RESEARCH IN ENGINE POWER PARAMETERS WHEN CHANGING THE ADJUSTMENT OF THE DISTRIBUTION PHASES

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Abstract. The article presents the research in the influence of the automobile Nissan 200SX distribution phase regulation on the power of the automobile and the torque. The shafts have been adjusted with a step 1^o. The optimal regulation of the distribution phases has been obtained that corresponds to the position of the inlet valve camshaft – 2^o (2^o sooner) and the position of the exhaust valve camshaft 0^o. At such regulation the average increase in power by 1.6% has been obtained and the increase of the torque – by 6.4%. The adjustment of the camshaft cams for other brands of automobiles has to be done individually.

Introduction

The notion of engine acceleration includes many different measures but a common aim of all these measures is to change the character of the engine operation parameters. It does not always mean to obtain maximally great power. Often exactly the torque is the most important and decisive. The importance of this characteristic feature of the engine is determined by the exploitation conditions of the automobile.

If the automobile is operated on a highway where the operation regime requires mainly high speed and high engine revolutions, the engine power will be the decisive factor. In turn, if the automobile is used in the conditions of rally where the speed is often changed and the engine operates more in middle and low revolutions, the torque will be the decisive factor.

One of the most important elements influencing the character of the engine is the gas distribution mechanism. The choice of the shape of the camshaft cams and its exact adjustment ensures the desirable character of the engine parameters. Knowing the expected conditions of the automobile operation also the needed camshaft is selected. In turn, an adjustable camshaft cam will help to adjust the distribution phases exactly for a definite engine and its operation regime.

Standard engine adjustment is based not on the obtaining of the maximal power of the engine or the torque but on the protection of the surrounding environment, saving of fuel and sustainability of the engine.

The aim of the research is by using of adjustable camshaft cams to find a position of regulation that ensures maximal power and also a position of regulation for maximal torque in relation to the factory standard adjustment.

Methods and equipment used in the experiments

Characterization of the experiments and the automobile

The experiments are carried out in laboratory conditions on a cylinder power stand MD – 1750. The ambient temperature in the laboratory is in the range from +19 ^{o}C to +21 ^{o}C, the air pressure is 761 mm/hg.

Before the measurements the automobile is fastened on the stand, the parameter recording devices are installed and the stand is prepared for work or the stand is heated till normal operation temperature of the units. During the experiment one kind of tests is used – “Power Curve”.

In the experiment an automobile Nissan 200SX with a 1.8 liter turbo engine and the engine code CA18DET is used. The engine construction is formed with two overhead located camshafts that are driven from the crankshaft pulley by a tooth belt. Instead of the existing standard camshaft cams modified cams with adjustment possibilities are mounted (See Figure 1).

Engine CA18 DET characteristics:

- operation capacity – 1809 cm^3;
- compression level – 8.5;
- actual power on the wheels in the third ratio before the experiment – 204 Hp / 6900 min^{-1};
- actual torque on the wheels in the third ratio before the experiment – 235.3 Nm / 5300 min^{-1}.

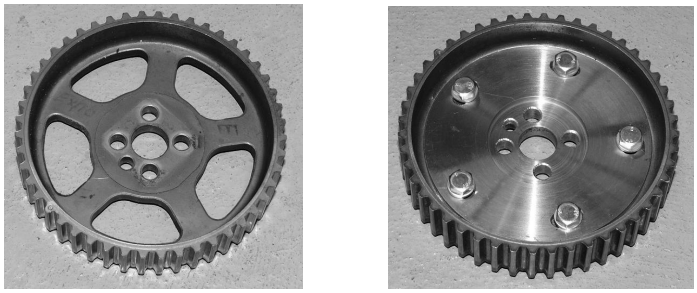

Fig. 1. **Standard and adjustable camshaft drive cam**

Equipment used in the experiment

For determination of the automobile power and the torque a cylinder type power stand Mustang MD – 1750 is used. The main parameters of the stand:

- maximal measuring power – 1750 Hp;
- maximal measuring speed – 360 km/h;
- maximal axle load on the cylinders – 4500 kg.

The control functions are carried out by the personal computer with MD – 7000 control platform.

