THE EFFICIENCIES OF USING COILED TUBING AND DOWNHOLE DRILLING MOTORS FOR SMALL WELLBORE CLEANOUT OPERATIONS

Naji Soas, Downhole Injection Systems
Tim Dame, Basic Energy Services, New Force Division
Darren Seglem, Sloan Petroleum, Inc.

ABSTRACT

Small diameter holes or slimholes (smaller than 5.75") is a technique that has been in practice in the oil and gas industry for over fifty years. The attraction of slimhole drilling is the prospect of greatly reducing the cost of drilling shallow and moderate depth holes. This is due to the reduction in well site area, pipe size and materials required for drilling and well completion. However, at the present time, smaller tools for drilling, logging, and other completion tools are not readily available as for those used in conventional size wellbores. Consequently, the cost of doing completion work or workover during the life of the well is higher compared to the conventional practices due to the rare availability of those tools.

Coiled tubing has become a major service for the oil and gas industry. During the last twenty years the coiled tubing industry has grown from an expensive primary cleanout tool into several viable options. Coil tubing today is not only used for cleanouts but with cementing, acidizing, fracturing, drilling, and horizontal operations. The use of coil tubing to clean out or drill inside slimhole tubing or casing has increased through the years. This method has increased profits and production for our customers by saving both time and money using coiled tubing.

With their advancement and improvement in design and availability, coiled-tubing units and downhole drilling motors are becoming the choice of the completion and workover of a slimhole. Reduction of costs of these units's makes slimhole completion more economical. Coiled tubing saves time and money because it requires fewer trips in and out of wellbore than conventional techniques. Since coiled tubing cannot be rotated in a wellbore, downhole positive-displacement motors (PDMs) must be used. PDMs drill up to four times faster than conventional methods, which will offset the cost increase for the coiled tubing unit (CTU). The subject of this paper is to show the versatility, cost-effectiveness and safety of using coiled tubing and downhole drilling motors to drill several solid plugs in a slimhole completion (2.3 inches inside diameter).

ADVANTAGES

Using coiled-tubing equipment and downhole drilling motors have several economical and safety advantages.

- Coiled tubing units take less space than conventional units, which adds to a reduced amount of environmental damage and footprint.
- Coiled tubing units take less time to rig up and down, are faster to go in and out of wellbore and take the place of several conventional method pieces, which will save mobilization costs.
- Downhole drilling motors drill two to four times faster than standard methods, which translate to a reduction in drilling and cleaning time, and return the well to production sooner that will generate a quicker return on operator investment.
- Since there is no rotation except at the drilling bit, there is less wear and tear on the casing and the workstring.
- Downhole drilling motors put the maximum torque at the bit and the torque will dissipate to a minimum at the surface opposite to the hydraulic power swivel. That means safer operation to the personnel at the surface working close to the wellhead.

SERVICE EQUIPMENT CONSIDERATIONS

The following issues need to be considered to choose the right tools for a specific job:

- The size of the drilling bit depends on the drift diameter of the pipe. The kind of drilling bit depends on the nature of the plug (in this case a blade bit was used for drilling salt/sand plugs and pipe cleanup)

- The size of the downhole drilling motor and coiled tubing depends on the drift diameter multiplied by 0.95 or 0.92 which will determine the annular clearance for the purpose of fluid velocity and allow the cuttings to circulate to the surface. The PDM configuration and number of stages will be dictated by the coiled tubing size (O.D. and I.D.), pressure limitation, rate of fluid or foam at tubing max pressure, and torsional yield of coiled tubing.
- Type of workover fluid or foam depends on the reservoir characteristics, bottom hole pressure, temperature and frac gradient. Compatibility of fluid or foam with reservoir geology.
- Use the right bottomhole assembly configuration to avoid unforeseen problems (i.e. blade bit, downhole drilling motor, dual-circulation sub; FAU hydraulic disconnect, dual-backpressure valve and slip-on coiled tubing connector).
- Wellhead configuration and its compatibility with well-controlled equipment.

EQUIPMENT DATA

- Coiled tubing unit (Figure-1)
  The CTU that was used is truck mounted and equipped wit 6000 feet of 1 ½" steel coiled tubing. The body load configuration of the unit is preferred. The CTU also has a dual blowout preventer and tubing stripper.

