## *High-Power Turbodrill and Drillbit for Drilling with Coiled Tubing*

### DE-FC26-05NT15486

### Goal

The project entails developing and testing an effective downhole drive mechanism and a novel drillbit for drilling small-diameter vertical and horizontal wellbores with coiled tubing.

### Performers

*Technology International, Inc.*
*Houston, TX*

*Smith International, Inc.*
*Houston, TX*

### Results

Baseline testing of an existing 2⅞-inch diameter turbodrill with polycrystalline diamond compact (PDC) and impregnated diamond drillbits has been successfully performed at Gas Technology Institute's Catoosa, OK, field test site. The hydraulic efficiency of the baseline MK2 turbine blades has been increased so far by 13%.

### Benefits

Benefits to the industry from successful development of a microhole coiled tubing (CT) turbodrill and high-speed drillbit include:

- Delivery of more power to the bit than with positive displacement motors.
- Lower reactive torque for improved directional control.
- Longer drillbit life, less vibration, and steady dynamics at the bit.
- Smaller cuttings that are easier to clean from the hole.
- Drilling at a higher rate of penetration (ROP) with less weight on bit (higher rotary speeds to 2,200 rpm provide higher ROP and lower cost per foot drilled).
- Operation at high downhole temperatures.
- Operation in two-phase muds at higher rotary speeds and for underbalanced drilling applications.
- Improved hole quality and high reliability.

The PDC and impregnated diamond drillbit being developed in this project.

### Background

Dr. Steve Holditch, 2002 president of the Society of Petroleum Engineers, said, "To economically recover gas, we need to learn how to drill smaller boreholes more rapidly and less expensively." But drilling today does not necessarily mean using a conventional drilling rig. CT units increasingly are being used to drill for oil and natural gas deposits at lower costs and with a much smaller environmental footprint. CT drilling is a cost-effective alternative for drilling highly deviated wells or drilling new hole sections in existing wells. The use of a relatively high-speed turbodrill and high-temperature drillbit will reduce the cost per foot drilled.

### Summary

The prototype CT turbine motor and drillbit being developed in this project are designed to:

- Drill a vertical hole to 5,000 feet and drill laterals to 1,000 feet.
- Demonstrate the economic advantages of the CT drilling operation when compared with conventional drillpipe-conveyed downhole assemblies.

The performance of the turbodrill and bit system will lead to an advance in the design of components that ultimately will lead to a higher-power turbine section.

The next step in the project is to incorporate the design improvements into a new downhole drilling assembly for a microhole drilling system. Tools will be made available to microhole project partners for independent field applications in re-entry wells and workover operations using commercial coiled tubing rigs.

A thermal model is being developed to predict cutter temperatures while drilling hard and abrasive rock at high rpm. Being able to estimate cutter tip temperatures will aid in the development of a more durable drillbit employing high-temperature cutters.

A fluid dynamic model developed by NASA Ames Research Center, Mountain View, CA, is being used to increase the hydraulic efficiency of the existing 2⅞-inch diameter Turbodrill. The result will be a shorter tool to aid directional control and greater torque to increase ROP.

### Current Status (January 2006)

Initial tests of prototype hardware were conducted at drilling research centers to expedite the testing process and to ensure maintenance of carefully controlled operating conditions not compromised by customers' operational drilling requirements. Task 1, the baseline turbodrill and drillbit testing, was completed in March 2005. A turbine blade hydraulic design model was used to redesign the turbine blades, and successful dynamometer testing was completed in June 2005. Further Turbodrill hydraulic modeling is under way, as well as thermal modeling of the drillbit cutters.

A drillbit thermal model has been completed and is being tested for 3½-4⅛-inch diameter fixed-cutter bit designs employing both PDC and thermally stable diamond cutters. Cutter temperatures will be estimated for bits operating at rotary speeds that match the capabilities of the improved 2⅞-inch diameter Turbodrill, with rotary speed capabilities up to 2,200 RPM.

**Project Start / End:** 2-7-05 / 8-6-06
**DOE / Performer Cost:** $759,668 / $200,000
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