

# Holding back the tide

Scott Ellenbecker for Atlas Copco, US, provides a case study detailing the successful drilling of an aquifer.

**L**&S Drilling does most of its work in the Cherokee Basin formation in central Kansas, which has been a developing CBM region in the US for at least 20 years. "The Cherokee group has as many as 13 coal producing seams, but primarily eight producing CBM seams," said Mark Brecheisen, consulting geologist for L&S Drilling. Most Cherokee coal seams are 1 – 2 ft thick, with the deepest seam, the Riverton, being 2 – 6 ft thick. Once drilled, a CBM well could easily have a producing life of 20 years: "I have actually seen gas production increase

five years after a well was first drilled and another that was producing the same volume of gas eight years after it was first drilled."

According to Brecheisen, the eastern flank of the Cherokee Basin is about 850 ft from surface, going down to as much as 15,000 ft on the western flank. Coal is great for holding and producing gas because it is its own source and reservoir rock: the gas is contained within the matrix of the formation, which is slowly released. The best CBM producing coal formations are 100% saturated and, as water is removed

from the cleats, more gas is released. However, drilling formations with high water content is not easy. The remainder of the article considers a case study from an oil and gas formation, where L&S succeeded in drilling a strong aquifer using a high volume of air under high pressure. Similar conditions are experienced when drilling a CBM seam.

## **Case study: drilling in strong aquifers**

The Arbuckle formation is an oil and gas producing formation in Kansas.

The formation is also a strong aquifer, which in the past has been a stopping point for hammer drilling, at least at production hole size (6.75 or 7.88 in.; 20 cm), and a water discharge formation.

In earlier geological papers written on the formation, it has been described as having columns of oil and gas, which are generally near the top. Over the past 100 years, it has produced 36% of the total 2.19 billion barrels from 21

oil fields. Oil production peaked in the 1950s at 68 million barrels in 1955, tapering off to the point that, today, 90% of the wells produce less than 5 bpd.<sup>1</sup>

The formation occurs at depths ranging from about 500 ft (152 m) in southeastern Kansas to more than 7000 ft (2134 m) in southwestern Kansas. Arbuckle strata thicken as a whole from north to south and are thickest – up to 1390 ft (424 m) – in the southeastern corner of Kansas.<sup>2</sup>

According to Jim Lorenz, L&S Well Service, “the Arbuckle is very porous with lots of water: it’s like drilling in the bottom of the ocean.” The aquifer is brine water to the west, while further east into Missouri, the elevation rises and it actually produces fresh water.

### Air drilling

Air drilling is the method of choice for L&S, and having a dependable booster is critical to the process: “I have a mud pump, but haven’t used it in a year! I like air,” comments Lorenz. Lorenz aims to finish a hole in a day to prevent ‘watering out’, or having to stop because the column of water reduces bit force on the rock. Increasing air pressure through the hammer

discharges the head of water, allowing the bit to strike rock. L&S carries 2460 ft (750 m) of 4.2 in. (11 cm), 30 ft drill pipe with them, but generally does not need to go deeper than 2200 ft (671 m).

Going deeper in the bore hole puts more water around the annulus of the drill string and water weight under the bit, also called head pressure, which then requires more air volume to evacuate water from the hole. According to Jeff White, a product support specialist, “a good guideline is that each foot of water requires 0.5 psi to evacuate the water.” A good trick to unload the hole, if it has filled up with water (e.g. in a morning start) is to trip out a few sections of pipe, reducing the head pressure on the bit.

L&S operates a new Atlas Copco RD20 drill rig, equipped with a 1250 cfm 350 psi air compressor (1250 cubic ft of free air delivery at 350 pounds/in.<sup>2</sup>). Once drilling into water, the head pressure begins to build. To evacuate excess water, the company’s driller, Dustin Hirrlinger, engages the auxiliary booster; however, he admits that “I usually crank up booster early because I can drill faster.” L&S runs a two-stage Atlas Copco Hurricane booster, although it is possible to



The secret to tripping pipe.

This two-stage Atlas Copco Hurricane can boost 350 psi air from the drill rig to 2000 psi, enough to evacuate a 1000 ft column of water. Couplers between the rig and booster allow for fast rig-up time.




operate this unit in single stage mode in more shallow situations.

The booster sucks air from the rig compressor and any auxiliary compressor and converts it to a higher pressure. L&S runs a 6T 855 62B 2000 Hurricane with their RD20, which can produce 2000 psi (137.9 bar) with 350 psi (24.13 bar) of suction. At 350 psi suction, the unit produces 2400 cfm (67.96 m<sup>3</sup>/min).

According to Hirrlinger, "it is important to know what you're doing when engaging the booster, because the water discharges at such a high pressure." He emphasises chaining down the discharge line when unloading the hole and starting slowly. At idle, the Hurricane puts out 1500 rpm, which equates to 600 psi: "If you don't know what you're doing, you could really hurt somebody with a 1000 ft (305 m) water column: it comes out of the hole with a roar."

Lorenz also points out the necessity of having a booster: "Drilling a 7.88 in (20 cm) hole requires twice the water that a 4.88 in. (12 cm) hole will. To lift the water, it takes a minimum of 1000 psi to drill into the Arbuckle 400 ft (122 m). If you don't have the air, you'll lose circulation."

Speed is a big advantage when drilling with air, but Lorenz also said that he can get a straighter hole using air and a smooth-bore stabilizer: "When logging our holes, we have less than a 2 ft (0.6 m) deviation, where others can have 20 – 30 ft (6 – 9 m)."

Not all wells are disposal wells for L&S: Lorenz does everything from geothermal wells to gas and oil wells. However, whatever the well's outcome, he has the air power to go the depth of 6500 ft with the RD20 and 3500 ft with the T4W with the long derrick to handle three different sizes (4 ½, 3 ½, or 2 7/8 in.) of 30 ft drill pipe. The 3 ½ in. pipe is used for drilling a slim hole or for drilling the inside of a 5 ½ in. casing, while the 2 7/8 in. pipe is used for drilling 4 ½ in. casing. 

## References

1. *Geological Controls on Variable Character of Arbuckle Reservoirs in Kansas: An Emerging Picture*, (Kansas Geological Survey Open-file Report 2003-59).
2. KEROHER, R.P. and KIRBY, J.J., 'Upper Cambrian and Lower Ordovician Rocks in Kansas', *Kansas Geological Survey Bulletin*, 72, (1948), p. 140; COLE, V.B., 'Subsurface Ordovician-Cambrian rocks in Kansas', *KGS Subsurface Geol. Series* (1975), p. 2, 18.