THE INFLUENCE OF IMPURITIES ON SPT-ATON THRUSTER OPERATION.

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Abstract

It was studied the hydrogen influence upon integral properties of the thruster and upon discharge current oscillations at hydrogen injection into the propellant anode line with xenon. Integral properties for pure Xe and for different percentage of H_2 are represented. The discharge current increases and the efficiency decreases with the growth of the hydrogen addition. The typical oscilloscope traces of the discharge current for pure xenon and for different percentage of hydrogen addition are represented. Hydrogen injection results in complex changing of both frequency and amplitude of discharge current oscillations spectrum.

In given experimental series it was studied the hydrogen influence upon integral properties of the ATON-type thruster and upon discharge current oscillations at hydrogen injection into the propellant anode line with xenon. The experiments were carried out at MIREA stands. The chamber was pumping out with oil pumps. The oil BM-5 was used. Static pressure was 4E-5 mmHg (respectively to the air).

The integral properties were obtained for three thruster

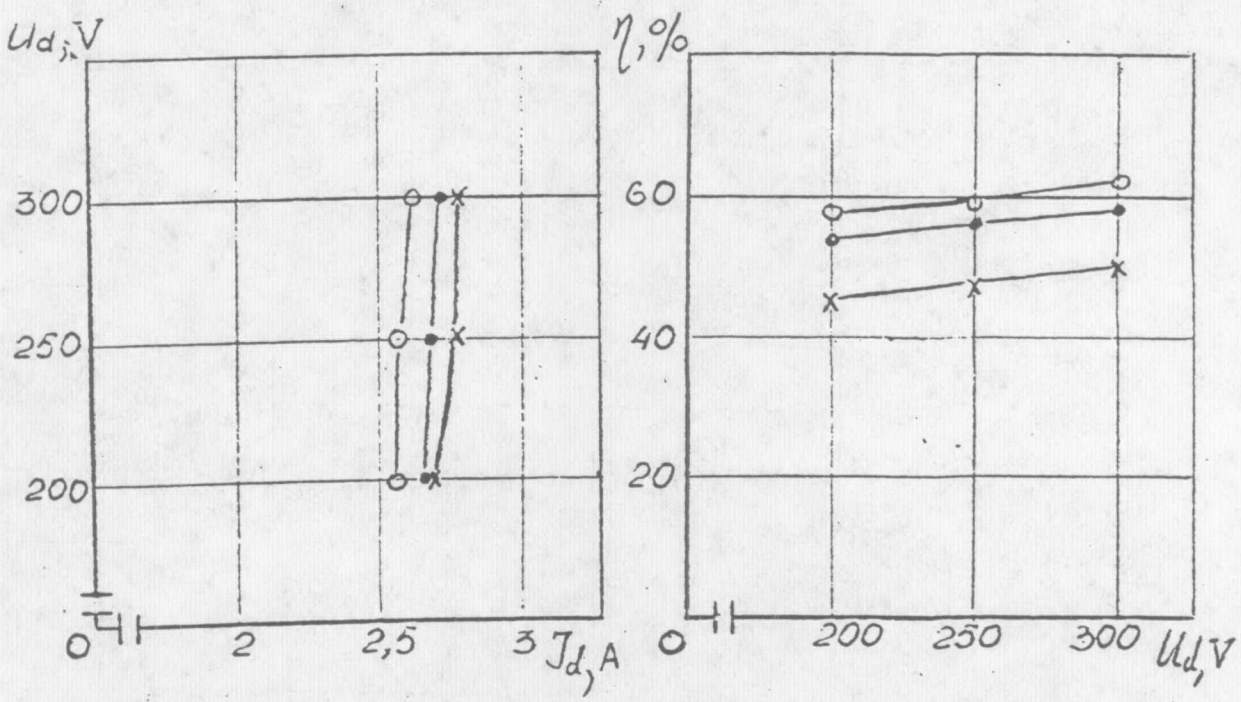

Fig.1. Integral properties for pure Xe and for different percentage of H_2: ○ – Xe, ● – Xe + 4% H_2, X – Xe + 24% H_2.

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operating modes in the discharge voltage: 200 V, 250 V, 300 V.The anode and cathode flow rates of xenon were 2.5 mg/s and 0.4 mg/s respectively. For given mass flow rate the dynamic pressure (respectively to the air) was 3E-4 mmHg. The measurements of thruster integral properties were carried out both if thruster operated using pure xenon as a propellant gas (without hydrogen injection), and at the fixed percentage volume flow rates of hydrogen from volume flow rate of xenon.

The typical curves of integral parameters of the thruster at pure xenon under remained conditions and at 4% and 24% of hydrogen addition are shown on fig.1. One may see, that the discharge current increases (fig.1a) and the efficiency decreases (fig.1b) with the growth of the hydrogen addition.

The nonstationary behaviour of the thruster discharge current was investigated for following operating mode: U_d=300 V,the anode and cathode flow rates of xenon were 2.5 mg/s and 0.4 mg/s respectively, I_d=2.68A. The discharge current oscillations were obtained both for pure xenon as a propellant gas, and for the fixed percentage volume flow rates of hydrogen from volume flow rate of xenon.

