

Original Research Article

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Comparative Study of 35 HP Range Tractors

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ABSTRACT

Agriculture is the most important sector of Indian economy. About 78% farm holdings belong to small and marginal farmers, about 22% belongs to semi medium, medium and large farm holders. Therefore, 35 hp tractors are most commonly used in India. Torque of Swaraj tractor is best in the comparison of other tractor manufacturers which is 14 kg-m at the standard speed. Engine speed of Mahindra and Mahindra tractor found greater than the other tractor manufacturers. It is found 2300 rpm. Displacement volume of Swaraj tractor is 2600 cc which is greater than other tractors. Escorts and Swaraj tractors have upto speed 1000 rpm which is greater than the other tractors. HMT, New Holland and Sonalika tractors have more hydraulic lifting capacity as the compare of other tractors. 1200 kg weight can lift by these tractors. PTO power of Swaraj and HMT is the best as the comparison of other tractor manufacturers. It is found 34 hp in these tractors. Mean effective pressure of cylinder of TAFE tractor is 6.85 kg/cm² which is greater than the other tractor manufacturers. Swaraj tractor has the minimum noise level which is comfortable or operator and the value of noise level for this tractor is 90 db. From the above points, it was concluded on the basis of specific fuel consumption which was minimum among different tractors *i.e.* 0.2 kg/kWh to 0.25 kg/kWh at the torque 10.9 kg-m for Mahindra tractor. But for maximum torque *i.e.* 13.5 kg-m at the rated speed of 1400 rpm of Swaraj tractor.

Keywords

Tractor, Torque, Horsepower and Speed.

Article Info

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Introduction

Agriculture is the most important sector of Indian economy. Most of the farming is done on small holding. About 78% farm holdings belong to small and marginal farmers, about 22% belongs to semi medium, medium and large farm holders Therefore, 35 hp tractors are most commonly used in India. Tractor is a main source of power on the farm. The main reason of using 35 hp tractors in India is that a large strength of farmers is belonging to poor and small land holdings. Market growth is about 4-5% per annum. Government Subsidy

drives sales but there is no subsidy on tractors above 35 hp. Domestic sectors growing due to an increase in the irrigated area, Government policy related to export which decides crop switching by farmers. Smaller tractors are very popular (35 hp); this is the fastest growing segment. Tractor is a self-propelled power unit having wheels or tracks for operating agricultural implements and machines including trailers. It gets its driving force in the combination with an engine and driving wheels or tracks.

Materials and Methods

Escort

Engine

The 35 hp escort tractor has engine of 3 no. of cylinder, the bore and stroke is 91mm and 110 mm, respectively. The displacement volume of piston is 2146 cc, compression ratio is 18:1, the maximum torque is 13.2 kg-m; the rated engine rpm of the engine is 2200 rpm.

Transmission system

The constant mesh type gear box is used, the 8 forward and 2 reverse with high-low selector lever is present in this system. The single plate type cultch of 250 mm is present in this tractor. The single sped PTO is fitted, the dia. and no. of spline is 34.67 mm and 21 respectively. The rpm of PTO is 1000 at the engine rpm 1863. The maximum PTO hp is 31 hp.

Brake

The disc brake is present in this tractor. The brake pedal is with 38-43 mm.

Hydraulic system

The automatic draft and position control hydraulic system is fitted in this tractor, the lifting capacity of systemic 1000 kg at end of lower links. The gear type pump is used.

HMT

Engine

The HMT Tractor has a 40 hp HMT AVL engine, this engine is four stroke water cooled engine. The bore and stroke of the engine is 95 mm and 110 mm respectively, displacement volume is 2340cc, the compression ratio is 17.4:1 and the rated rpm is 2100.

Transmission

The dual clutch is fitted in this tractor, the two dry plates with the diameter 295 mm and thickness of 9.5 mm, one plate for tractor drive and the other for PTO shaft drive. 8 forward and 2 reverse speeds with high low selector are available.

