NOWDAYS ASPECTS OF THE SELECTION OF THE PARAMETRS OF THE INJECTION OF THE FUEL IN DIESEL ENGINES

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Abstract

In the article one introduced the problems of the selection of diesel engines injector nozzles parameters and limitations of the pressure of the fuel injection. One talked over conditioning being with the stimulator of their systematical height. The methods of the selection guilty so to embrace, except the selection of constructional parameters , also the selection taking into account concurrent occurrences , for example the pressure and the speed of injected fuel or the stress distribution. One executed analyses of restrictive factors of the endeavour to the further lifting of maximum values of the pressure of the fuel injection. In the recapitulation one underlined important of the problem and his participation on the future development diesel engines.

Key words: diesel engine, development, new technologies, fuel equipment

1. The introduction

Is difficulty univocally to give methods of principle of the selection of parameters of injector nozzles, considering additionally their influence on impurities of combustion gases of the diesel engine. The methods of the selection, taking into account the environment protection, cannot assemble exclusively on parameters of the part executive, is what just the injector nozzle. It should make allowance for also the construction and parameters of co-operative parley and reasons and consequences of concurrent occurrences to the injection and the atomization of the fuel in the cylinder of the diesel engine.

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Considering placings requirements and occurrences happening {reaching} in the correctly working nozzle, methods of the selection of parameters of constructional injector nozzles one can divide on two core groups:

a) methods of the selection:
- methods optimization, leaning on the theory of the optimization of the construction,

− methods simulatory, leaning on findings with the use of specialized computer programmes (for example the stress distribution and thermal charges);
b) empirical methods of the selection:
  − methods visualization leaning on the investigation (for example by means the instrument AVL Engine Video System) of the construction {the build} and the shape sprayed fuel,
  − motor leaning methods on the practical investigation of sets of injector nozzles about accepted parameters with the regard of measurement of concerning issues of toxic relationships.

2. The selection of parameters of injector nozzles by means mathematical optimization methods

These methods consist in finding of best solution (in relation to the settled criterion) from the set of possibly (admissible) solutions. The conduct relies so on the research of the value of parameters for which is the realizing condition determining recorded mathematically the criterion of the examined occurrence, at the realization of recorded mathematically limitations.

The course of optimization problem one can divide on three stages:
  − the acceptance of the criterion function and suitable groups of independent variables,
  − the elaboration of the set of limitations,
  − solution of optimization problem.

As the criterion function one can accept one from parameters of the work of the engine, for example the effective power N_e or the moment torque M_o. Answering to them independent variables will be each parameters of injector nozzles.

These parameters are treated independently, in the reality however the influence on the issue of impurities of combustion gases and the power or the moment generated by the engine have all combinations of occurrent sizes in at present the investigated injector. The only individual approach to every size gives the full possibility of the use of worked out technics and optimization algorithms.

The most of performance characteristics of the diesel engine can be approximated with the polynomial quadratic. Solution of the assignment must contain himself in the set of solutions admissible, appointed in our chance by admissible values of the issue of toxic relationships in combustion gases. This postulate assure only restrictive non-linear conditions, irregularity, for example HC_{tot} (parameters of the nozzle) $\leq HC_{totDOP}$.

Solution of optimization problem consists in the effective research the minimum of the criterion function in the admissible area traced by limitations - for example on the delimitation of the direction research of the point the minimum and on his qualification.

This type the approach to the theme of the selection of parameters of injector nozzles is, thanks to the quick development of computers and their possibilities counting, more and more often practical, from the regard even if on low costs of working out of optimum- solutions.

One cannot here however forget that is this typical theoretical approach and not always finding of best theoretical solution ties in with his immediate use in effect, because the progress in the development of computational methods considerably outdistances possibilities of their utilization in real model solutions.

Heaps of times on the hindrance to these best mathematical solutions stand up technological limitations or rememberings strength of materials limitations.

