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SIMULATION OF VALVE OPENING POINT IN GASOLINE ENGINE USING THE DIESEL-RK SOFTWARE

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Abstract. *This work presents a theoretical study of the performance of a 4-stroke gasoline internal combustion engine, used as propellant of some vehicles currently produced in Brazil. This part of the study was adjusted the opening point of the intake valve using the best results obtained for combustion chamber shape and better intake valve diameter. To determine the best opening point of the intake valve, a 1D scanning simulation was performed.*

Keywords: *Computational Simulation, Internal Combustion Engine, Gasoline, Valve Opening Point*

1. INTRODUCTION

Internal combustion engines of the alternative type 4 times are widely used in diverse needs, mainly in the automotive area. The continuous evolution of the internal combustion engine, led by lowering the limits of consumption and polluting emissions, brings with it the need to design increasingly complex engines and sophisticated new technologies, able to manage all possible operating conditions. To meet the requirements of the standards and also of customers, surveys are carried out using current projects by computer resources, that allow the development of several engine simulations.

The simulation by means of engine models are critical as the aid for the creation of the control system of the respective subsystems. Currently the simulation of internal combustion engines alternative-type has been widely used by the factories and assembly plants with promising results, as it avoids some of the experimental trials, thereby reducing the cost and time of project. Doing the simulation of an engine enable, the possibility of get results more quickly, rather than develop the entire project until you reach the stage of testing. It would take a long time until this engine being tested on test benches and the cost would be very high.

2. DEVELOPMENT OF COMPUTATIONAL MODEL

For the development of this work of computer simulation, it was used the version free academic program DieselRK®. This software was developed by Kuleshov, in 1982. Is currently in version 4.3.0.189. Developed in Moscow State Technical University, Bauman became a commercial version in 1991. Here are the main steps of development of a given model.

The Diesel-RK[®] program starts with five windows to insert basic data from the desired, the following will be described. The first window has the function to select the work cycle, which can be 2 and 4 times, the type of fuel to be used and the method of injection of the engine to be designed (Kuleshov, 2008).

In Figure 1 an example of how the optimum opening point of the inlet valve can be seen. The point is adjusted respecting the octane limit that for this work was 90 octane; so the 1D scanning allows the user to identify where the best opening point is, not exceeding the maximum octane limit. The Diesel-RK software maps an octane chart and the intake valve opening point shown in Figure 5.18; in this case, as an example it can be seen that the best opening point for the inlet valve is around -10.1 ° before the upper dead center, since the octane limit 90 is at that point. This procedure was repeated for all engine operating conditions, sweeping all rotations with their respective work loads.

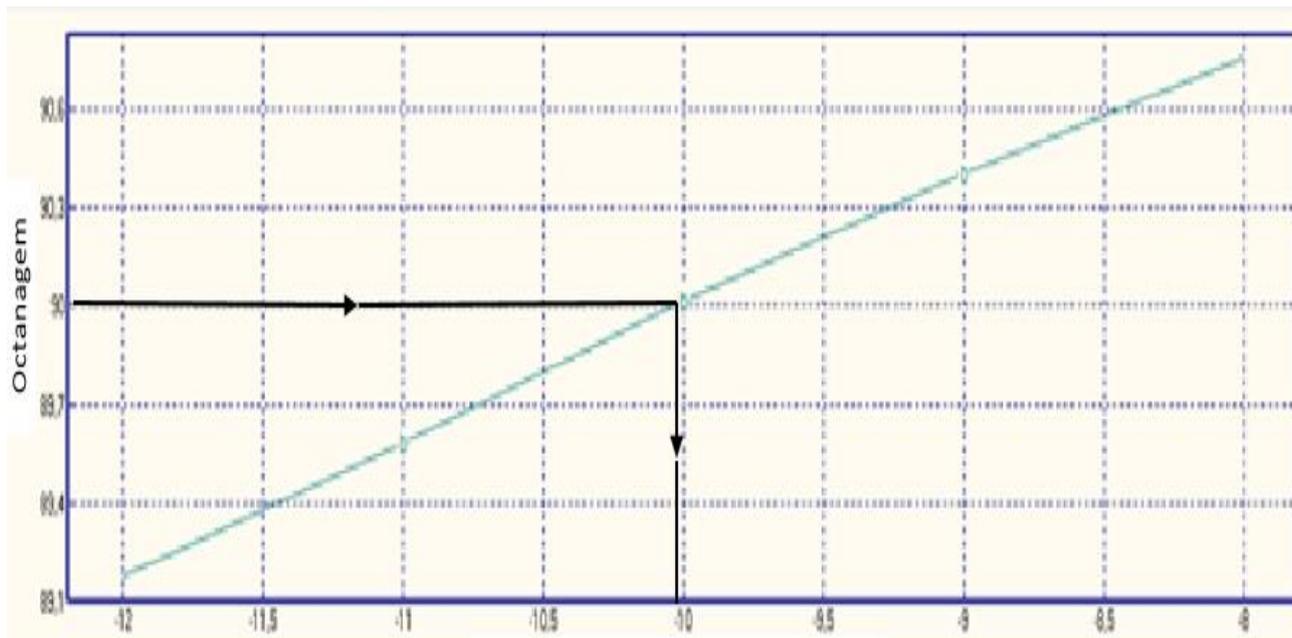


Figure 1. Adjusting the opening point of the intake valve on the Diesel-RK®.

3. RESULTS

Thus, the graphs of torque, specific consumption and performance for 1500, 3000, 4500, 6000 and 6900 rpm are presented.

Figure 2 shows the behavior of the torque curve with the inlet valve aperture point adjusted relative to the calibrated torque curve of the model for the 1500 rpm rotation. For this rotation, the motor showed a better performance than the calibrated values, at approximately 75% load. The engine showed a 32% improvement in its performance, with an average increase of 13.4% over the adjusted model.

Figure 3 shows the specific consumption for this same rotation range. The specific consumption had a significant reduction for low loads up to approximately 75% of load, but the average reduction for the whole range was of 2.7% in relation to the adjusted model.

