THE DOWNHOLE VIDEO SERVICE
CURRENT APPLICATIONS IN THE PERMIAN BASIN

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Abstract

The Downhole Video Service provides a real time and on-site image of wellbore conditions in both the open and cased hole environments. In the open hole environment, the video service may

1) record images of hydrocarbon entry from the formation into the wellbore,
2) show the presence of natural fracture systems that intersect the wellbore and
3) reveal the placement of hydraulically induced fractures.

Because of these features, the Downhole Video Service can be used for making pipe setting decisions and for optimizing the stimulation techniques.

Introduction

The Downhole Video Service is currently utilized in the open hole to solve two distinct problems. The first problem involves determining whether a gas reservoir is commercially productive. The Downhole Video Service can be used in evaluating the flow of gas entry into the wellbore and identifying formation properties surrounding the gas entry that provide the necessary mechanisms for producibility potential. A second problem that can be solved by the video service involves determining the best stimulation technique for a reservoir rock. The Downhole Video Service can be used to visualize and compare the placement, vertical height, and effectiveness of two different stimulation techniques in different wellbores. A decision can then be made on the type of stimulation procedure that will be most financially rewarding.

Description of the Downhole Video Service

The main components of the Downhole Video Service (Fig. 1) are the video camera, fiber optic cable, and the surface electronics system. The camera assembly (Fig. 2) has an outside diameter of 1 11/16 in. , length of 72 in., and weighs 31 lb. (Table 1). The visual integrity of the image is maintained because of the camera recording of 30 frames per second. The fiber optic cable assembly (Fig. 3) has an outside diameter of 7/32 in. and a tensile strength rating of 1200 psi. The fiber optic element consists of a 50 micron core with a 125 micron cladding. The surface electronics system consists of three viewing monitors and a digital recording system. The video images are recorded on 8mm data tapes. The digital video image can then be transferred to a VHS tape, thermal print, or transmitted through the electronic-mail systems.

Applications - Open Hole Well Evaluation

The first Downhole Video Service application in the open hole is obtained from two wells drilled in Permian-Pennsylvanian aged reservoirs. In order to avoid exposing the shales surrounding the sandstone to drilling fluids, the wellbores have been air-drilled. The typical logging suite consists of the gamma ray/density/epithermal neutron/temperature log. One objective for running open hole logs is to evaluate the possibility of the presence of naturally occurring fractures associated with the sandstone reservoirs. It is generally thought that the presence of natural fracture systems associated with these sandstone reservoirs enhances the producibility potential of the reservoir. The main reason for running the video service is to better understand the relationship between air-drilled wells that exhibit positive gas production potential from the open hole logs but are poor gas producers when completed. Thus a paradox exists in that many wells that appear to be naturally fractured have not always fulfilled the anticipated or predicted performance. Since the absence of drilling fluids precludes the utilization of conventional borehole imaging tools; the video service is deployed into the wellbore. The purposes for running the video services are:

1) to examine the intensity of the natural gas entry into the formation,
2) to determine if the gas entry is associated with, or in the proximity of any natural fracture events, and
3) then base the pipe setting decision upon satisfying these two criteria as observed with the Downhole Video Service.

Fig. 4 shows the standard logging presentation for a Pennsylvanian aged sandstone interval. Track 1 and Track 2 show a highly variable range in the caliper and density porosity measurements through the Pennsylvanian aged sandstone. This variation in the measurements may be caused by borehole rugosity. The borehole rugosity which may be caused by

1) natural fractures intersecting the borehole,
2) borehole breakout, or
3) differential erosion of shale laminae in a thinly bedded sand and shale interval.

A borehole anomaly caused by natural fractures would have a positive impact on the gas production. The natural fracture system would serve as a conductive pathway for the entry of gas from the matrix to the wellbore. Natural fracture systems also serve as connections from the source rock into the matrix rock of the sandstone. Contrarily, if the borehole rugosity is caused by a laminated shale and sandstone zone, this would have negative implications for the gas production. Not only is there an absence of the positive effects of the fracture system, but the net sand thickness is overly optimistic in a laminated sequence of shale and sand. Borehole breakout would suggest the presence of preferential stress orientations which could be a positive factor. The results of an incorrect inference regarding the interpretation of the well log could be economically disastrous. Fig. 5 shows the video image for the depth of 7650 ft. of the Pennsylvanian aged sandstone well. The video service shows a very robust gas entry. In addition, the video service showed that the intensity of this gas entry combined with the presence of natural fractures appearing in the rock would indicate that the well should be an economically viable gas producer. Today, the well is producing 1.2 mmcfpd.

