EXPERIMENTAL ANALYZE OF COMBUSTION CHAMBER OF A GAS TURBINE PLANT

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Abstract: In this paper we analyze from experimental point of view the main parts of a SoLoNO$_x$ combustion chamber: premixing zone, combustion primary zone, dilution secondary zone, air inlet, main fuel inlet, pilot fuel inlet, air swirler, hot gas flow to the turbine inlet.

Keywords: gas turbine, combustion temperature

1. INTRODUCTION

Gas turbine plant performance is driven by the firing temperature, which is directly related to specific output [1]. The two parameters, which most affect high turbine efficiencies, are temperature and pressure ratios [2]. Experimental research was performed on 130 GTP Titan group of 14.3 MW [3].

2. GAS TURBINE DESIGN

In Figure 1 is presented a cutaway of a single shaft turbine.

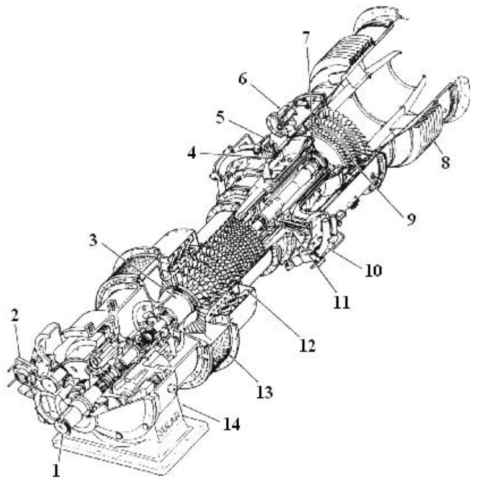

Fig.1. Single shaft turbine: 1 – output shaft; 2 – accessory drive; 3 – compressor rotor; 4 – fuel injector; 5 – combustor housing; 6 – bleed valve; 7 – turbine shaft; 8 – turbine exhaust diffuser and bellows; 9 – turbine rotor; 10 – fuel manifold; 11 – compressor diffuser; 12 – compressor variable vanes IGV; 13 – air inlet; 14 – gearbox.

The combustion chamber is designed as an annular inline construction with a single component internal casing and fuel injectors. The fuel injectors are inserted and flanged from outside the casing.

3. SoLoNOx COMBUSTION CHAMBER

In Figure 2 is presented the SoLoNOx combustion system scheme. The $SoLoNO_x$ combustion system allows for compliance with strict NO_x emission values, without water injection. Combustion under lean-mixture conditions reduces the transformation of atmospheric nitrogen to NO_x inside the gas turbine combustion chamber, where the flame temperature is reduced.

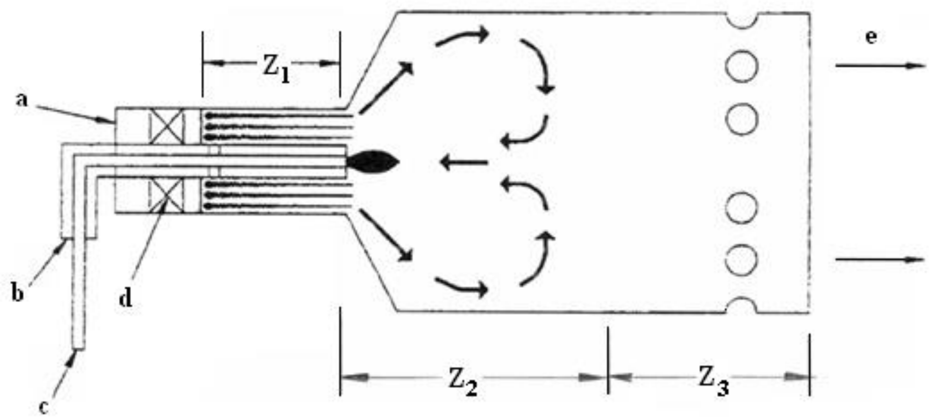

Fig.2. SoLoNOx combustion system: Z_1 – premixing zone; a – air inlet; b – main fuel inlet; c – pilot fuel inlet; d – air swirler; e – hot gas flow to the turbine inlet; Z_2 – combustion primary zone; Z_3 – dilution secondary zone.

Reduction of the combustion temperature is achieved in two ways. First, combustion takes place in the primary burner area at a lower average temperature than in conventional combustion chamber (lower average fuel/air ratio). This avoids the localized NO_x forming hot spots that occur in conventional systems. A lean-mixture operation is achieved by increasing the air flow through the primary-burner area, with a corresponding lower amount of dilution air. The overall air flow over burners and the hot gas exit temperature are thus unchanged, so that there is no detriment to the gas turbine performance for specific fuel requirements or to the life time of the hot gas components.

4. CONCLUSIONS

Since NO_x generation is an exponential function of the flame temperature, a lower combustion temperature is extremely important for reducing NO_x emissions.

The consumption of fuel in gas turbine plant is only 1,7027% from the flow rate of air, fact which explain the frequent adoption of the hypothesis about the invariance of the working fluid composition in GTP.

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