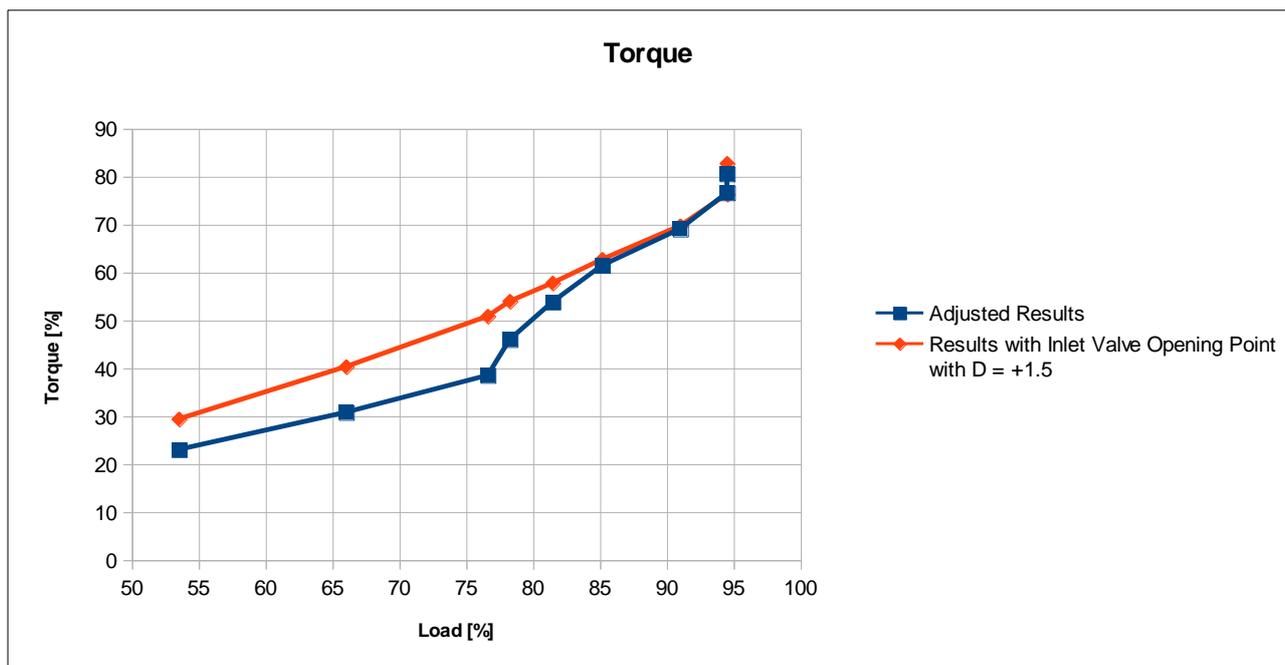


Figure 2 – Torque by Charge to the inlet valve set point adjusted, to 1500 rpm.

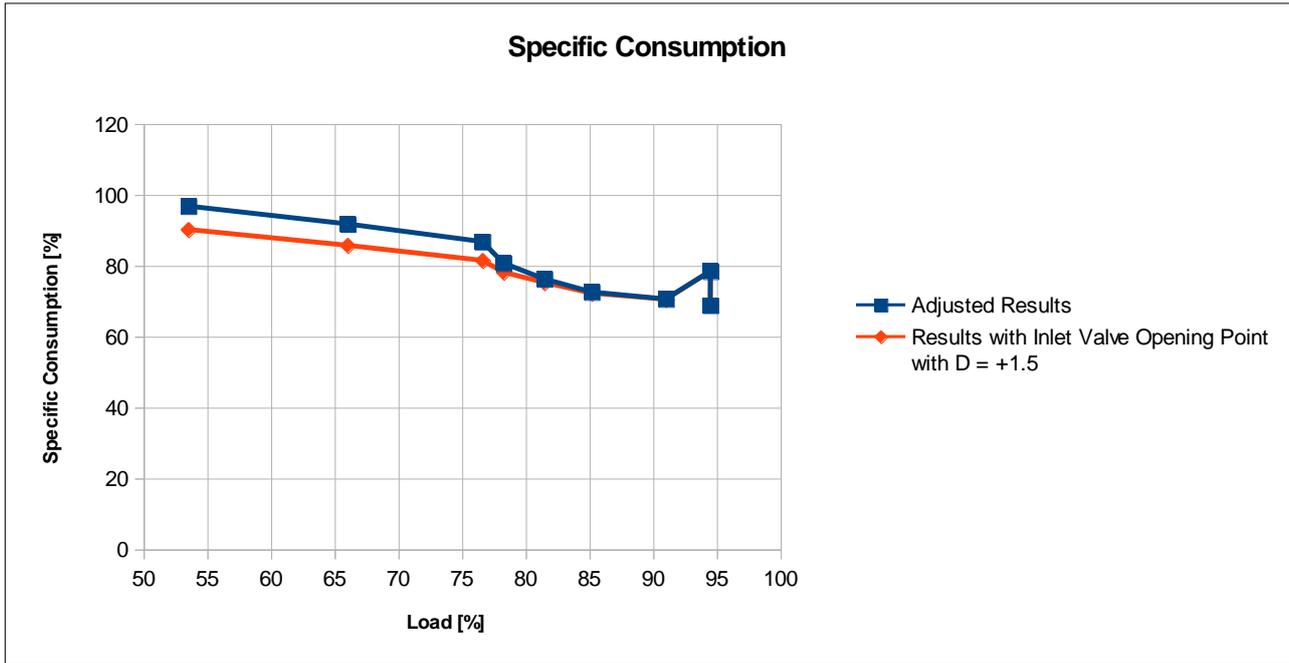


Figure 3– Specific consumption by the load with the inlet valve opening point adjusted, for 1500 rpm.

Figure 4 shows the throughput for the 1500 rpm rotation, where it can be noted that the engine with the adjustment of the opening point of the inlet valve has a better efficiency up to 80% load compared to the adjusted model. From this load the yield remains the same as the adjusted model. For this range of rotation, the engine presented an average gain of 2.9% in its yield.

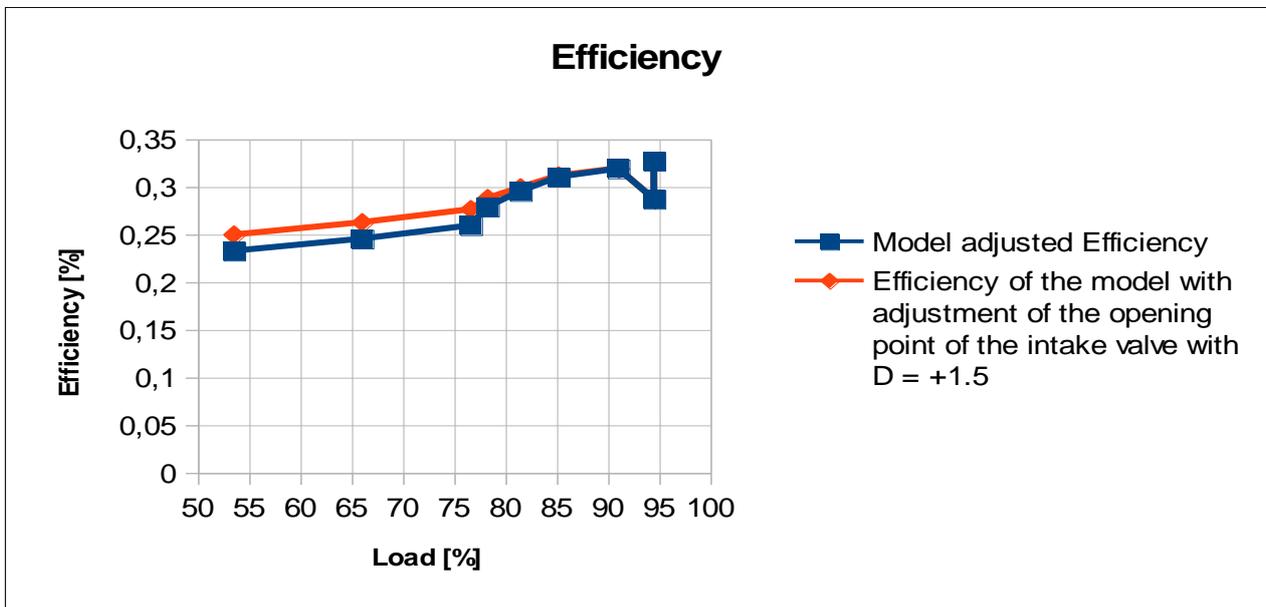


Figure 4 – Motor throughput for load for 1500 rpm rotation.

