

NUSTIM™ SERVICE – EAST TEXAS

OPERATOR CHALLENGE:

An operator was faced with **inconsistent results** when completing wells with **multiple Cotton Valley sands** across a field in East Texas. Erratic post fracture production results presented several questions:

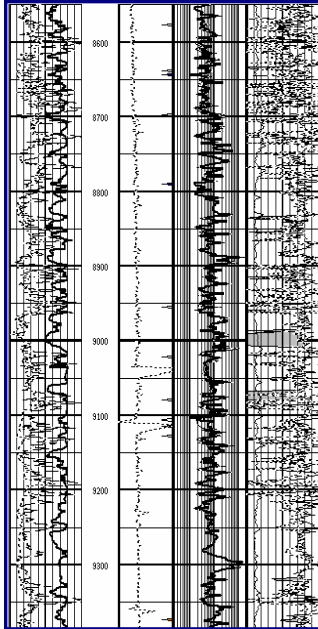


Figure 1: Conventional log data for Cotton Valley well.

- Were the intervals as productive as first thought by conventional log interpretation and field analysis?
- Is the current completion strategy adequate for all wells in the field?
- Is it reasonable to use net ft of pay as a determination of stimulation treatment size?
- Is it good practice to compare net feet of measured porosity from the conventional log analysis as a measure of well performance?
- How could further completion optimization be economically realized in this tight gas sand play?

Historical field-wide completion strategies involved stimulating the wells in **three stages**, which did not always prove to be economic. While all the intervals appeared very similar based on conventional logging response (Fig. 1), each interval **behaved uniquely**. The operator requested NuTech Energy Alliance apply their petrophysical and stimulation services to properly characterize the reservoir and determine an optimal completion strategy.

The operator provided the digital fracture stimulation and initial production response data from the Lower Cotton Valley interval in their new well and tasked NuTech with designing the completion of the Middle and Upper Cotton Valley intervals in that well, which were yet to be completed.

NUTECH SOLUTION:

NuTech Energy Alliance employed its **NuLook Textural Vision™ (NTV)** and **NuStim™** processes to properly evaluate, determine the flow capacity, and identify the optimal completion strategy for each interval. NuTech evaluated all three pay intervals in the new well via the NTV process which properly characterized the reservoir by identifying the quantity of bound and free fluids and describing the permeability distribution.

The NuLook NTV reservoir description provided (Fig. 2):

- Log data normalization
- Clay volume determination
- Textural distribution
- Producing fluids
- Core calibrated permeability

With the normalization and reservoir description steps completed (NuLook) several rock mechanics curves were created. A detailed **in-situ stress profile** was generated and then calibrated to the previous fracturing treatment on the Lower Cotton Valley interval via the NuStim process. The **permeability distribution** was further refined to match the production response for the Lower Cotton Valley interval in concert with the leakoff profile from the pressure matched fracture dimensions.

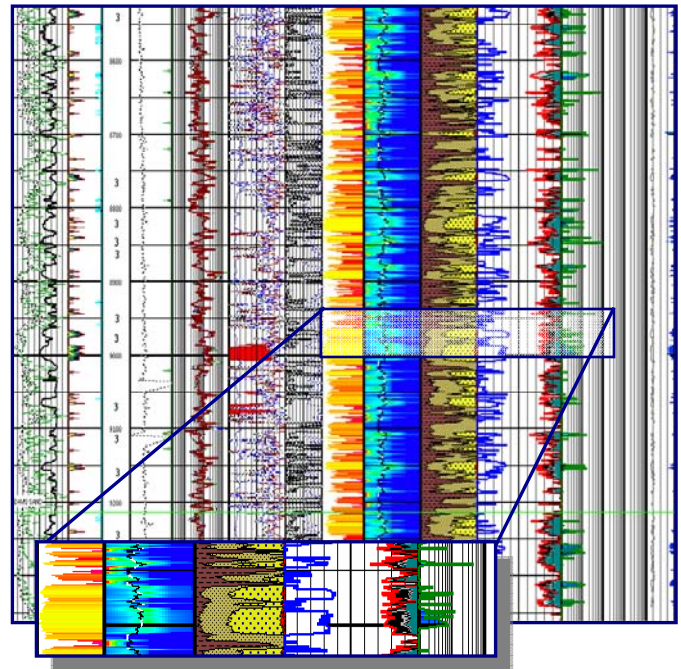
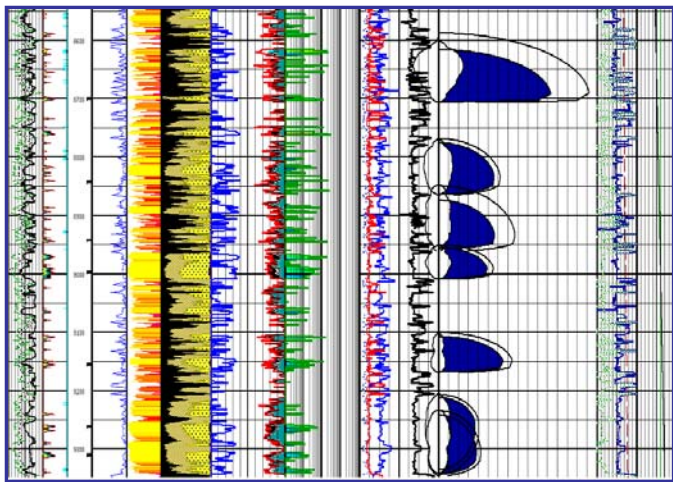


Figure 2: NTV analysis of Upper and Middle Cotton Valley intervals.