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                    ┌─────────────────────────┐
                    │      Optimization       │
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Optimization
of selection nozzles parameters
with research Ne max
with limitations:

$e_{HC,PM,NOx,CO}\left(h_i,L_d,l_d,l,b,\alpha,d_{cr}\right)\le e_{HCdop}$

Polyoptimization
of selection nozzles parameters
with research minimum:

$e_{HC,PM,NOx,CO}\left(h_i,L_d,l_d,l,b,\alpha,d_{cr}\right)$

for $Ne_o \ge 0,95$ Ne

Optimization
With method multicriterial analysis
Determine optimum solution of injector
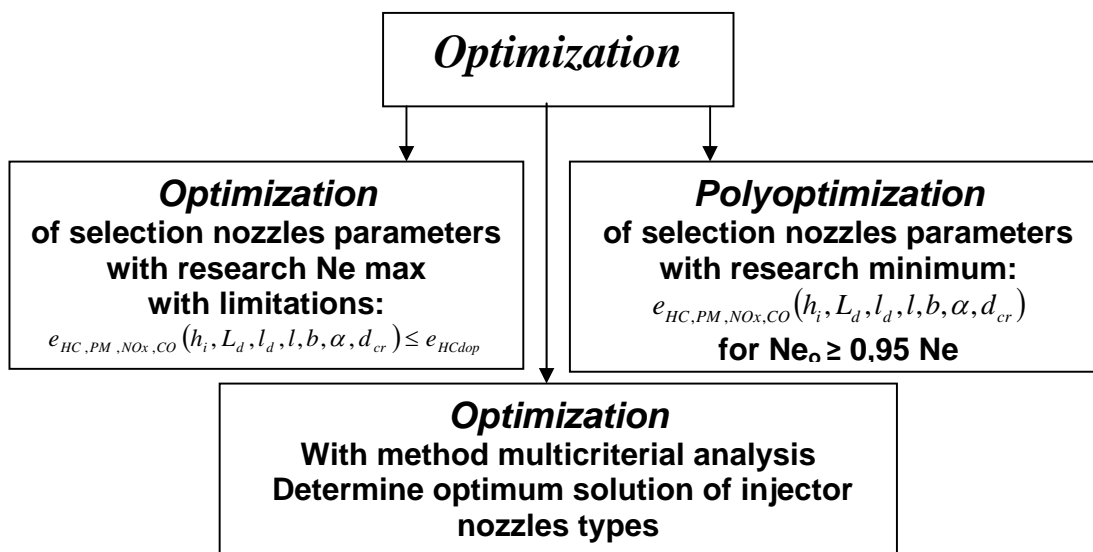**nozzles types**

Fig. 1. Methods of the optimization of the selection of parameters of injector nozzles [2]

3. The selection of parameters of injector nozzles with the regard of the shape and the construction of the stream

The spray pattern of the fuel, his construction, the quality of spraying - the drop diameter and their schedule chiefly decide about the degree of the entire and complete combustion in the cylinder of the diesel engine, and what himself with this binds and emissivities of this engine.

For the purpose of the graphic performance of the quality of spraying one prepares the characterization of the proportional participation drops of the fuel in the dependence from their diameter. These characterizations are often called in the literature unjustly a phantom of spraying; in reality are a thickness of the probability of drop diameters and can be prepared for different of their decisive sizes about spraying.

In at present produced engines self-igniting more and more are more often practical injectors with two spring which make possible the realization of the two-grade injection. How show research, the use of the two-grade injection and injector nozzles VCO lowers the issue of nitrous oxides and hydrocarbons in combustion gases [1].

Simultaneously research showed that such fuel injection conjointly with injector nozzles VCO unfavourably bore on the smokiness of combustion gases. Enlarging smokiness is especially visible at low engine loads.

4. The selection of parameters of injector nozzles with the regard of limitations of the height of the pressure of the injection

Introduced to production engines are already provided into container parley Common Rail of the second generation, with enlarged pressure of the injection (160-180 MPa), in nearest years one foresees the enlargement of the pressure even to 220 MPa.