- Positive-displacement drilling motors: (Figure-2)
  Downhole positive-displacement motors (PDMs) utilize a steel rotor and a rubber stator to convert hydraulic power to mechanical power to rotate the drill bit. PDM stators contain one more lobe than the rotors as shown in figures 3 and 4.

  For a given rotor/stator design, motor speed is proportional to flow rate and motor torque is proportional to pressure drop across the motor. Multi-lobe motors have larger volumetric displacements than single-lobe motors and therefore deliver higher torque and run at lower speeds.

The pressure drop, p, across a motor equals:

$$P=nPs \qquad \text{(Equation 1)}$$

Where

P = motor pressure drop
Ps = pressure drop per stage
n = number of stages

Equation 1 shows that the motor pressure drop (i.e. power output) can be increased by increasing the number of stages (i.e. increasing motor length) or by increasing the pressure drop per stage (e.g. tighter interface between the rotor and the stator) increasing pressure torque, but does not change rotor speed.

Figure- 5 shows a cross-sectional view of a 4:5 lobe configuration and cavity to lobe in PDMs power section. Cavity volume is purely a function of a power section design. It is defined as the pumping area multiplied by stator pitch (stator pitch is shown in figure-6).

Downhole drilling motors can be used in place of a hydraulic power swivel with large-diameter tubing (2 ⅜", 2⅞"…) using anti-rotation circulating tubing heads which will prevent the working string from rotating (anti-rotation circulating tubing heads is a Wenzel Downhole Tools Ltd. Technology as shown in figure-7). Advantages with this approach are preventing wear and tear on working strings and casing (especially for old casing or if there are squeezed holes above) and is a great safety device. Using downhole motors require no working string or drill pipe because PDMs drill with higher RPMs and require minimum weight on the drilling bit, which is opposite of the power swivel. PDMs can save up to 50% of the time drilling cement, cast-iron bridge plugs, cement retainers and well's deepening.

