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The Sperry-Sun Pressure Transmission System (P.T.S.) continuously monitors bottom-hole pressure from any surface control point. The reliable and rugged down-hole package uses no electronics or moving parts; therefore, the possibility of having problems with the down-hole package is very remote. The bottom-hole pressure are transmitted to the surface unit through a small stainless steel capillary tube that is .094" O.D. and .054" or .026" I.D., that is charged from the surface with an inert gas (Nitrogen or Helium) to establish a single phase gas system.

The down-hole system utilizes two (2) types of chambers -- suspension and concentric chambers. The suspension chamber is 1.66" O.D. X 10 feet long, although other sizes can be made for special applications. The suspension chamber can be run in wells through a stuffing box and lubricator in the same manner as conventional gauges are run. There are depth limitations when running the suspension chamber due to the strength and long continuous lengths of the capillary tube. Generally, when using the .094" or .026" I.D., #1 temper, fully annealed tubing, the depth is limited to approximately 3000 feet: the .094" O.D. X .054" I.D. tubing limited to approximately 7000 feet. This tubing is a #3 temper, cold drawn, with a tensile strength of 145,000 to 165,000 P.S.I. Additionally, the size of tubing to be used will depend on the pressure range to be measured.

The reason for the two (2) different I.D.'s of tubing is that in some instances, with large B.H.P. changes, the .026" I.D. tube has to be used in order that a standard chamber can be used. For example, the small I.D. tubing (.026-inch) has a volume of 6.37 cubic inches per 1000 feet. The large I.D. tubing (.054-inch) has a volume of 27.48 cubic inches per 1000 feet or 4.3 times more. The larger I.D. tube will require that the down-hole chamber be 4.3 times larger than one used with the small I.D. tubing. At low pressures, say 10 to 510 psi which is a 500 psi change, a 10-foot concentric chamber will work with the small I.D. tubing 1000 feet deep, but a 43-foot concentric chamber would be required using the larger I.D. tube. The same 500 psi change between 2000 and 2500 psi would require only a 1-foot concentric chamber for either size tube.

The concentric chambers are made from a full joint of production tubing with an outer jacket welded to the joint of tubing. The jacket length is normally 25 feet long on a 30 foot joint of tubing. These chambers are made from J-55 and N-80 EUE 8rd. tubing and are available in most sizes of standard production tubing.

The .094" capillary tube is banded to the outside of the production tubing in the annulus. To date, the deepest installation made has been approximately 11,300 feet. The highest angle hole ran to date is 58° angle, 6000 feet deep, utilizing a new type collar tubing protector developed by Sperry-Sun.

There is no apparent depth or temperature limitations of the down-hole package. Installations have been made in geothermal wells up to 625°F., utilizing both types of down-hole chambers. Either down-hole package can be permanently installed for measuring B.H.P. in Rod Pump wells, gas storage wells, oil and gas wells, etc., where build-up and draw-down pressures, as well as long term dynamic pressure test at high temperatures are required.

The major problem area of using the Pressure Transmission System in geothermal wells the type material used in the capillary tube to withstand the high temperatures and hostile environments for prolonged periods of time. To date, we have used 304, 304L, 316, 316L, 321, and E-Brite 26-1 to make the capillary tube. The 300 Series metals lasted from as short as four (4) hours (304 and 321) to as long as one (1) year with the 304L, 316 and 316L. The E-Brite 26-1 material looked extremely good in the initial test of this metal, tubing was made with a .032" I.D. in a #2 temper. Failure of this tubing downhole occurred as short as 30 days after installation to as long as six (6) months from the twelve installation that were made. This tubing also failed from severe pit corrosion and chloride stress corrosion cracking. Additional problems were encountered in welding the strip material as the weld would start cracking as the tubing was pulled to the small .094" size.

At this time, we are evaluating several other materials to make tubing with, with primary emphasis on resistance to chloride stress corrosion cracking and pit corrosion, that has good welding characteristics and can be pulled in long lengths. Some of these materials are Carpenter 20, Monel 400, Inconel 625, and Incoloy alloy 825. A short length of tubing made from the Incoloy 825 is presently being tested in a laboratory now and will soon be installed in a geothermal well for evaluation.

