results**

Actual oil production indicates an increase of up to 27% daily after AICD installation, with associated reduction in water cut.
Overview

AICDs have been implemented in many brownfields as a retrofit solution after water cut typically reaches ineffective or uneconomical levels. In China, one of the first AICD retrofit installation in a heavy oil environment, was to control water cut. The results have shown a significant increase in oil recovery as shown above. The installation since 2014 has shown significant water cut reduction from average 96.2% water cut before AICD installation to around 93.6% water cut after AICD installation. This is a significant reduction of water cut for a well that is producing at 1000m³/day liquid rate. The water cut reduction increased oil production from 43m³/d to 55m³/d of oil production.

The results from these wells have shown an increase of oil production of approximately 27% after installing AICD. Based on these positive results, there have been many more wells in the field completed with AICD as either a retrofit solution or primary completion for new wells.
Wireless intelligent technology

PulseEight is the first truly intelligent completion system that works autonomously to optimise production.

PulseEight

PulseEight wireless intelligent completions technology reacts to changing downhole conditions to selectively open, close or choke zones or laterals within the reservoir, whilst sending critical pressure and temperature data to surface.

Driven by a microprocessor, the fully-electric system can be programmed to respond to wireless commands from surface, or to react to the well environment e.g. well shut-ins, or changes in pressure or flow rate.

Utilising Tendeka’s patented Pressure Pulse Telemetry, PulseEight can eliminate control lines to provide a simple-to-install, cost-effective solution for oil, water, and gas control in greenfield, brownfield, extended reach and multi-lateral applications.

When applied to the following application areas, PulseEight can help to save time and money in the operation, improve reservoir recovery and understanding, and provide greater HSE benefits.

PulseEight application areas:
1. Pressure/temperature profiling for improved reservoir understanding
2. Variable interval control for reduced water cut and improved recovery factors
3. Multi-lateral control for efficient well construction and performance
4. Active water injection conformance management
5. Autonomous deep-set plug
6. Autonomous gas lift for optimal well performance
7. Downhole regulator for optimal gas hydrate prevention
8. Autonomous crossflow prevention during well shut-ins

Retrofit PulseEight

PulseEight has been developed with the aim of providing intelligent completion solutions to brownfield applications.

This inline through-tubing device can be retrofitted into existing wells on a single intervention run and set using a conventional bridge plug or lock mandrel. This addresses some of the problems faced in mature fields such as failed permanent completion equipment and outdated/inefficient technology.

Once in the well, the PulseEight device can be actuated from surface using pressure pulse commands, and send PT data back to surface. The wireless communication uses a unique semi-duplex pressure pulse telemetry for multi-phase flowing environments and utilises the existing wellhead equipment to interface with the downhole device.

In addition to this direct surface controlled operating mechanism, PulseEight can be configured to work autonomously based on changes in downhole conditions or on pre-set timer.

The performance of PulseEight can continue to be optimised throughout the period of installation by updating tool parameters remotely from surface. This provides a unique benefit over other intervention based systems where devices must be recovered to surface to reconfigure.
Case Study:
Wireless intelligent completion technology delivers P/T data

Norway’s largest gas reservoir has been on-line since 1996 and is expected to continue production for the next 70 years. Declining pressure means that more compression is required to drive production. An accurate understanding of reservoir pressure and decline is critical to meet contractual gas deliveries and achieving recovery targets.

- Obtain bottom hole data to aid production optimisation
- Use an intervention based solution to enable data collection beyond the service life of permanent gauges

Tendeka’s Solution
The PulseEight wireless pressure/temperature gauge was installed to provide daily flowing bottom-hole pressure and static well data following a shut-in. No surface acquisition equipment or data relay system was required as the existing wellhead sensors were used to read the signal. Pressure regulation was introduced to the pulse signalling to ensure data transmission over the large range of flow rates.

Project Results
The system remained highly effective with less than 0.5bar pressure pulses for 428 days. The gauge was retrieved and found to be in excellent condition. Accurately and efficiently delivering data on the status of reservoir pressure provided great value to the client. The device also acted as a memory gauge while in hole, and the high-resolution data was successfully obtained after recovering the device to surface.

Case Study:
The world’s first cloud connected wireless intelligent completion

Following on from previous installations of PulseEight where the pressure pulse telemetry has been successfully proven using manual interpretation techniques, a further step was required to configure the system as a fully digital solution.

This would provide the opportunity to fully prove the digital oilfield capabilities of the system on a live producing well.

Tendeka’s Solution
With the purpose of showcasing a fully digital solution, Tendeka looked to install a complete system on an existing well which had no monitoring & control infrastructure, and do so efficiently to prove the suitability of this technology for mature and existing assets. The chosen system consisted of 3 individual components which can easily be transported to any wellsite.

