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Evaluation of new agricultural tractors engines by using a portable dynamometer

Avaliação de motores de tratores agrícolas novos utilizando dinamômetro móvel

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— NOTE —

ABSTRACT

Official agricultural engineering testing aims to determine torque and power, which are important information for decision making when buying an agricultural tractor. In this research the torque and maximum power values provided by manufacturers with the dynamometer tests values, were compared. Forty new agricultural tractors commercialized in the brazilian market were used. Tractors were classified according to the power range in: Class I (less than or equal 22.1kW); Class II (between 22.1 and 51.5kW); Class III (51.5 and 73.5kW); Class IV (73.5 and 117.7kW); and Class V (117.7 and 183.9kW). Variables were analyzed with the statistic t-Student test (P≥0.05). Class IV tractors engines power is bigger in comparison to the values specified by manufacturers. As for Class III tractors engines, torque values observed were bigger when compared to the specified, while for Class V was presented smaller values. As conclusion, with respect to the maximum engine power, it was verified that 67.5% of the evaluated tractors meet the information provided by manufactures.

Key words: *diesel cycle, torque, power.*

RESUMO

Os ensaios oficiais de motores agrícolas visam à determinação do torque e potência, que são informações importantes para a tomada de decisão no momento da compra de uma máquina agrícola. Neste trabalho, foram comparados os valores de torque e potência máxima do motor, fornecidas pelos fabricantes com os dados obtidos a partir de testes dinamométricos. Para tanto, utilizaram-se 40 tratores agrícolas novos comercializados no mercado brasileiro. Os tratores foram classificados quanto à faixa de potência em: Classe I (menor ou igual a 22,1kW); Classe II (entre 22,1 e 51,5kW); Classe III (51,5 e 73,5kW); Classe IV (73,5 e 117,7kW); e Classe V (117,7 e 183,9 kW). As variáveis foram submetidas ao teste estatístico t de Student (P≥0,05). A potência dos motores dos tratores da Classe IV é maior em comparação aos especificados pelos fabricantes. Para os motores de tratores da Classe III, os valores observados de torque são maiores em relação aos especificados, enquanto que, para os da Classe V, esses valores foram menores. Como conclusão, no que diz respeito à potência máxima do motor, verificou-se que 67,5% dos tratores avaliados atendem às informações disponibilizadas pelos fabricantes.

Palavras-chave: *ciclo diesel, torque, potência.*

In Brazil, for more than 20 years there was no official test on agricultural engines. However, educational and research institutions, as well as agricultural machines manufacturers perform some dynamometric tests for engine performance information (NIETIEDT et al., 2011).

In order to conduct performance evaluation, internal combustion engines should be accessed through full load tests, through the flywheel or the Power take-off (PTO). On agricultural tractors, it is usually applied

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the assessment through PTO (CORRÊA et al., 2008; FIORESE et al., 2012).

One of the main interests of consumers refers to the acquisition of tractors properly adjusted to their reality, to be sure of the technical specifications of such tractors, which will be the basis of good measurement of the mechanized activities on farms (GARAY et al., 2013).

The power achieved in the dynamometric tests of engines can be subject to a tolerance on the power stated by the manufacturer. The existence of tolerance and its scope should be established by the engine manufacturer itself (ABNT, 1995). Thus, the Diesel cycle engine that equips tractors plays an important role in agriculture since it is the component that forms the basis for the decision of purchasing the tractor, mainly through the analysis of power factor (SILVEIRA et al., 2008).

Due to the need to know the actual situation of engines performance in the new agricultural tractors, the following research aimed to compare the torque and maximum engine power values obtained from dynamometer tests with the technical information provided by the manufacturers.

Forty tractors were assessed, being separated according to the trademarks of the tractors and engines, power classes and engine settings. Data were collected through dynamometric tests conducted on the premises of agricultural machinery concessionaires of a region in the state of Rio Grande do Sul called Depressão Central. The tractors were ranked for power range in: Class I (less than or equal to 22.1kW); Class II (between 22.1 and 51.5kW); Class III (51.5 and 73.5kW); Class IV (73.5 and 117.7kW), and Class V (117.7 and 183.9kW). The rating has been adapted from MÁRQUEZ (2012).

For testing, it was used a portable dynamometer bench, brand EGGERS®, model PT 301 MES. Through this, torque and maximum engine power values were collected, performing three repetitions for each tractor model evaluated. The test procedures followed the instructions contained in the Code 2 of OECD (2014).

The recorded values were fixed in 10%, considering the losses in transmission between the engine and the PTO, mentioned by rule ASAE (2003). Subsequently, data collected was compared with the results published by the manufacturers.

Data were statistically analyzed in order to verify the significance of the differences between specified and observed values, through the t-Student test, with 5% level of probability error ($P \geq 0.05$). Regarding average power observed in each class, it was calculated the confidence interval (CI), which represents the deviation, for more or less, which, statistically, is estimated to be inserted in the samples of tested engines (MIALHE, 1996).