Figure 5 shows the behavior of the torque with adjustment of the opening point of the intake valve with the model adjusted for the rotation of 3000 rpm, where it is noticed that it has an increase of torque when the load is increased up to 90%, in relation to the adjusted model. With the adjustment of the opening point of the intake valve, the torque had an average increase of 12.8%, reaching 34% when the engine is at 75% load.

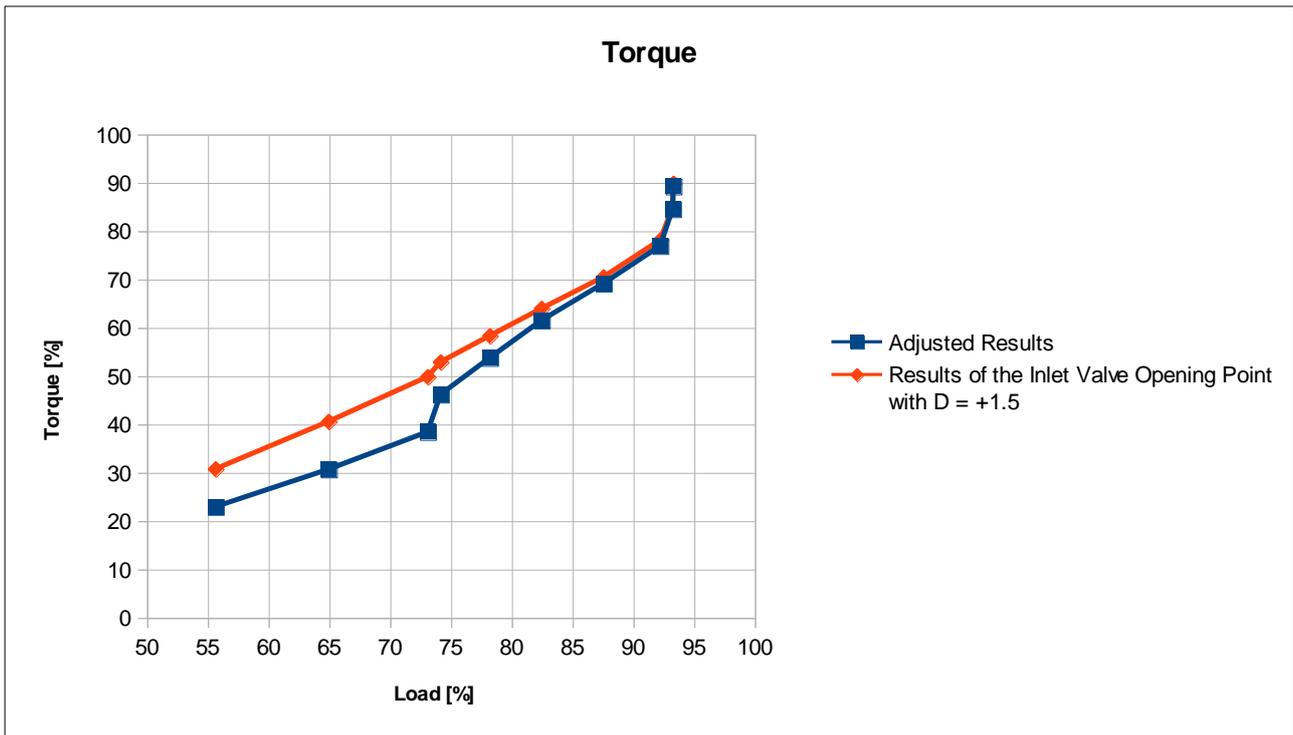


Figure 5 – Torque by Charge to the inlet valve set point adjusted, to 3000 rpm.

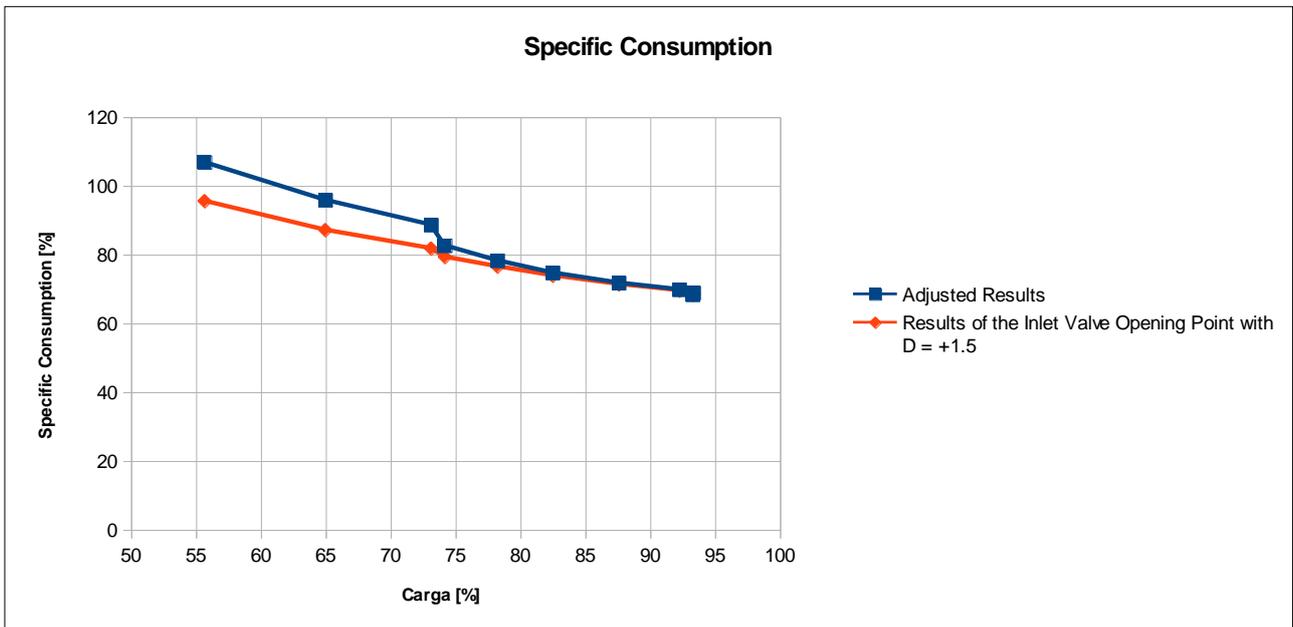


Figure 6 - Specific consumption by the load with the inlet valve opening point adjusted, for 3000 rpm.

