[PS]An Approach to Inter-Branch Distance Optimization in Heavy Oil Multi-Branch Horizontal Wells*

Diego Moglia[1], Esteban M. Pieroni[1], Ariel R. Buchini[1], Enrique A. Peralta[1], and Pablo E. Lacentre[1]

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[1]YPF, Buenos Aires, Argentina (diego.moglia@YPF.com)

Abstract

Llancanelo Field, located in Malargüe department of Mendoza province in Argentina, is currently the only productive heavy oil field in the country (10 API/10000 cP). It produces from the Neuquén Group on the northeastern margin of the Neuquén Basin. The area is extended over the Llancanelo Lake and Wetlands Natural Reserve (RAMSAR site). There are many factors that increase operation costs of the field. Some of these are the power generation on site by GLP generators and transporting production by truck. In this context, the economics are compromised by high operation costs, so it is necessary to improve productivity of wells. Multi-branch wells (MBW) in Llancanelo Field are designed with five, almost parallel, 1000 m long horizontal wells, sharing the same wellhead and intermediate section. Field development strategy based on MBW has two main advantages: (1) Reduction of environmental impact because of fewer number of locations and surface facilities needed. This also implies savings in operation costs (fewer pumps, less interventions, etc.), and (2) Improvement of productivity because of MBW's effective length is much greater than the standard horizontal well. Economic indicators for multi-branch wells are much better than the ones of the present "type well" of the field.

Production profiles of MBW is regulated by the interference between branches as the primary factor. Lower inter-branch distances result in more interfered branches with greater reserves acceleration, but with lower final cumulative production. Nearer branches also result in a smaller area drained by a well, or in other words, a higher number of wells per area. This affects the economy of the full field development plan. Inter-branch distance optimization has been done with dynamic simulation in a sector model of the field. A single horizontal well was placed at the center of the sector and a parallel identical well at each side separated a given distance from the first. Production profile of the central well/branch, interfered at both sides, has been calculated as a function of inter-branch distance. MBW production has been estimated based on single-branch productivity. Given the amount of MBW needed to develop a hypothetical area for each inter-branch distance studied, the economic evaluation has been carried out for each case and optimal inter-branch distance has resulted in between 100 m and 150 m. Based on the study results, the first two multi-branch wells of Argentina were designed with an approximate inter-branch distance of 150 m.

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YPF

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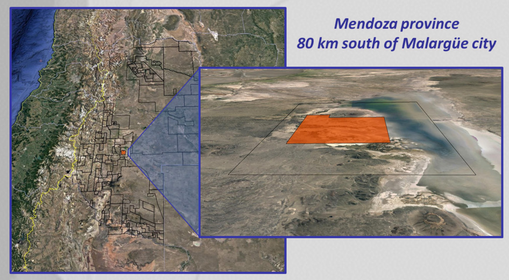
Geographic Location of Llancanelo field

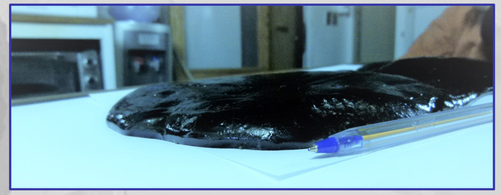


Mendoza province
80 km south of Malargüe city

Llancanelo's Challenges:

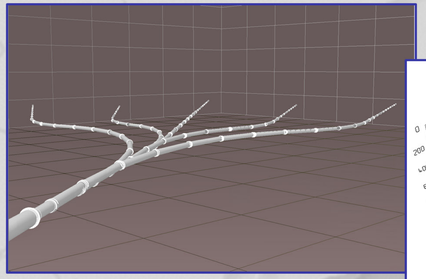
Strong environmental regulations (RAMSAR site)

Extra heavy oil (viscosity up to 12,000 cP)

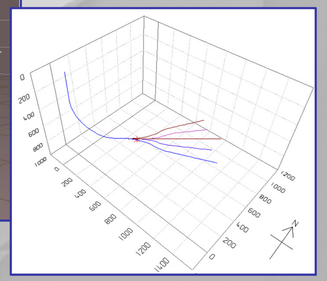


Production delivered by truck and power generated "in situ" with GLP generators

Llancanelo's Multi-Branch Well Design



Five 1000 m long, almost parallel open hole branches

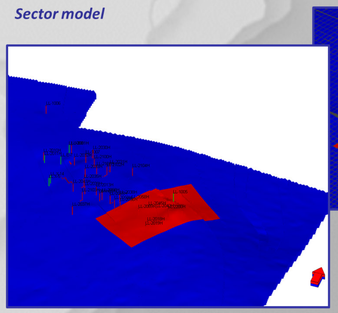


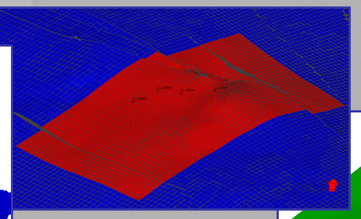
Advantages over standard horizontal single wells:

- *Higher well productivity*
- *Greater developed area per well*
- *Higher power efficiency*
- *Less environmental impact*
- *Fewer locations*
- *Less surface facilities*
- *Fewer pumps*
- *Less interventions*

Dynamic Model

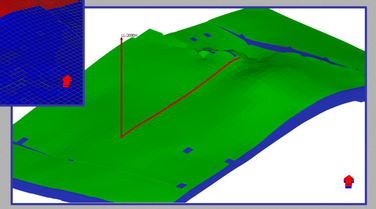
Sector model



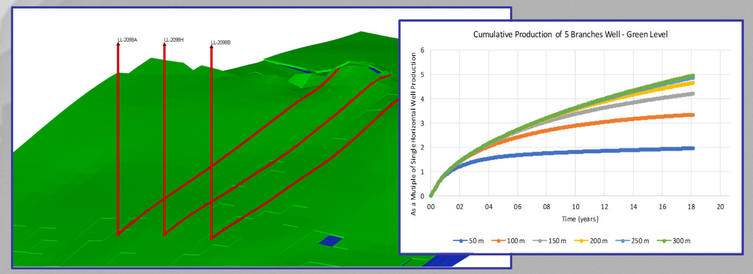


Sector model placed in the developed zone

Fictitious horizontal well placed in the center of selected sector model

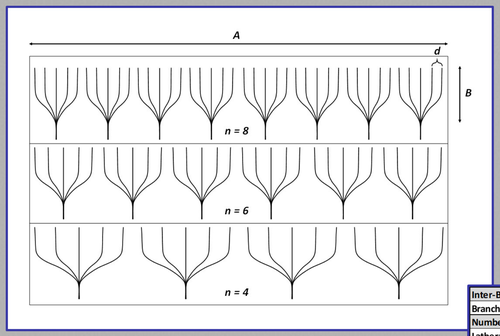


Parallel identical horizontal wells to model interference as a function of inter-branch distance



Cumulative production of a five branch well, estimated from a both sides interfered single branch productivity.
Inter-branch interference decreases as inter-branch distance grows.
For an inter-branch distance of 300 m there's almost no interference and a multibranch well accumulates 5 times the production of a single horizontal well

Inter-Branch Distance Optimization



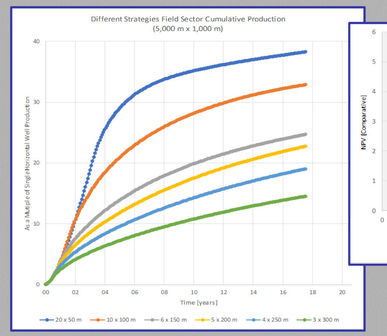
Different development strategies for a given sector of the field (AxB dimensions) depending of inter-branch distance "d".
Lower inter-branch distance is associated with:

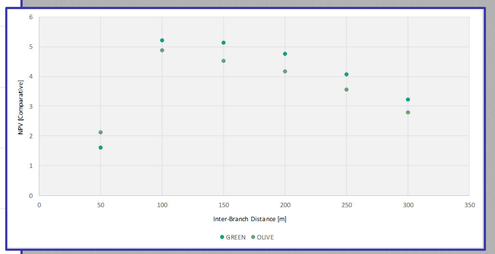
- *Greater number of wells "n"*
- *Higher group production*
- *Higher group inversion*
- *Higher interference*
- *Lower single multibranch well productivity*

Using A=5,000m and B=1,000m

Inter-Branch Distance [m]	50	100	150	200	250	300
Branch Length [m] (B)	1,000	1,000	1,000	1,000	1,000	1,000
Number of Wells (n)	20	10	6	5	4	3
Latheral Lenght [m] (A)	5,050	5,100	4,650	5,200	5,250	4,800

Cumulative production and economic evaluations





Optimal strategy defined as the one that maximize NPV

Conclusions

- ***Optimal** inter-branch distance is between **100 m and 150 m.***
- *Multi-Branch wells shows **better economic indicators** than simple horizontal wells. The increase in net pay is proportionally greater than costs increases so **investments** gets **more efficient.***
- ***Fewer locations** needed for full field development **reduce environmental impact** of project.*