TESTING THE EFFICIENCY OF INTERNAL COMBUSTION CATALYSTS POSITION MODEL.

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Abstract: *In order to determine the effectiveness of the catalytic coating applied to the engine valve, a study model. For this purpose built test stand made of elements of the real engine. The catalyst temperature was controlled by electric heating. The position of the working gas fumes were collected with a spark-ignition engine, idling. Performed a simultaneous measurement of gas composition at the inlet to the model and the output from the system. The study was conducted at a constant flow rate and variable temperature exhaust gas catalyst system. The results of the study are presented in the form of comparative charts. It has been found highly effective activity of the catalyst for carbon monoxide and relatively high efficiency for hydrocarbons. Measurements of nitric oxide levels showed no significant changes in concentration in a range of temperatures.*

KEYWORDS: THE INTERNAL CATALYST; POSITION MODELS;

1. Introduction

In the present paper under the notion of internal catalyst there is understood the substance of catalytic features which is applied fragmentally or entirely on the walls creating the combustion space of the internal combustion engine or a part of this space- e.g. valve, heat plug which were previously covered with ceramic coat setting the media for this substance.

The ceramic layer fulfills two important functions:

- weakly conducts heat and sets thermal barrier, which enable temperature raising in the place of active factor application
- sets the media for catalytic layer (and thanks to spongy structure it is possible to get bigger contact surface between active layer and gas factor.)

Between external surface of engine element (bearer) and the ceramic layer there has been applied an intermediate layer which aim is to prevent both corrosion and detaching of the ceramic layer due to heat expandability between materials (Fig. 1.1)

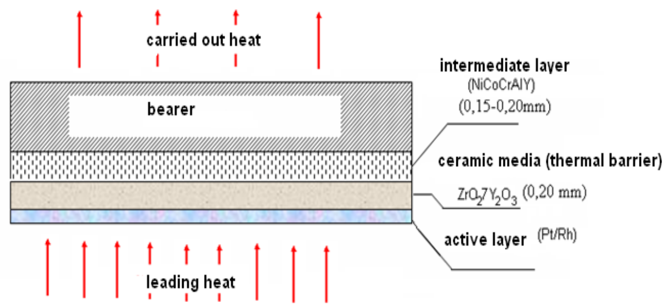

Fig.1.1 *Ideological scheme of inner combustion catalyst structure.*

Depending on the kind, size and placing of the catalyst as well as on load and engine rotational speed, the effectiveness of catalyst working in the particular stages may change.

In the considered case the active layer has been made on the surface of valve mushrooms. Making the active coat on the engine valves may cause certain limitation of catalyst influence on the combustion process connected with placement interactions of valve- piston, which in the GMP area cause limitation of the contact of the catalytic coat with the factor inside cylinder. However, in the spark ignition engine, where valves are placed at an angle to the piston surface, the problem of interaction limitation is low.

From the Zeldowicz's formula it follows that the velocity constant of chemical reaction is directly transferred into spread velocity of flame front:

$$U \approx \left(\sigma V e^{-\frac{E}{RT}} \right)^{\frac{1}{2}} \sim \frac{1}{\tau^{1/2}} \qquad (1)$$

which is essentially crucial concerning the fact that, as it has been mentioned in the present chapter, the catalyst contributes to the increase of chemical reaction velocity (speeds up the reaction).

As an effect, the heat source power is decreasing in the temperature field, but with retaining carrying out of heat at the foregoing level, which influences the load transformation of the introduced fuel as well as the decrease of the local temperature gradients. The maximum and average temperature over piston are both reduced. On the pointer diagrams then, there can be noticed "soothing" of engine working thus the decrease of an amplitude.

The system aims at balance condition. According to the law of conservation of energy and spin in the process there ensues extra "residual energy" which levels remaining radical processes. Assuming that in the first phase there comes the effect of so called heat explosion, then the second, final phase of ignition caused by residual energy will have character of light pressure increase. Although the pointer diagrams indicate the overall loss pointer efficiency, the mechanical efficiency raises and thus the engine working effectiveness increases.

On the basis of the abovementioned analysis, there can be stated that making use of factor of catalytic qualities in the engine combustion space has an impact on the improvement of engine working.

