

## Stimulation

# Carbonate 20/20<sup>SM</sup> Acidizing Service

## Candidate Selection and Acidizing Process for Optimized Production from Carbonate Reservoirs

**W**hen you use the Halliburton Carbonate 20/20 acidizing service, you get more than an acid job. Carbonate 20/20 service gives you a complete system of expert personnel, analytical/diagnostic tools, products, and processes that place the right fluid across the carbonate formation to leave the formation conductive farther from the wellbore, for a longer productive well life.

Carbonate 20/20 service focuses on the rock. Why? Because the rock properties dictate what we should do, how much we should do, and how we should do it. For example, the rock temperature and composition (is it calcite or dolomite?) together tell us about the rock's reactivity, which combines with rock lithology and laboratory testing to tell us which fluid system to use.

The rock's permeability and porosity tell us the severity of the fluid-loss problem we will encounter. The rock's mechanical properties tell us whether or not the rock can support the closure pressure once it has been acidized.

So Halliburton Carbonate 20/20 service focuses on....and listens to.....the rock.

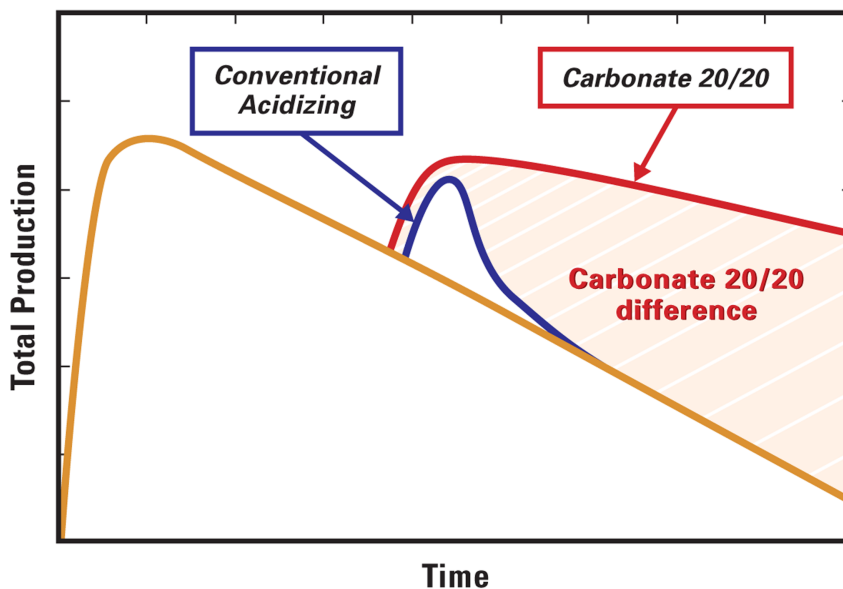
### Success Stories

- SUPRA CE treatments using Zonal Coverage Acid on 36 wells double the production, add economic value of \$50 million per year
- Carbonate Completion Acid™ restores high production rate in a highly sludging oil environment... generates \$18,000/day
- Zonal Coverage Acid creates \$25 million yearly production increase from an Italian horizontal well

### Three Decades

Halliburton's "Technical Briefing on Carbonate Acidizing" chronicles Halliburton improvements in acid stimulation over three decades of effort. Highlights of that work include

- Higher, sustained production following acid treatments
- A systematic approach to the complex engineering required
- Specialized testing and analysis for a thorough understanding of the rock properties



*Based on understanding the formation properties, Carbonate 20/20 service has been shown to provide better production results, both initially and long term.*

**HALLIBURTON**

# Candidate Selection and Acidizing Process for Optimized Production from Carbonate Reservoirs

Halliburton has committed untold man-years of research and field work to an effort that has come to fruition in Carbonate 20/20 service. You don't have to work on it for three decades; call your Carbonate 20/20 service representative. Ask for a copy of "Technical Briefing on Carbonate Acidizing."

Our decades-long acid-stimulation service record has naturally left us with many lessons learned, which we have collected into five "best practices" documents available to our Carbonate 20/20 service planners, designers, and operators. Ask for a copy to learn about the practices we follow.