According to the proposed classification, 50% of the tractors which had its engines assessed belong to Class III, 30% to Class IV, and the rest are divided between Class II and Class V (10% each) (Figure 1A). These values can be attributed to power demanded by the farming operations of Depressão Central region in the state of Rio Grande do Sul.

Concerning the division of tractors by commercial brands (Figure 1B), there was predominance of the brand Massey Ferguson® - MF (70.0%), followed by Valtra® - VT (15.0%), John Deere® - JD and New Holland® - NH, both with 7.5%.

At a total, six brands comprised the sample engines (Figure 1C), and the engine brand AGCO Power® was most frequently found (37.5%). Among the evaluated types, which showed the highest representation was the four cylinders naturally aspirated (47.5%), followed by the four cylinders turbo charged (25.0%), three and six cylinders turbocharged, three cylinders aspirated, and six cylinders turbocharged intercooler (Figure 1D).

A different percentage is noticed between -3.8% and 5.2% when analyzing the torque values (specified and observed) for tractors Class II , which means that the tractor number 4 has 13.0 Nm more when compared with the value reported by the manufacturer and the number 1 with 6.3 Nm less (Table 1). The low value of torque observed in Class V engines, according to MÁRQUEZ (2012), might be explained by the type of fuel injection pump, because for high power engines, it is necessary to use an electronic fuel injection system.

There was a difference between the average torque value specified and observed in Classes III and V, while for power difference it occurred only in Class IV. It was also observed that the accuracy of torque and power values specified by manufacturers did not have a direct relationship with the size of the engine.

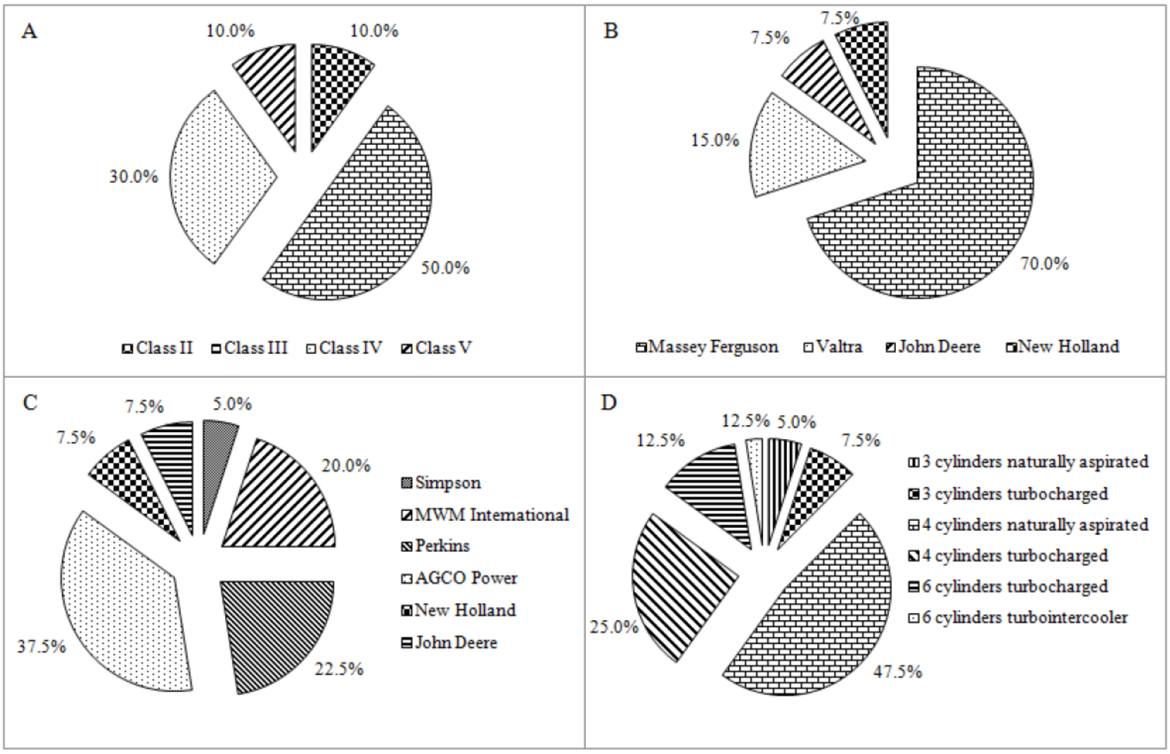

Figure 1 - Distribution of agricultural tractors for classes (A) and trademark (B); and distribution of the engines about the trademark (C) and engine type (D).

The results corroborate those presented by CORRÊA et al. (2008), when detecting that the power obtained was 11.5% lower than the value specified by the manufacturer, in evaluating the performance of a new Diesel engine with 46 kW power, belonging to Class II.

Confidence intervals and standard deviations around the mean values of the observed powers found were 1.64 (1.39); 0.51 (1.32); 1.95 (3.77), and 6.80 (5.78) for Class II; III; IV, and V, respectively. This means, for example, that the maximum power observed in the engines of tractors Class II can have a tolerance of 1.64kW, for more or less, on the maximum power specified. Thus, using this methodology, it can be observed that 27.5% of the tractors are subjected to dynamometer testing according to the manufacturer regarding the maximum engine power (Table 1).

