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Downhole equipment for petroleum and natural gas industries — Progressing cavity pump systems for artificial lift —

Part 1: **Pumps**

Équipement de fond de trou pour les industries du pétrole et du gaz naturel — Pompes de fond à cavité progressive pour activation des puits —

Partie 1: Pompes

Reference number
ISO 15136-1:2001(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 15136 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15136-1 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC4, *Drilling and production equipment*.

ISO 15136 consists of the following parts, under the general title *Downhole equipment for petroleum and natural gas industries — Progressing cavity pump systems for artificial lift*:

— *Part 1: Pumps*

— *Part 2: Drive heads*

Annexes A and B form a normative part of this part of ISO 15136. Annexes C, D, E and F are for information only.

Introduction

This part of ISO 15136 has been developed by users/purchasers and suppliers/manufacturers of progressing cavity pumps (PCP) for artificial lift use in the petroleum and natural gas industries worldwide. This part of ISO 15136 is intended to give requirements and information to both parties in the selection, manufacture, testing and use of progressing cavity pumps. Further, this part of ISO 15136 addresses supplier/manufacturer requirements, which set the minimum parameters with which suppliers/manufacturers must comply to claim conformity with this part of ISO 15136.

A progressing cavity pump comprises two helical gears, one rotating inside the other. The stator and rotor axes are parallel and spaced between each other. The external helical gear (stator) has one more thread (or tooth) than the internal helical gear (rotor). Whatever the number of threads of the two elements, they must always differ by one. The fluid moves from suction to discharge. The discharge and the suction are always isolated from each other by a constant length seal line. Definitions of the accessories, engineering methodology and description of the PCP system, including illustrations, are provided in annexes D, E and F respectively.

Users of this part of ISO 15136 should be aware that further or differing requirements might be needed for individual applications. This part of ISO 15136 is not intended to inhibit a supplier/manufacturer from offering, or the user/purchaser from accepting, alternative equipment or engineering solutions. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the supplier/manufacturer should identify any variations from this part of ISO 15136 and provide details.

Downhole equipment for petroleum and natural gas industries — Progressing cavity pump systems for artificial lift —

Part 1: **Pumps**

1 Scope

This part of ISO 15136 provides guidelines and requirements for subsurface progressing cavity pumps (PCP) used in the petroleum and natural gas industries for the production of single and multiphase fluids, based on the principle defined in [2].

This part of ISO 15136 is applicable to the subsurface progressing cavity pump. It refers to, but is not applicable to, intermediate components and accessories that are necessary to make a complete pumping unit. It does not include requirements for shipping, loading and transportation.

2 Terms and definitions

For the purposes of this part of ISO 15136, the following terms and definitions apply (for illustration, see annexes D, E and F).

2.1
cavity
lenticular, spiral, separate volume created between the pump stator and rotor when they are assembled

2.2
displacement
volume of fluid pumped in one revolution of the rotor in the stator

2.3
drive string
device transmitting power (usually sucker rods) between the drivehead and the PCP

2.4
dynamic level
fluid level under standard conditions of temperature and pressure when the PCP is in operation

NOTE Standard conditions, unless otherwise indicated, are 15 °C and 0,101 3 MPa.

2.5
flowrate
volume of fluid pumped per time unit

2.6
head rating
maximum allowable differential pressure of the PCP

2.7
helix
continuous spiral with a constant pitch

2.8
insert pump
pump whose stator is inserted into the tubing using the drive string

2.9
interference
radial fit between the pump rotor and stator

2.10
pitch length
distance between two crests belonging to the same seal line

NOTE The rotor and stator have different pitch lengths, p_r and p_s respectively (see Figures E.1, E.2 and F.1).

2.11
PCP
progressing cavity pump
pump consisting of a stator and a rotor whose geometry of assembly is such that it creates two or more series of lenticular, spiral, separate cavities

2.12
rotor
pump shaft, whose external surface is in the form of a single or multiple helix, provided with a connection to attach to the drive string

2.13
rotor stop
device which determines the rotor position during PCP installation

See Figure D.1.

2.14
seal line
helix formed by the line of contact between rotor and stator

2.15
slippage
fluid leakage occurring across the dynamic seal lines between the cavities

2.16
static level
stabilized fluid level under standard conditions of temperature and pressure when the PCP is at a stopped position

NOTE Standard conditions, unless otherwise indicated, are 15 °C and 0,101 3 MPa.

2.17
stator
housing and a lining (typically elastomeric) in the form of a double or multiple internal helix, which always has one more helix than the rotor, with a connection to the production tubing

2.18
submergence
difference between the dynamic level and the PCP setting depth

2.19
tubing-conveyed pump
pump whose stator is connected to the bottom of the tubing

3 Symbols

d_r rotor minor diameter, i.e. the diameter of the circle tangent to the inner rotor lobes

D_r rotor major diameter, i.e. the diameter of the circle tangent to the outer rotor lobes

d_s stator minor diameter, i.e. the diameter of the circle tangent to the inner stator lobes

D_s stator major diameter, i.e. the diameter of the circle tangent to the outer stator lobes

P_r rotor pitch length

P_s stator pitch length

n_r number of rotor lobes

N pump revolutions per minute

For illustration, see Figures E.1, E.2 and E.3.