It can be seen in the graph that the reduction of specific consumption goes up to about 85% of load in the engine. For this rotation, with the adjustment of the opening point of the intake valve, the engine presented an average reduction of 3.6% in fuel consumption for the entire load range.

Figure 7 shows the yield with the load for the rotation of 3000 rpm, where it can be noticed that, the engine trimming with the adjustment of the intake valve opening point there is an improvement of up to 85% engine load, from hence the yield does not show improvements in relation to the adjusted computational model. For this rotation the engine with the adjustment of the opening point of the intake valve showed an average yield of 3.9% over the entire load range. For low loads the model with adjustment of the opening point of the intake valve shows an improvement in the performance in relation to the adjusted computer model, reaching a maximum point increase of 11.8% with a 55% load on the engine.

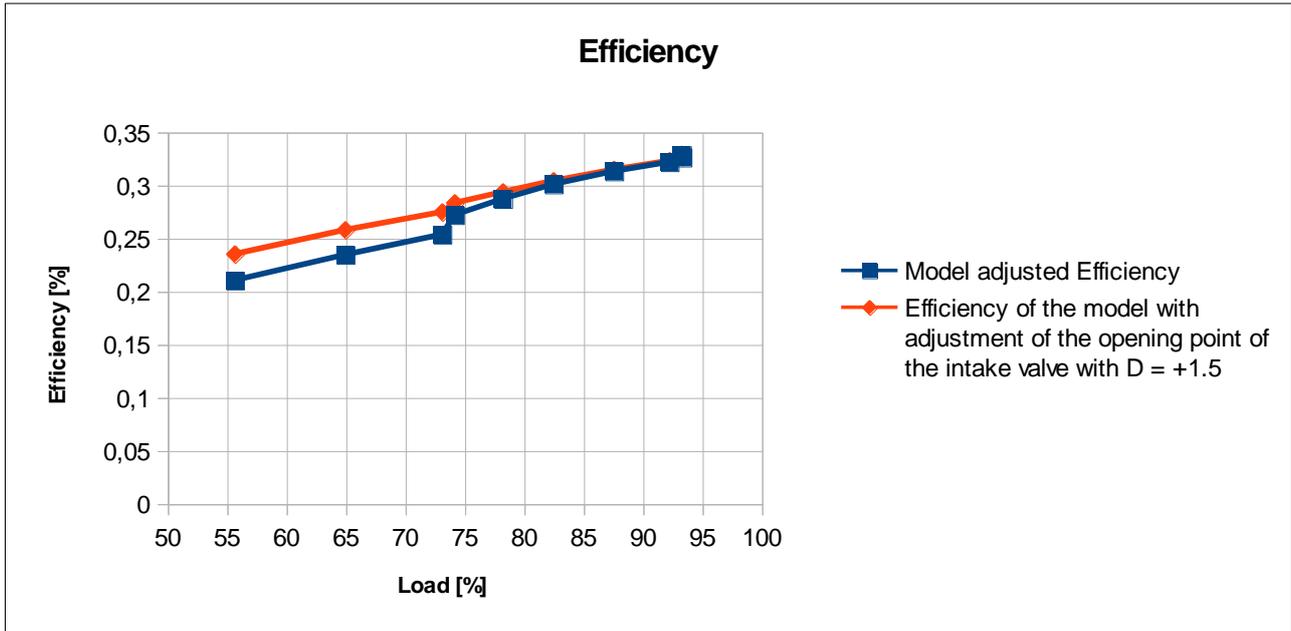


Figure 7 – Motor throughput for load for 3000 rpm rotation.

Figure 8 shows the torque curves with the load for the 4500 rpm rotation, where it can be observed that throughout the entire load range of the engine, the torque performed better at low and full load with the model, where the intake valve opening point has been adjusted. In intermediate loads, the torque did not present any gain in relation to the adjusted computational model. The model with valve opening point adjustment showed an average gain of 3.2% over the entire load range and a maximum point gain of 11.5% at low load.

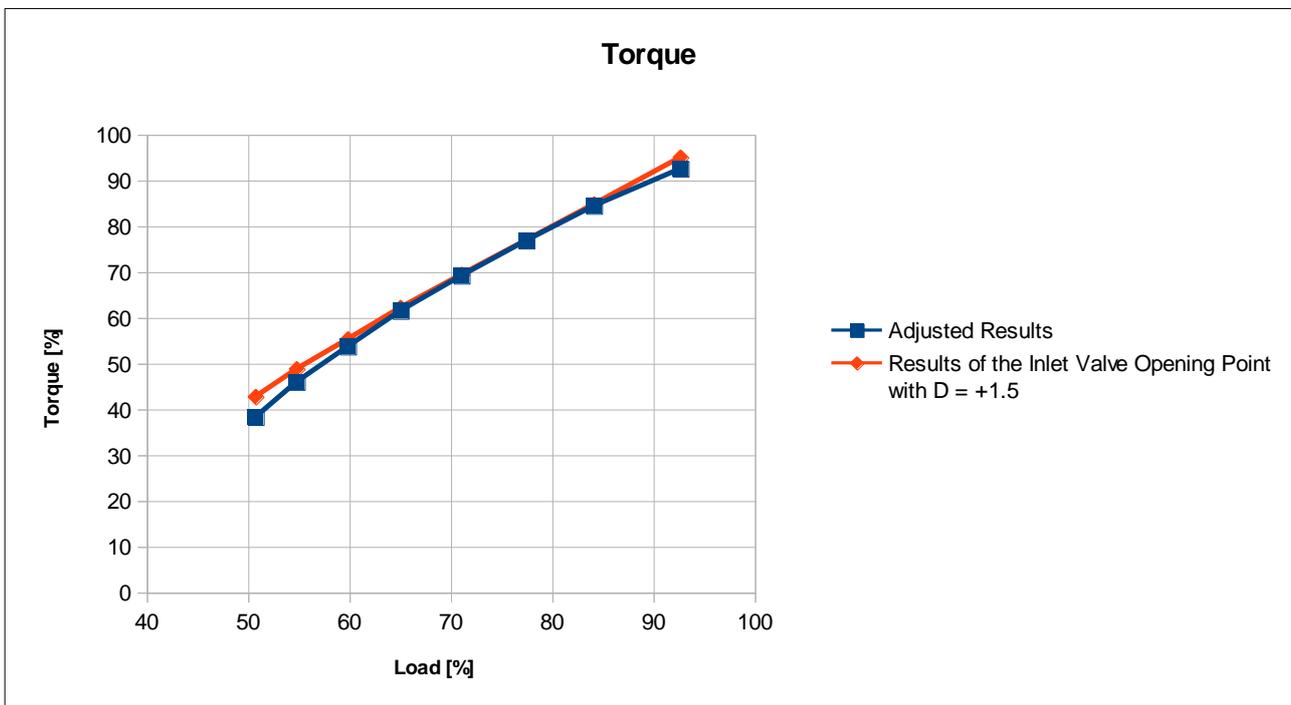


Figure 8 – Torque by Charge to the inlet valve set point adjusted, to 4500 rpm.