PTO Independent standard rpm 545 at 2100 engine rpm. Ground PTO rpm 271 to 1150 rpm available through gearbox at rated engine rpm.

Brakes

The brake levers are available foot brake and hand brake. Mechanical disc brake, operated by two pedals with latch to brake the wheels simultaneously and independently. The hand brake is Integral with pedal which is locked by latch.

Mahindra & Mahindra

Engine

The Mahindra 35 hp tractor has engine type MDI 1785, the no. of cylinder in this engine is three, the bore and stroke is 88.9mm and 96mm respectively, the displacement is 1788 cc, and rated rpm of engine is 2300.

Transmission system

The sliding mesh gear box having 8 forward and 2 reverse speeds with high- low selector lever, the cultch having 10'' single dry driven plate in fitted and the rear mounted PTO having six splines and 627 rpm (low range) at rated engine rpm.

Brakes

Totally enclosed, self-energizing, disc with dry friction liner type brakes is used in this tractor.

Hydraulic system

Vary tough, fully live hydraulic with position and draft control hydraulic system is fitted in this tractor, the lifting capacity is 100 kgf at the end of lower links.

Electrical system

The electric system of this tractor is consist of 12-volt battery, solenoid operated starter motor, generator, regulator, head light, rear brake light, parking lights, turning light, plough lamp, fuse box registration lamp, horn etc.

TAFE

Engine

Diesel engine in tractor has 3 cylinders and bore stroke ratio is 0.7. The cubic capacity (cc) is 2365, rated rpm 2000.

Transmission

The clutch has oil bath type and single. The transmission 6 forward and 2 reverse gear, the max speed on the road 26.18 km/h, max forward speed 13.31kmph and reverse speed 6 km/h. the pto has 540 rpm @ 1500 ERPM and no. of splines is make1, speed of operation is position draft, response controls

Hydraulic system

The hydraulic system is 1100(lower link in horizontal position), the lifting capacity has 1100 kg

Swaraj

Engine

Swaraj tractor has 39 hp range and model is R V-3 T.R; Kirlosker. This tractor has four

stroke, direct ignition diesel engine. Number of cylinders in this engine are 3 and bore stroke is 100 x 110 mm. Rated speed of engine is 2000 revaluation/min and displacement of piston is 2592 cc.

Transmission system

Transmission system of this tractor has a heavy duty, single dry plate type clutch of 280 mm diameter. Number of gears is 8+2 (by high and low selector lever). Maximum speed of tractor is 28 km/hr in forward direction and 12 km/hr in reverse direction. PTO of 21 splines have 1000 rpm at rated engine speed. A shaft of 6 splines can also be used which have 540 rpm with an engine speed of 1650 rpm.

Brakes

High working capacity, self-energizing, water proof disc brakes are used in this tractor. Oil immersed multi disc brake can also be used in this tractor.

Hydraulic system

A two-lever live hydraulic system-automatic position with draft and mix control is provided in this tractor. A gear type hydraulic lift pump is used in this system for the purpose of oil transfer with a speed of 17 liter/min at rated engine speed.

SONALIKA

Engine

The 35 hpsonalika tractor has contain 3 cylinder, direct injection cooled diesel engine and its bore stroke ratio 95/118 in this tractor compression ratio is 18:4:1 and its displacement 2510, rated rpm 2100,max torque (Nm) 140,sfc at rate speed has 184 gm /ps.hr.

Transmission

The constant mesh type gear box with high low selector lever is present in this tractor. In this tractor is single dry type plates the dia of plate is 280 mm the single speed live pto is used in this tractor, the no of spline and rpm of pto is 6 and 540 respectively speed the maximum pto power 30.57 hp.

Brake

In this tractor have dry disc brake /oil immersed brakes.

Hydraulic

In this tractor has constant 2 levers, automatic position & Draft, lifting capacity (kg) is 1200.