The wireless wellhead sensor was installed on the wellhead, upstream of the surface choke, and the Surface Acquisition Unit (SAU) was installed roughly 100m from the well bay. Confirmation that the wellhead pressure data was being transmitted to the SAU and was visible through the cloud-based server was required before installing the downhole component.

The PulseEight device was deployed using the client’s slickline service. No special arrangements were required for deployment and the valve was placed using standard locking mandrel procedures.

Project Results
The well was brought back on-line within 15 minutes, and after a pre-programmed delay period, the valve began communicating with surface and performed a sequence to optimise the pulsing parameters.

Over the following 7 days the valve communicated to surface, sending pressure/temperature telegrams and valve diagnostics, as well as responding to wireless commands to change parameters sent from surface. All this interaction was viewed across multiple platforms by field crew, travelling colleagues and staff in the office, clearly demonstrating reservoir data can be shared using a fully wireless system to any location in the world.
Data solutions for fibre optic installations

Tendeka has developed a powerful portfolio of software and services to enable the monitoring and modelling of multiphase flow. To help you draw the greatest insights from complex flow, we provide specialist interpretation expertise.

DataServer

The DataServer product is a SQL database-driven application that is used to import and fully manage optical path, DTS, log and point data.

Case Study: DataServer migration delivers significant results

The Challenge

An Asia Pacific operator had been collecting well data and storing it within Tendeka’s legacy product, DataHub. One of the big challenges for the customer was the desire to eliminate Oracle and replace it with Microsoft SQL Server as a storage medium. In addition, the process by which DTS data flowed from the process control domain to the office domain was not only inefficient, but involved multiple systems that all needed to remain in sync with each other and required an overly broad security hole between the process control and office domain firewall.

Tendeka Solution

Install new software and run initial evaluation to ensure that the software met the required performance, security and workflow goals. Ensure the new system reflected the desired data storage hierarchy.

Project Results

Completion of the project provided for some significant and impressive results.

Data from nearly 100 wells was migrated. The culmination of this data had produced over 2million measurement sets comprising nearly 6billion traces.

The entire project took approximately 3 weeks from the start of the initial analysis to completion of the migration.

FloQuest

FloQuest is a distributed and point data processing, visualisation and modelling software capable of handling large datasets efficiently. It can function as a standalone package or connect to data server for seamless data importation.

Case Study: Reservoir monitoring and characterisation with FloQuest

The Challenge

The task was to understand downhole productivity to help with future developments, operation practices and reservoir model calibration. An Australian operator, coal seam gas wells are typically open hole completions, run with a pre-perforated liner and no external packers to separate formations. This setup adds uncertainty to results from conventional wireline production logging tool (PLT) run inside the pre-perforated liner.

Tendeka Solution

Permanent fiber optic solution was presented as an alternative to the traditional PLT surveys. The fiber was run on the outside of the production string and in few cases the casing. Fiber optic data was then collected every 6 hours and transmitted wirelessly to DataServer to allow for immediate visualisation. Using FloQuest, this data was then viewed, processed and interpreted to extract meaningful information.

Project Results

Dormant and active zones were identified by observing temperate changes related to flow activities down hole.

Crossflow during well shut-in was clearly seen and contribution / thief zones identified.

Flow profiles based on inversion of the DTS temperature showing contribution of the different zones was provided.
Swellable sealing systems

Tendeka has the in-house capability to custom design a range of sealing solutions, from non-standard diameters to unique fluid parameters, ensuring the end result is a perfect fit for well projects.

SwellStack

Downhole safety valves can become corroded or damaged due to wireline activity. Standard chevron stacks commonly provided with insert safety valves are unable to effectively seal in this damage. This results in a leak path for hydrocarbons to migrate up the control line.

The only solution for a leaking safety valve was to perform a straddle or workover, and replace the damaged valve. This proved to be costly and time consuming.

However, in 2013, Tendeka released SwellStack, a swellable sealing solution which can be installed in place of an existing chevron stack and seal in damage within the bore of a safety valve.

This patented technology has since been utilised with multiple operators globally, to regain well integrity via the safety valve. Comprising of a swellable seal element, and multiple chevron seals, the swellable element seals damage in the seal bore and activates the chevron seals, effectively providing a seal.

Example of SwellStack Configuration
1. Swellable Element - Oil or Water Swell
2. Inner V-Seal
3. Centre V-Seal
4. Stainless Steel End Ring

Due to valve size, further chevron seals may be added.

Case Study:
SwellStack regains well integrity without requirement for workover

Well Data

Location: North Sea, UK
Well Type: Gas producer
Installation Date: June 2016
Safety Valve: 5.963" SCSSSV

Background
A UK client had a damaged SCSSSV, meaning the well was shut in. Existing isolation system was damaged and could not stop the leak through the valve. A more robust sealing solution was required to ensure long-term production of the well. The challenge was to design a seal system strong enough to hold 5000psi differential pressure in a damaged seal bore with possible corrosion. The system also had to be flexible to be retrieved from the safety valve when required.