Figure 9 shows the behavior of the specific consumption curves with the load for the model with adjustment of the opening point of the intake valve in relation to the computer model adjusted for the rotation of 4500 rpm. It can be seen that for this 4500 rpm rotation, the model with adjustment at the opening point of the intake valve had a lower fuel consumption for the entire engine load range than the adjusted computational model. At low loads the model with adjustment at the point of opening of the valve showed a greater reduction, increasing a maximum value of 4.0% of economy, and also presented an average of 1.15% of fuel consumption for the entire load range for this rotation.

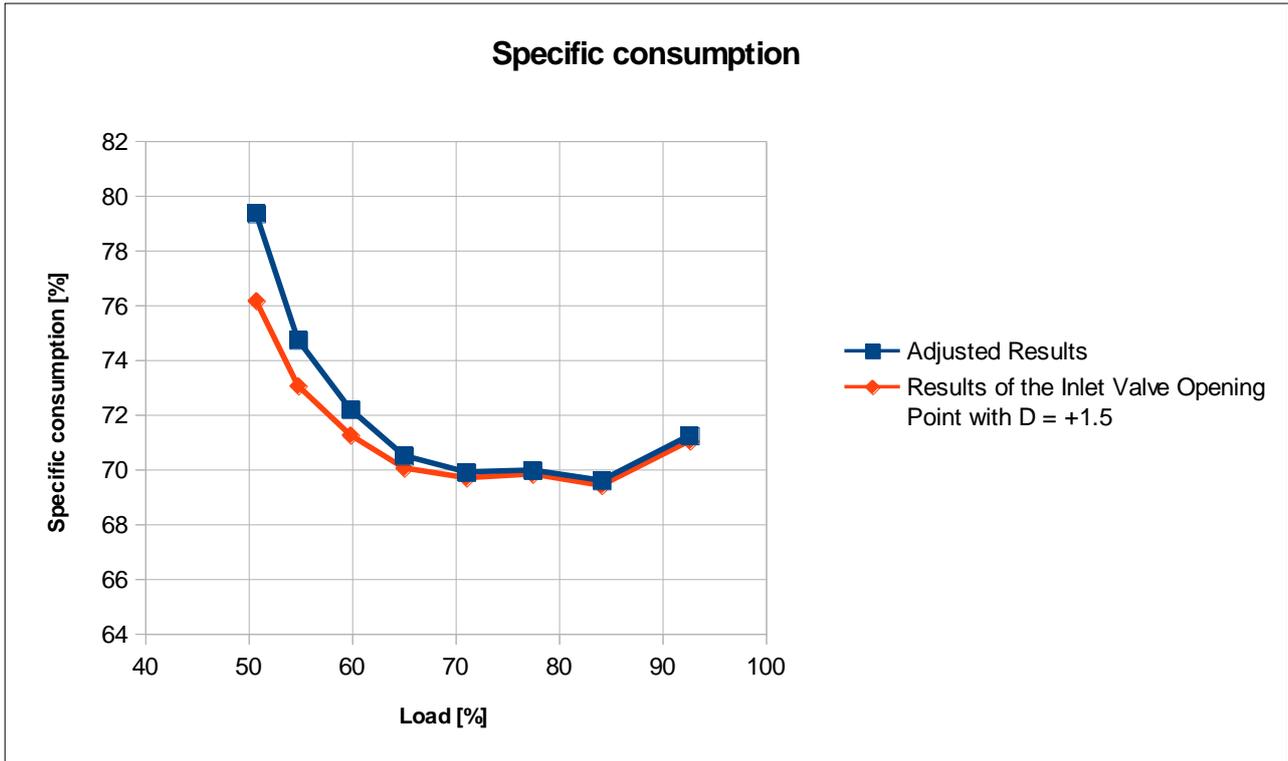


Figure 9 – Specific consumption by the load with the inlet valve opening point adjusted, for 4500 rpm.

Figure 10 shows the yield with the load for this same rotation of 4500 rpm, where it can be seen that the model with adjustment at the opening point of the intake valve had a better performance compared to the adjusted computational model. It can also be noticed that the model with adjustment at the opening point of the intake valve had a higher efficiency at low loads, approximately 65% load, where it presented a maximum point increase of 4.2% for the load of 50 %, and an average increase of 1.2% for the entire load range at this 4500 rpm revolution.

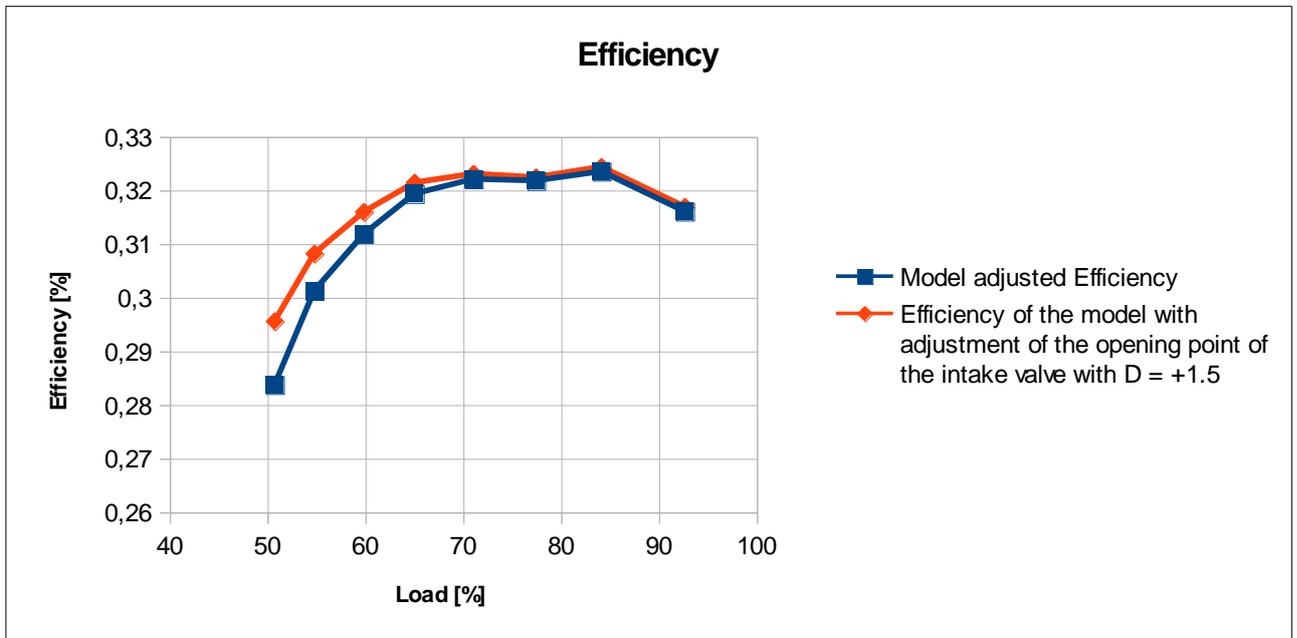


Figure 10 – Motor throughput for load for 4500 rpm rotation.