Considering the positive percentage difference between the maximum power observed and specified (Table 1), one can see that 67.5% of the evaluated tractors meet the information contained in manufacturers catalogs. The lower values of torque and maximum power found in some tractors may adversely affect their field performance by interfering in the machines and implements size. In addition, at the time of acquisition, may cause economic losses to the farmer, as its final value is associated with the engine power.

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Table 1 - Comparison between torque and maximum engine power, specified by manufacturers and observed through dynamometer tests, by means t-Student test ($P \geq 0.05$), for the forty agricultural tractors evaluated, according to power Class.

N.	Model	Class	--------------------Torque** (Nm)--------------------				----------------------Power** (kW) --------------------			
			Spc.	Obs.	Dif. (%)	Dif. (A)	Spc.	Obs.	Dif. (%)	Dif. (A)
1	MF 255A	II	167	160.7	-3.8	6.3	36.8	32.4	-11.9	4.4
2	MF 255A		167	168.7	1.0	1.7	36.8	34.0	-7.5	2.8
3	MF 4265*		235.5	246.5	4.7	11.0	47.8	47.3	-1.0	0.5
4	MF 4265*		252	265.0	5.2	13.0	47.8	47.6	-0.4	0.2
5	MF 4275*	III	267	315.3	18.1	48.3	55.2	55.6	0.8	0.4
6	MF 4275*		267	289.6	8.4	22.6	55.2	55.9	1.3	0.7
7	MF 4275*		267	302.8	13.4	35.8	55.2	55.5	0.7	0.3
8	MF 4275*		267	308.1	15.4	41.1	55.2	57.6	4.4	2.4
9	MF 4275*		267	279.8	4.8	12.8	55.2	56.6	2.6	1.4
10	MF 4275		267	276.7	3.6	9.7	55.2	51.9	-5.9	3.3
11	MF 4275*		267	278.3	1.2	11.3	55.2	55.0	-0.4	0.2
12	MF 4275		267	300.2	9.2	33.2	55.2	53.0	-3.9	2.2
13	MF 4275*		267	315.3	14.7	48.3	55.2	56.4	2.2	1.2
14	MF 4275*		267	295.6	7.5	28.6	55.2	55.1	-0.1	0.1
15	JD 5078E		257.4	279.8	8.7	22.4	55.3	53.3	-3.6	2.0
16	JD 5078E*		257.4	277.1	7.7	19.7	55.3	55.7	0.7	0.4
17	JD 5078E		257.4	266.2	3.4	8.8	55.3	53.3	-3.6	2.0
18	NH TL75E*		264	291.9	10.6	27.9	56.6	59.0	4.2	2.4
19	NH TL75E*		264	305.1	15.6	41.1	56.6	59.5	5.1	2.9
20	NH TL75E		264	279.8	6.0	15.8	56.6	55.9	-1.4	0.7
21	VT A750		296	310.8	5.0	14.8	57.4	53.3	-7.2	4.1
22	VT A750		296	310.4	4.9	14.4	57.4	56.4	-1.7	1.0
23	VT A750*		296	311.9	5.4	15.9	57.4	59.8	4.3	2.4
24	MF 4283		288	300.2	4.2	12.2	62.5	55.5	-11.2	7.0
25	MF 4291*	IV	400	415.1	3.8	15.1	77.2	81.5	5.6	4.3
26	MF 4291*		400	372.0	-7.0	28.0	77.2	78.2	1.3	1.0
27	MF 4291*		400	401.5	0.4	1.5	77.2	82.7	7.1	5.5
28	MF 4291*		400	372.0	-7.0	28.0	77.2	79.3	2.6	2.1
29	VT BM100		398	404.5	1.6	6.5	78.0	74.3	-4.7	3.7
30	VT BM100*		398	415.1	4.3	17.1	78.0	79.5	1.9	1.5
31	MF 4292*		430	414.4	-3.6	15.6	80.9	85.8	6.0	4.9
32	MF 4297*		460	482.8	4.9	22.8	88.3	93.6	6.0	5.3
33	MF 4297*		460	471.8	2.6	11.8	88.3	98.8	12.0	10.5
34	MF 4297*		460	474.1	3.1	14.1	88.3	101.3	14.8	13.0
35	MF 7140*		510	516.8	1.3	6.8	103.0	108.5	5.4	5.5
36	MF 7150*		600	624.9	4.2	24.9	110.3	116.8	5.9	6.5
37	MF 7180*	V	720	704.3	-2.2	15.7	132.4	149.5	12.9	17.1
38	MF 7180		720	710.8	-1.3	9.2	132.4	131.0	-1.0	1.4
39	VT BH180		663	650.6	-1.9	12.4	139.0	129.2	-7.0	9.8
40	MF 7415*		920	910.0	-1.1	10.0	158.1	162.6	2.9	4.5
Average			364.3	376.9			71.9	73.2		
Standard error			12.9	5.1			4.5	2.4		

* Tractors with maximum engine power values equal to or higher than those provided by manufacturers.
** Official standard ISO TR 14396.

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