Applications of linear permanent magnet actuators in offshore applications

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Abstract: - This paper mainly describes the research concepts and application possibilities in replacing the linear hydraulic and pneumatic devices with linear permanent magnet actuators, especially in offshore field. With the recent rapid progress in permanent magnet technologies, a range of compact, flexible and high performance linear actuators are available for many applications. But even now the hydraulic devices take the major lead in many application areas where the requirement of high power density and reliability needed. To overcome the difficulty of achieving high power from linear actuators alone, a concept of double gas spring is introduced. This presentation mainly focuses on the summarizing the application areas that are suitable for replacing hydraulic devices with linear permanent actuator based on gas spring concepts.

Key-Words: - Linear actuator, offshore applications, permanent magnet, gas springs

1 Introduction

A linear electric actuator is an electromagnetic device which develops directly short travel oscillatory or progressive linear motion. These devices would be advantageous in many applications like compressors, pumps, electromagnetic valve actuators, active shock absorbers, vibrators etc. In extension to these applications the oscillatory motion of linear electrical actuator can be effectively utilized in more demanding offshore oil industry drilling applications, wire line jar applications and also in wave power generation.

2 Applications

2.1 Drilling

Even though the rotary steerable systems are evolving rapidly and delivering unprecedented rates of drilling penetration, drillers nevertheless seek technology that speeds the drilling process even more. The operational view of linear permanent actuator in drilling application is shown in Fig.1. The design is unique because of the combination of a heavy piston and gas springs. The gas springs allow the piston to oscillate at high frequency and with a long stroke length, in spite of the pistons large weight. A large electromagnetic force, due to the use of permanent magnets makes a high power linear electric actuator available. The heavy piston causes a considerable vibration in the housing which is utilized in the drilling application. The load can then be attached directly to the housing and the machine can be made hermitically sealed, which eliminate leakage problems. These features make the actuator suitable as a hammer in oil drilling applications [1].

Fig.1. Operational view of linear actuator in drilling

2.2 Wireline jar applications

Today there is a wide variety of jarring and stroke tools available to pull the struck objects in the oil wells [2][3]. Most of the available techniques use one heavy stroke or a straight pull in freeing the stuck
tool. The concept of integration of gas springs with linear actuator makes strong vibrations. These vibrations can be effectively utilised to remove the stuck objects in deep wells. In this case the operation of actuator is same as drilling applications except the direction force applied. This device can be used in both horizontal and vertical wells for jarring operations. The operational view of wire line jar application in wells is shown in Fig.2.

![Operational view of linear actuator in wire line jar application](image1.png)

**Fig.1.** Operational view of linear actuator in wire line jar application

### 2.3 Wave power generation

Power potential of ocean wave power plant is very large due to high buoyancy force. A linear electric generator which converts this slow moment high force ocean wave energy into electrical energy by direct conversion [4] (piston in the generator is moving in the same way as the float) will never be cost effective due to its large size and expensive. The slow movement (low frequency) of the ocean energy wave must be converted into a faster movement (high frequency) to reduce the size of the generator. The conversion of low frequency ocean wave energy to high frequency is not possible with normal gear due to high force or compressing and decompressing fluid due to introduction of high energy loss. This conversion is possible by introducing the double gas spring on both sides of the linear machine as shown in Fig.3. The slow moving piston connected to the float compresses and decompresses the volume where the secondary piston (linear electric machine piston) containing magnets oscillate with high frequency.

![Simple view of linear actuator in wave power extraction](image2.png)

**Fig.3.** Simple view of linear actuator in wave power extraction

### 2.4 Marine applications

Small power linear hydraulic actuation systems used in elevators, hanger doors, winches, pumps, valve operations etc. in marine applications are not efficient, they are heavy, noisy, inefficient, require continuous maintenance and they consumes considerable amount of space. Due to the recent developments and availability of high strength permanent magnets, gave the possibility to replace the available hydraulic and pneumatic systems with compact and flexible linear electrical actuators to reduce weight and consumed space and to get quick accelerations.

### 3 Conclusion

Different possible applications of linear permanent magnet actuator in offshore areas are presented. Mainly this paper focuses on applications of linear actuators with gas springs in more demanding oil drilling applications, wire line jar applications. This actuator with gas springs can also be utilised as a frequency converter in ocean wave power extraction to convert low speed, high force power to high speed low force power. This presentation mainly summarizing the application areas that are suitable for replacing hydraulic devices with linear permanent actuator based on gas spring concepts.

### References:


[2] [http://www.petrotools.no](http://www.petrotools.no)