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THE MATHEMATICAL MODELLING OF CHANNEL TEMPERATURE MEASUREMENT OF AIRCRAFT ENGINE EXHAUST GASES

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Abstract: *One of the important diagnostic parameters of an aircraft engine is a process of the gas temperature behind the turbine. It is crucial for assessing the condition of its heat-stressed parts to identify the failure and before failure conditions and thus to determine the limits of the the operational limit . The solution part of a given problem is also the channel mathematical modelling of the exhaust gas temperature measurement.*

Keywords: *engine, exhaust gases temperature, mathematical modelling.*

1. INTRODUCTION

One possibility examining the properties of real objects is a mathematical description of processes in their development. The content of an identification system is then creating a mathematical model based on theoretical and experimental analysis.

For evaluating the technical conditions of aircraft turbo-engines (ATE), a key issue is the investigation of gas temperatures behind a turbine and monitoring of this parameter in operation. In most cases, for the purpose of its high reliability, thermoelectric sensors (thermocouples) are used. The dynamic error of thermocouples, however, prevents the use of gas temperatures behind a turbine recorded during the flight to diagnose engine dynamic behaviour in dynamic modes t_{4c}.

A possible solution is to create a mathematical model of gas channel temperature measurements recorded using the known operating parameters. This procedure requires the solution of tasks associated with the identification of ATE. The mathematical models and processing measured values can be implemented in Matlab Simulink [1, 2].

2. MODELLING OF CHANNEL TEMPERATURE MEASUREMENTS BEHIND A TURBINE

The dynamic error channel temperature measurement of gases behind a turbine can be corrected by establishing an appropriate model, the output will be its corrected value of temperature $t_{4c\ kor} \approx t_{4c\ sk}$. The solution is to create a forward dynamic model of channel temperature measurement of exhaust gases and then its inverse model (Fig. 1), where the required corrected temperature value will be on its output $t_{4c\ kor} \approx t_{4c\ sk.}$ The synthesis of a dynamic model of channel temperature measurement of gases behind a turbine is based on knowledge of its dynamic characteristics.

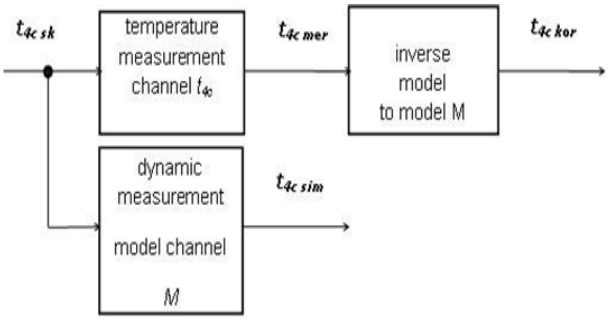


Fig. 1 Determination of the temperature t_{4ckor} using mathematical modelling

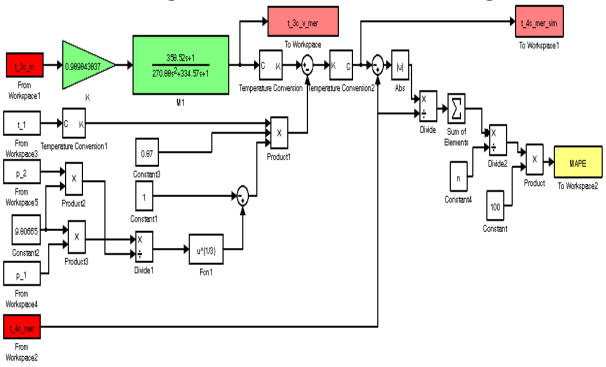


Fig. 2 Structural diagram of verification of the forward linear model channel temperature measurement t_{4c}

To create a linear model of the channel temperature measurement of gases behind a gas turbine, the data measured at a stand of ATE (outputs of the functional FET engine tests) were used with the required modification for use in Matlab Simulink [4, 5].

For verification of multiple versions of models (Fig. 2) and their behaviour in transient modes, the error was investigated between the outputs of the model $t_{4c\ sim}$ a $t_{4c\ mer}$ with quality evaluation using indicators of MAPE and MAAPE models. The outcome of this process was the selection of the optimal transfer function.

The similar verification procedure was designed for the inverse linear transfer function model of the channel temperature measurement of gases behind a turbine.

