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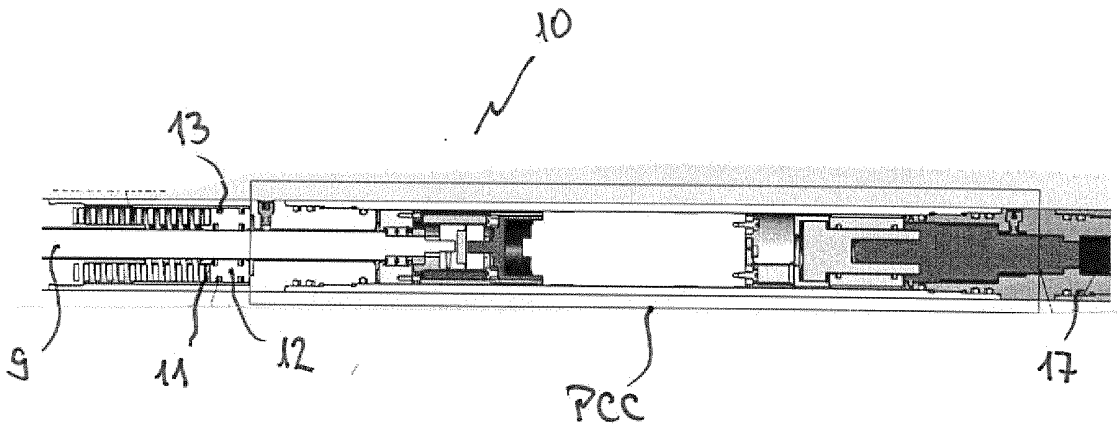
(54) MEASURING DEVICE

(57) A downhole device for measuring the fluid flow in a wellbore comprising a housing, a power supply, a motor control, a motor coupled to a spinner, viscosity, pressure and temperature measurement sensors, wherein a pressure compensation system comprising a spring means supported by a spring holder, a piston in contact with the spring, a pressure compensation fluid chamber and seals sealing the pressure compensation chamber against the piston.

Fig. 3



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Description

[0001] The invention relates to a downhole device for measuring the fluid flow in a wellbore comprising a housing, a power supply, a motor control, a motor coupled to a spinner and sensors for measuring the viscosity, pressure and temperature of a fluid.

[0002] The evaluation of fluid flows within a well bore is a frequently encountered problem in the oil and gas production industry. There are a number of different flow regimes including multi-phase fluid flows. Factors influencing the flow regimes can include a degree of borehole deviation and proportion of the phases, relative differences in phase densities, surface tension and viscosity of the phases as well as velocity, pressure and temperature.

[0003] Understanding the fluid flow regime in a well may be used to understand the performance of a production well. A production log records one or more in-situ measurements that describe the nature and behavior of fluids in or around the borehole during a production operation, including an injection operation. Production logs can provide for example information about dynamic well performance and the productivity or injectivity of different zones. This information may be used to help diagnose problem wells or monitor the results of a stimulation or completion.

[0004] Characterization of a fluid flow especially in horizontal wells is very uncertain. Normally, flow rates are measured by means of a conventional spinner, and fluid velocity is highly dependent on conventional spinner survey. Unfortunately, spinners have a lot of limitations especially in heavy viscous fluids, low rate environments and turbulent flow.

[0005] It is an object of the invention to provide a downhole device that is designed to obtain reliable data on the fluid flow within a wellbore. The device must be able to adapt to the pressure and temperature regime within the well and be able to obtain data when the well is flowing or shut.

[0006] The object is met with a device as addressed above, which is equipped with a pressure compensation system comprising a spring means supported by a spring holder, a piston in contact with the spring means, a pressure compensation fluid chamber and seals sealing the pressure compensation chamber against the piston.

[0007] The device of the invention comprises at least one sensor each for measuring relevant data within the well. Relevant data are in particular data on the fluid viscosity, pressure and temperature. The sensors are preferably arranged in the form of a tool string.

[0008] Besides the flow data obtained by the spinner, most important are the pressure and viscosity data. The measuring module is equipped with at least one viscosity sensor and preferably more than one pressure sensor in order to register pressure differences. Two pressure and two temperature sensors are preferred.

[0009] For differential pressure measurement, the sensors are mounted at a distance. Preferably, one pressure sensor is in or close to the spinner head and the other one at or close to the tail of the device. The same holds for the temperature sensors.

[0010] In order to obtain reliable data, it is important to have a pressure compensated system. Only with this compensation, the sensors and electronic elements will provide data that allow the precise prediction of a production rate, besides the data from the spinner.

[0011] The pressure compensation system is needed when the inside and the outside pressure are different along the downhole tool. The pressure compensation system is designed to create the pressure balance between the inside and outside of the tool in order to avoid a pressure difference that may cause leakage.

