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Dynamics of HRWEC wave energy device and development of a novel power take-off (PTO) system

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Abstract. This presentation discusses a flap-type wave energy device known as the Hull Reservoir Wave Energy Converter (HRWEC), along with a potential secondary power takeoff concept that is currently under investigation. First, the HRWEC concept and the hydrodynamics of the device are explained. The HRWEC is kind of hybrid concept of the Pendulum Wave Energy Converter (PeWEC) and the Pendulor wave energy converter. It mainly consists of a floating reservoir (Hull) with a top-hinged flap that hangs inside it. The motion of the flap is activated by both the movement of the float and the fluid motion within the reservoir. Power takeoff occurs through the relative motion between the flap and the float. Because the HRWEC closely resembles the PeWEC, a similar float design is utilised to enable comparison with existing data. The dynamics and power capture are analysed using a frequency-domain model, and power capture is maximised for damping-only control of regular waves. This new concept exhibits a broadband response, attributed to an additional mode generated by the internal water body motion. Consequently, the HRWEC is expected to be a suitable candidate for applications in diverse wave climatic conditions. Secondly, the presentation introduces a novel concept for a power takeoff (PTO) system. It proposes a new slipper bearing design for a wobble plate axial piston pump, specifically targeting extremely slow-speed conditions typical of PTO systems in ocean wave energy converters. Until now, research on slipper bearings has primarily focused on single land and grooved slipper designs for conventional applications. This study compares the characteristics of a new pocket slipper design (called thrust control pools) with conventional designs through analytical methods and a series of Computational Fluid Dynamics (CFD) simulations. To validate the current methodology, existing conventional designs are reevaluated, yielding good agreement with previous findings. This analysis suggests that the new pocket slipper exhibits promising performance compared to traditional designs for applications that require extremely slow speeds.