Abstracts

Group F: Mobile Hydraulics

F1 Typical performance cycles of mobile machinery taking into account the operator influence

S. Mieth, S. Voigt, G. Kunze

Mobile machines such as wheel loaders or excavators are used in a variety of applications. Thus the assessment of typical load cases for the design and development process of a machine will never incorporate all possible scenarios. Even bench tests may not be sufficient since environmental conditions and particularly the operator have a major influence on the state of the machine. The paper presented here describes a method to extract typical load cycles from “real-life” measurements of a given tasking into account different skill and experience of the operator. Firstly cycle-specific features such as criteria for the evaluation of operator skill must be identified. Secondly a general approach for data reduction is used to derive a small subset of significant datasets from an extensive field test database of work cycles. That way, typical task- and feature-dependent cycles can be found. Finally those cycles can be used as input or reference for simulation experiments. This approach is demonstrated for the trenching process with a 20t excavator.

F2 System comparison of hydraulic and electrical traction drives in self-propelled harvesters

M. Lindner, S. Wöbcke

The concept of a diesel-electric traction drive of a self-propelled sugar beet harvester is presented. Main focus is the comparison with the previously used hydrostatic drive. A simulation of the electrified drive that is based on load cycles collected with the conventional hydraulic driven machine delivers first estimates on behavior, dynamics, power consumption and degree of efficiency. Particular attention is paid to the efficiency analysis and a cost-benefit estimate of both drive systems. Eventually the feasibility of a production implementation is discussed.

F3 Analysis and control of a complementary energy recuperation system

K. Pettersson, K. Heybroek, A. Klintemyr, P. Krus

Recent years, hybrid technologies have been in focus for both industry and academia. This paper deals with a hydraulically connected energy storage system based on a hydraulic transformer. The hydraulic connection enables easy disconnection possibilities and possibly fewer power domain transformations than the conventional mechanically connected parallel hybrid structure. The control feasibility and different control aspects are investigated and a control strategy is proposed. The control strategy is built on linear control techniques and it is shown that even with simple models of the system, sufficient control performance can be achieved.

F4 Optimization of the efficiency of hydrostatic drives

B. Vanwalleghem, C. Dousy, G. Pinte, B. Vanseveren

Heavy duty mobile machines such as road construction vehicles, agricultural and forestry machines are frequently driven by hydrostatic transmissions. The compact hydraulic components in these transmissions allow to provide continuous speed control while very large torques can be produced. Because of the increasing fuel price and stringent emission regulation, manufacturers of hydrostatic driven applications are pushed to improve the efficiency in order to stay competitive. Different strategies can be chosen to realize this objective: the hydraulic pump and motor can be replaced by components with higher efficiencies or the control of the different drive components can be improved by taking into account their interaction. While in many cases efficient pumps and motors are already being used, the control of these components is suboptimal. In this abstract an optimization procedure for the speed control of a hydrostatic drive train is described and validated on a 110 kW test bench.

F5 A new Electrohydraulic Load Sensing Control System for Hydraulic Excavators

B. Xu, W. Liu, M. Chen, H. Yang

In order to obtain an advanced operation performance and an improved energy efficiency of hydraulic systems in excavators, a new electrohydraulic load sensing system (EHLS) is introduced, which works in a synchronous of electro-proportional valves and electro-proportional pumps and open-loop control mode. An experimental prototype of 2-ton excavtor equipped with the EHLS system has been developed and a corresponding virtual prototype model has been built based on AMEsim and Adams. Compared with the hydraulic-mechanism load-sensing (HMLS) system, the stability, response and energy-saving performance of the EHMC system were investigated by simulation and experiment. A new method of pressure and flow compound control is proposed. Using the methods, the problems of overflow and energy loss were solved, and the pressure impact was effectively inhibited.

F6 Efficiency Improvement of a Constant Pressure System using an Intermediate Pressure Line

P. Dengler, M. Geimer, H. Baum, et al.

The paper introduces a new hydraulic system based on a constant pressure system with the aim to increase the efficiency of actuation of hydraulic cylinders in mobile machines. Using a third pressure level located between high pressure and tank pressure called intermediate pressure the system enables additional pressure potentials from high pressure to intermediate pressure and from intermediate pressure to tank pressure. This reduces throttle losses at hydraulic cylinders when driven at low or medium loads. An accumulator connected to the intermediate pressure line is being charged or discharged in function of which pressure potential is currently used. Using the example of a typical duty cycle of a wheel loader the paper describes how the accumulator can be applied in order to reach best efficiency results for the new system and it reveals a theoretical efficiency improvement of 20% compared to a conventional Load Sensing system. Furthermore it proposes an online control strategy using Model Predictive Control with an optimization algorithm created with the Dynamic Programming method.

