Abstracts

Group 3: Fluid Power in Specific Applications

3-0 Power Transmissions for Wave Energy Converters: a Review

A. Plummer, C. Cargo

Ocean wave power is a huge, largely untapped energy resource, and is considered a viable option for future renewable energy generation by many nations. This review describes the state-of-the-art for devices and systems designed to convert wave energy to electrical energy, focusing on the transmission of wave interface motion to generator motion. Hydraulic power take-offs (PTOs) are often preferred, and hydraulic circuit design options are described. The PTO design needs to be closely linked to the control strategy employed to maximize energy capture. The interaction between the wave interface, the PTO, and the electrical generator creates a complex dynamic system and thus design optimization is difficult. This is further hampered by a lack of experimental data due to the size and cost of land-based test rigs, and the fragility of prototypes in sea-based trials.

3-1 Dynamic Analysis and Measurement of Hydrostatic Transmission for Wind Turbines

J. Schmitz, N. Vatheuer, H. Murrenhoff

Within the scope of a current research project a hydrostatic transmission for wind turbines is being developed at IFAS. In this paper, two different strategies to control a hydrostatic transmission in wind turbines are presented and discussed. Main criteria are the optimal adaption of the system to the current wind situation and at the same time the reduction of loads on the system. In the second part of the paper the two strategies are analysed on a test bench. Therefore three different types of loads are applied considering the behaviour of the controller and the drive train. It can be proven that a torque based controller has the ability to adjust the rotation speed and at the same time reduce peak loads on the drive train. In an outlook, the next steps on the way into a pilot plant are described.

3-2 Oyster- Wave Energy Power Plants: A new Challenge for Hydraulic Cylinders

I. Rühlicke, M. Haag

A very efficient method to use wave energy in close to shore sea areas is the use of the powerful horizontal movement of the waves. The Oyster wave energy power plant is installed on the sea bed and has a vertical installed flap of 12 m x 26 m which is driven forwards and backwards by the horizontal wave movement. Two hydraulic cylinders, connected to the tilting flap, pump water based hydraulic fluid via pipelines to an onshore installed Pelton turbine – generator unit with a design capacity of 800 kW.
For the hydraulic cylinders it is a very special challenge to permanently move in an underwater environment by using water based hydraulic fluid. The aspired 25 million cycles between the planned services represent very well the high requirements to the reliability of the whole system. To qualify the cylinder design to these requirements modified seal and bearing elements, the Hunger Ultraplate offshore rod coating and an inner barrel corrosion protection by a stainless steel liner were used. Parallel to the design and production phase a test rig for the seal and bearing elements was build and ran over millions of cycles to test the reliability and lifespan of the seals under simulated operation conditions.

3-3 Hydraulic Power Take-off Design for an Axi-symmatric Heaving Point Absorber

K. Schlemmer, F. Fuchshumer, C. Villegas, N. Böhmer

The FP7 'STANDPOINT' project aims to establish the axi-symmetric, self-reacting point absorber device as a viable standard approach to harvesting wave energy. In this context, the power take-off (PTO) system needs to combine survivability under extreme weather conditions and efficient, continuous power production. A hydraulic PTO system is proposed which provides means of energy storage and smoothing to decouple power output and input. A modular, maintainable and adaptable circuit design enables high efficiency of the energy conversion. Through optimisation of component layout and sizing, an appropriate compromise is found between installation space and costs on one side and the capability of harvesting power peaks on the other side. For this purpose, a combined dynamic model of the wave energy converter (WEC) system has been developed and simulated for typical sea conditions of the Portuguese test site. Simulation results have validated the viability of the hydraulic PTO design.

3-4 Hydraulic Pitch Control Technology for Tidal Current Turbine

H. Liu, W. Li, Y. Lin, M. Shi, S. Ma

Tidal energy is potentially a large renewable energy, which can be harnessed for electricity generation by a tidal current turbine. A pitch control mechanism is necessary for a horizontal axis tidal current turbine to work in bidirectional tidal current and keep the output power constant at above rated velocity. In this paper, a hydraulic pitch control system and the pitch actuator are designed and the performance of them are studied. The simulation results and experiment results testified that the designed hydraulic pitch control system could satisfy the requests of the tidal current turbine.

3-5 Adaptive hydraulic transmission for small power wind turbine

D. Călăraşu, C. Chiriţă, P. Drumea, B. Ciobanu

Hydraulic transmission of eolian energy to the ground is a research direction that we found in R-D programs related to renewable energy. Hydraulic transmission and driving included in the eolian plant has all the advantages of hydraulic driving. Small power horizontal-axis wind turbines equipped with adaptive hydraulic transmissions can operate at variable speed. The adaptive hydraulic transmission allows adjustment of the outlet to the consumer demands (power or constant speed), without affecting the performance of the turbine. Adaptive hydraulic transmission requires a constant speed of the motor shaft during variations in pump speed at the hydraulic motor shaft. For the cases analyzed, it is found that the adaptive hydraulic transmission behaves like a stable system of damped oscillatory type with good dynamic performance. The proper tuning of the regulator leads to an improved unit step response. The paper present the experimental testing stand concept, numerical simulation results and experimental data. The socio-economic impact of implementing small power wind turbines can be amplified by the fact that nearly half of the country’s population lives in rural areas. These turbines are designed specifically for these rural areas.