The Results of Researching of Low-Current Selfheated Hollow Cathodes on Electric Current Range from 0,3 up to 0,5 A

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Abstract

We present in this article outcomes of experimental researches of a series feeble current less incandescent of cathodes, which one can be utilized for SPT by power from 50 up to 250 W. The main distinctive feature of cathodes of this type is the absence of the heater of an emission insert. It allows essentially to simplify a design and to increase their reliability, besides the response curves of start are essentially improved. The basic requirements at mining were maintenance of a minimum burner voltage of discharge in a diode mode at the consumptions 0,03... 0,15 mg/s and maintenance start at the fixed consumptions.

Cathodes on operating currents 1... 3 A

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M3.07 cathode specification

	Range	Normal
Discharge current, A	0.7…3.5	1.5
Mass flow	0.1…0.4	0.15
Discharge voltage, V	16…35	20
Number of ignition from cold state		10^4
Emitter	High emission material	
Ignition time from cold state	< 1 sec	
Size, ∅ x l (mm)	18x80	
Mass of cathode	< 70 gramm	

Volt-Ampere Characteristic

The scheme of measurement of current-voltage characteristic is shown in a fig. 2. A measuring complex standard described by us in [1]. The observed dates are retuned in a fig. 3.

One of the relevant parameters lessincandescent cathode is it breakdown characteristic (BC). The present cathode is optimized on BC, which one is shown in a fig. 4.

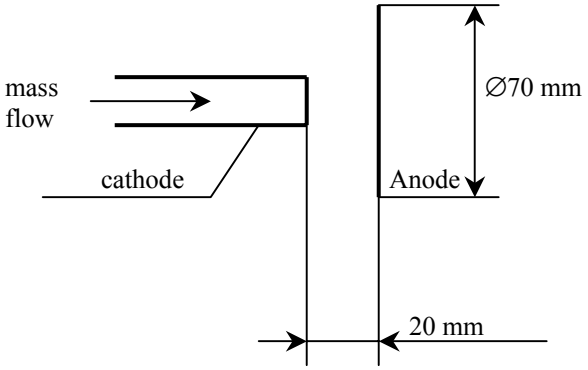

Fig. 2 The scheme of measurement of current-voltage characteristic.

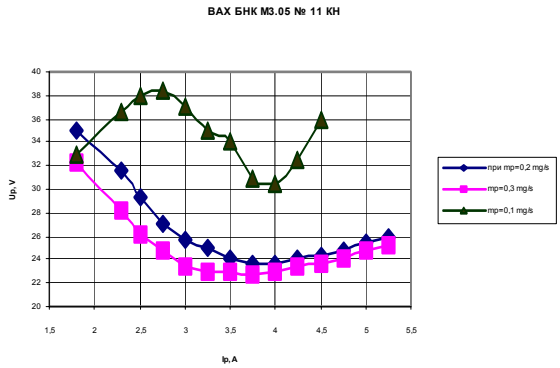

Fig. 3 Current-voltage characteristic

From [2] it is known, that influencing firing oscillations of a propulsive mass on firing erosion of the cathode is however great. The firing account characteristic is shown in a fig. 5. Apparently, that dynamics of an output of the consumption on fixed (or close to this) operational mode does not exceed 50 msec.

The important fact is the safe life of the cathode. The realization of straight lines of tests is very long-lived and expensive. Therefore for prediction by us was used a method designed in [3]. The relation of speed of erosion of the emitter of the cathode is shown in a fig. 6. The recalculation of the data demonstrates, that the actual safe life can reach 7000 operating hours with allowance for of 10^4 start of the cathode.