Figure 11 shows the behavior of the torque curves with the load for the model with adjustment of the opening point of the intake valve, in relation to the computer model adjusted for the rotation of 6000 rpm. Note that for this rotation, the torque with the model with the opening point of the valve is shown with a better result in relation to the adjusted computational model, for the entire load range of the motor. Thus for this rotation, the engine had an average torque

gain of 3.9% over the full load range of the engine, and with a load of 55% it presented a punctual gain of 7.3% in relation to the calibrated model.

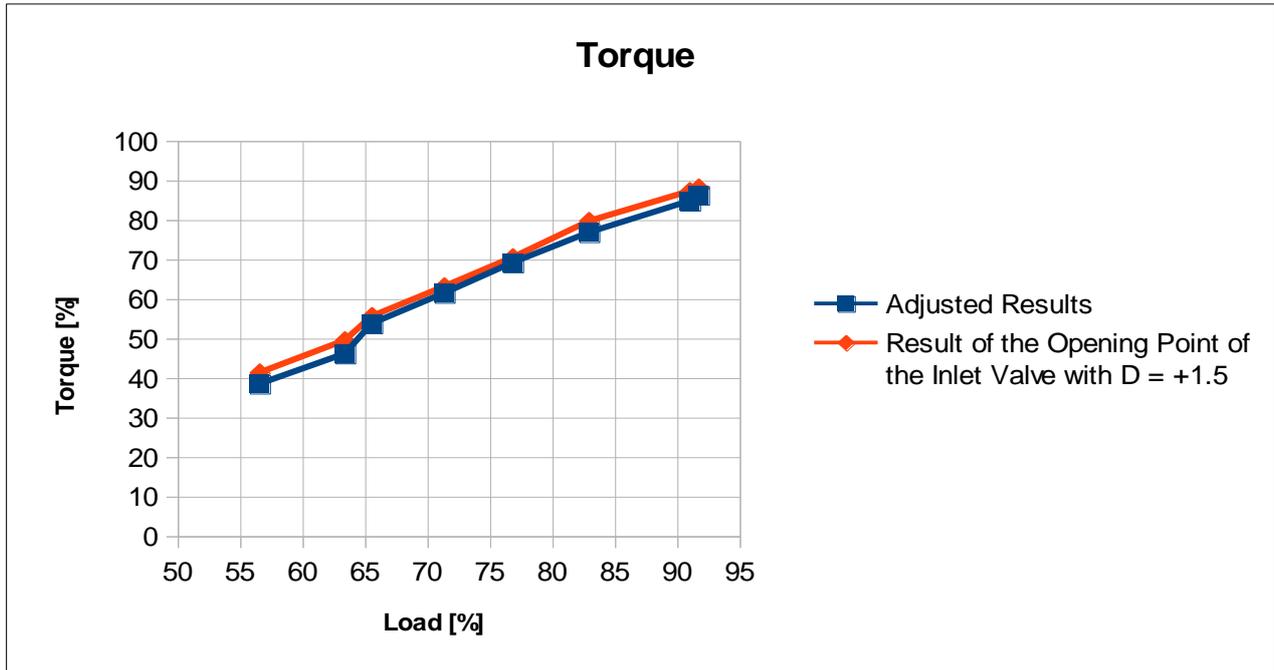


Figure 11 – Torque by Charge to the inlet valve set point adjusted, to 6000 rpm.

The specific consumption for the rotation of 6000 rpm presented a lower consumption for the entire load range with the model with adjustment at the opening point of the intake valve in relation to the adjusted computational model. Figure 12 shows the behavior of the specific consumption curves for both models. The model with adjustment at the opening point of the intake valve had a mean reduction in fuel consumption of 1.1%, in relation to the adjusted computational model, at some points such as 55 and 60% of load in the engine the model presented a reduction of consumption of approximately 2.2% for that rotation of 6000 rpm.

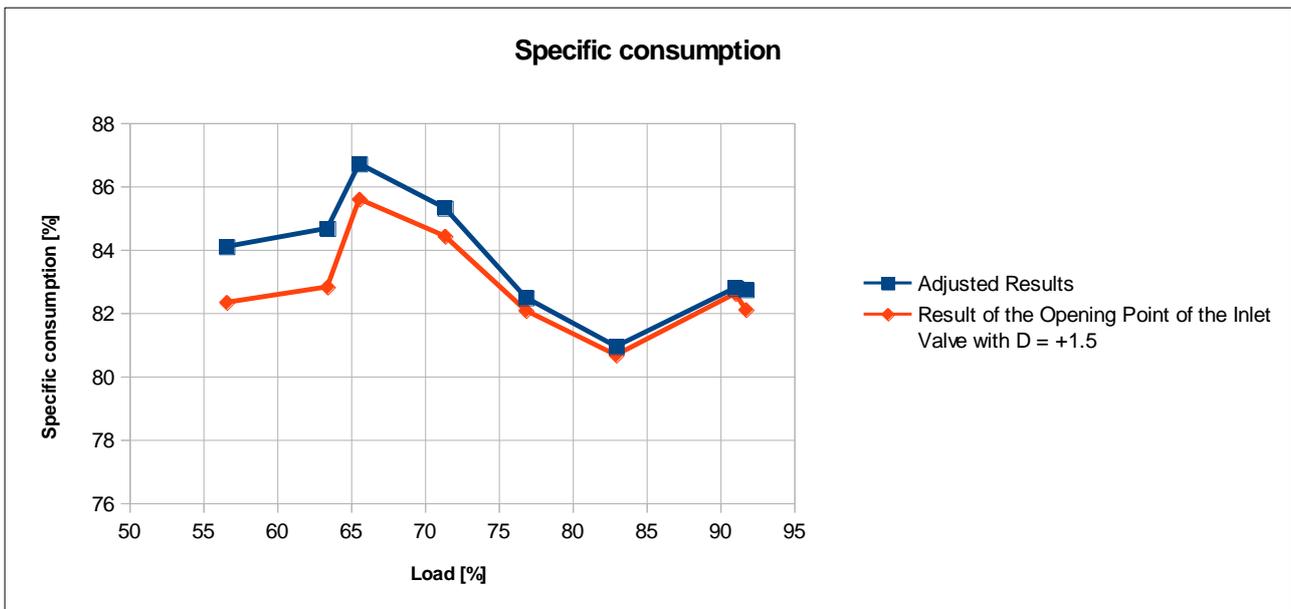


Figure 12 – Specific consumption by the load with the inlet valve opening point adjusted, for 6000 rpm.