One can conclude that the catalyst placed inside the combustion space may influence several stages of the fuel mixture combustion process in the engine combustion space [3]:

- preparing of combustible mixture phase- injected fuel cracking processes
- pre flaming phase- shortening of ignition delay
- combustion phase- combustion velocity increase
- hydrocarbon in the wall layer and CO finish burning phase.

In Poland, the first information about internal catalyst made on ceramic coat appeared in the works of Merkisz and Walkowiak [3].

2. Model position

For the purposes of the present work, as the active factor platinum and rhodium have been chosen- the precious metals commonly used in catalytic transducers destined for purifying exhaust gases from internal combustion engines.

Extracting literature data, there have been worked out the procedure of depositing the catalytic coats (platinum, rhodium) on the cylinders used in trials on the model researches seats and on the engine construction elements which have direct contact with air-fuel mixture in the combustion space.

The coverage of the method of depositing the active factor on particular engine elements can be divided into three stages:

- Stage I. The choice of way of depositing precious metals on the ceramic layer.
- Stage II. Implementation of catalytic coat on the proper seat elements for model and actual researches .
- Stage III. Physicochemical researches of coats with catalyst.

In order to determine the effectiveness of the working of catalyst applied on the zircon coat made on engine valve, there have been built the seat for model researches. It has been decided to make the seat based on real engine elements. For this purpose, there has been applied the fragment of engine head with valves and piston which was placed in the cylinder made of eutectic alpaks, on which the spiral electric heater with power of about 2kW has been placed. The heater was supplied by autotransformer system which allows to regulate heating power. The model has been tooled up in the regulating system of piston and valves position. In the space over piston there have been placed 5 thermocouples enabling the temperature changes observation. As working gas, the fumes out of working ZI engine were used. During the researches the composition of fumes leading and carrying out of model has been analyzed. After initial trials there has been assumed that the measurements will be taken out with the catalyst temperature of about 250^{o}C by the fumes flow at about 30l/min. The scheme of model position is presented in the fig. 2.1.

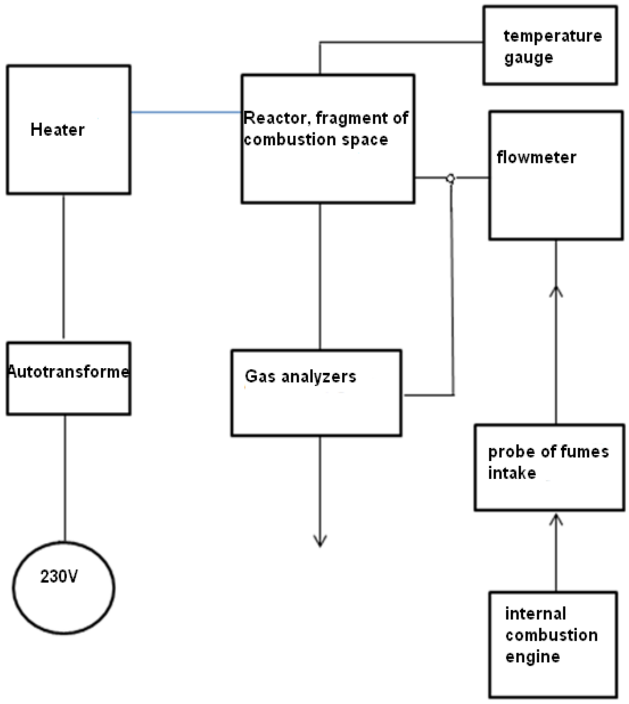

Fig. 2.1. *The scheme of model position for effectiveness of the internal catalyst researches.*

Assembled model position has been placed in the cubicycle of the roller performance tester near the engine which was used as the fumes generator. The view of the position is presented in the fig. 2.2

