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CONTROL SYSTEM OF LE-9 ENGINE USING ELECTRIC DRIVE VALVES

Abstract

Japan Aerospace Exploration Agency (JAXA) has been developing LE-9 engine as the new first stage rocket engine for H3 launch vehicle. The thrust and mixture ratio of LE-9 engine are controlled using four electric drive valves; TCV (Thrust Control Valve), MFV (Main Fuel Valve), CCV (Chamber Coolant Valve) and MOV (Main Oxidizer Valve). It is possible to change the thrust and mixture ratio continuously and smoothly using these electrical drive valves because the opening ratio of these valves can be set and moved freely while LE-9 engine is firing. These valves are connected to MDU (Motor Drive Unit) and ECU (Engine Control Unit), which is a controller of LE-9 engine. ECU controls engine sequence and gives electrical signals to each electrical component of LE-9 engine, including MDU. MDU has a function to calculate open ratio of the electrical drive valves in order to approach the thrust and mixture ratio to predetermined performance according to the signal from ECU. This innovative function realizes to simplify AT (Acceptance Test) of LE-9 engine. In the traditional method of AT, some parameters such as orifice size are calculated and set in advance to achieve predetermined performance. If the result of AT does not accomplish the predetermined performance, retest is needed. In this case, it is required to recalculate the characteristics of an engine and exchange some orifices to adjust the amount of flux, because the pneumatic valves which are usually used as control valves can only open or close. Therefore, this traditional method needs accurate analysis and large amount of works for the test. On the other hand, LE-9 engine needs only one-time AT because ECU and MDU can find appropriate open ratio of the electric drive valves to accomplish the predetermined performance automatically. Therefore, it is possible to conduct AT with lower cost and higher reliability using the control system of the LE-9 engine than using the traditional method. The firing test of the LE-9 engine has been conducting since 2017. The control system of LE-9 engine has been demonstrating and the usefulness of the control system has been shown through firing tests. In this article, the development status and results of firing test about control system of LE-9 engine are discussed.