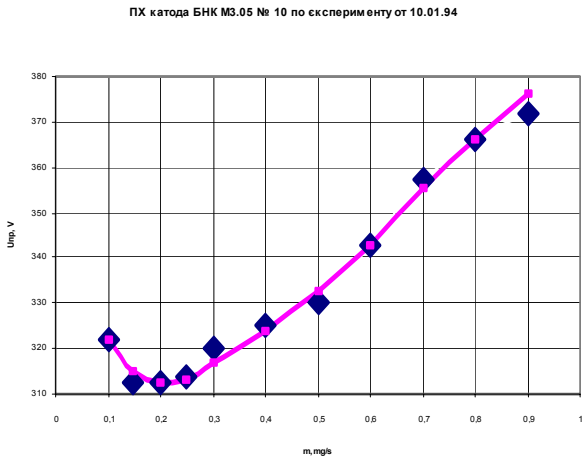

Fig. 4 Breakdown characteristic

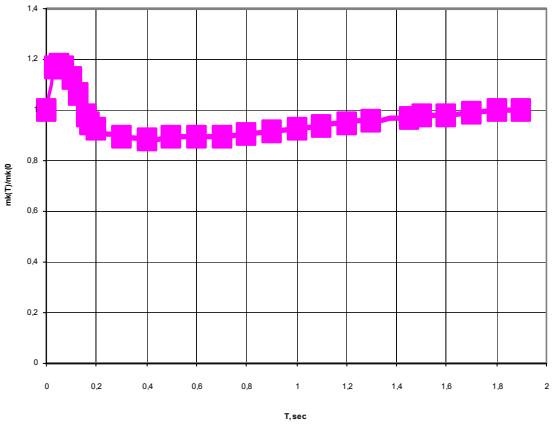

Fig. 5 Gas start characteristic

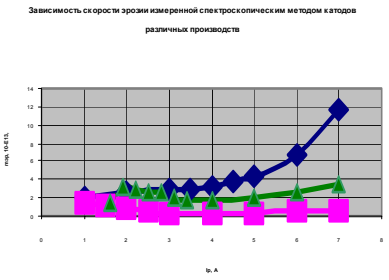

Fig.6 Erosion characteristic

Cathodes on operating currents 0,3...0,9 A

The further modification of cathodes was conducted for achievement of minimum operating currents up to 0,9 A and decrease of the consumed

consumption PT up to 0,05 mg/sec. The photo of the cathode M1.07 is adduced in a fig. 7.

Fig. 7 Photo of the cathode M1.07

The emitter, and in a tool holder of the cathode became agrees to calculations till [4] apparent necessities of improvement of the thermal scheme of the cathode and decrease of heat losses as by radiation. For this purpose each of screens was selected on a minimum radiation value in the conforming temperature range and drove special thermo-chemical processing. The special attention was given designs of a tool holder of the capsule of the cathode for a decrease of an added mass. The cathode drove tests for operating currents 0,3... 0,9 Φ and consumptions 0,03... 0,08 mg/sec. Its start is similar to start of more high-current modification, however firing block subjected also to changes. The make time of the firing block made 90 sec at power giving in category discharge 2,4 W. The basic performance curves of the cathode of a series M1.07 are shown in a fig. 8, 9.

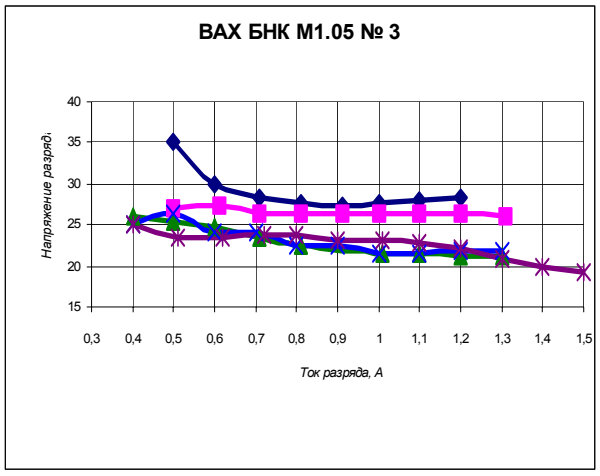

Fig. 8 Current-voltage characteristic

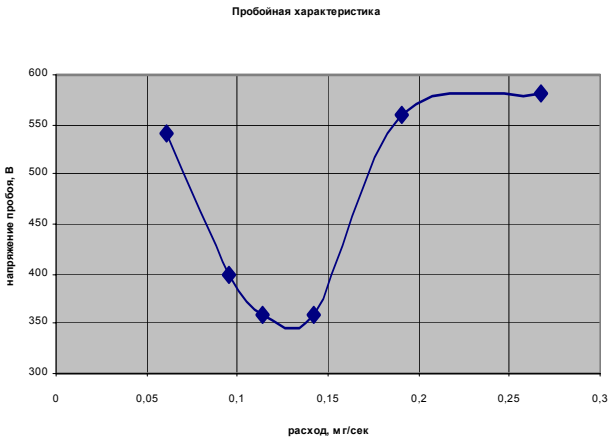

Fig. 9 Breakdown characteristic

M1.07 cathode specification

	Engineering model	Qualification model
Discharge current, A	0.3…0.9	0.25…0.8
Discharge voltage, V	20…28	14…25
Mass flow	0.03…0.07	0.03…0.07
Life time, hour	500	12000
Number of ignition from cold state	10^4	$5x10^4$
Ignition time from cold state	< 1 sec	
Size, ∅ x l (mm)	∅24x105	∅24x72
Mass of cathode, gramm	< 50	< 40