Fig. 6 shows the standard log suite from a well drilled into a Wolfcamp sand reservoir. The log exhibits properties similar to the previous example. That is, an erratic caliper and spiking density porosity would suggest the possibility of the presence of a natural fracture system, borehole breakout, or a laminated sequence of sands and shales. Fig. 7 shows the video image of the zone. The gas entry is very sluggish when compared to past observations. There are no visible fractures and there appears to be no borehole breakout. The caliper and density anomalies appear to be associated with laminated shales within the main sand zone. Although the Downhole Video Service showed none of the criteria for setting pipe, a well completion was initiated. The well produced gas in the amount of less than 50 mcfpd and was plugged after six months of declining production.

Applications - Open Hole Well Stimulation

A second Downhole Video Service application in the open hole is to compare two different types of stimulation treatments for the San Andres formation. Fig. 8 is a type log showing the main zone of interest. The San Andres formation in the study area is a dolomitic facies with anhydrite inclusions dispersed throughout the zone. The basic purpose for stimulating these wells is to increase production in a low permeability formation by achieving maximum vertical exposure but minimizing growth into the water zone at the bottom of the interval. Fig. 9 is a video image from an open hole wellbore in which a slow rate acid job (1-3 bpm) was applied to the formation. A total of three 5000 gallon acid jobs were applied. The video image shows that the entire acid volume from the three jobs went into a very small area of the open hole resulting in minimum fracture height growth and poor production results(7 bopd and 37 bwpd). The well was later sand-fractured with a Delta Frac treatment. The well is currently producing 78 bopd. Fig. 10 is a video image in which a Closed Fracture Acidizing technique was performed after a CO_2 foam fracture job. Closed fracture acidizing is the stimulation technique in which acid is applied at low pump pressures and in low volumes. In this wellbore a 10,000 gallon 65 quality foamed CO_2 and 2000 gallons acid were applied. The result was to increase the observed fracture height with a small volume/rate job compared to the previous well example.

Summary

The Downhole Video Service is an important key in determining whether a low permeability sandstone will produce hydrocarbons because of the presence of a natural fracture systems and the robust entry of the natural gas into the wellbore. In the absence of these two factors, it becomes highly questionable as to whether the sandstone will be an economic success. Likewise, the different methods of well stimulation can be verified for effectiveness with the images provided by the Downhole Video. Specifically, the videos showed that the acid/diverter jobs were ineffective because the acid still goes into the same small area even after the diverter is used. The Closed Fracture Acid jobs were effectively covering the zones of interest without exiting the bottom of the wellbore and penetrating the water zone. From the initial exploration phases to the stimulation techniques, the Downhole Video Service can have a beneficial impact on the financial success of a well.

Table 1
Downhole Video Service Specification

Components	Size\Dimensions
Camera assembly O.D.	1 11\16"
Fiber optic cable assembly O.D.	7\32"
Cable tension limits	
@ cablehead	500 lbs.
@ surface	1200 lbs.
Maximum pressure	10000 psi.
Maximum temperature	225 degrees
Camera assembly length	72 inches
Light source	Double halogen 80-150 V DC
Minimum illumination	3 lux @ f1.4
Camera lens	4.8 mm w\120 degrees field of view
Horizontal resolution	570 lines
Signal\noise ratio	50 db