4 Functional specification

4.1 General

The user/purchaser shall prepare a functional specification to order products which conform with this part of ISO 15136 in which the requirements and operating conditions listed in 4.2 to 4.6, as appropriate, and/or the supplier's/manufacturer's specific product (see example of data form in annex C) shall be specified.

These requirements and operating conditions may be conveyed by means of a dimensional drawing, data sheet or other suitable documentation.

4.2 PCP type

— Tubing-conveyed;

— insert PCP.

4.3 Well parameters

— Sizes, grades, mass, thread of casing, liner, tubing;

— depth (true vertical and measured);

— perforation intervals (true vertical and measured);

— deviation survey;

— packer, anchor data, landing nipple or other restriction if any.

4.4 Operational parameters

- PCP setting depth;
- current production system and rate;
- planned production rate;
- static and dynamic fluid level; or
  - static level and productivity index; or
  - dynamic fluid level and bottomhole pressure;
- normal producing tubing and casing pressures;
- required wellhead pressure;
- chemical treatments;
- well monitoring and alarm points.

4.5 Environmental compatibility

- Specific gravity of oil and water;
- oil/emulsion viscosity;
- bubble point;
- production gas/oil ratio;
- water cut;
- mole fraction (as a percent) of aromatic solvents, (i.e. benzene, toluene and xylenes);
- gas specific gravity;
- mole fraction (as a percent) of H_2S and CO_2;
- solids content (i.e. type, size, shape and concentration);
- corrosive agents, (i.e. type and concentration);
- PCP inlet temperature or reservoir temperature and temperature gradient;
- wellhead temperature range;
- pH;
- completion fluid characteristics;
- rotor material, plating/coating material;
- elastomer material.

4.6 Compatibility with well equipment

- Tubing threads or insert size;
- wellhead connection;
- drive string (type, size, properties and connection);
- power source;
- electrical supply (voltage, frequency, zone classification);
- ambient temperature (minimum, maximum).

4.7 Quality control requirements

Quality control requirements may be specified by the user/purchaser.

4.8 Design validation documentation

User/purchaser may request performance curve and test report, as per annex A and annex B.

5 Technical specification

5.1 General

The aspects in 5.2 to 5.7 shall be considered in the design/application of a PCP system (see annex C).

5.2 PCP characteristics

Physical dimensions can limit the selection of a PCP.

The stator shall:

- be able to pass through the casing and all other devices which are part of the casing string;
- allow annular space for tools, i.e. over-shot or wash pipe;
- allow annular space for gas separation;
- allow annular space for fluid passage, if the PCP is landed below perforations.

The rotor shall be able to pass through the tubing and all other devices which are part of the tubing string.

A sufficiently large inside diameter shall be provided in the tubing to allow for the eccentric movement of the rotor. If the tubing inside diameter is not large enough, a transition length of tubing (or pup joint) having an acceptable inside diameter shall be placed immediately above the stator (see Figure D.2).

5.3 Design criteria

5.3.1 Head requirements

The differential pressure across the PCP should not exceed the head rating of the PCP, as efficiency will be affected and could result in premature wear on components.

The differential pressure is the sum of the following, taking into consideration gas and different liquid densities:

- the head of fluid in the tubing minus the head of fluid in the annulus at the PCP inlet;
- the frictional loss in the tubing between the PCP outlet and the wellhead, which is a function of:
  - inside diameter of the tubing;
  - outside diameter of the drive string;
  - pressure drop across restrictions such as couplings and centralizers;
  - viscosity and velocity of the fluid.
- the flowline back-pressure.

5.3.2 Volume requirements

The PCP shall be capable of displacing the volume required per revolution at the anticipated head within the speed limitations mentioned in 5.3.3.6. Volume requirements should consider the presence of free gas, transport of solids and PCP cooling.

5.3.3 Materials

5.3.3.1 Thermal effect — Elastomers

Wellbore temperature and fluid characteristics shall be considered for each application.

The PCP operating temperature may cause thermal expansion of the elastomer. Elastomer expansion will result in reduction of the internal stator diameter. Therefore, the rotor shall be sized to accommodate for this reduction to ensure appropriate interference fit.

The maximum operating temperature of the PCP shall be below the maximum rated working temperature of the elastomer published by the manufacturer.

The PCP operating temperature is influenced by:

- fluid temperature around the PCP;
- friction effect due to interference, rotating speed and differential pressure;
- elastic deformation;
- gas compression;
- fluid lubricity;
- heat transfer effects.

5.3.3.2 Chemical effects — Elastomers

Detrimental effects on elastomers, such as swelling and hardening, can be caused by chemicals, aromatic solvents (i.e. benzene, toluene and xylenes), napthenes and water. Rotor/stator sizing shall be adjusted accordingly.

Where chemical treatments are anticipated, caution shall be exercised in the selection of materials.