F7 Optimized Damping in Cylinder Drives Using the Meter-out Orifice - Design and Experimental Verification

M. Axin, J.-O. Palmberg. P. Krus

This paper analyses the damping of a flow controlled cylinder with a mass load and an outlet orifice. By using linear models, a mathematical expression for the damping is derived. It is shown that the volumes on each side of the piston have a high impact on the damping. In case of a small volume on the inlet side, the damping becomes low. However, the most important thing is to design the outlet orifice area properly. There exists an optimal orifice dimension; both smaller and larger orifice areas give low damping independently of the size of the volumes. In this paper a design is proposed of the outlet orifice area that optimizes the damping of the system. Experimental results which confirm the theoretical expectations are also presented. The conclusions are that without an outlet orifice, the hydraulic system will not contribute with any damping at all. Furthermore, large dead volumes in the cylinder will increase the damping, but at the expense of the system's efficiency.

F8 Development of an active and integrated suspension system

T. Bedarff, P. Pelz

The traditional solutions of active, semi active or adaptive pneumatic and/or hydraulic spring damping elements are characterized by disadvantages, such as e.g. leakage problems or the large number of components in the case of valve-based damper control or in the case of level control by means of pump or compressor. The complexity of these solutions generates uncertainties in manufacturing and function, in operation the uncertainties are generated by long force response times as well as by wear and ageing of sealing elements. The objective of the concept of this project is the development of a suspension strut and the testing of it in the overall system which does not include the a.m. components. The function of the pump is

assumed by an actuator integrated in the strut which adapts the surface acting with pressure to the currently prevailing load request. This paper presents the developed, constructed, built and tested prototype of an active fluid suspension system (HFDS): The prototype is based upon a standard air spring bellows, used in serial-production for premium car suspension systems.

F9 Electro-Hydraulic Hybrid Actuator System using Integrated Power Unit

R. Aman, H. Handroos, P. Ponomarev, J. Pyrhönen

Electro-hydraulic hybrid power transmission system can save fuel while maintaining the same performance in comparison to the conventional fluid power system driven by the combustion engine in mobile working machine applications. This paper introduces the electro-hydraulic hybrid actuator system specially developed for compact assembly. In this assembly all the components are located near each other to avoid the long fluid power transmission lines which quite commonly appear in big mobile working machines. Normally, in this type of machinery the transmission lines are flexible hoses and pipes of small diameter which cause remarkable power losses. Proposed actuator design allows the replacement of long flexible pipe lines by electrical cables. In the cables the losses due to their internal resistances are apparent but negligible in comparison to the losses apparent in the hydraulic transmission lines. The present paper introduces the electro-hydraulic hybrid actuator system and the integrated electro-hydraulic power unit. The actuator system is simulated.

F10 Resource and energy efficient process integrated development with virtual prototypes for mobile machinery

T. Hentschel, C. Schramm

Environmental protection, rise of energy-costs, economic crisis – mechanical engineering is forced to come up with innovative and sustainable concepts to keep up with competitors. This has a notable impact especially in the branch of mobile processing machinery. Besides such directives like the emission-directive for mobile processing machinery, which is becoming effective, the EU stated the goal of reducing, the emission by 20%.
To meet the legal requirements considering the increasing variety of concepts for power-transmission a methodology and an analysis-tool for development and evaluation of energy-saving drivetrains are required. This objective is the concern of the research-project ENPROVI supported by the Federal Ministry of Research and Technology. Besides the lead partner Forschungszentrum Karlsruhe (PTKA) the development proposal is carried out together by the associated partners ITI GmbH, TAKRAF GmbH and TU Dresden (IVMA-BFT). The ITI GmbH supplies the computing platform for the realisation of the analysis tool “Power Balance” in terms of SimulationX®. The new feature “Power Balance” can be used to investigate power flows and energy consumption in model of technical systems. It describes how powers are calculated, categorized and summed with the help of the Power Balance. The practical application of the analysis tool is tested by means of a demonstrator model of the TAKRAF GmbH.