APPLICATION

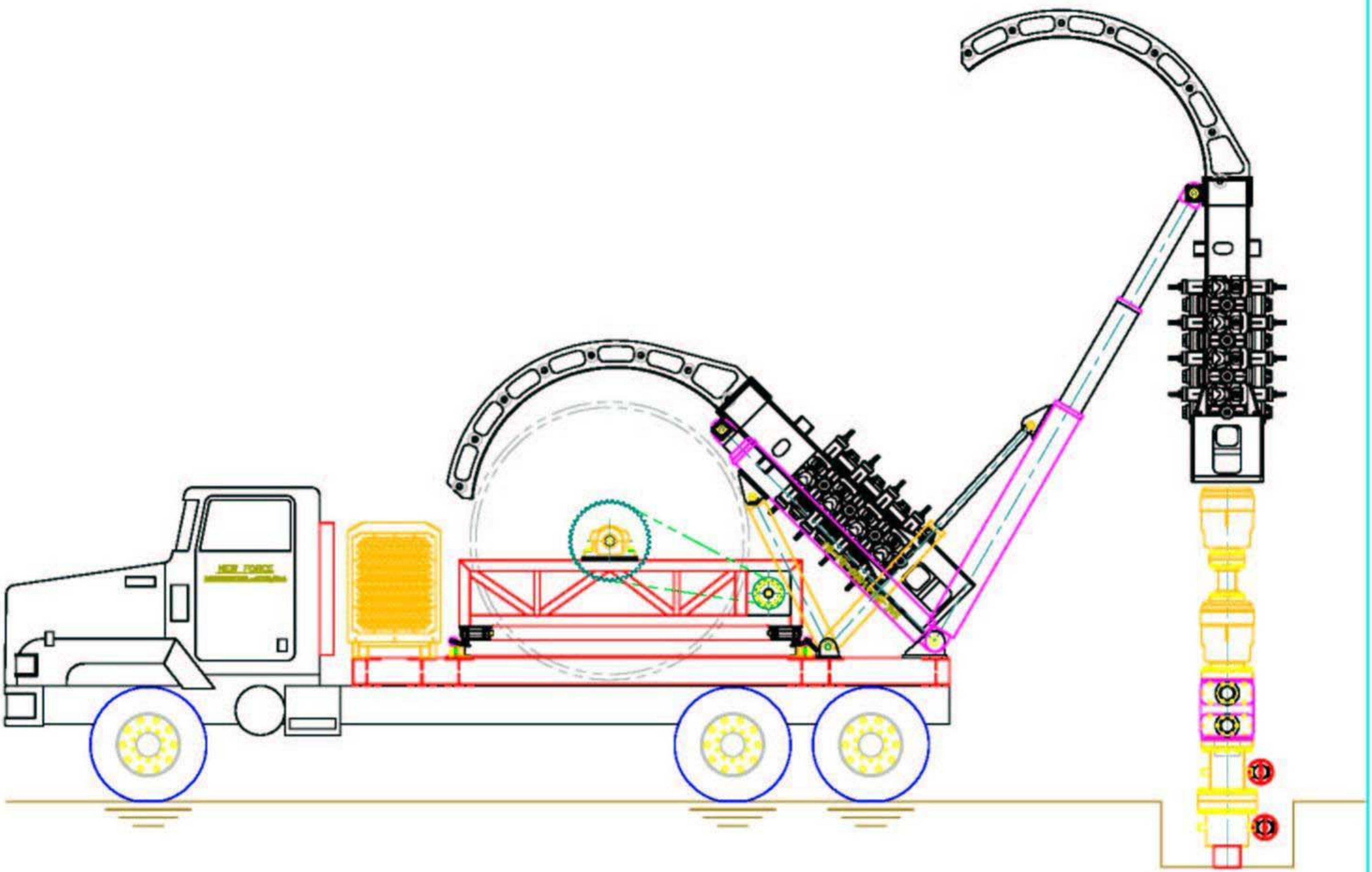
The oil company (Operator) currently owns 40 wells producing from the Yates gas sand (+/- 3000') in Andrews County, Texas. Five of the wells were drilled with 2 7/8 drill pipe and slimhole cemented to surface. The Yates zone produces very little water, but what is produced from these gas wells comes in a fine mist that carries salt. This salt has become a tremendous impediment to production volumes. The salt can form a complete salt block inside the production tubing in a matter of days. The Operator remedied these blocks quite easily in the conventional holes by either pulling the tubing or circulating fresh water. But the Operator's problem and the subject of this paper is the remedy of cleaning out several salt blocks and restrictions from one of his slimhole completion wells. In that situation, pulling the tubing or circulating the hole was not an option. The Operator considered two options for the procedure. First, a spaghetti string of pipe and a reverse unit type cleanout, or second, use of some more recent technology of coil tubing and 1 ¾ downhole motor. The Operator bid the cost of both jobs and realized that the coil tubing, downhole motor technology would save significant money and time over the more conventional and accepted well bore clean out procedure. The job went as routinely as designed. The costs were as quoted and the well was back on production in a timely manner.

CONCLUSION

An effective and economic procedure for removing organic restrictions from a slimhole completed well bore is the combined usage of a portable coil tubing unit and a small sized down hole drilling motor. The operating company saves time and expense by reducing rig up costs and the need for additional equipment required by conventional clean-out methods. The method also reduces the risk of accidents and improves safety conditions with the lessening of human exposure because of fewer required people and work hours at the well site.

REFERENCES

Maurer Engineering Inc. - "High Powered Drilling Motor Field Tests"
R & M Energy Systems – "Stator Life of a Positive Displacement Down-Hole Drilling Motor"
Wenzel Downhole Tools Ltd. – "anti-rotation circulating tubing head"