Results and Discussion

The laboratory test on testing centre and the field operation on 35 hp tractors is give the following main aspect on which the comparison of different manufacturer's tractors is performed. The following are the main aspect on which the comparison takes place:

Torque and engine speed

Like power, torque is an important measure of engine performance. Any force applied on some point to cause a turning effect is called torque, mathematically represented by force multiplied by the distance of force from the centre of shaft, i.e. Torque,

$$T = F \times r$$

As shown in graph 1 the hp curve continuous to rise as the engine speed increase until maximum power is attained. This is also true with the torque curve, but the torque will reach its maximum point much earlier. An engine develops more torques at intermediate speeds than at the maximum speed. This is

because the volumetric efficiency is higher at intermediate speeds.

Torque

The maximum torque is obtained at a standard engine speed of 1400 rpm. The different tractor manufacturer like, Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland, Sonalika is specified the values of torque is 13.97 kg-m, 12.90 kg-m, 10.90 kg-m, 13.46 kg-m, 13.65 kg-m, 11.94 kg-m and 11.94 kg-m respectively. These values of torque are plotted against engine rpm at a rated speed of 1800 rpm. Swaraj tractor is best because torque of this is maximum in 35 H.P. series tractors. The comparison of torque is given in graph 2.

Engine speed

Tractors are mostly equipped with high speed engines running at about 2000 rpm. The different tractor manufacturers like Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland, Sonalika are provide the engine rpm 1800, 2000, 2300, 2000, 2100, 2100 and 2100 respectively. The comparison of engine rpm is shown in graph 3.

Displacement volume

The displacement volume is specified by different tractor manufacturer like Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika are 2592 cc, 2400 cc, 2788 cc, 2146 cc, 2340 cc, 2500 cc, and 2510 cc respectively. The comparison of displacement volume of different tractors is shown in graph 4.

Number of gear

Gear box is fitted between the engine and rear wheel for variable torque and speed. The different tractor manufacturer specified different numbers of gears. Such as Swaraj,

TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika have the no. of gears six forward and two reverse, six forward and two reverse, eight forward and two reverse, and eight forward and two reverse respectively. It is shown in graph 5.

PTO speed

The PTO shaft is an extension of the gearbox lay shaft which is being continuously driven. Both of these shafts rotate in clockwise direction when viewed from the rear of the tractor. The PTO speed of different tractor such as Swaraj, TAFE, Mahindra, escorts, HMT, New Holland and sonalika are 1000, 540, 623, 1000, 540, 540 & 540 respectively. The comparison is shown in graph 6.

Stroke-bore ratio

It is the ratio of length of piston stroke to diameter of the cylinder. This ratio for the tractor engine is about 1.25 and it varies between 1-1.45. The stroke-bore ratio of different tractor manufacturer like Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland, and Sonalika recommended 1.1, 1.4285, 1.07986, 1.20879, 1.1578, 1.00 and 1.242 respectively. The difference of stroke-bore ratio is drawn in the graph 7.

Discharge of hydraulic pump

The volume of oil delivered by pump per minutes is called discharge capacity of hydraulic pump; the time taking in raising or lowering the lift is depends upon discharge of pump. The discharge of different tractor manufacturers is recommended such as Swaraj, TAFE, Mahindra, escorts, HMT, New Holland and sonalika are 17, 16, 9.5, 22, 22, 18 & 17.5 liters per minute respectively. The comparison is shown in graph 8.

Lifting capacity of hydraulic system

The lifting capacity of different manufacturers of 35 hp tractors such as, Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika are 1000, 1100, 1000, 1000, 1200, 1200 and 1200 kg respectively. The comparison of lifting capacity is shown in graph 9. The tractor used in such type of work should have maximum lifting capacity in 35 H.P. series H.M.T., New Holland and sonalika is best with lifting capacity of each tractor 1200 kg.

Minimum speed of the tractors

The minimum speed of a tractor is obtained in first-low gear; in this gear the maximum torque is obtained. Minimum speed of different tractors is expressed in km/h.

