

# International Journal of Fluid Power

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## **AIMS AND SCOPE**

*International Journal of Fluid Power* is dedicated entirely to the full range of science and technology associated with hydraulics and pneumatics. The objective of the journal is to provide the engineering community with high quality information about advances in research, design and application of fluid power technology. Special emphasis will be placed on presenting papers concerned with component and system development, analysis, modelling and control of components and systems, monitoring, computer aided engineering methods and dynamic analysis of fluid power systems.

The scientific integrity of the journal is maintained by an International Editorial Board of leading experts and by the review of all papers by at least two and sometimes three peers.

The journal will be published quarterly starting with two issues in 2000.

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# STEADY STATE AND DYNAMIC CHARACTERISTICS OF WATER HYDRAULIC PROPORTIONAL CERAMIC SPOOL VALVE

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## SYNOPSIS

Water hydraulics is both old and new technology area. The first fluid power applications were using water as pressure medium already in 1800-century, but the modern water hydraulics has been rapidly growing just recently in 1980's and 1990's. The main reasons for the comeback are environmental and safety aspects. Water hydraulics offers a significant alternative to establish motion control systems in environments, where possible oil leakages can cause serious problems.

One of the major tasks to solve in modern water hydraulics is to achieve more accurate control systems that today's technology enables. The present water hydraulic control valves are not yet in same technology level than in oil hydraulics. This means that a lot of effort has to be put to develop better and more accurate valve constructions and on the other hand more intelligent control methods has to be developed to achieve reasonable valve characteristics.

This paper concentrates to study water hydraulic proportional valves, which are still very new developments in water hydraulics. The steady state and dynamic characteristics of water hydraulic proportional ceramic spool valve is studied both by computer simulation and laboratory tests. Some constructional improvements for the valves are studied and also different control methods are discussed and proposed.

**Key words:** Proportional valves, Water hydraulics, Fluid power

## STATIONARY AXIAL FLOW FORCES ANALYSIS ON COMPENSATED SPOOL VALVES

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## SYNOPSIS

The paper deals with the application of a simplified numerical analysis, based on Computational Fluid Dynamics (CFD), of the flow field inside the compensated port connections of a reference spool valve. The aim of the study was the evaluation of the proposed analysis procedure, to put in evidence the major effects related to the presence of steady state flow forces affecting the spool equilibrium. Starting from an initial summary of the dimensional analysis proposed by the authors to approach the application of CFD to hydraulic components, the paper presents the results of three commonly used compensating profiles for two reference spool positions. In order to validate the simulation, the curves obtained for one of the three geometries are compared with the experimental data obtained on an equivalent port connection of a commercial distributor.

**Key words:** CFD Simulation, compensated spool valves, steady state flow forces

## VALVING LAND PHENOMENA OF THE INNAS HYDRAULIC TRANSFORMER

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### SYNOPSIS

The design of a hydraulic pump or motor with a variable displacement could be much simpler if a rotating valve plate could be used to vary the displacement. An essential aspect of the rotating valve plate is however that the passage of the cylinder ports from one kidney to the other often occurs while the pistons are moving. Experiments have revealed that this leads to high pressure spikes and cavitation. Because of this it is an unwritten rule that in hydraulic pumps and motors the passage of the so-called valving lands has to take place in the top and bottom dead centres.

Against this rule there is a new hydraulic transformer developed (the Innas Hydraulic Transformer or IHT) in which the rotating valve plate is introduced again. In stead of varying the displacement the position of the valve plate now defines the pressure ratio between the load and the supply port. As will be shown this has a crucial effect on the valving land phenomena. In stead of increasing pressure pulsation's and cavitation the rotating valve plate can now help to reduce these effects.

**Key words:** Hydraulic transformer, valve plate, pressure pulsations, cavitation

## INVESTIGATIONS OF THE TEMPERATURE BEHAVIOUR OF THE PISTON CYLINDER ASSEMBLY IN AXIAL PISTON PUMPS

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In this paper the temperature behaviour of the piston cylinder assembly in swash plate type axial piston pumps is investigated. For the theoretical investigations a mathematical model is used that allows the calculation of the non-isothermal gap flow between piston and cylinder. For this purpose the Reynolds Equation, the energy equation and the equations of motion have to be solved. The gap flow and the pressure distribution in the gap is calculated by solving the Reynolds Equation numerically with a finite volume method. The temperature distribution is obtained by solving the energy equation over the piston cylinder assembly also numerically with a finite volume method. It is known that the piston undergoes an eccentric motion in the cylinder that has a significant influence on the gap flow. To calculate this motion a simplified equation of motion, based on the external forces, the hydrodynamic forces and the forces caused by elastic deformation, is used. A method is described that combines the calculation of these three equations and that allows calculation of the gap flow and the temperature distribution in the assembly depending on the design and the operating parameters of the machine. The experimental investigations were made on a standard pump that was modified for the measurements. The temperature distributions in the whole cylinder block of the machine and the dynamic pressure in the displacement chamber were measured under real operating conditions using a telemetry unit. The results were used to verify the simulation model.

**Key words:** axial piston machine, piston cylinder assembly, nonisothermal gap flow, Reynolds Equation, energy equation, temperature distribution.

COMPUTERIZED GENERATION OF NOVEL GEARINGS  
FOR INTERNAL COMBUSTION ENGINES LUBRICATING PUMPS

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SYNOPSIS

The paper presents a general procedure for the computerized design of gerotor lubricating pumps for internal combustion engines. The approach is applied to gerotor gearings with circular arc profiles, nowadays the most used, but also to pumps featuring novel parabola arc profiles. Obtained results allow, on one hand, to guide the designer in selecting gerotor (circular arc) prototypes best suited for a given application and, on the other hand, to scrutinize novel profiles by the same generalized approach.

**Key words:** Lubricating pumps, Gerotor, Cycloidal gearings