Advantages of a Piston-Cylinder Vibrator

Resonance Technology International (RTI) uses a hydraulic piston - cylinder geometry to generate high magnitude, high frequency oscillating force. This is a very different mechanism than used in conventional sonic drills and sonic vibrators. How and Why?

RTI uses elegant, patented valve geometry to achieve the high frequency flow switching necessary to oscillate the hydraulic piston at up to 180 Hz. The valve is cylindrical and stationed within a hollow piston, right at the piston shoulder (short travel distance for the reversing fluid) with porting to allow the flow to switch from one side of the piston shoulder to the other. By rotating the valve the ports mate and switch the flow to alternate sides of the piston. The valve rotation is controlled electronically for maximum accuracy of the desired sonic frequency. The flow of hydraulic oil delivered to the valve determines the amplitude (flow rate) and peak force (pressure).

By using a separate valve to control frequency, independent of the vibrator flow (amplitude) and pressure (force), the driller now gains independent control over these vital operating parameters. Sonic drills cannot offer separation of frequency and power or amplitude. Through this independence the Resonant Drill offers a number of advantages over sonic drills. Before we explore these, let's discuss the conventional sonic drill mechanism.

Conventional sonic drills and sonic pile driving vibrators use a rotating eccentric mass to produce an oscillating force. When two eccentrics are placed side by side and turned in opposite directions they have the advantage of making a perfectly sinusoidal force time history. But the advantages stop here. The power and force of a conventional sonic vibrator are defined by the square of the frequency at which they operate. [The power of a sonic drill is the function of the square of the frequency multiplied by the moment arm multiplied by the eccentric mass. The moment arm and the eccentric mass are constant so the force varies with the square of the frequency.] At low frequencies a sonic drill produces very low peak force (1/10 the rated peak force or power). The peak force slowly climbs with increasing frequency but doesn't reach a peak until the very highest rated sonic frequency. This is inefficient because most sonic drilling and driving is done at lower frequencies.

The graph below shows frequency versus peak force of a Resonant Drill (which is the same at all frequencies) and the varying peak force of a sonic drill. Notice that a sonic drill offers higher peak force than a similar sized Resonant Drill at the ultimate rated frequency, but the peak force of the Resonant drill is higher throughout most of the operating range for a sonic drill.

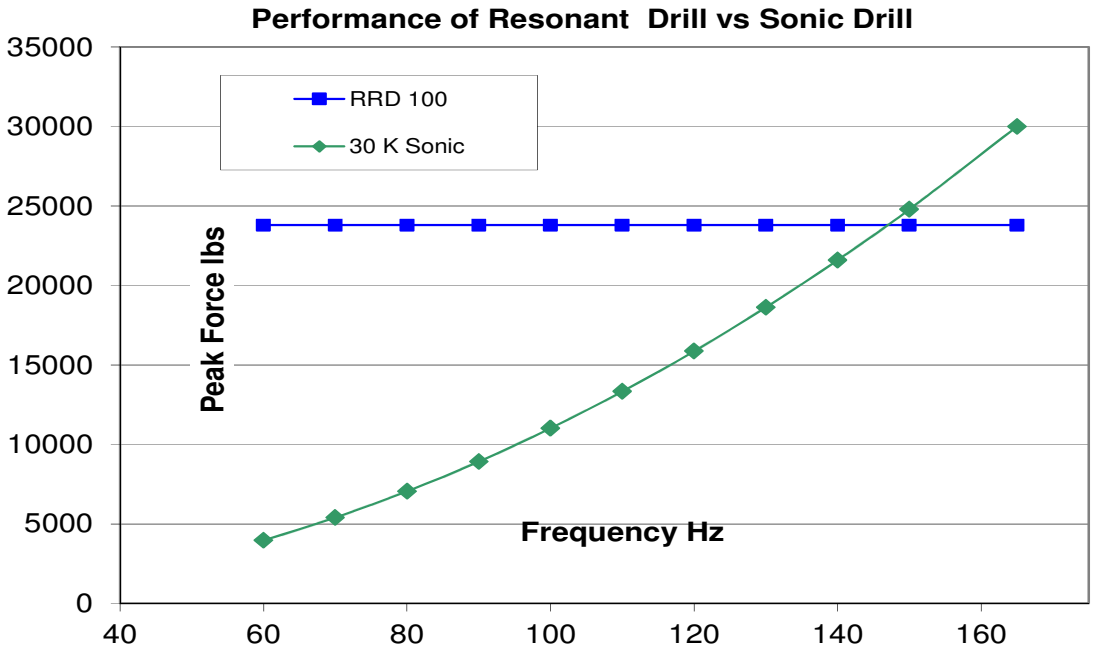

Figure 1. Frequency vs. peak force for typical Resonant and Sonic Drills

Additional advantages of the Resonant piston-cylinder method include:

1. RTI has developed a self-tuning algorithm for the Resonant Drill. This allows the driller to automatically tune to resonance and achieve maximum efficiency and maximum force at the drill bit. The self-tuning feature accelerates driller training to mere days.
2. No start up or shut down shaking of the drill mast and base machine. Since the frequency of the Resonant Drill is set independently of the vibration power, the Resonant Drill can 'idle' at the target frequency during rod changes and start up at the desired frequency. This saves time and prevents wear and fatigue on the base machine.
3. The Resonant Drill can operate at low power and force at any frequency allowing a large drill to work with small diameter, light drill string and casings, or use a power pack that is undersized. One Resonant Drill fits more applications.
4. The Resonant Drill amplitude is limited by the flow rate of the power pack. This has the inherent advantage of limiting the maximum amplitude the drill can achieve, preventing galloping oscillation at resonance and subsequent catastrophic stresses and strains in the drill tooling. Eccentric mass based sonic drills cannot limit the power or amplitude if they achieve resonance. This leads to galloping oscillation, high amplitudes and strains in the drill tooling and failure.

The result is that a Resonant Drill offers numerous advantages over conventional sonic drill technology including: highly efficient, safe drilling at resonance with a minimum of driller training, reduced wear and fatigue on the base machine and drill and more control placed in the drillers hands through independent control over drilling frequency, amplitude and force.