Methods of the experiment

The main task of the experiment is to record the main parameters of the engine – power and the torque at different positions of the camshaft drive cams. Before starting the adjustment power is measured in order to obtain the initial data. As the automobile engine has two camshafts and with this also two drive cams, both gears are adjusted. At first we obtain the optimal torque and power at the adjustment of the inlet camshaft drive cam. After that besides these optimal inlet camshaft drive cam adjustments the exhaust camshaft cam is adjusted and the maximally possible torque and power are obtained. The procedure scheme of the experiment is shown in Figure 2.

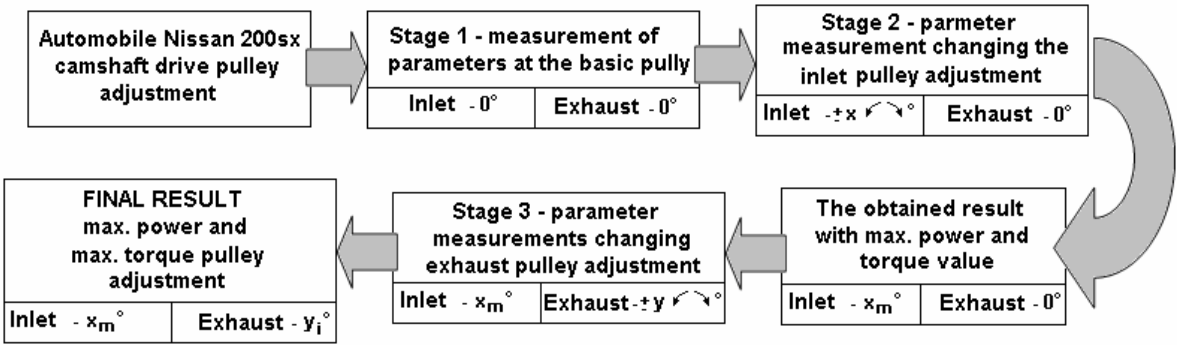

Fig. 2. **Procedure of the experiment**

The step selected for the adjustment is 1^o. Every measurement is repeated three times. The measurements of power and the torque are carried out with the third ratio ($i_3 = 1.361$), that is not the direct ratio ($i_4 = 1.000$). Such a regime has been selected in order to reduce the total loading time of the automobile and the engine and it does not influence the result of the final aim of the experiment. In relation to the fact that from the end of the exhaust shaft the ignition impulse sensor is driven, adjusting the exhaust shaft drive cam also the engine impulse moment is changed. To avoid the influence of this factor on the results of the experiment after every adjustment of the exhaust shaft drive cam also the ignition moment is readjusted in accordance with the requirements of the engine producers.

Figure 3 shows the results of the second stage, that is, the adjustment of the inlet valve cam. The curves – 1 show the power and the torque at the standard camshaft position. The curves – 2 show the power and the torque adjusting the inlet camshaft by 2^o sooner. Continuing to adjust the camshaft by 3^o sooner – the power and the torque start to fall again but these parameters still are higher than the power and the torque at the standard camshaft adjustment. The curves – 3 show the power and the torque with the adjustment of the inlet camshaft by 2^o later.