The accuracy of the Pressure Transmission System has been proven in oil and gas wells and geothermal wells. However, when this system is to be installed in these high temperature wells, where there will be flowing and shut-in test, the use of Helium is recommended as the transmission media, as it is more stable than Nitrogen to the large average temperature changes that will occur.

The Pressure Transmission Surface Recorder is a precise measuring instrument which continuously displays psi gauge pressure in digital form and provides a paper tape print-out of pressure.
and delta time, at time print modes from 18 seconds to 30 minutes. A built-in battery pack is available so that no information will be lost in the event of an AC power failure. The standard pressure ranges are 0 - 1,000 PSI, 0 - 5,000 PSI, and 0 - 10,000 PSI. Other ranges are available special order. The accuracy is .05% of the full scale range of the sensing element. Sensitivity is .005% of the full scale range of the sensing element. Response time is 15 seconds for full scale transition, depending on the pressure range. The pressure sensing element utilized a Bourdon tube and a force-balance servo system in which the pressure system is combined with an electro-mechanical feedback system. The force developed by the Bourdon tube in response to an input pressure is matched by an equal force developed by a temperature-stable linear feedback spring which returns the system to a null (balanced) position. This eliminates losses in sensitivity and accuracy, commonly associated with conventional mechanical linkages, and limited sensing element-tip travel minimizes temperature and hysteresis effects.

A Digital Pressure Monitor that only displays pressure in digital form is also available. These units may also be used in place of dead weight testers, as they are more accurate, faster, and easier to read.

Additionally, these units may be used for calibrating pressure instruments in the laboratory or in the field, Process Control Instrumentation and Production Line Instrumentation.

Within the past two (2) years, another service has been developed and field proven. When the .054" I.D. tubing is used in the Pressure Transmission System to measure bottom-hole pressures, a chemical can be injected down the capillary tube to treat the wellbore fluids, near the perforations, as it rises in the production tubing. Less chemicals can be injected at the correct rate on a continued basis at the desired depth downhole for maximum efficiency of the well. When pressure data is again desired, the capillary tube is purged of the chemical by injecting a solvent to remove the chemical film on the inside of the tube and then injecting an inert gas (Nitrogen or Helium), to obtain the single phase gas system required. One thing to check is the temperature flash point of the chemical to be injected, as some chemicals have a low flash point and will tend to plug the tubing. When bottom-hole pressure is not desired, a chemical injection sub has been installed in the production string for continuous injection of chemicals. Field tests to date have been as deep as 10,400 feet. Injection rates using methanol of up to 50 gallons per day have been obtained in gas wells to keep the well from freezing up and shut-in, which has resulted in substantial increased production. Approximately 25 to 30 such systems have been installed to date.

Sperry-Sun has another precision subsurface pressure gauge. This gauge is widely used in the oil and gas industry. With an accuracy of .05% and sensitivity of .055% of the full-scale range of the sensing element, and at near calibration temperature, this gauge is ideally suited for draw-down test, build-up test, interference test, static test, gradient test, variable flow rate test, and drill stem test, to provide necessary information for a thorough analysis of any type reservoir.

This gauge has eight pressure sample rates, ranging from 15 seconds to 32 minutes, with a maximum sample time of twenty-eight (28) days, depending on temperature. This is a self-contained gauge and is a solid state electronic instrument that uses a Bourdon tube as the primary sensing gauge, but does not have a physical connection between the Bourdon tube and the recording section. The gauge is powered by batteries and has a temperature limitation based on the electronics and batteries available to the industry.

Sperry-Sun also provides gyroscopic single shot and multishot instruments for surveying cased holes in the oil and gas industry. Additional magnetic single shot and multishot instruments are available for surveying of uncased or open holes. When the magnetic instruments are run inside a thermal shield, records can be obtained in holes up to 600°F. for a shot duration of time, normally, 6 to 8 hours.

Sperry-Sun recently made a major breakthrough in the design of a gyroscopic directional instrument, utilizing a thermal shield, that is capable of surveying wells with temperatures up to 600°F. This instrument has been run in geothermal wells as deep as 10,000 feet successfully, surveying the cased and open holes.

In the oil and gas industry, a survey steering tool is available to monitor down-hole conditions when drilling with a mud motor in directional controlled holes. This tool is run on a conductor wireline and provides a continuous reading on the surface of toolface, (high side and magnetic) drift, directional bearing, and mud temperature above the mud motor.