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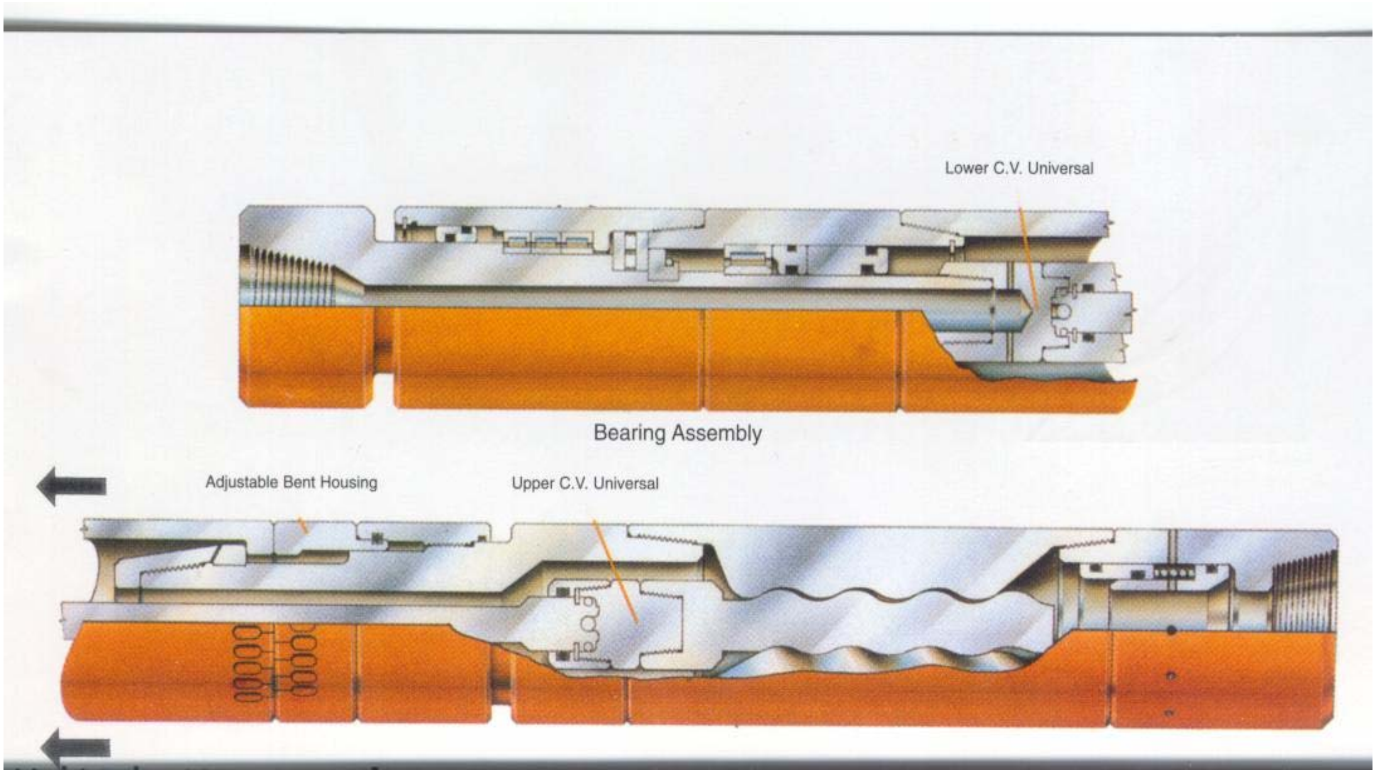