[0012] When positioning the tool downhole, the ambient temperature will increase dramatically. This will also increase the temperature of the pressure compensation fluid inside the chamber. The pressure compensation fluid normally is an oil, e.g. a combustion oil. The volume of the fluid will expand with the temperature increase. The expanded oil will exert a pressure on to the piston within the pressure compensation system. When the oil pressure within the system is higher than the outside pressure and the pressure supplied to the piston is big enough to compress the spring, the oil moves the piston against the spring. When the oil is fully expanded, the piston will stop moving, thus acting as a pressure release valve. At this time, the pressure inside the pressure compensation chamber will equal the outside pressure. Pressure balance is reached.

[0013] The pressure compensation system provides a means to compensate for pressure and temperature changes within and outside the device. Predominantly the pressure compensation system is needed when moving the device downhole to the location of its operation and when tripping out the tool from the well. The system provides for constant and reproducible conditions within the device. This allows the system to produce reliable data with its sensors.

[0014] The downhole device of the invention generally consists of a tube-like housing, which is more or less conventional, a power supply, a motor coupled to a conventional spinner, at least one sensor, and the pressure compensation system. The housing is an elongate tube having the spinner at its head and a plug at its tail and the working elements inside. There is a power supply, which normally is a battery, but can also be an electrical cable reaching downhole. The battery provides power to a motor for driving the spinner in the head section. At least part of the sensors are arranged in the head section. Preferably, the device is equipped with phased pressure and temperature sensors.

[0015] The pressure compensation system comprises a spring means, preferably a compression spring, which is supported by a spring holder. In addition, there may be a spring guide attached to the spring holder which guides the

longitudinal extension and compression of the spring. The spring, at it's other end, faces a piston, which is movably arranged within a ceramic sleeve. The piston comprises a sealing system made up by O-rings and for U-cup rings providing a seal between the distant body and the sleeve. The sealing rings seal the adjacent pressure compensation fluid chamber against the piston. The chamber itself is also sealed to the head section of the device by means of sealing rings, preferably O-rings.

[0016] For filling the chamber with the pressure compensation fluid, normally an oil, there is a filling port arranged at the wall of the housing.

[0017] The invention is further illustrated by the attached drawings. In the drawings

Fig. 1: shows a device of the invention;

Fig. 2: is a sectional drawing of the device of Fig. 1;

Fig. 3: shows the pressure compensation system of the device of Fig. 1 and 2; and

Fig. 4: shows an enlarged drawing of the spring/piston section of Fig. 3.

[0018] Figure 1 is a drawing of the inventive device (1) with the housing (2), the spinner head (3) and the sealing plug (4) at the tail.

[0019] Figure 2 is a sectional view of the device of fig. 1. The device is divided into two parts, the battery section B housing the battery (5) and the motor section M housing the motor control (6), the motor (7), the piston chamber (8) and the spinner head (3). A battery connector (BC) isolates the battery section from the motor section. In case of any leakage in the battery section the main module will not be effected. A motor connector MC forms the isolating part between the motor and the electronic elements. The motor connector separates the high pressure section (motor and spinner) from the electronics.

[0020] Figure 3 is a sectional view of the pressure control system (10) with a central driving shaft (9) and a compression spring (11) arranged around the driving shaft (9). The compression spring supports a piston (12) also enclosing the driving shaft (9) with sealing rings (13). Adjacent to the spring/piston combination (11/12) is a pressure compensation chamber PCC, which is sealed against the piston (12).

[0021] Figure 4 gives details of the spring/piston arrangement of fig. 3. The spring (11) arranged around the driving shaft (9) is supported by the spring holder (16) which extends along the driving shaft (9) as a guide of the spring (11). The spring (11) ends at the piston (12) which itself is movable along the driving shaft (9) in a longitudinal direction of the device. Sealing rings (13) in form of U-cup seals provide sealing against a ceramic sleeve (18) and the driving shaft (9).

[0022] Adjacent to the piston is the pressure compensation chamber (15) which in operation is filled with an oil, e.g. a normal combustion oil. The chamber has a filling port (14), which also has a valve function. Sealing rings (17) provide tightness against housing elements.

[0023] A temperature rise in the pressure compensation chamber PCC results in an expansion of the oil, which drives the piston (12) in direction of the device tail. At the same time, compression spring (11) is compressed, until a pressure equilibrium is reached. On the other hand, in case of a temperature drop, e.g. when the device is retrieved from a well bore, the spring expands to compensate for the diminishing volume of the cooling oil in the chamber.

[0024] The ceramic sleeve (18) guiding the piston (12) is pre-bonded onto the piston housing. It provides less friction on the seal rings than the piston housing and is easy to be replaced in case of damage. The U-cup seals are selected because they have better sealing performance in the dynamic application comparing to regular O-rings.