The recommended minimum speed of Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika is 2.23, 2.23, 2.1, 2.06, 2.1, 2.50 and 2.65 km/h respectively. These values of minimum speed of tractors are drawn in the graph 10. At the minimum speed of tractor, the maximum torque is obtained.

Maximum speed of the tractors

The maximum speed of a tractor is obtained in top-high gear; in this gear the minimum torque is obtained. Maximum speed of different tractors is expressed in km/h. The recommended maximum speed of Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika is 27.4, 22.24, 26.90, 26.88, 30.00, 28.04 and 30.00 km/h respectively. It is shown in graph 11.

Maximum PTO power

The PTO is least used and most efficient power outlet of tractors. The maximum power of pto shaft of different tractors such as, Swaraj, TAFE, Mahindra, escorts, HMT, new

Holland and sonalika are 34, 30, 30.57, 31, 34, 30.8 and 30.57 respectively. The comparison of pto hp. is shown in graph 12.

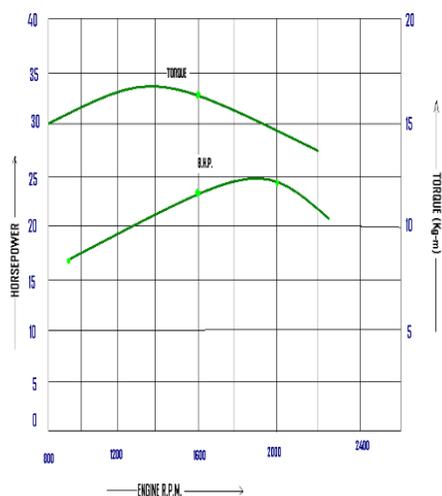
pressure for different tractor manufacturers like Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland, Sonalika are 6.774, 6.853, 6.40, 6.674, 6.599, 6.45 and 5.98 kg/cm² respectively.

Mean effective pressure

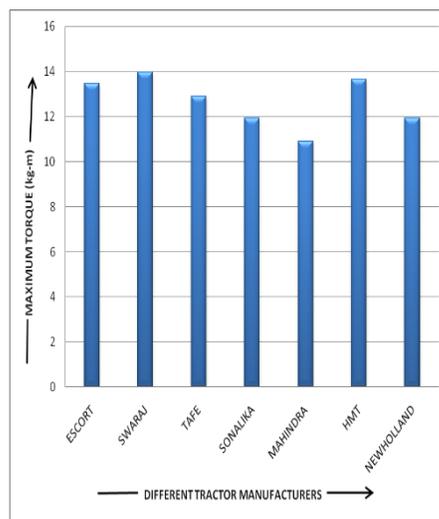
This pressure actually forces the piston down during the power stroke. The mean effective

The comparison of mean effective pressure is shown in graph 13.

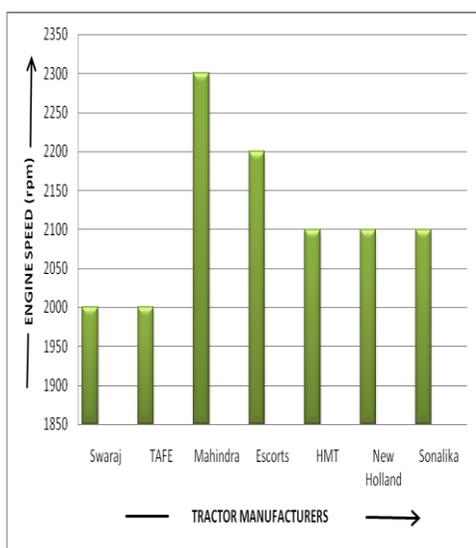
Graph.1 RPM VS Horsepower at a Standard Speed 1400 Rpm.