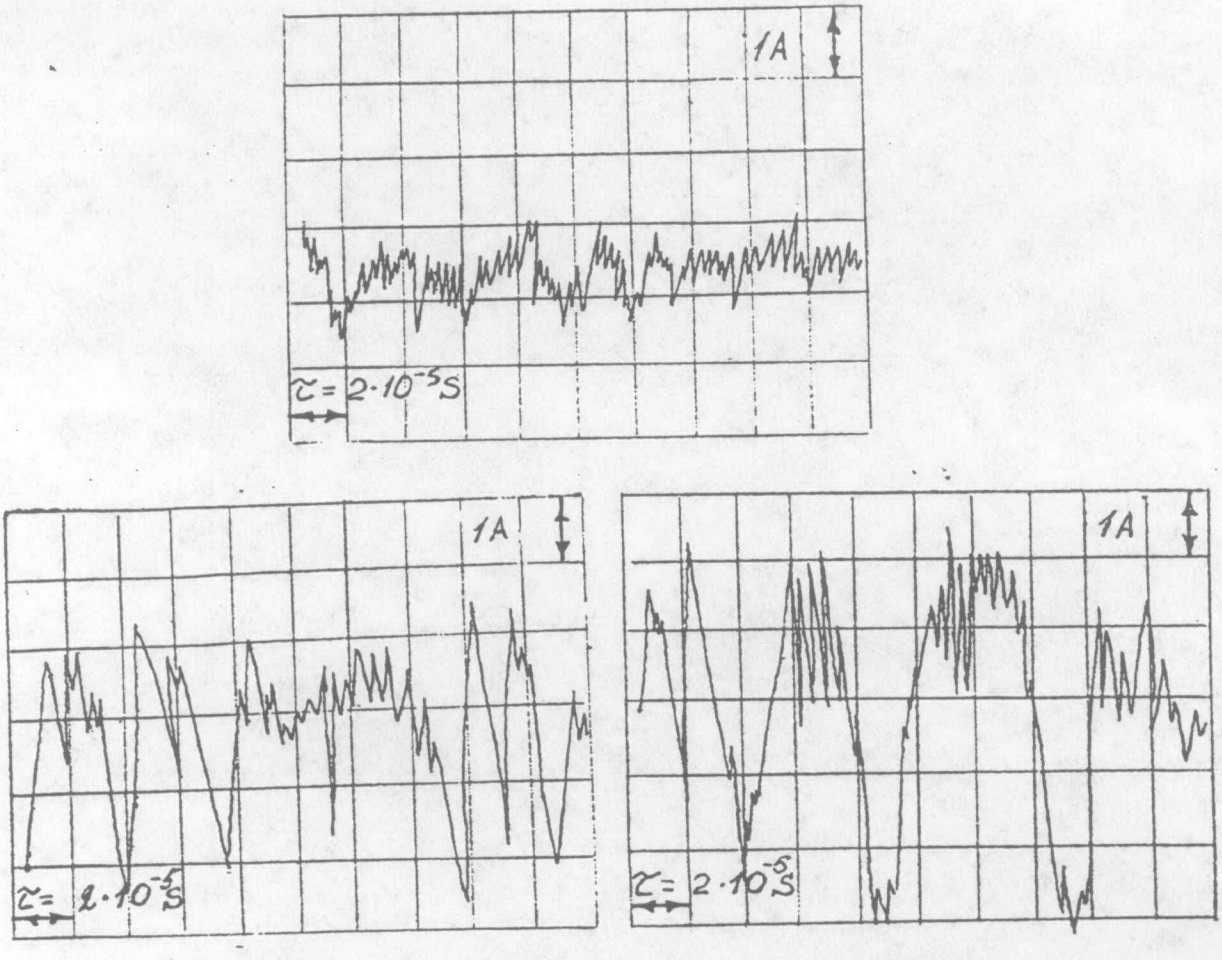

Fig.2.Effect of hydrogen addition on the discharge current oscillations: a - Xe, b - Xe + 4% H_2, c - Xe + 12% H_2.

The typical oscilloscope traces of the discharge current at pure xenon and at 4% and 12% of hydrogen addition, injected into the anode, are represented on fig.2. For pure xenon (fig.2a) the typical frequency and amplitude of the low frequency component of the spectrum were ~ 50kHz and ~ 0.5A respectively, and the typical frequency and amplitude of the high frequency component of the spectrum were ~ 300kHz and ~ 0.15A respectively.

The injection of 4% of hydrogen (fig.2b) results in the frequency of low frequency component of discharge current oscillations decreases (it becomes equal to ~ 25 kHz), in spite of its amplitude increases (it becomes equal to ~ 1.5A). The frequency and amplitude of the high frequency component of discharge current oscillations remains approximately the same.

The increase of hydrogen injection up to 12% (fig.2c) results in the further amplitude growing of both low frequency component and the high frequency component without changing of their frequency.