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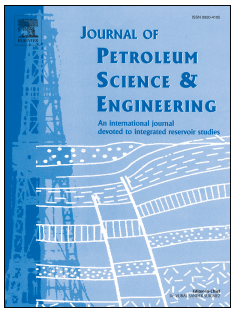

Calculation for cross section and area efficiency of progressing cavity pump with hypotrochoidal multilobe using the differential geometric envelope approach

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Calculation for cross section and area efficiency of progressing cavity pump with hypotrochoidal multilobe using the differential geometric envelope approach

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Abstract

Now progressing cavity pumps (PCPs) and downhole mud-motors (DHMs) with cycloidal profiles are widely used in oil and gas industry. This study presents the method to design the cross section of PCP or DHM with hypotrochoidal multilobe.

The conditions for conjugate envelope of hypotrochoidal rotor were derived by using the differential geometric approach. On the basis of this, we made the formulae for the envelope and its offset curve and worked to calculate the area efficiency of cross section and curvature of hypotrochoid. The field of trochoid ratio and offset distance were selected to get the rational offset curve. These results enable to design the cross section of PCP or DHM with multilobe of hypotrochoid which has the continuous and limited curvature.

These results also can be used for multilobe PCP or DHM with solid stator.

Keywords;

progressing cavity pump; PCP; DHM; Envelope; Hypotrochoid; Differential geometry

1. Introduction

Progressing Cavity Pump (PCP) and downhole mud motor (DHM) are widely used in drilling and production of oil and gas. French Rene'Moineau (Moineau, 1930) developed the concept for a series of helical gear pumps in late 1920's and devised PCP in early 1930's. PCP was not used for oil and gas industry until the late 1970's. PCP is used to transfer not only viscous heavy oil but also multiphase fluid containing solids and gas. PCP is the rotary pump similar to the motion mechanism of the positive displacement pump and is able to pump liquid uniformly without pulsation. PCP has a rotor/stator pair. The stator always has one more lobe than rotor. PCP is based on the principle which discrete sealed cavities helically progress toward axis of rotation in contact of rotor and stator (Cholet, 1997). The rotor rotates with eccentricity in stator and the whirling motion of the rotor center is the nutational motion around the center of a stator (L.Nelik and J. Brennan, 2005). While cavities are in helical progressing, sealing between stator and rotor must be enough tight so that the fluid in cavities could not easily leak out under the outlet pressure. The geometric design of cross section of PCP is important for above mentioned demands. The geometric studies of PCPs have been done on any one cross section. Niels Aage et al., 2006 proved theorem which the motion of rotor in stator could be completely determined by the motion in one cross section. The traditional profile of multilobe PCP or DHM is the isometric cycloid (Robles, J., 2001). Tan Nguyen et al., 2014 presented the universal mathematical model to calculate the pump factor for multilobe PCP by using 3-D vector approach and the Hypocycloid theory. There are