Project Results
Within 24 hours, the SwellStack was installed, activated and was holding the required pressure of 350 bar / 5000psi. By installing the SwellStack system, it extended the life of the safety valve and avoided the alternative of an expensive workover that would have involved pulling the completion to replace the entire system. Well integrity was regained and was placed back on production without the requirement for a workover.

Example of SwellStack Configuration
1. Swellable Element - Oil or Water Swell
2. Inner V-Seal
3. Centre V-Seal
4. Stainless Steel End Ring

Due to valve size, further chevron seals may be added.
Tendeka’s swellable seals have been designed to replace chevron seal stacks on dummy valves, providing pressure integrity to damaged side pocket mandrel bores.

**SwellRight Side Pocket Mandrel Plug**

The Side Pocket Mandrel can be designed to house a gas lift valve which typically measures 1” or 1½” diameter. This allows gas from the annulus to be injected into the flow stream via a port to aid in the lifting of produced hydrocarbons. Tendeka’s SwellRight Side Pocket Mandrel Plug is designed as a dummy valve to provide isolation to damaged or leaking side pocket mandrels and gas lift valves.

Tendeka’s patented elastomer technology is designed to deliver extremely reliable zonal isolation barriers across a range of temperature and salinity profiles. With the in-house capability to custom design a range of sealing solutions, from non-standard diameters to unique fluid parameters, Tendeka will ensure the end result is a perfect fit for well projects.

Tendeka’s oil and water swellable elastomers operate within a wide temperature range from 32°F (0°C) to 480°F (250°C), and are rated to 5000psi continuous working pressure.

**Case Study:**

**SwellRight Side Pocket Mandrel Plug seals damaged mandrel bore for North Sea operator**

Tendeka was asked to provide a sealing solution for a leaking side pocket mandrel. It was essential to provide a solution to avoid the need for an expensive workover.

**The Challenge**

Tendeka’s SwellRight Side Pocket Mandrel Plug was deployed to seal the leaking mandrel bore, proving to be the ideal solution. A dummy valve was wrapped with water swellable rubber capable of sealing in the leaking mandrel bore and holding 5000psi. The ease of installation and effectiveness of the product was extremely beneficial to the operator as it eliminated the need for intervention, pulling the entire completion to replace the leaking mandrel bore. Not only was it the simplest of solutions, it also reduced the risk factor and the cost of intervention.

**Project Results**

Tendeka’s SwellRight Side Pocket Mandrel Plug successfully isolated the leaking side pocket mandrel, withstanding the required 5000psi, and eliminating the requirement for a workover.
Swellable packer for zonal isolation

Tendeka’s Retrievable SwellRight Packer has been designed to isolate the wellbore whilst enabling the easy removal of the entire assembly from the wellbore without any milling operations.

Retrievable SwellRight Packer

The retrievable packer can be designed to be utilised with monitoring systems as part of Tendeka’s DTS Solutions range, as well as other technology ranges such as for inflow control and wireless completions. The swellable packers isolate the wellbore into multiple zones allowing for independent measurements of pressure and temperature from each zone. These packers come with feed-thru slots to enable cable to be passed through the packer and clamped to the pipe.

Tendeka’s standard swellable packer range is available with an oil or water swelling elastomer. This single element design uses a patent pending technology to provide high performance over short element lengths.

The design enables the packer to be released by straight pull, releasing the sealing element and enabling the assembly to be pulled out of hole.

The retrievable packer can be designed to fit inside the original completion string and successfully isolate problem areas, preventing the requirement to fully pull out the completion string.

The retrievable packer can be utilised with Tendeka’s inflow control technology to effectively compartmentalise the inner string and provide a full retrofit solution.

Case Study:
Isolation of gas breakthrough with retrievable completion string

During production of horizontal wells, a Russian operator was met with gas breakthrough in the heel zone of the wells. Application of a retrievable completion string was planned to isolate such zones and allow a design change of the recompletion string if deemed necessary in the future. The challenge was to isolate gas breakthrough zone(s) of the horizontal wells by using a retrievable completion string.

Tendeka Solution

In order to allow the retrieval of the recompletion string, Tendeka suggested installing a retrievable design of swellable packers. According to formation data, water and oil SwellRight retrievable packers were recommended to the client.

Tendeka designed both oil and water 3.50” retrievable packers for sealing inside 6-5/8” and 5-1/2” casing. Tendeka successfully undertook a qualification program to confirm pressure holding capability, prior to the installation of the packers.

Project Results

Recompletion was successfully completed in September 2017 on the wells within the timeframe of workover jobs on these wells.

- Gas breakthrough zones has been successfully isolated
- Oil production has been recovered
- Possibility to retrieve retrofit completion has been provided

This project has been acknowledged successful and as a result Tendeka Retrievable SwellRight Packers will be recommended for utilisation to all sister companies of the client.