For the rotation of 6000 rpm, the model with aperture point of the adjusted intake valve had a better result than the computational model. Figure 13 shows the behavior of the yield curve for both models, where it can be seen that the model with adjustment at the opening point of the intake valve had a better performance. Specifically in the 65% load,

the model presented a punctual gain of 2.2%; for the entire load range studied, the model with adjustment of the opening point of the intake valve had an average gain of 1.1%.

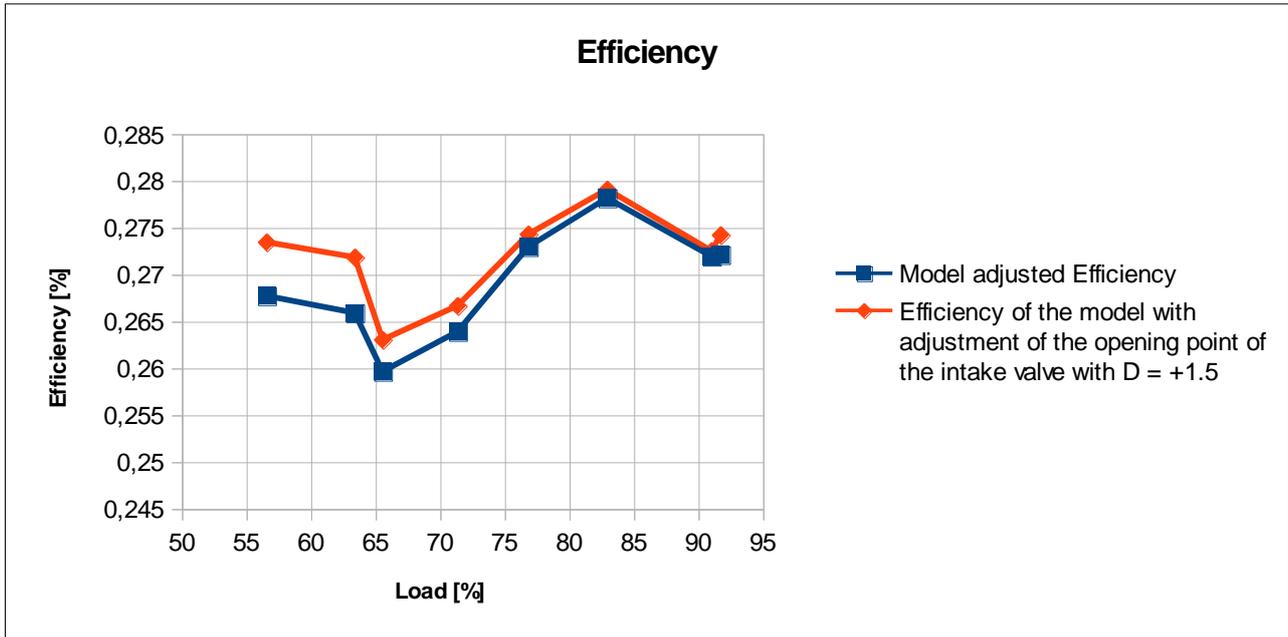


Figure13 – Motor throughput for load for 6000 rpm rotation.

For the rotation of 6900 rpm the model with adjustment of the opening point of the intake valve had a better performance of torque with high load in relation to the adjusted computational model. Figure 14 shows the behavior of the torque curve for both models, and it can be seen that the torque of the model with adjustment of the opening point of the intake valve has a better performance in the torque with increasing load on the engine. At full load, the model with valve opening point adjustment had a gain of 8.5% and an average gain of 5.0% for the entire engine load range.

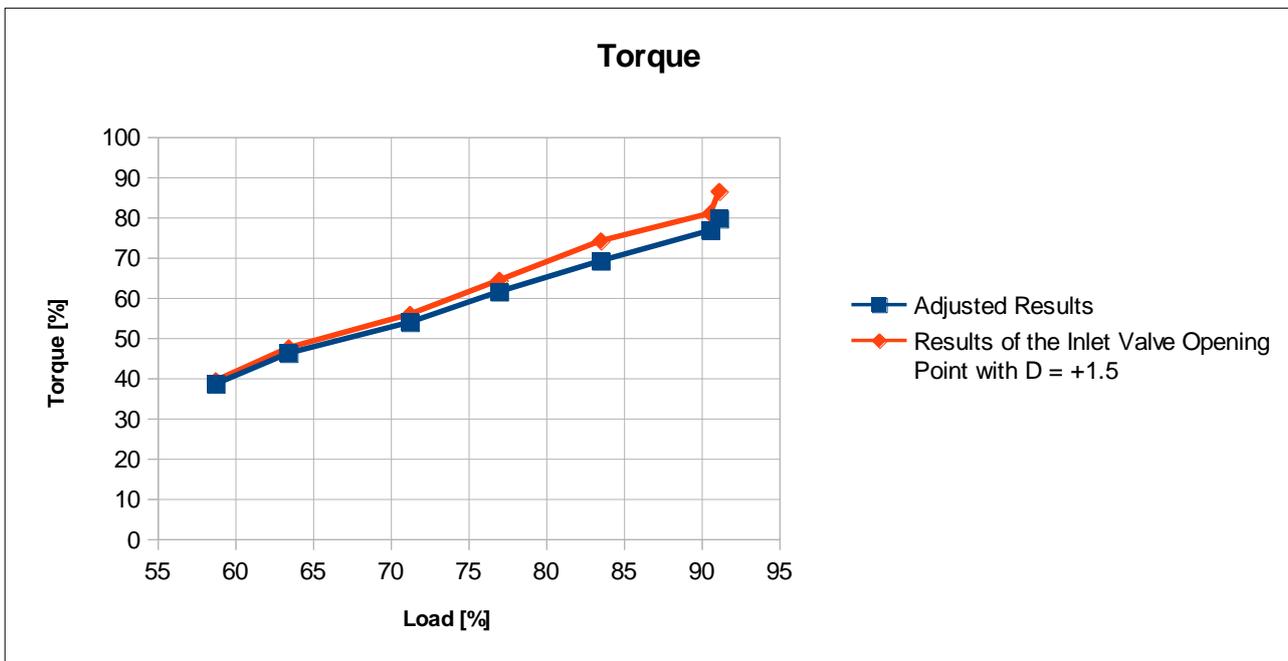


Figure 14 – Torque by Charge to the inlet valve set point adjusted, to 6900 rpm.

Figure 15 shows the specific consumption behavior for the rotation of 6900 rpm. It can be seen in the graph that the model with adjustment of the opening point of the intake valve is more economical in relation to the results of the adjusted computational model. The model with opening point of the adjusted valve had a reduction in fuel consumption at full load of 3.5%, and for the entire engine load range, the adjusted model had an average gain of 1.1% in relation to the calibrated model.