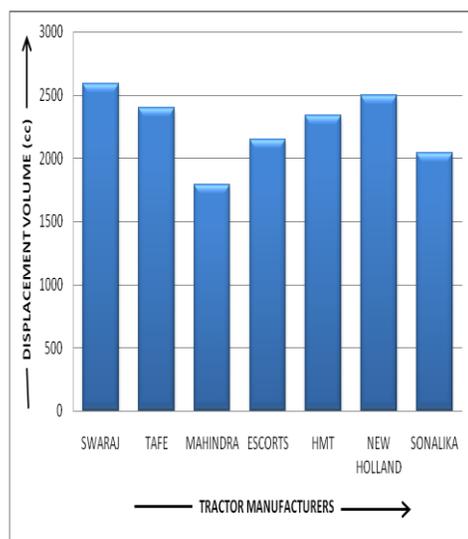
Graph.2 Comparison of Maximum Torque



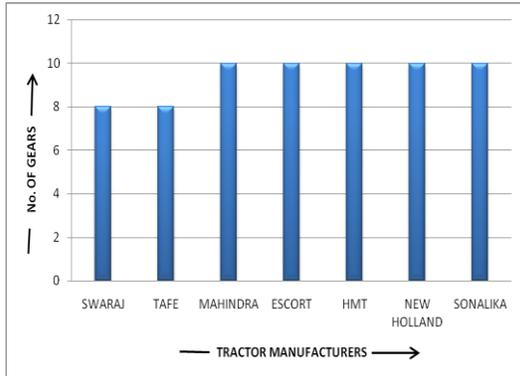
Graph.3 Comparison of Engine Speed of Tractors



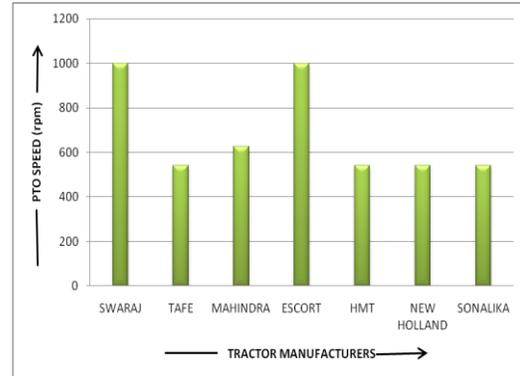
Graph.4 Comparison of Displacement Volume



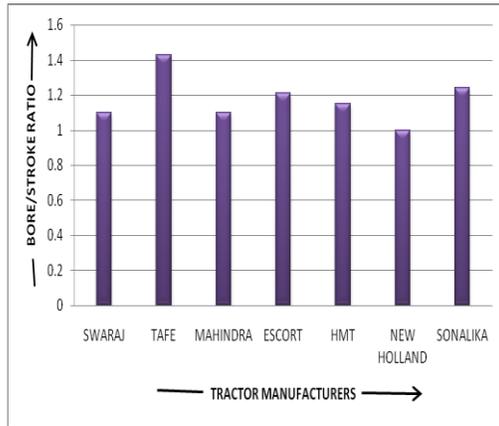
Graph.5 Comparison of no. of gears of tractors



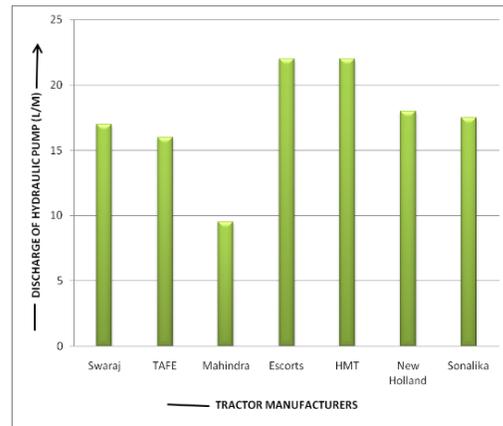
Graph.6 Comparison of PTO Speed of different Tractors