Best practices subjects available are

- Fracture acidizing
- Matrix acidizing
- Logging (formation evaluation)
- Laboratory testing
- Diversion

## Candidate Selection

Carbonate 20/20 service starts with problem identification and a complete analysis of the target carbonate formation, leading to a go/no-go decision. The following Carbonate 20/20 service tools enable the decision process:

- Imaging logs
- Downhole video
- RESULTS software— performance prediction
- Checklist/problem identification
- Prior treatment history
- Mineralogy

## Design

Carbonate 20/20 service follows a simplified, user-friendly approach to complex engineering problems, resulting in

- Simplified fluid choices
- Improved simulation graphics
- Reasonable comparisons of productive rates among various treatment designs



Figure 1—The left-side sample is a limestone (calcite) core as it was taken. On the right is a view of the same core showing the uneven etching that is the goal of a Carbonate 20/20 treatment. A formation etched in this manner will resist crushing from overburden pressure.

Job design is assisted by several custom engineering tools:

- Specialty laboratory testing
- AcidXpert Log
- Diversion Kit
- Engineering software
  - C-MAP—carbonate matrix acidizing program
  - FRACPRO®\*—fracture acidizing treatment design
  - StimWin—databases, general engineering calculations, post treatment reporting
- Minifrac

## Fluid Systems

- Zonal Coverage Acid—for optimum acid distribution in long pay intervals
- Carbonate Completion Acid—a cost-effective acid blend that works on even the most trying oils of the world (sludging, asphaltenic oils)
- Fines Recovery Acid—an energized foamed acid system for easy flowback and superior fines removal
- Carbonate Stimulation Acid—a viscous acid system for improved fluid-loss control and deep penetration
- Hot Rock Acid—high temperature, low-corrosion acid system with enhanced fluid-loss control properties
- Carbonate Emulsion Acid—an emulsified acid system with superior wormholing characteristics

Hydrochloric acid (HCl) is the primary acid used to treat carbonate formations. In fracture acidizing, the goal sought by the Carbonate 20/20 service is to achieve “uneven etching” of the carbonates. An uneven etching pattern leaves a structure in place to resist crushing from closure pressure, but with enough void spaces etched out to provide a path for hydrocarbon flow to the wellbore. Figure 1 shows calcite samples before and after etching. Rock etched in this manner would resist crushing after being treated with acid.

In matrix acidizing, zonal coverage is a major objective. Figure 2 shows acid-spending control achieved by using of linear gel (left) and Carbonate 20/20 Zonal Coverage Acid (ZCA) at right. The linear gel permitted creation of large wormholes through acid spending. ZCA controls contact with near-wellbore rock, conserving the acid to enable greater zonal coverage along the wellbore.

## Placement

**Fracture acidizing** creates conductive channels a long distance (a few hundred feet) from the wellbore to help make a low-permeability formation produce at an economically acceptable rate. Fracture acidizing treatments are pumped at pressures above the fracture gradient of the formation. Halliburton’s SUPRA™ CE, SUPRA FLC, and SUPRA EHC sustained-production acidizing techniques contribute to the balancing and optimization of nature’s three fundamentals in fracture acidizing: conductivity, fluidloss control, and reactivity.

**Matrix acidizing** treatments are pumped at a pressure below the fracture gradient to acidize through near-wellbore damage and/or connect the wellbore with undamaged native permeability to allow a moderate- to high-permeability carbonate to produce under radial flow conditions. The C-MAP program helps determine which zones are contributing to the flow and what improvements to make.

## Monitoring

Several options are available to monitor and report Carbonate 20/20 service performance.