Nascent tensions at pressures 200 MPa are already too large for the persistence of some elements, first of all talked over injector nozzles. In spite that trunks of injector nozzles are executed steel

chromic-nickel-tungstenic, about the large endurance on the extension, this however due tensions with high pressures of the injection can reach the border of the plasticity of given material. Such state of the load can as result of of the fatigue of material bring to the damage of the sprayer.

Calculations of the nozzle with eight holes [2] whose the section one showed on the fig. 2, laden with the pressure 200 MPa and with the pressure 300 MPa, so such, what appears at the destruction of the sprayer in some parley of the power supply, showed that greatest tensions came into being on the passage of the nest of the cone-shaped trunk into the well. They carry out for the first chance 710 MPa, while for second 1065 MPa. Large tensions come into being also at edges of intake- injection's openings and carry out properly 510 MPa and about 947 MPa. Itself bottom of the well is not strongly laden, because prevalent there tensions in the dependence from the pressure of the fuel hesitate from 80 to 125 MPa. From these calculations it results that the pressure of the injection carrying out 300 MPa seems greatest, possibly to the usage for the fuel injection in the diesel engine for the endurance and the persistence of injector nozzles. So high pressures demand usages of materials about greater than till now endurances on the extension, what doubtless increases costs of the realization of injector nozzles. Practical until quite lately universally to this end chromic-nickel-aluminium steels, chromic-nickel- tungstenic and similar, are taken place steels about the greater endurance, for example steels nickel- and other modern materials. Such are carbide-steels in which the participation of carbides, mostly TiC, carries out to 50%. Constantly these, after the heat-treatment, attain the hardness about 70 HRC, even in elevated operating temperatures and the large resistance on the erosion and cavitation, are however difficult in the tooling and expensive.

On injector nozzles of greater engines it begins to comply stellites. This are very hard alloys (What - 65%, Cr - 25%, In - 5%, C - 2% and V, Fe and other) about the very small linear expansion, what causes the very good dimension- stability in elevated temperatures, the high abrasion resistance and the resistance on aggressive fuels, the corrosion and the oxygenation.
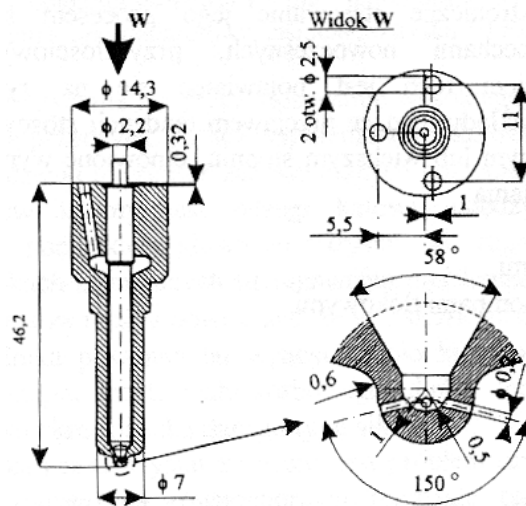

Fig.2. Injector nozzle with eight holes [2]

Stellites have the high price, but are not as usual permanent and make possible the diminution of the mass of the nozzle, what for greater injector nozzles begins to be profitable economically.

The height of the pressure of the injection can be also limited by the compressibility and the stickiness of the fuel, and also rectifier valves master with the flow of the fuel which will have to quickly and unfailingly to work conditioned of enlarged loads.

The diesel fuel under the pressure 300 MPa diminishes her own volume about 15-20%. Such his wring at small doses of injected fuel can cause disturbances of the injection. Higher pressures cause also the height of the stickiness of oil, what favours to the formation large, badly burning up drops of the fuel.

5. Conclusion

Introduced problems of the selection of parameters of injector nozzles show as not as usual difficult is optimum- synchronizing of all parameters, so that they realize requirements placed to the present diesel engine, inclusive of with more and more sharper ecological requirements.

Perfecting of the injection′s apparatus in today′s engines of this type, with taking into account of norms of concerning issues of impurities, is one from most important criteria of the choice of best solutions of these decisive engines about the success of chosen constructions.

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