DOWNHOLE VIDEO SERVICE

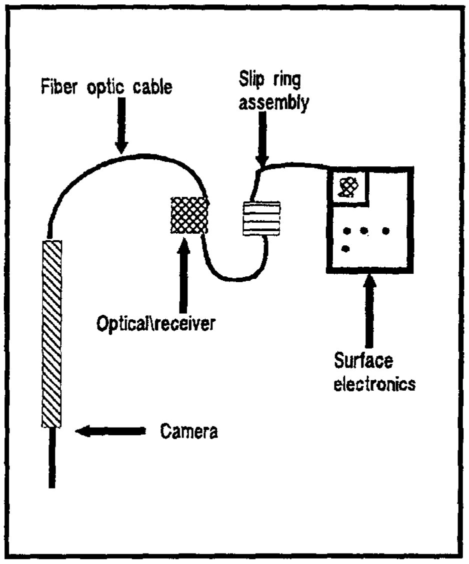

Figure 1 - The main components of the Downhold Video Service

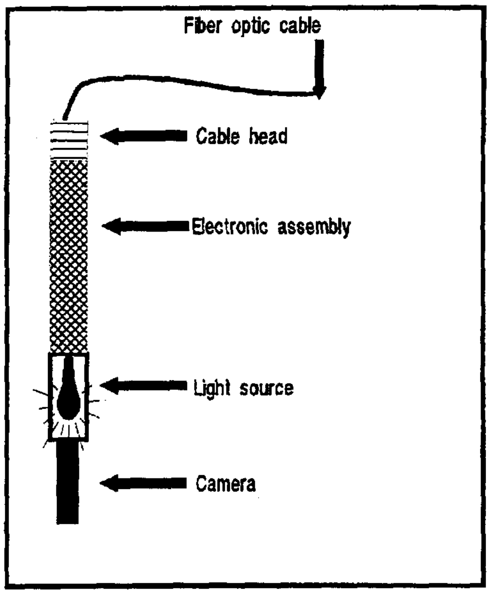

Figure 2 - The Downhole Video Camera assembly

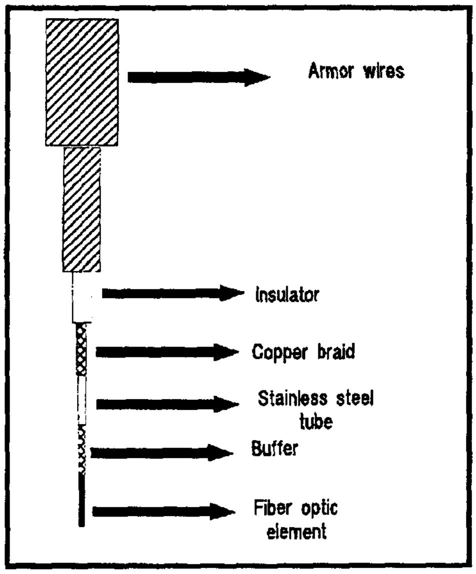

Figure 3 - Main parts of fiber optic cable

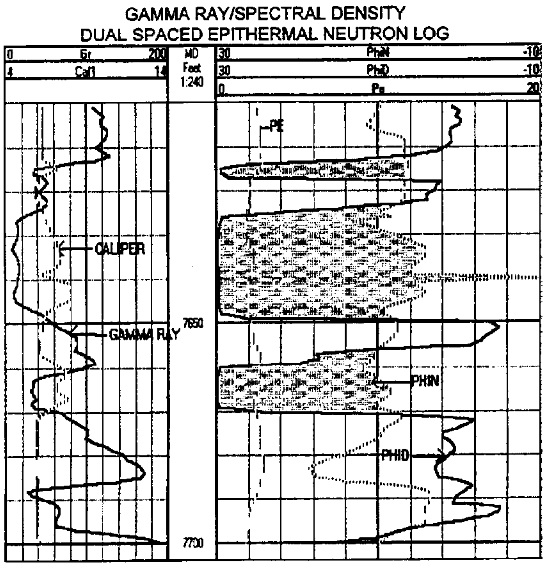

Figure 4 - Example of Pennsylvanian aged sandstone "pay zone".

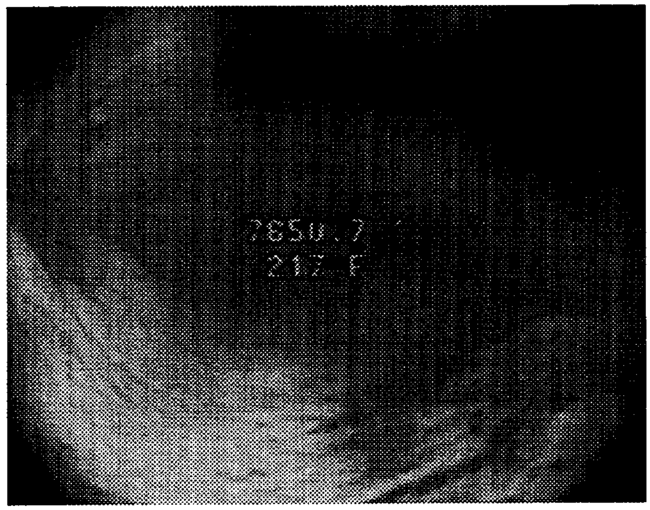

Figure 5 - This video image of the sandstone shows both an elliptical borehole and natural fractures. The image is smeared because of the gas entry from left side of wellbore.