[0025] The device of the invention is designed to help the interpretation of fluid flow and to give more reliable data on the flow rate. The pressure and viscosity data may be used according to the following calculations.

[0026] Calculations:

$$Q = \frac{KA\Delta P}{\mu L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

[0027] In wellbore,

$$C = \frac{KA}{L} \ldots\ldots\ldots\ldots\ldots (2)$$

$$Q = \frac{c\Delta p}{\mu} \qquad (3)$$

[0028] Where,

Q: Rates Index, cm3
K: Permeability, D
A: Cross sectional area of wellbore or production casing, cm2
L: Length between sensors, cm
μ: Viscosity, cp
C: Constant
P: Pressure

[0029] The data obtained by the viscosity and pressure measurements are regularly more precise than the data obtained by a regular spinner measurements.

Claims

1. A downhole device for measuring the fluid flow in a wellbore comprising a housing, a power supply, a motor control, a motor coupled to a spinner and viscosity, pressure and temperature measurement sensors, **characterized by** a pressure compensation system comprising a spring means supported by a spring holder, a piston in contact with the spring means, a pressure compensation fluid chamber and seals sealing the pressure compensation chamber against the piston.

2. The device of claim 1, wherein the power supply is a battery.

3. The device of claim 1 or 2, wherein the spring means is a compression spring.

4. The device of claim 3, wherein the spring means his mounted on and guided by a spring holder.

5. The device of anyone of the preceeding claims, wherein the piston is a guided within a ceramic sleeve.

6. The device of claim 5, wherein the seals sealing the pressure compensation fluid chamber against the piston are mounted on the piston.

7. The device of anyone of the preceeding claims, wherein the seals are O-rings.

8. The device of claim 7, wherein the seals are U-cup rings.

9. The device of anyone of the preceeding claims, wherein the pressure compensation fluid chamber has a filling port.

10. The device of anyone of the preceeding claims comprising two pressure and two and two temperature sensors allowing differential measurements.

11. The device of anyone of the preceeding claims comprising flow rate and flow velocity sensors.

12. The device of anyone of the preceeding claims further comprising means for data storage and/or wireless data transmission.