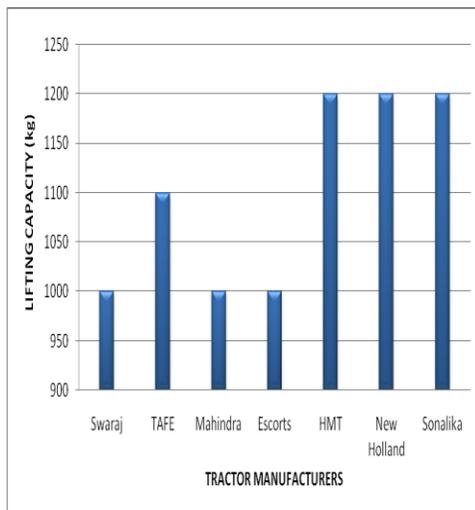
Graph.7 Comparison of Stroke /Bore Ratio of Tractors Cylinder



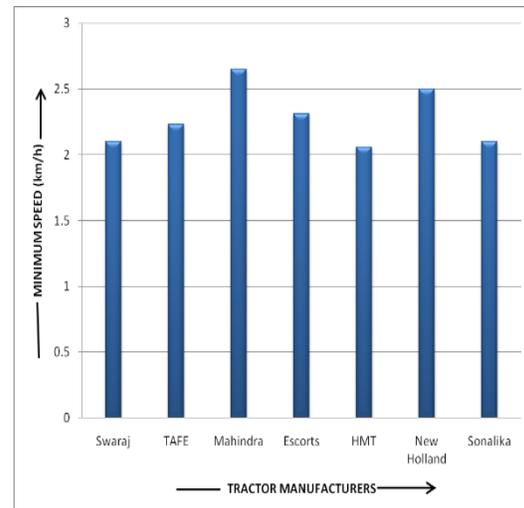
Graph.8 Discharge of Hydraulic Pump of Tractors



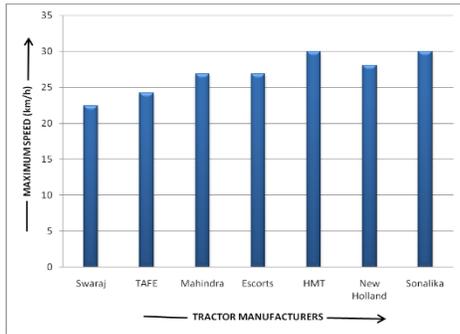
Graph.9 Comparison of Lifting Capacity of Hydraulic Lift of Tractors



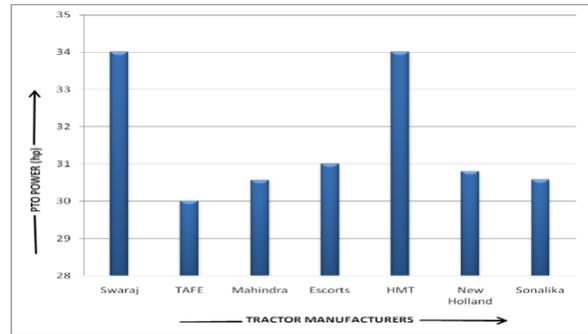
Graph.10 Minimum Speed of Tractors



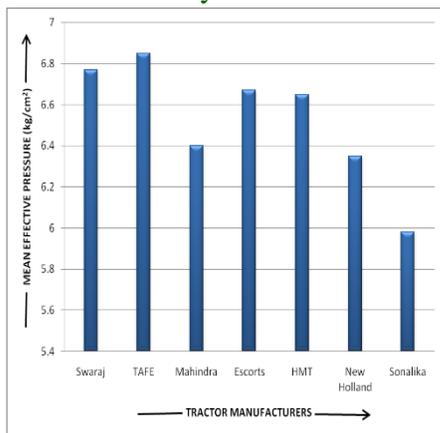
Graph.11 Maximum Speed of Tractors.