Ignition block

We present exterior of engineering model of the firing block lessincandescent cathode. He provides optimization, the maintenance of discharge at most "dangerous" stages of achievement of modes of fixed activity and is the coordinated device to cathodes of a series M1.07. In the table 1 some basic performances of engineering and qualifying model IB are resulted.

Table 1. IB specification

	Engineering model	Qualification model
Range of input voltages, V	24…32	24…32
Range of operation temperatures, °C	0…+50	-60…+85
No-load voltage	700…900	800…850
As much as possible consumed power	2.4	2.6
Efficiency of the	92	97

device, %		
Overall dimensions		
Mass, gm	< 90	< 60

Discussion

Having wide experience of designing and manufacturing of cathodes on currents from 2 up to 50 A the writers mark a series of essential singularities for cathodes, operating currents which one less than 2 A.

Basic of which the impossibility of achievement of activity of the diaphragm of the cathode in a mode with thermal contraction. For example, in a fig. 10 the comparative characteristics of distribution of temperature electron components of plasma on width of a spray for cathodes of a series M3.05 are shown. This series is counted on operating currents up to 4 A. The analysis of the charts demonstrates, that at transition with 4 A up to 5 A current it is sharply and essentially drops that results in brownout of combustion of discharge and kind of other positive changes in its frame.

Following aspect of discussion can be a problem on a correctness of measurement of volt-ampere characteristics. Is not a secret, that the difference of the measuring techniques (schemes of realization of experiments, spacing interval and form of an anode) depends one of basic performances of the cathode - power inputs on maintenance of operating current. So, for example, in a fig. 11 the relation of a potential of the diaphragm firing electrode is shown. In our comprehension it nipper of the cathode. The characteristics "cathode - anode" there are shown. The essential differences, are obvious, which one handicap a capability of correct matching of cathodes of different designs.

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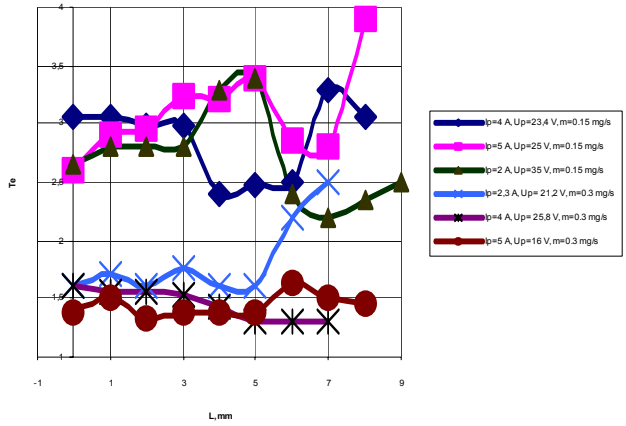

Fig. 10 Distribution of temperature electron components of plasma

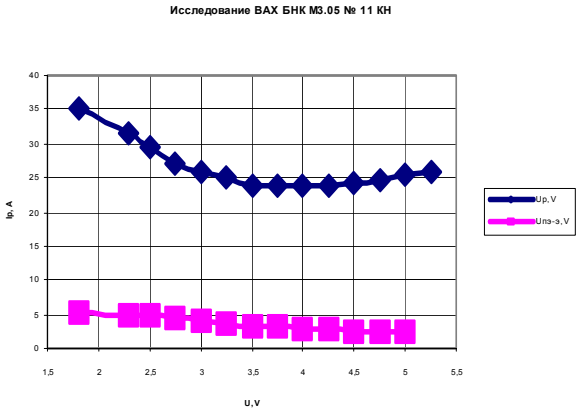

fig. 11 The relation of a potential of the diaphragm firing electrode