Figure 2 – Downhole Drilling Motor

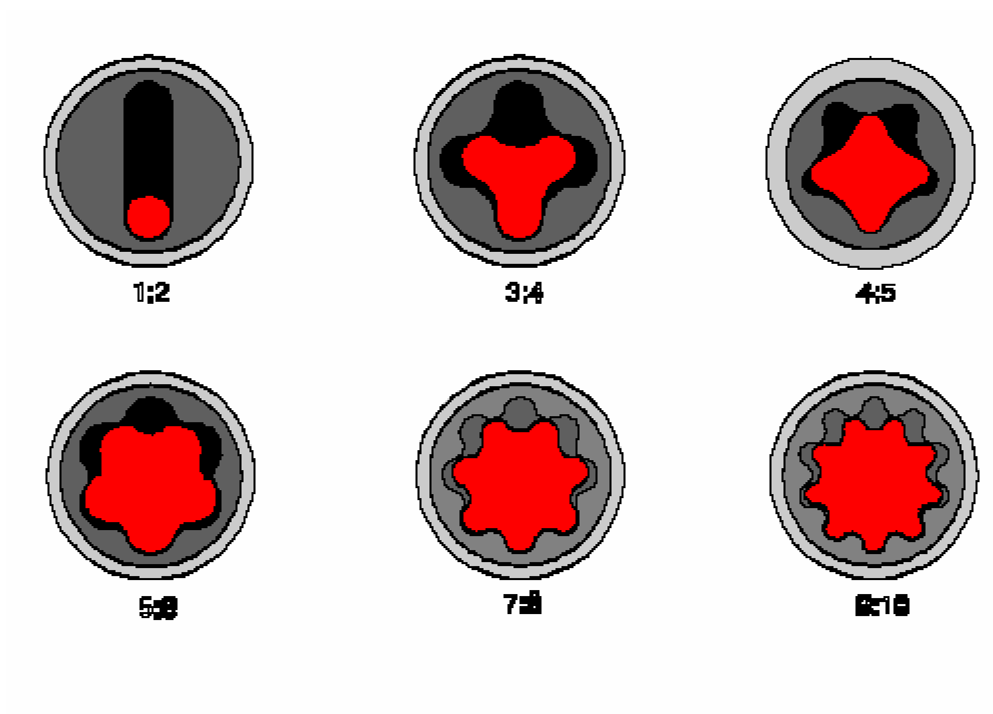

Figure 3 – PDM Multilobe Stator Configurations

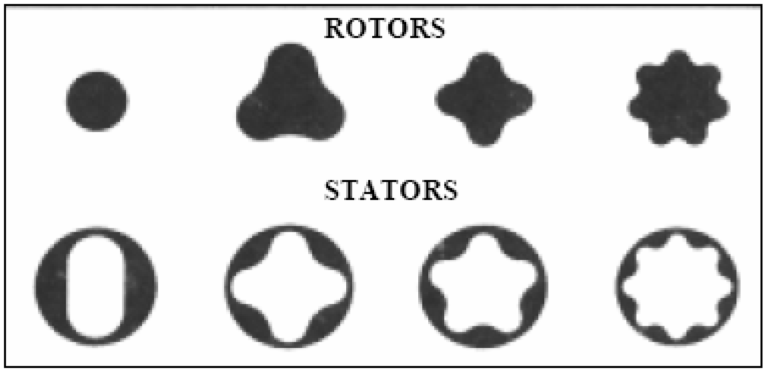

Figure 4 – Various Lobe Configurations

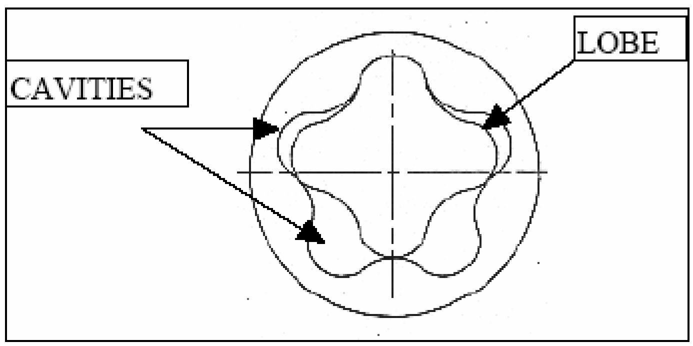