- Acquire
- FRACPRO®

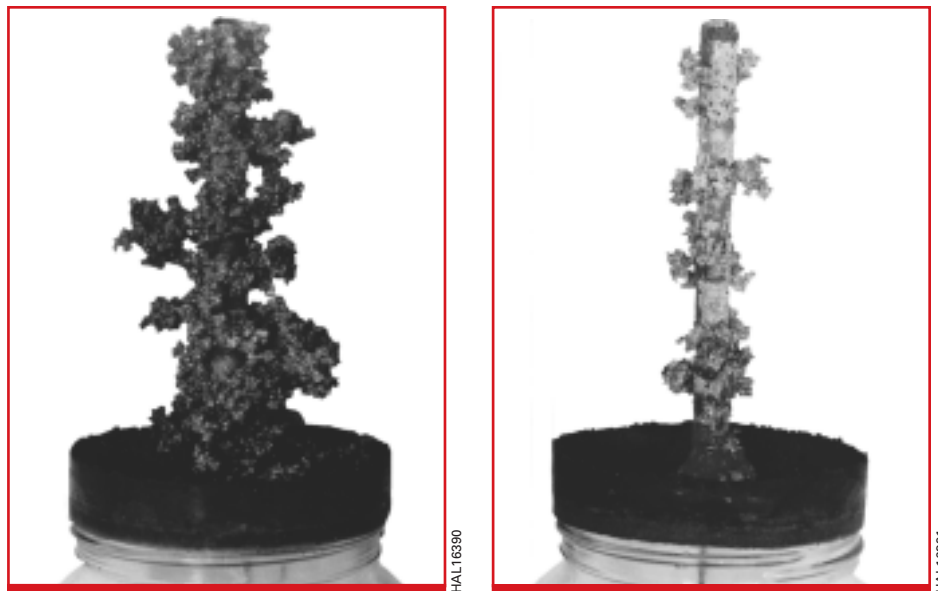


Figure 2—Acid contained in linear gel permits acid spending near the wellbore (left). ZCA (right) limits continued wormhole growth to conserve acid for better zonal coverage.

- StimWin
- PSW (Pumping Services Workstation)

Using data acquired during treatment, Carbonate 20/20 service experts conduct detailed analyses of the job design and performance.

## Carbonate 20/20 Process Summary

- Problem identification
- Candidate selection
- Job design
- Fluid system selection
- Placement
- Monitoring/evaluation
- Optimization

## Case Histories

**Case 1**—In west Texas, six wells were producing at less than optimum performance—only 1.5 to 2MMcf/D. BHTs ranged from 180 to 200°F while BHPs ranged from 2,500 to 2,800 psi. After careful analysis of the well and formation conditions, Halliburton recommended fracture acidizing treatments using the SUPRA CE sustained production acidizing technique in conjunction with the ZCA zonal coverage acid system. For these six wells, treatment volumes ranged from 12,000 to 15,000 gal. Post-treatment production ranged from 2 to 7.5 MMcf/D for an average 4.1 MMcf/D—over twice the production before treatment. Approximately 30 additional wells were treated and produced similar results for a total economic value of over \$50 million per year.

**Case 2**—In Reforma, Mexico, PEMEX had experienced damage to Well Samaria 1199, drilled in a heterogeneous limestone formation. The well should have been producing more than 1,000 BOPD, but it was no longer flowing. After analyzing the well history and an oil sample, Halliburton recommended Carbonate Completion Acid, with the non-acid N-Ver-Sperse O™ dispersant system and a high-quality foam acid system as a diverter. Carbonate Completion Acid was created for use on oils with a high tendency to form sludges, while N-Ver-Sperse O™ dispersant helps remove the damage created by oil-based muds. Within just 24 hours, the

well was flowing through a 3/8-in. choke with 300 psi WHP. Production was up to 1,267 BOPD, and the prognosis was excellent.

**Case 3**—In the Val d' Agri area in southern Italy, AGIP's challenges were to remove near-wellbore damage caused by drilling operations and to improve the permeability of the carbonate formation. This required stimulating three naturally fractured zones with different permeabilities in the 500-m openhole section. Halliburton, working closely with AGIP's stimulation department, recommended a ZCA zonal coverage acid treatment. This would be the first ZCA treatment performed in Italy.

The ZCA treatment was bullheaded to the formation in two stages. After the second stage, tubing pressure changed from a negative to a positive slope. Once the well was put on production, it came in on its own. After cleanup, production rates stabilized at 5,350 BOPD (850 m3/d) and 2.8 MMcf/D with a maximum potential of 10,000 BOPD (1,600 m3/d) and 4.5MMcf/D. The job cost was recovered within one week. AGIP is applying the ZCA diversion technique in other wells in the same area as well as in their HP-HT wells in northern Italy.

**For more information about the Carbonate 20/20<sup>SM</sup> Acidizing Service,  
contact your local Halliburton representative  
or email [stimulation@Halliburton.com](mailto:stimulation@Halliburton.com).**

[www.halliburton.com](http://www.halliburton.com)

Produced by Halliburton Communications

H01157 06/05  
© 2005 Halliburton  
All Rights Reserved  
Printed in U.S.A.

Sales of Halliburton products and services will be in accord solely with the terms and conditions contained in the contract between Halliburton and the customer that is applicable to the sale.

**HALLIBURTON**

**Production Optimization**