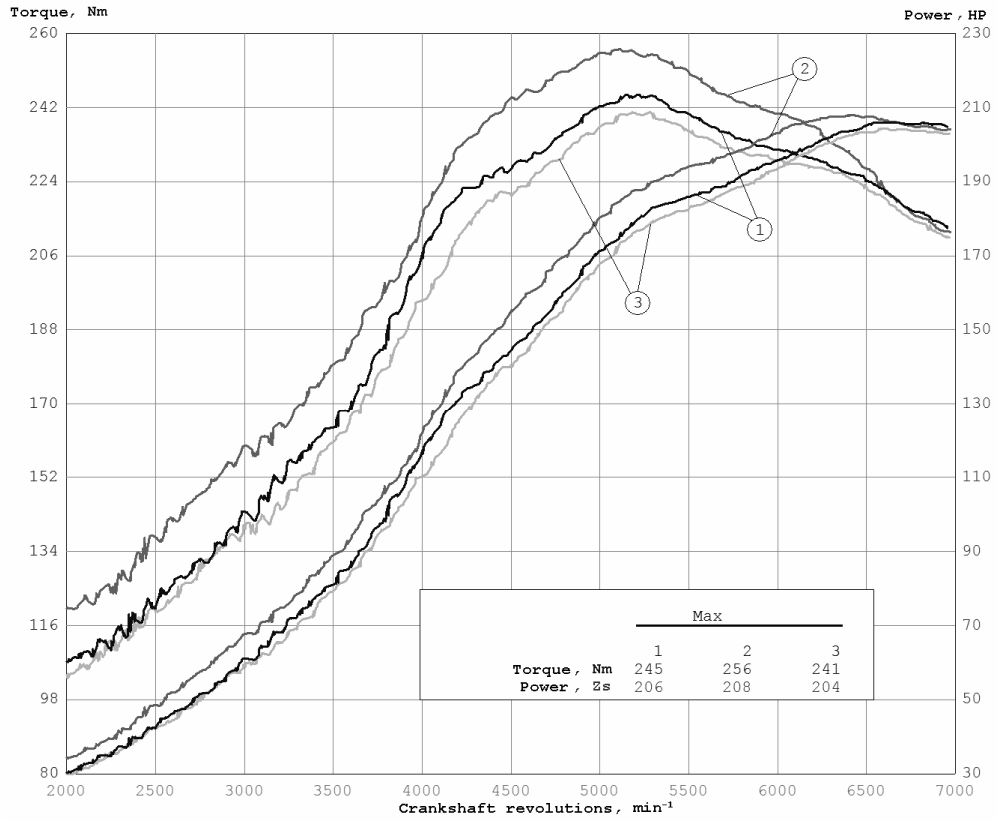

Fig. 3. **Characteristic curves of the power and the torque adjusting the inlet camshaft drive cam**: curve 1 – countdown point – inlet 0^o, exhaust 0^o; curve 2 – inlet 2^oA (sooner), exhaust 0^o; curve 3 – inlet 2^oR (later), exhaust 0^o

Adjusting the exhaust shaft at the position of the inlet shaft by 2^o sooner there is no increase of the power or the torque. Figure 4 shows the maximal effect that can be achieved for the given automobile adjusting the camshaft drive cams by a step 1^o.

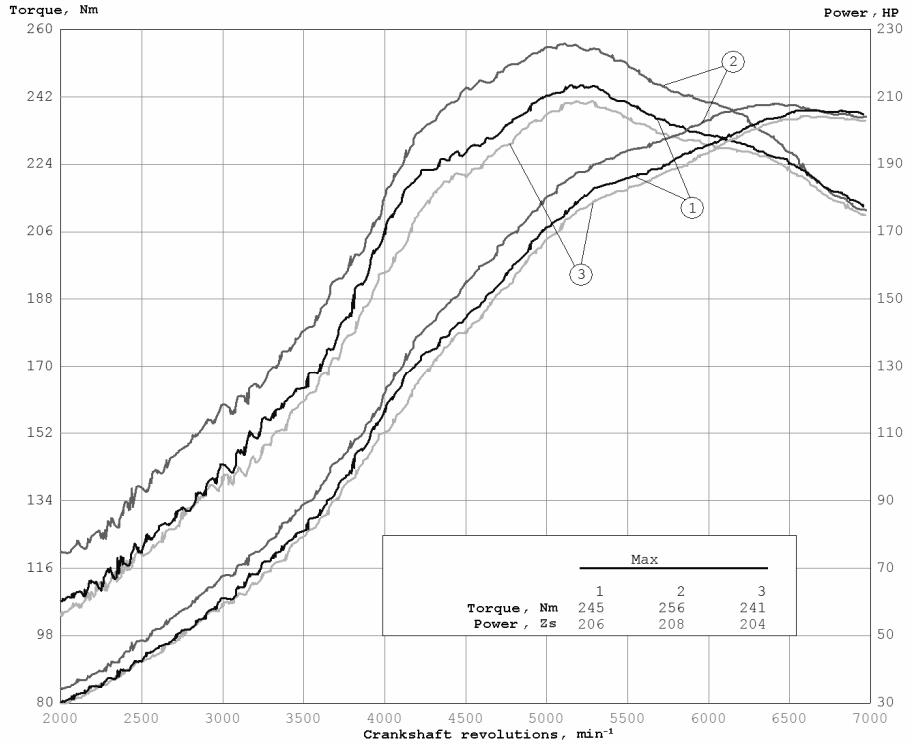

Fig. 4. **Characteristic curves of the power and the torque before and after adjustment**

In the diagram every characteristic curve of the power and the torque is constructed using three average values of the experimental result. According to the results of the diagram it can be seen that before adjustment the maximal power on the wheels was 204 hp at 6900 min^{-1} and the torque was 235.3 Nm at 5300 min^{-1}. After adjustment the maximal power is 207.3 hp at 6600 min^{-1} and the torque 250.3 Nm at 5100 min^{-1}.