NuList Parameters: *Upper and Middle Cotton Valley*

Pay Ft	AVE Rank	PHIE _{AVE}	Perm _{ABS}	Perm _{ABS} Ft	Hyd-Por Ft
26	3	8.6 %	0.128 md	3.4 md Ft	1.458
13	3	8.0%	0.092 md	1.2 md Ft	0.548

NuStim modeled the completion of the Middle and Upper Cotton Valley intervals using the current completion strategy and predicted that while completion of the Upper Cotton Valley interval would be economic, completion of the Middle Cotton Valley interval would be noncommercial. However, instead of completing the Upper Cotton Valley interval alone, NuStim recommended a **limited entry perforation approach** that would allow both intervals to be economically stimulated in one stage, reducing completion costs and significantly **improving project economics**.



THE RESULTS:

The NuStim process illustrated that, if properly designed, a single stage fracturing treatment would positively impact the economics of the well, making **all three intervals commercial**. NuTech's advanced modeling properly identified the stress profile throughout the reservoir and allowed for a complex limited entry design to be conceived.

NuTech's limited entry technique limits the number of perforations in a completion interval to promote the development of perforation friction during a stimulation treatment. If designed properly the perforation friction allows the simultaneous entry of fracturing fluid into multiple zones of varying in-situ stress states throughout the stimulation treatment. The implementation of the limited entry technique requires a high degree of control over the bottomhole treating pressure, resulting in a significant **reduction in completion costs and time**.

As a result of combining the NTV and NuStim processes, **accurate limited entry designs** (Fig.3) become possible for the field. All productive pay intervals in the wellbore are identified by the NTV analysis. Through the NuStim in-situ stress profile, a perforation design can be conceived such as to allow the simultaneous entry of fracturing fluid into multiple zones of varying in-situ stress states. In order to ensure the proper distribution of the fracturing fluid throughout the entire treatment several factors must be accounted for. Perforation erosion effects, wellbore friction changes, hydrostatic column changes, pump rate variations, fluid viscosity, sand mesh size and concentration all effect the progressive increase in hole diameter that occurs during a fracturing treatment. Only by modeling these changes throughout the job, not simply in the PAD, can the **inter-zonal rate redistribution** be identified and accounted for. Not modeling perf erosion correctly is the main reason why limited entry hydraulic fracturing techniques frequently result in screenout and economic failure.

The NuStim process allowed the economics for **up to 30 individual fracturing scenarios** to be compared and the optimal treatment to be determined. After comparing the simulated decline curves of all of the different treatment scenarios (Fig. 4) and applying the operator's economic data, a cost to benefit comparison was made for each of the scenarios (Fig. 5) leading the operator to the **correct stimulation treatment for that specific wellbore**.

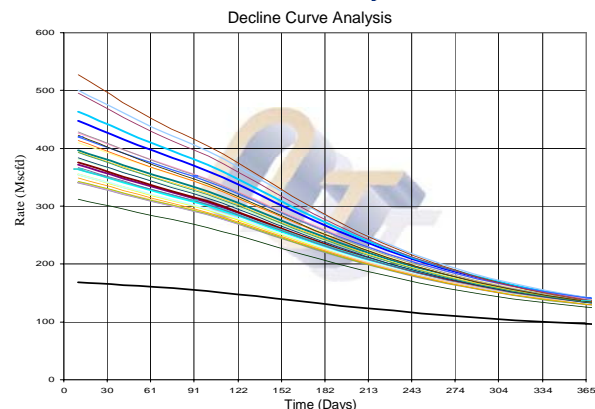


Figure 4: Production decline comparison for 30 fracturing scenarios.

CONCLUSIONS:

By utilizing the NuLook and NuStim technologies, the operator was able to establish the proper reservoir and completion parameters and **diagnose the true capacity of each interval's potential**. NuTech allowed them the ability to alter their completion strategy by effectively stimulating a larger pay interval in **one trip to the wellhead**.

The revised completion strategy of completing the Upper and Middle Cotton Valley intervals together, in addition to selecting the correct treatment size via the NuStim process, showed that **true optimization can be achieved**. The operator has since applied this completion strategy to thirteen new drill wells in the field, **saving over \$1.5MM in completion costs alone**.

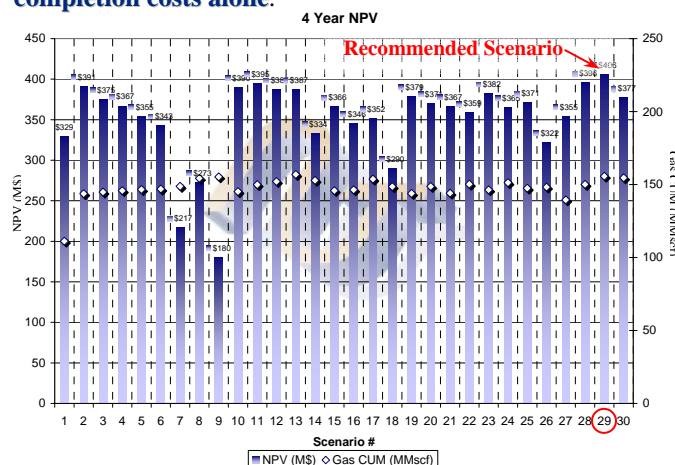


Figure 5: NPV analysis for Upper & Middle Cotton Valley intervals.



For more information about how NuStim and NuLook TEXTURAL VISION can impact your bottom line, contact your local NuTech representative.