Figure 5 – Cross-Sectional View of a 4:5 Lobe Power Section

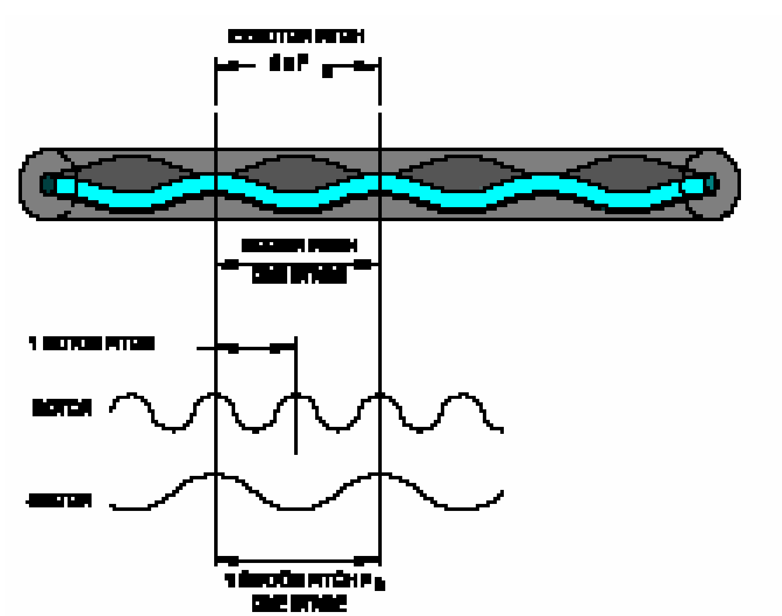

Figure 6 – PDM Rotor/ Stator Pitches

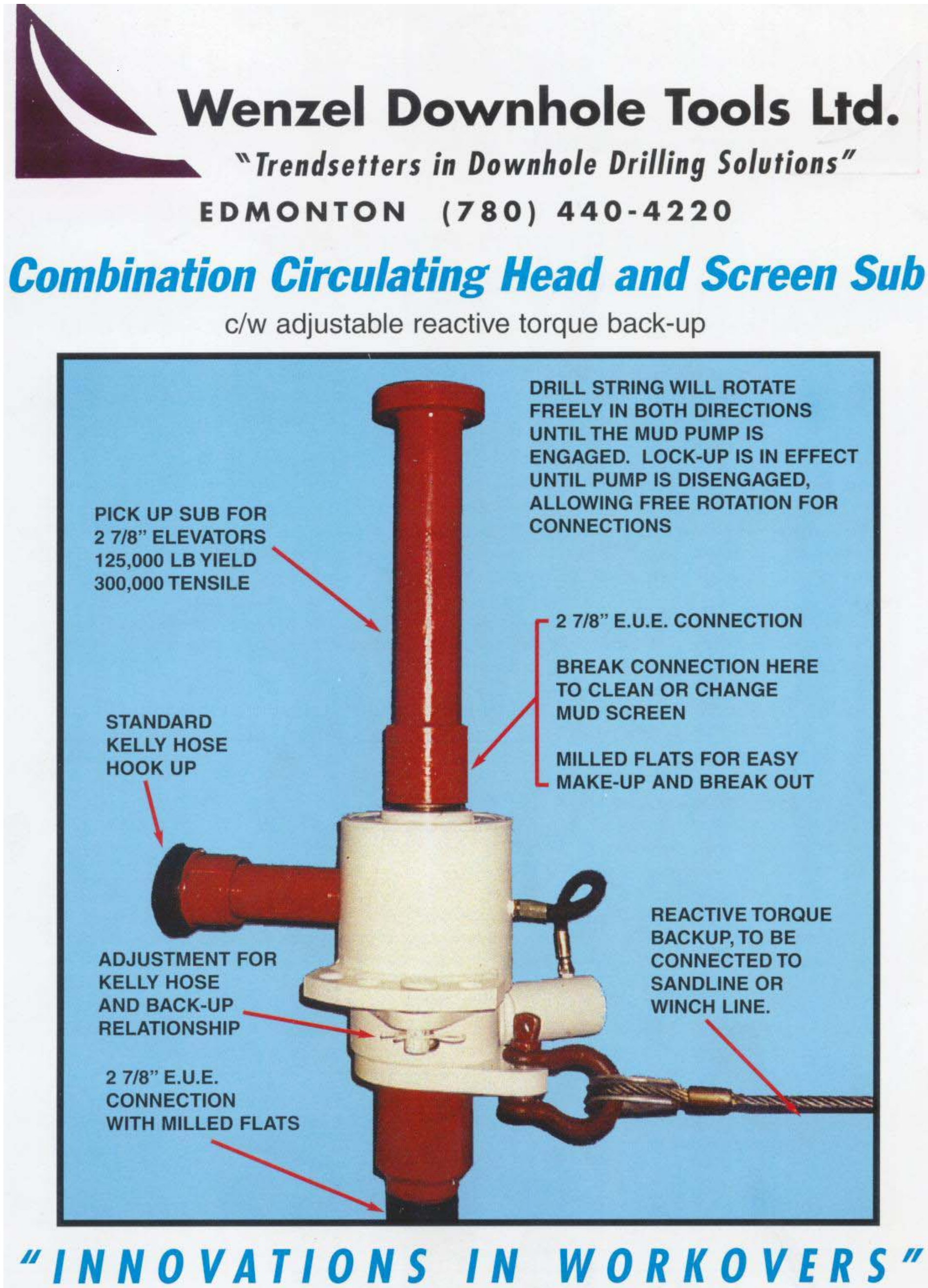

Figure 7 - Anti-Rotation Circulating Tubing Head