Figure 5 shows the gas distribution phase diagram at standard adjustment (a) and at the optimal obtained adjustment (b). At optimal adjustment the shaft overlapping angle has increased from 9° to 11°.The possible increase of the power and the torque has been achieved exactly by the influence of this factor. Better cylinder filling with the fresh fuel air mixture is obtained.

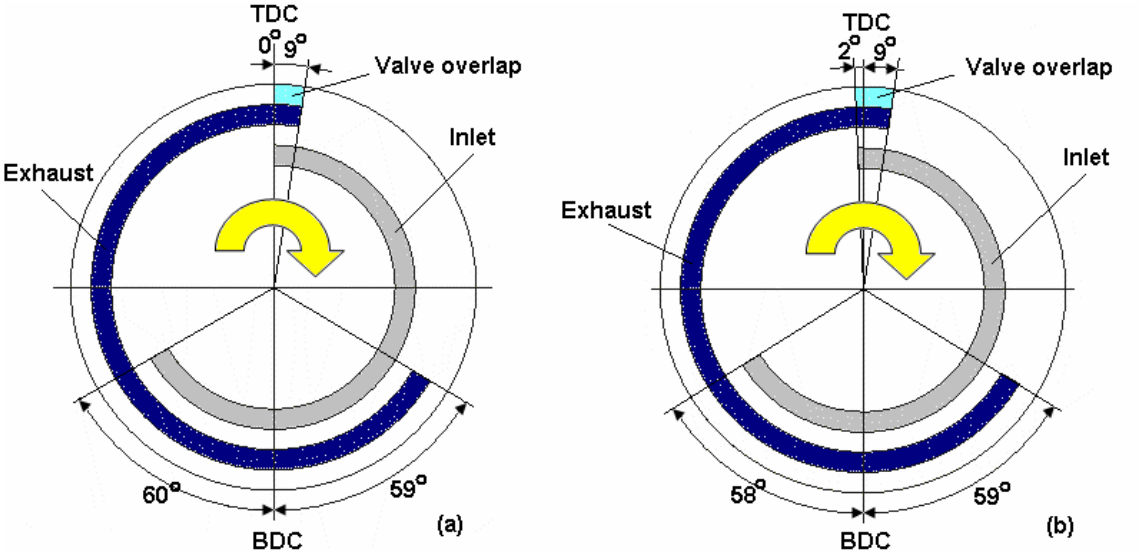

Fig. 5. **Diagrams of gas distribution phases**

Conclusions

1. One of the ways to increase the power of power vehicles is optimal adjustment of the camshaft angles.
2. For power vehicles with two camshafts it is useful to do the adjustment first for the inlet valve camshaft obtaining the maximal power and torque, but afterwards – for the exhaust valve camshaft.
3. The highest engine power N_k = 207.3 Hp at 6600 min^{-1} and the torque M_k = 250.3 Nm at 5100 min^{-1} are obtained with the adjustment of the inlet camshaft cam by 2° sooner than the standard adjustment.
4. At the adjustment of the inlet camshaft by 3° sooner a fall in the power and the torque are obtained in comparison with these parameters at the adjustment 2° sooner, but the obtained parameters are higher than at standard adjustment.
5. Changing the exhaust shaft adjustment angles increase in power is not obtained. The increase in power is obtained increasing the valve overlap angle from 9° to 11°.
6. Adjusting the shaft setting angle the increase of the power delivered to the wheels of the automobile by 1.6% has been obtained, but the increase of the torque delivered to the wheels – by 6.4%.
7. Adjustment of other engines should be done individually using the power stand or any other method of assessment of the dynamic parameters.

Literature

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