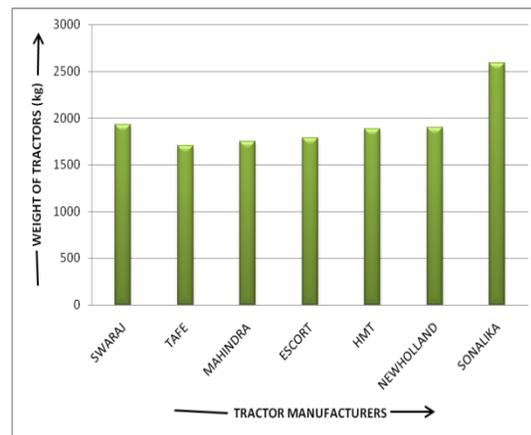
Graph.12 Comparison of Maximum PTO Power of different Tractors



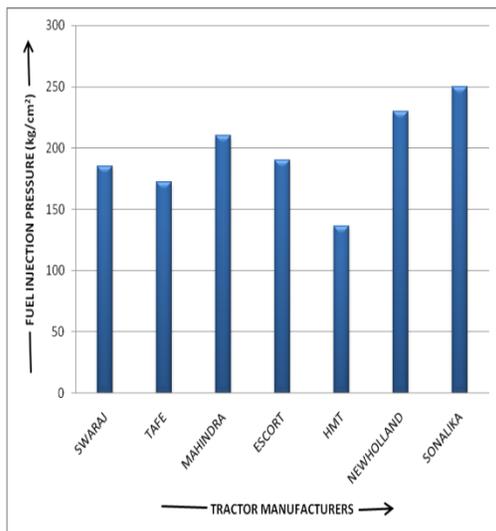
Graph.13 Mean Effective Pressure of Cylinder



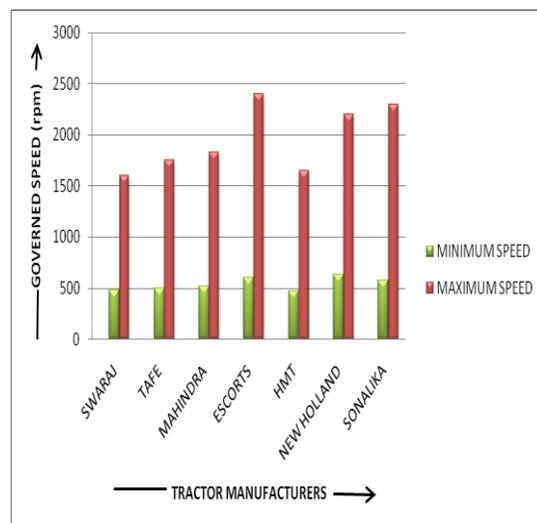
Graph.14 Total Weight of different Tractors



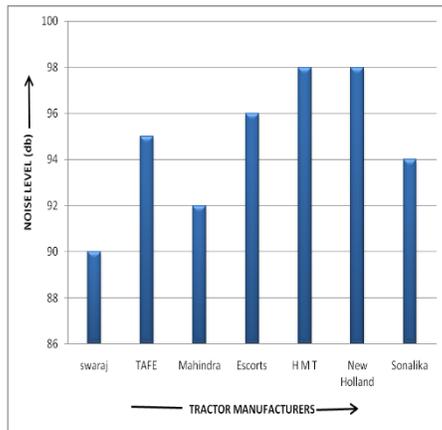
Graph.15 Fuel Injection Pressure of Injection of Different Tractor Engines Tractors.



