Dynamic Response of a Two-Dimensional Thrust-Vectoring Nozzle

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Abstract

In this study, a micro gas turbine engine (Thunder Tiger P-15) is used to formulate its dynamic transfer function and compare with the test data to understand the dynamic response of an engine. The steady-state performance of the jet engine is studied first. The results show that the servo command to the output of fuel flow rate, engine thrust, and rotational speed has a linear relationship between 80000rpm and 120000rpm. Second, the dynamic response of the engine is examined by the Bode plot. The transfer function that fit the frequency-domain data is a first order system for the rotational speed and the engine thrust and a second order system for the exhaust temperature. Besides, the transfer functions for the rotational speed and the engine thrust are almost the same. Hence, the response of the rotational speed can be used to represent the dynamic performance of the engine. The modeled transfer is compared with several set of operations and shows a very good agreement in its dynamic response in time-domain. Finally, several operating parameters are used to study the effect of dynamic response for a step change in thrust. Changing the fuel from a 50% gasoline and a 50% kerosene to a 100% gasoline, the rotational speed show a delay of 0.2sec at the beginning of jump, but catch up the original response for the remaining part of the operation. When changes the fuel to a 100%

kerosene, the response delays overall for 0.5sec compared to the original performance. For the inlet temperature raises from 30℃ to 50℃, no significant change one the engine response. Changing the fuel injection pressure from 6kgf/cm2 to 7kgf/cm2, the response of the step change is improved from 2.4sec to 1.9sec. Finally, two different servo actuators, one is 0.12sec/60˚ and the other is 0.27sec/60˚, are examined. There is a delay of 0.1sec at the beginning of the jump for the slower actuator, but the response is almost identical for the remaining operation. Even though there are no detail models for fuel evaporation, fuel air mixing and rotor shaft dynamic, the current first order model serves very well to represent the engine dynamic performance for

the above operations. From the current study, the fuel penetration length, fuel evaporation, and fuel-air mixing dominate

Keyword：micro turbojet engine, bode plot,
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