

SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)  
Future Space Transportation Systems Technologies (5)

Author: Dr. kangwu zhu  
CASC, China

Mr. junyong fu  
China

Mr. Cheng Fang  
China

Mr. Baoliang Ji  
CASC, China

STUDY ON A NOVEL QUADRUPLEX REDUNDANT POWER BY WIRE ACTUATION SYSTEM  
FOR LAUNCH VEHICLE THRUST VECTOR CONTROL

**Abstract**

The power by wire ( PBW ) system is a new concept actuation system, it has integrated energy system, therefore, it is only need the electric energy support from launch vehicle or aircraft. It is more compacted, and easier to be placed than traditional actuation system and its reliability is higher. Based on advantages above, the PBW system is one of main development directions of actuation system. To solve the problems that the control performance of EHA system is poor and the temperature rise of valve control system is violently, some improved hybrid PBW systems that combine the advantages of pump and valve control has been proposed. However, these systems are only the simple combination of two types of system, the servo electromotor and servo valve have to be controlled at the same time, the control system is complicated, and reliability is lower. In this paper, a novel quadruplex redundant PBW system based on load sensing concept is proposed. And then, the detailed working principle,hydraulic diagram, and system simulation model are given. The output pressure is only 1.5-2MPa larger than load pressure, the throttle loss can be reduced significantly, the heating problem can be solved. In this system, the load sensing pump can regulate the output pressure automatically, the DDV is the only component need to be controlled. The electromotor and pump have been widely used in active-duty models, therefore this new PBW system is simpler than other kinds of PBW systems and easily to be built. At last, by simulation studies, the effectiveness of PBW system proposed is proved. Its frequency response performance is better than EHA system, and as same as traditional valve control system. Its energy efficiency is better than valve control system especially in low-speed operating condition, and be close to EHA system. Most important, its control structure is simpler than other hybrid PBW system. In launch vehicle field, the new PBW system can be used in thrust vector control of solid booster and liquid hydrogen-oxygen engine to replace the traditional electro-hydraulic servo system.