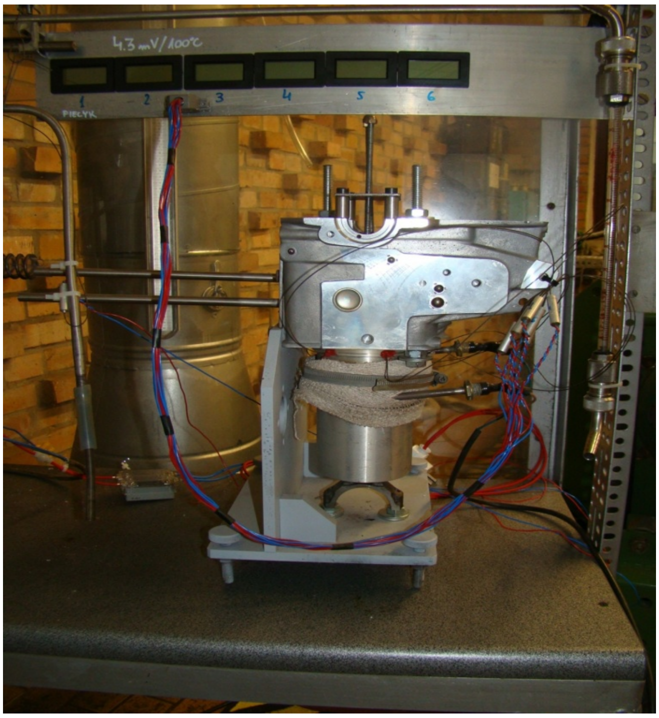

Fig. 2.2. *The view of model position.*

3. Research Methodology

As an operating factor in model systems the fumes from spark ignition engine working on idle running were used. The fumes composition in the range of CO and NO was measured by analyzer from the Hartmann- Braun company, which was working on the basis of nondispersive absorption in infra red, CO_2 and HC analyzers of Junkalor company, which were working on the same basis.

The temperature of fumes and system elements were measured by iron-constantan thermal couples with electric compression and electronic digital display.

The fumes flow strength was measured by the flowmeter with flow support of electric flow pump.

Measurements were made by heating of the reactor system by the use of electric heater which power was regulated by autotransformer with the system stabilizing the temperature.

4. Results of model researches

The researches were made with the use of engine valves with the plasma jet priming layer of zircon ceramic and also applied according to methodology presented in chapter 4 the platinum- rhodium catalytic layer. The valves were placed in the fragment of head in the open position, which enables the flow of the provided factor to the seat through the flexible cord from the fumes intake probe from the engine exhaust system. The system was electrically heated acquiring demanded temperature values of the factor.
There have been carried out series of measurements for three temperature values. The measurements results are presented in the following consolidation (table 4.1)

Table 4.1. *Researches results in the combustion space model.*

Lp	CO %	CO_2 %	HC ppm	NO %	Temp. ^{0}C
1	3,23	3,44	70	0,20	150
2	3,15	3,50	62	0,20	200
3	3,0	3,58	58	0,22	250

And in the fig. 4.1 *where the process of CO and HC concentration changes are presented.*

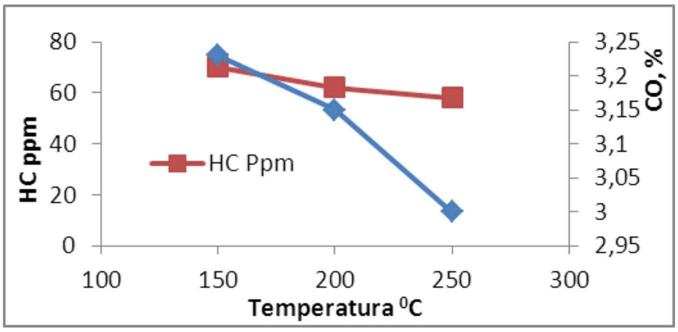

Fig. 4.1 *. Measurements results of the effectiveness of catalytic coats in the model studies.*

5. Conclusions

- There have been carried out the model researches of solutions series of active coats estimating the influence of internal combustion catalysts on the concentration of fumes toxic components and obtaining their essential reduction.
- The model researches reaffirmed the effectiveness in internal combustion catalysts in CO and HC reduction. There has been affirmed the CO and HC concentration loss of about 10% with the temperature change from 150 to 250 ^{o}C.
- On the case of hydrocarbons there has been affirmed the group composition change of HC compound. The changes of concentration proportions for particular groups of components were essential just for the temperature of 200^{o}C. This phenomenon has been decided to be explained in the further researches.

6. Literature:

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