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As production optimization depends on accurate, decision-making well and reservoir data, data collection and planning techniques have become increasingly important. RESMAN offers a proven yet innovative chemical tracer technology that can deliver zone-specific well production data, trends for use in production optimization and continuous well performance evaluation.

Data without Risk: How does RESMAN Inflow Tracing Work?
Polymer material containing chemical tracers are typically installed in the completion in different producing zones of the well. When the permanent tracers are contacted by target fluid (oil, water or gas), they will selectively release based on physical fluid contact.

A typical application using inflow tracers is to quantify flow under transient conditions. When the well is shut-in, a high concentration of tracers is built up around the vicinity of each monitored zone and then flowed back when the well is opened. By analyzing the arrival signatures of each tracer and tracer concentration decay at surface, it is possible to determine both qualitatively and quantitatively where production is coming from. The inflow tracer data can be applied during well clean up, understanding the production efficiency of different well completions over time, monitor toe contribution in extended reach wells and the identification of water ingress over time. However, with longer life time of inflow tracers - currently up to 10 years – has enabled a very low incremental cost to the operator. This is achieved through continuous monitoring of zonal well performance trends under steady state production conditions.

With RESMAN’s well monitoring technology, small amounts of tracers are released continuously, and by analyzing samples taken from the well over a period of time (e.g. over two months with one sample taken every week) it is possible to correlate trends in zone-specific tracer concentration with trends and changes in production behavior for the well. This can be related to oil/water/gas production rates, water cuts, gas-oil ratios, bottom hole/tubing head pressure/temperature and sand production. Consequently, the inflow tracers add a zonal resolution to the well production data for targeted well performance assessment and operational decisions. For instance, if the water cut suddenly increases, an increase in tracer signal from one of the zones will indicate from where and when the increased water comes from and what zone to keep under observation e.g. a targeted water shut-off operation. Similarly, a sudden drop in oil tracer signals can be used to identify targets for zone-specific stimulation to increase oil production from these zones. To expand the scope of fluid-specific information, RESMAN has also undertaken development to gas inflow tracers and are pilot ready to identify where gas breakthrough is occurring in oil reservoirs and the quantification in dry gas wells.

Other production optimization benefits
Operators commonly use inflow tracers to determine if the different zones are producing after initial start-up and to assess if the well has been properly cleaned up. They can also be very useful when testing different well designs or longer well paths to determine the relative production from a lateral or toe in the well (based on the transient flow model). Additional value can also be captured from steady state data over time by collecting well samples and looking for changing production trends coming from each zone. The individual samples may vary significantly, but over time one can typically detect distinct patterns and trends when correlated to other production data. More importantly, zone-specific well performance at different operational settings.
can be evaluated. Analyzing tracer profile changes during a multi-rate test, where changes of the well are intentionally induced by the operator, which can give important insight and decision-support for production optimization. If the choke is reduced, the drawdown and production rate is reduced and from tracer profiles it will be possible to see if, for example, tracers from specific zones disappear. This would indicate that this zone requires higher drawdown and hence provides information about differential pressure distribution along the wellbore. Conducting a controlled multi-rate test and correlating production changes with tracers' signals will provide the operator with essential information about the operational modes of the well and can be used for future production optimization.

Global Operator and Saudi Aramco Adoption
Within Saudi Aramco, RESMAN has been successfully deployed within several wells in the Abqaiq, Abu Safa, Manifa, and Berri assets. RESMAN proudly works with its local partner EROG to deliver operations to Saudi Aramco.

On a global front, inflow tracers have been adopted over the past decade and more details about how the chemical tracers work and how they have been applied to date is summarized in the following paper: SPE 187077 MS Ten Years of Reservoir Monitoring with Chemical Inflow Tracers - What Have We Learnt and Applied Over the Past Decade?
Globally RESMAN has successfully installed tracer systems in over 530 wells using 4670 systems with 57 Operators in 36 countries worldwide. In addition, RESMAN was qualified in an ICD sliding sleeve well (Abqaiq 84) in 2016 and monitoring campaigns are detailed in an SPE paper co-authored with Saudi Aramco in “SPE-189364-MS Permanent Downhole Chemical Tracer System for Wireless Surveillance and Optimizing Well Production” Therefore the technology is catalogued in Saudi Aramco for immediate deployment when required. Graphic above shows how the technology has been applied with a MSF (Multi Stage Frac) application in various locations globally and also in the Middle East.

Conclusions
In light of the increased longevity, inflow tracing enables years of continuous monitoring, where the signal trends can be cross-correlated with production data, which complements existing data workflows used for production optimization and reservoir surveillance. In this way, value can be extracted when inflow tracer data is uploaded into an operator’s existing database system and software platforms.
To this end, RESMAN has developed a software plug in called RESViZ that is designed to import qualitative and quantitative interpretations into Schlumberger’s industry leading Petrel reservoir modelling software. This enables efficient input of model updating to visualize interpretation results and a faster history matching process using quantitative results.