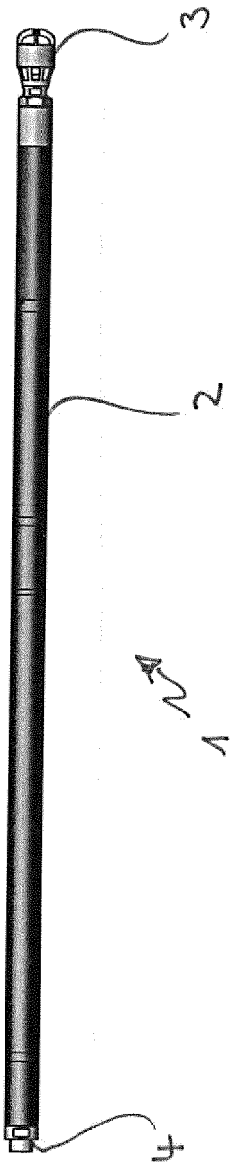

Fig. 1

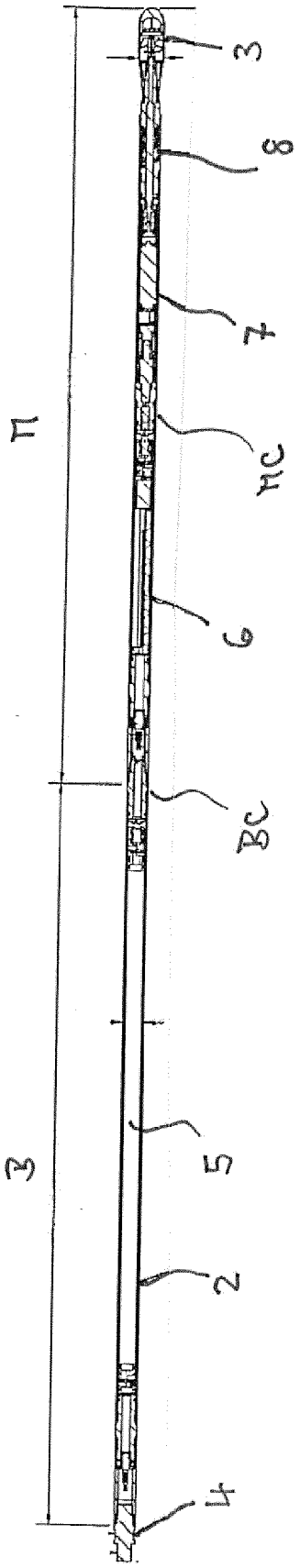

Fig. 2

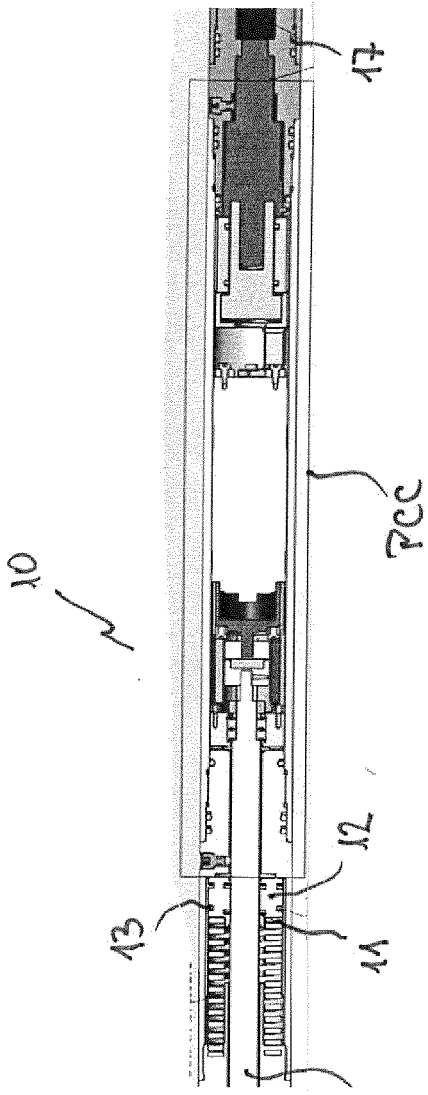

Fig.3

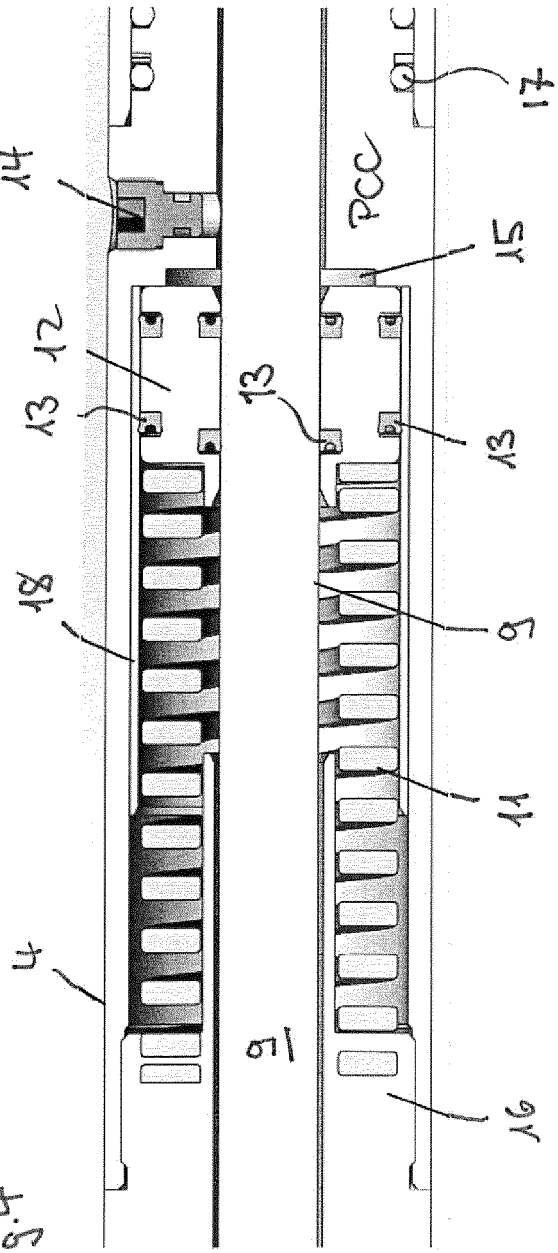

Fig.4

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EUROPEAN SEARCH REPORT

Application Number
EP 15 16 7011

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2008/190605 A1 (CLAPP TIMOTHY DALE [US] ET AL) 14 August 2008 (2008-08-14) * abstract * * figures 3A-K * * paragraphs [0016], [0068], [0056], [0034] - [0036], [0061], [0065] *	1-12	INV. E21B47/10
X	GB 2 460 533 A (WEATHERFORD LAMB [US]) 9 December 2009 (2009-12-09) * abstract * * page 25, paragraph 4 - page 26, paragraph 1; figures 10a-k * * page 45, paragraph 2; figure 15C *	1-12	

TECHNICAL FIELDS SEARCHED (IPC)

E21B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 October 2015	Wehland, Florian

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 15 16 7011

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