The verification procedure of inverse model was accomplished by structural scheme on Fig. 3. The output from model modifies the value of temperature $t_{4c\ kor}$.

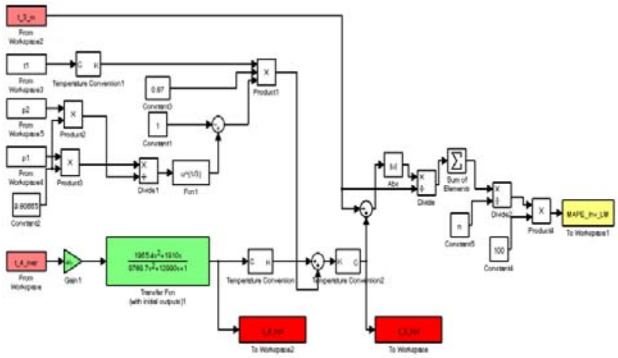


Fig. 3: Structural diagram of verification of the inverse linear model channel temperature measurement t_{4c}

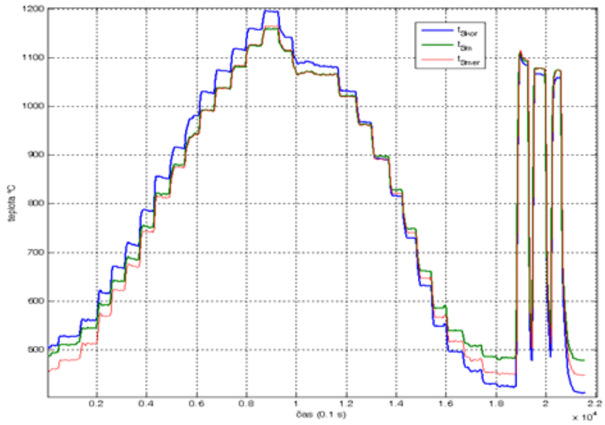
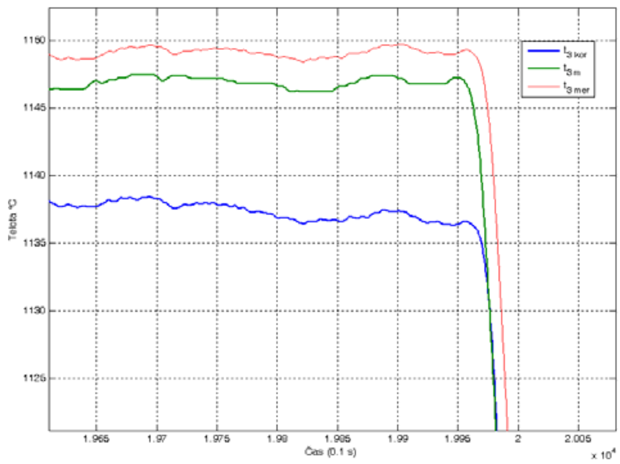


Fig. 4 Display output of a channel inverse linear model of temperature measurement t_{4c} for dataset FET



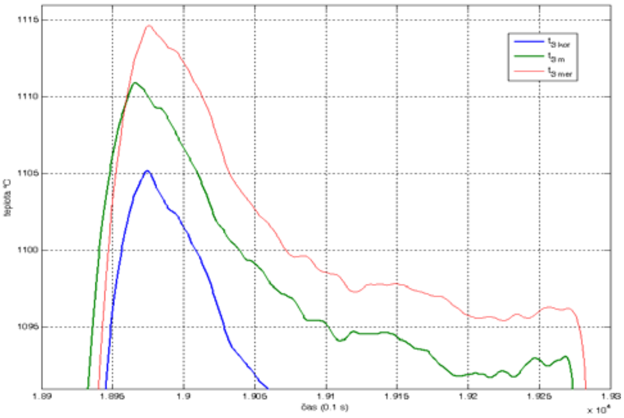


Fig. 5 Comparison of $t_{3c\ mer}$ (t), $t_{3c\ m}$ (t) and $t_{3c\ kor}$ (t) in the transient modes of engine

3. CONCLUSIONS

The goal of solving the above problems is to contribute to current trends in airline operations technology, i.e. to the the operational limit determination by the technical condition of aircraft turbo-engines through more accurate monitoring of heat stress.

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