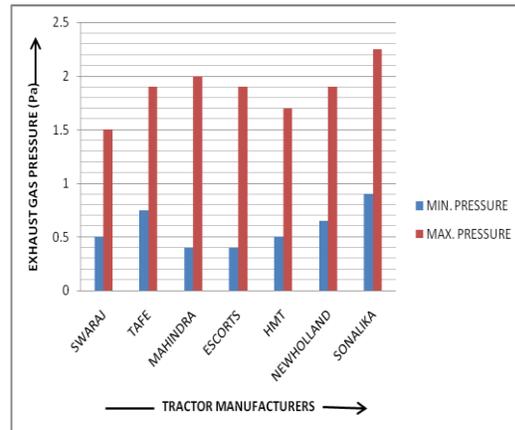
Graph.16 Governed Range of Engine Speed of Pump



Graph.17 Comparison of Noise Level of Different Tractors



Graph.18 Comparison of Exhaust Gas pressure



Weight of tractor

The tractors have a range of weight approximately 1700-2600 kg. The recommended weight of different tractor manufacturer like Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika is 1925 kg, 1700 kg, 1745 kg, 1785 kg, 1880 kg, 1900 kg and 2590 kg respectively. The graph based on the weight of tractors is drawn in the graph 14.

Fuel injection pressure

The fuel is injected with very high pressure, it is known as fuel injection pressure. It is always higher than compressed air, this pressure varies from 125 to 250 kg/cm². The injection pressure for different tractors such as, Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika are 185, 172, 210, 190, 136, 230 and 250 respectively. The comparison is shown in graph 15.

Governed engine speed

Variation of the governed engine speed of different tractors such as Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika are 480-2300, 510-2100, 520-2600, 600-2900, 450-200, 700-2700 and 695-2550

rpm respectively. The corresponding governed engine speed of each tractor shown in the graph 16.

Noise level

The noise level of different tractors such as Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika are 90, 95, 92, 96, 98, 98, and 94 db respectively. The noise level of tractor affects the working efficiency of operator. The noise level of tractor should be minimum as possible as, the minimum noise level in 35 hp tractors is in Swaraj in the range of 90 db. It is shown in graph 17.

Exhaust gas pressure

Different tractor manufacturer recommended different exhaust pressure for the tractors. Some manufacturers such as Swaraj, TAFE, Mahindra, Escorts, HMT, New Holland and Sonalika recommended the exhaust pressure range 0.5-1.5, 0.8-1.9, 0.4-2, 0.4-1.87, 0.5-1.7, 0.65-1.93 and 0.95-2.2 kPa respectively. The difference of exhaust pressure is drawn in the graph 18.

The technical specification data of 35 hp tractors was collected from different tractor

industry and different tractor testing centers. There are following conclusion could be drawn:

Torque of Swaraj tractor is best in the comparison of other tractor manufacturers which is 14 kg-m at the standard speed.

Engine speed of Mahindra & Mahindra tractor found greater than the other tractor manufacturers. It is found 2300 rpm.

Displacement volume of Swaraj tractor is 2600 cc which is greater than other tractors.

There are 10 gears found in five tractors out of seven. Those tractors are Mahindra & Mahindra, Escorts, HMT, New Holland and Sonalika.

Escorts and Swaraj tractors have PTO speed 1000 rpm which is greater than the other tractors.

HMT, New Holland and Sonalika tractors have more hydraulic lifting capacity as the compare of other tractors. 1200 kg weight can lift by these tractors.

PTO power of Swaraj and HMT is the best as the comparison of other tractor manufacturers. It is found 34 hp in these tractors.

Mean effective pressure of cylinder of TAFE tractor is 6.85 kg/cm^2 which is greater than the other tractor manufacturers.

Swaraj tractor has the minimum noise level which is comfortable or operator and the value of noise level for this tractor is 90 db.

Specific fuel consumption of Mahindra & Mahindra tractor is lesser than the other tractor manufacturers. From the above points, it was concluded on the basis of specific fuel

consumption which was minimum among different tractors i.e. 0.2 kg/kWh to 0.25 kg/kWh at the torque 10.9 kg-m for Mahindra tractor. But for maximum torque i.e. 13.5 kg-m at the rated speed of 1400 rpm of Swaraj tractor. So it was concluded that for heavy work load Swaraj tractor is best but on the basis of specific fuel consumption Mahindra tractor is best.

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