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The Extraction of Mud-Stuck Tubulars Using Vibratory Resonant Techniques

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Abstract

Stuck pipe has been identified as the largest single contributor to non-productive drilling time. The use of resonant vibration as a means of freeing stuck tubulars from a well bore has been demonstrated to be effective in both Drilling and Workover environments and has the potential to provide almost immediate results in many day-to-day applications. The challenge for the future is to further explore both proven and potential applications of this technology in order to evaluate the benefits and reduce the unknown associated with the technology. The long term industry benefit will be a new approach to stuck tubular recovery available in the form of superior technology that addresses real needs while substantially reducing costs. The technology offers the benefits of being quick and easy to apply, operations are conducted from surface with no downhole intervention, and results may be achieved very quickly. Good success in open hole work could mean that this technology could become the procedure of choice in virtually all drilling operations. In workover operations, the technology may accomplish the same results in hours that typically require days by current standards.

The Evolution of Axial Vibration of Pipe at Resonant Frequencies in Oil Field Applications

The concept of using vibration to free stuck objects from a wellbore originated in the 1940's, and probably stemmed from the 1930's use of vibration to drive piling in the Soviet Union. The early use of vibration for driving and extracting piles was confined to low frequency operation; that is, frequencies less than the fundamental resonant frequency of the system and consequently, although effective, the process was only an improvement on conventional hammer equipment.

Early patents and teaching attempted to explain the process and mechanism involved, but lacked a certain degree of sophistication. In 1961, A. G. Bodine obtained United States Patent 2,972,380[1] that was to become the "mother patent" for oil field tubular extraction. Mr. Bodine introduced the concept of resonant vibration that effectively eliminated the reactance portion of mechanical impedance, thus leading to the means of efficient sonic power transmission. Subsequently, Mr. Bodine obtained additional patents directed to more focused applications of the technology.

A 1987 Society of Petroleum Engineers (SPE) paper[2] detailed the nature of the work and the operational results that Resotek achieved. Resotek's work involving liner, tubing, and drill pipe extraction and was very successful, as was Baker Oil Tool's subsequent work[6] on continuing the work began by Resotek.

Non-Resonant Vibratory Systems – Jarring Operations

Stuck tubular extraction tools or systems have been available to the oil industry almost since the first well was drilled. Drilling or fishing jars are routinely run with the bottom hole assembly. Workover operations can run fishing tools on tubing, coil tubing or even wireline; as such, all fishing operations require downhole tool intervention such as spears, overshots, taper taps, washover pipes, etc.

Jarring operations may require anywhere from a few to sometimes thousands of impacts to release a fish. The time required to set the jar and trip it may be on the order of 2 to 3 minutes per impact and the total time involved for a successful jarring operation can reach over 50 hours of continuous impacts. Therefore, operations involving jarring usually last days, sometimes weeks, resulting in a considerable loss of productive rig time.

Another consideration when using jars is their placement relative to the stuck point. When run on the drill string, the assumption is made that the stuck point will be below the jar, otherwise jars would not serve any useful purpose. During a workover or completion operation, jars will always be placed above the stuck point but can suddenly find themselves below the point of usefulness should the pipe get constricted further up the hole due to sand deposition, mud solid buildup, casing collapse, junk being deposited in the hole or excessive friction due to irregular hole geometries.