AN APPROACH FOR FORCING MICRO GTEs

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There are different ways to increase the thrust or output power of gas turbine engines (GTEs). The most common approach is the use of the afterburner. In addition, several approaches involve injecting water into the flow path of GTEs. However, these methods have limited applicability for micro GTEs, which are typically used on unmanned aerial vehicles (UAVs), due to the excessive complexity and cost of the required components, such as:

- additional combustion chamber;
- adjustable nozzle (for turbofan and turbojet engines);
- additional water injection system.

It is also well known that increasing the turbine inlet temperature T_g^* leads to a rise in thrust for turbojet engines and in power for turboprop and turboshaft engines. Therefore, a short-term increase in T_g^* also can serve as a method of engine forcing.

However, the main challenge with this approach is ensuring that the turbine can operate under elevated temperature conditions without being damaged.

Micro GTEs used in UAVs typically utilize uncooled turbines, which means it is not possible to maintain the temperature limits of the turbine blades and disks by increasing the mass flow velocity of cooling air. Nevertheless, it is possible to use liquid cooling of the turbine components via a fuel, similar to the cooling methods that are used in liquid rocket engines.

Using fuel to extract heat from turbine blades and disks can be implemented either through cooling channels similar to air cooling systems or by creating a fuel curtain in front of the turbine blades.

The application of the fuel curtain is particularly suitable for micro GTEs used in UAVs, especially those equipped with uncooled turbine blades. In the fuel curtain zone, an over-enriched combustible mixture is formed, characterized by an excess air ratio outside the stable combustion range. This mixture does not combust, but instead absorbs heat from the working fluid to increase temperature and evaporate the liquid fuel. As a result, the temperature of the working fluid near the turbine blades is reduced, ensuring an acceptable thermal regime for the blades.

This method of forcing requires additional fuel consumption, as is the case with afterburners, but does not require an additional combustion chamber or an adjustable nozzle.

Furthermore, portion of the cooling fuel undergoes chemical oxidation with atmospheric oxygen in the turbine flow path and the exhaust system of the gas turbine engine releasing heat in the process. This heat release increases the temperature of the working fluid, thereby enhancing the expansion work within the thermodynamic cycle. As a result, both the thrust (or output power) and the overall efficiency of the GTE are improved.