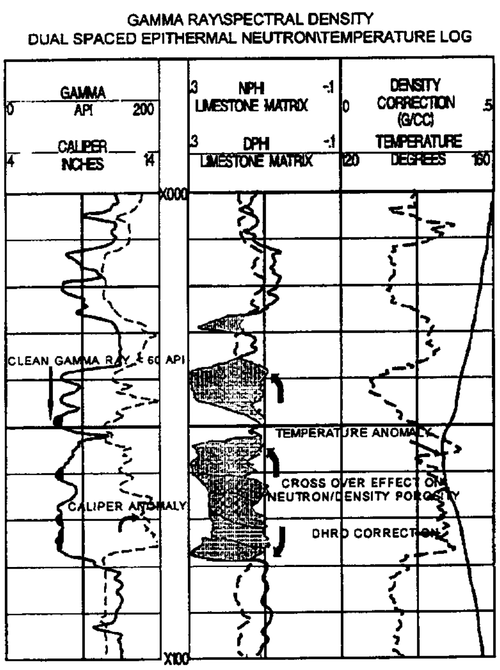

Figure 6 - Wolfcamp sandstone exhibiting "gas effect" on the Density Neutron porosity.

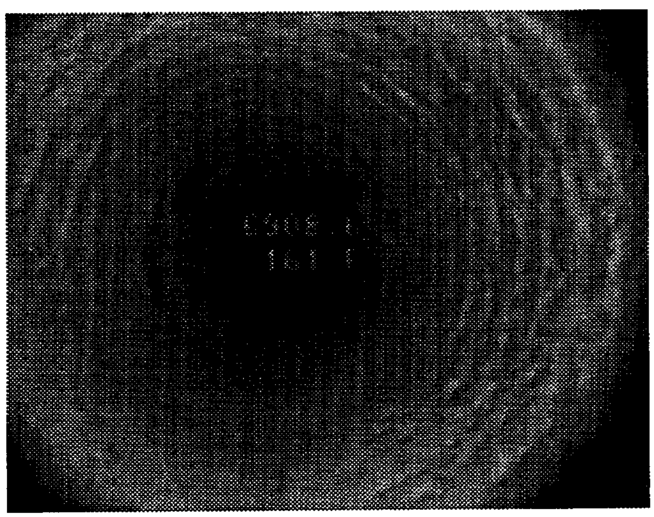

Figure 7 - This video image shows no fractures and a very lethargic entry of gas into the wellbore. The concentric ridges are caused by the sand/shale laminations within the sandstone interval

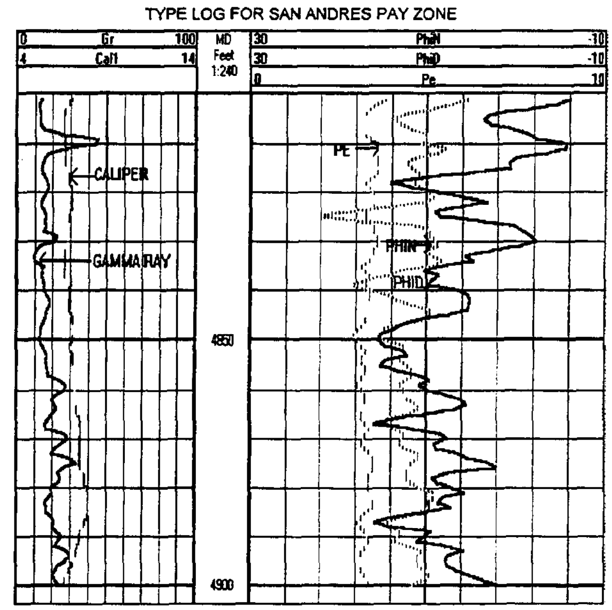

Figure 8 - Gamma ray/Spectral Density/Dual Spaced Neutron log of San Andres "pay zone"

Figure 9 - The video image shows the effect of the acid treatment which is isolated to a very small interval of the wellbore.

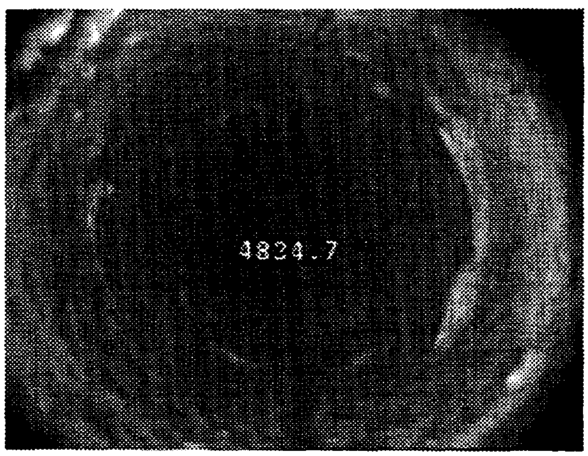

Figure 10 - The video image shows the result of a closed fractured acid job. The treatment covers the zone of interest.