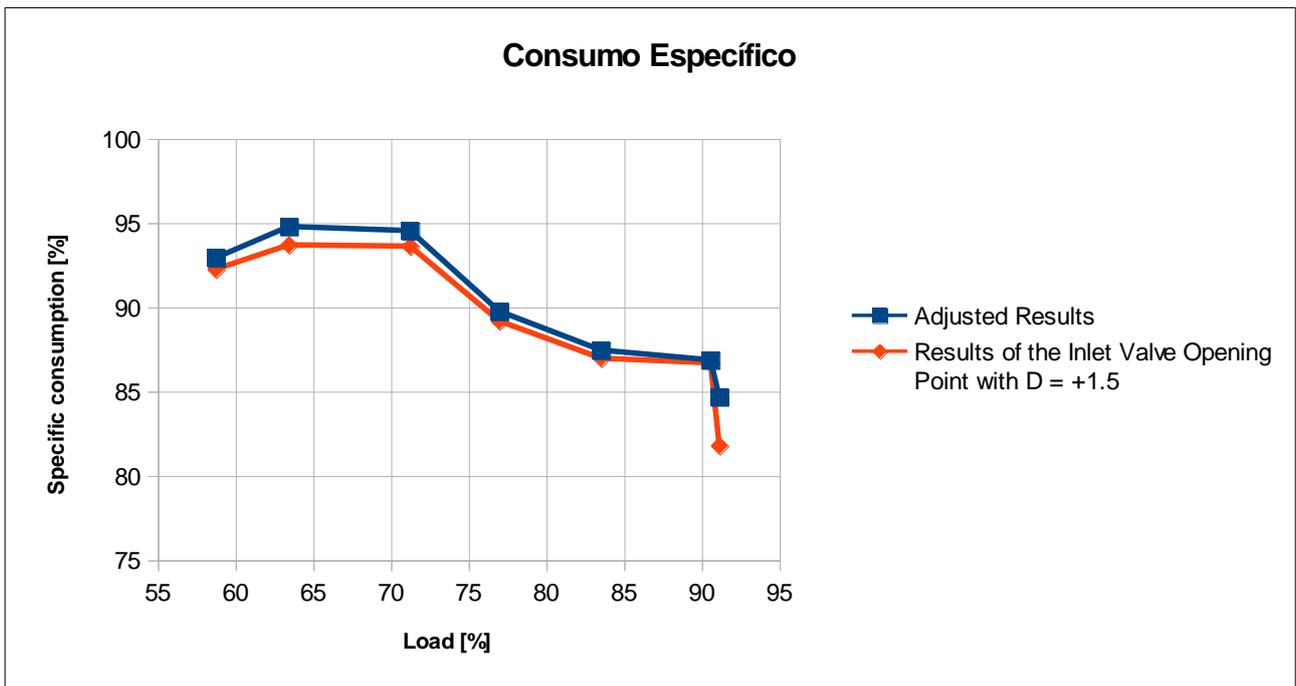


Figure 15 – Specific consumption by the load with the inlet valve opening point adjusted, for 6900 rpm.

For the rotation of 6900 rpm with the model with adjustment of the opening point of the intake valve showed a better performance compared to the model calibrated for the entire load range of the engine. Figure 16 illustrates the yield curves for both models, and it can be seen that the model with adjusted aperture point has a significantly more efficient yield at full load, where it presented a gain of 3.5% in this specific load in relation to computer model. However, it can also be observed that the model with adjusted aperture point presented a better performance in the entire load range, where it had an average gain 1.1% in relation to the model calibrated for the rotation of 6900 rpm.

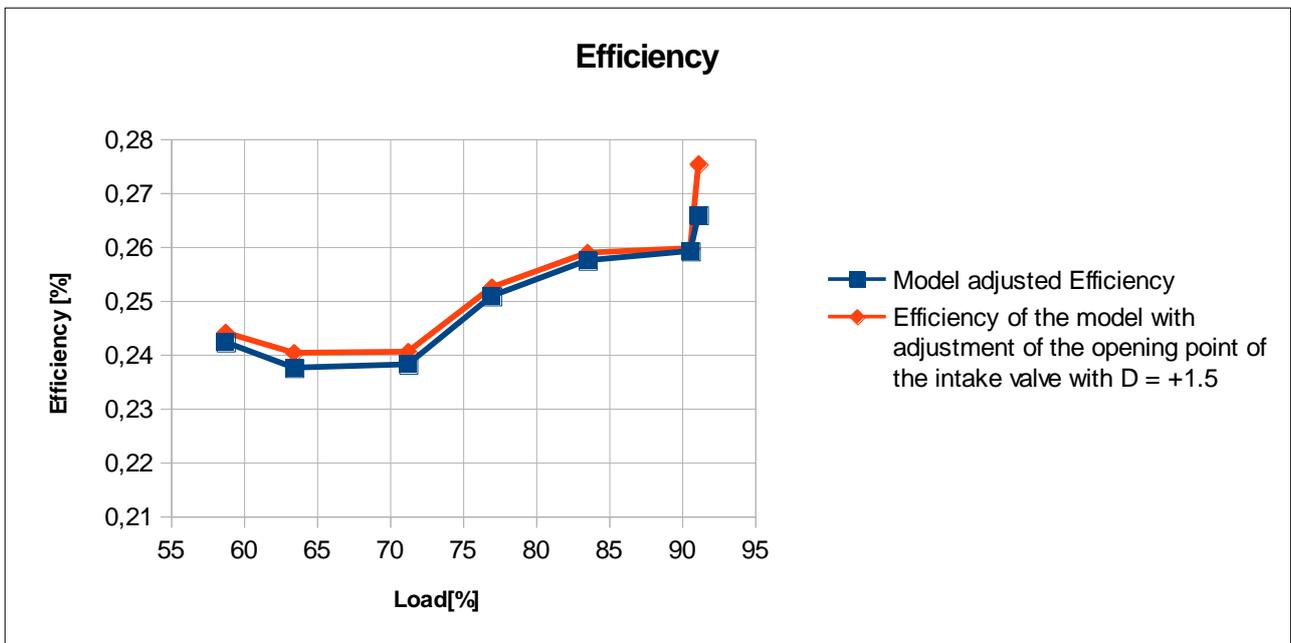


Figure 16 – Motor throughput for load for 6900 rpm rotation.

4. CONCLUSION

Thus, the model with the opening point of the adjusted intake valve presented a better behavior in the torque, specific consumption and yield in relation to the adjusted computational model. The maximum efficiency did not change the model with adjustment of the valve opening point; the yield at low loads had a gain of 2% in the model with adjustment of the valve opening point in relation to the adjusted computational model.

5. REFERENCE

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6. RESPONSIBILITY NOTICE

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