UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific
CSAM

CAMTC

TRAINING ON ANTAM STANDARD CODE For TESTING OF KNAPSACK MISTERS CUM DUSTERS

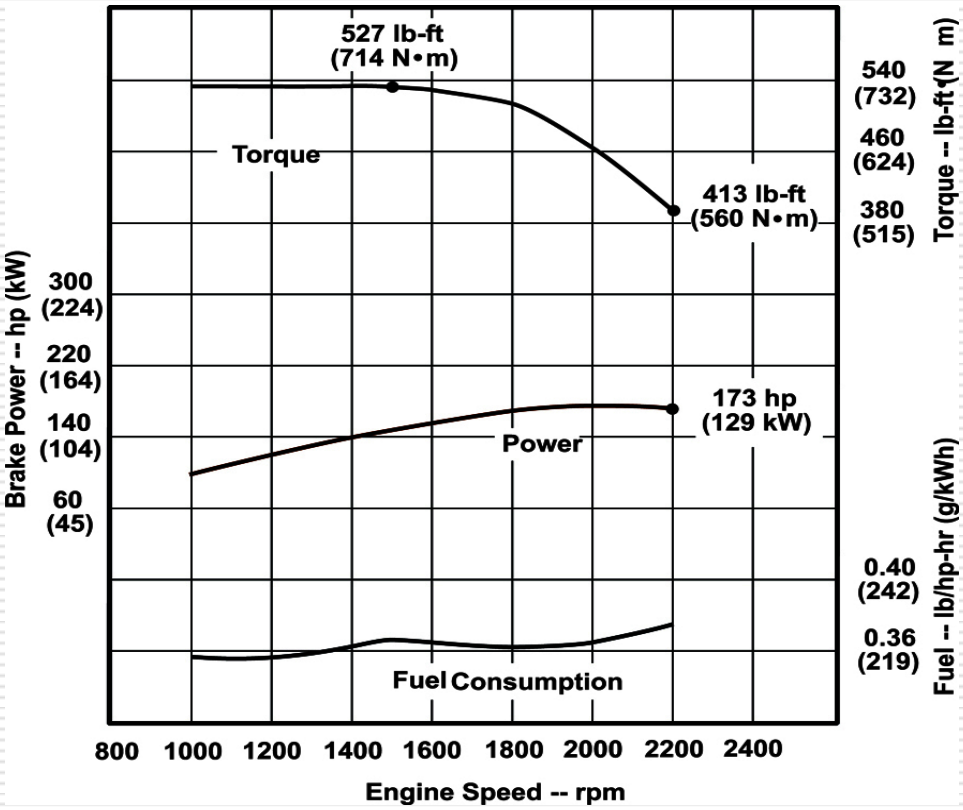
Theory 8: Engine performance- characteristics

2nd Training of Trainers on ANTAM Codes
16 - 28 October2016, Nanjing China

ANTAM
Asian and Pacific Network for Testing Agricultural Machinery

Typical spec of a Tractor Engine

- Application ratings Intermittent
- Rated power/Rated speed 129 kW (173 hp) @2200rpm
- Peak power 132 kW (177 hp) @2000rpm
- Power bulge 3% @ 2000rpm
- Peak torque 714 N.m (527ft-lb) @1500rp
- Torque rise 28%


527 lb-ft
(714 N•m)
Torque
413 lb-ft
(560 N•m)
173 hp
(129 kW)
Power
Fuel Consumption
Brake Power -- hp (kW)
300
(224)
220
(164)
140
(104)
60
(45)
Torque -- lb-ft (N m)
540
(732)
460
(624)
380
(515)
Fuel -- lb/hp-hr (g/kWh)
0.40
(242)
0.36
(219)
800 1000 1200 1400 1600 1800 2000 2200 2400
Engine Speed -- rpm

Torque rise and its need

The amount of torque is determined by the quantity of fuel delivered to the cylinders. By injecting a larger quantity of fuel at an intermediate engine speed, a higher torque can be achieved than what is available at the engine's rated speed and load. The difference between the amount of torque at this intermediate speed (called torque peak) and the torque available at rated power is called torque rise. The amount of fuel delivered is directly related to and determined with electronic calibrations and fuel curves today.

Electronic controls are more responsive (almost immediately) to torque demands and make it possible to achieve a significant "power boost" below rated RPM. This was not possible with mechanical engines.

With sufficient torque rise, a tractor can be "lugged down" from rated RPM to torque peak RPM without danger of stalling, and easily pull through tough field conditions without changing gears. Without torque rise, the engine would quickly lose RPM and stall

http://www.grainews.ca/2009/02/23/torque-rise-explained/

Maximum Power

- This as per ANTAM 1001-2016 is the average of at least six readings made at regular intervals during the 2 hour period.
- (readings every 20min)
- When the Power tiller is operated at the engine speed where

  maximum power occurs continuously for a period of 2h after the engine warms up and runs in stable state.
- The readings should not deviate by more than ±2 percent from the average,
- If the variation of individual measurement are above ±2 percent, the test should be repeated (once?).
- If the variation continues, the deviation is repeated
- (6.1.2 IS 12036: 1995 and 5.3.1 GB/T 6229-2007)

Difference in Indian standards-

IS12036-1995 reaffirmed 2004 (tractor PTO test)

- The measured value should be within tolerance of -7 .5 / +15 percentage of the declared value by the manufacturer.

How to arrive at Maximum Power

- The Maximum power is determined by measurement using dynamometer.
- 1. The throttle is fully open (Metering rack completely in)
- 2. The load is increased until the product of speed and torque is maximized under stable condition
- The maximum Power should be obtained at a point at which the engine can operate stably and continuously for a period of 2hrs

Calculating Shaft power

- Power output by a rotary power source like and Engine or Electric motor is given by

$$P = T \times \omega$$

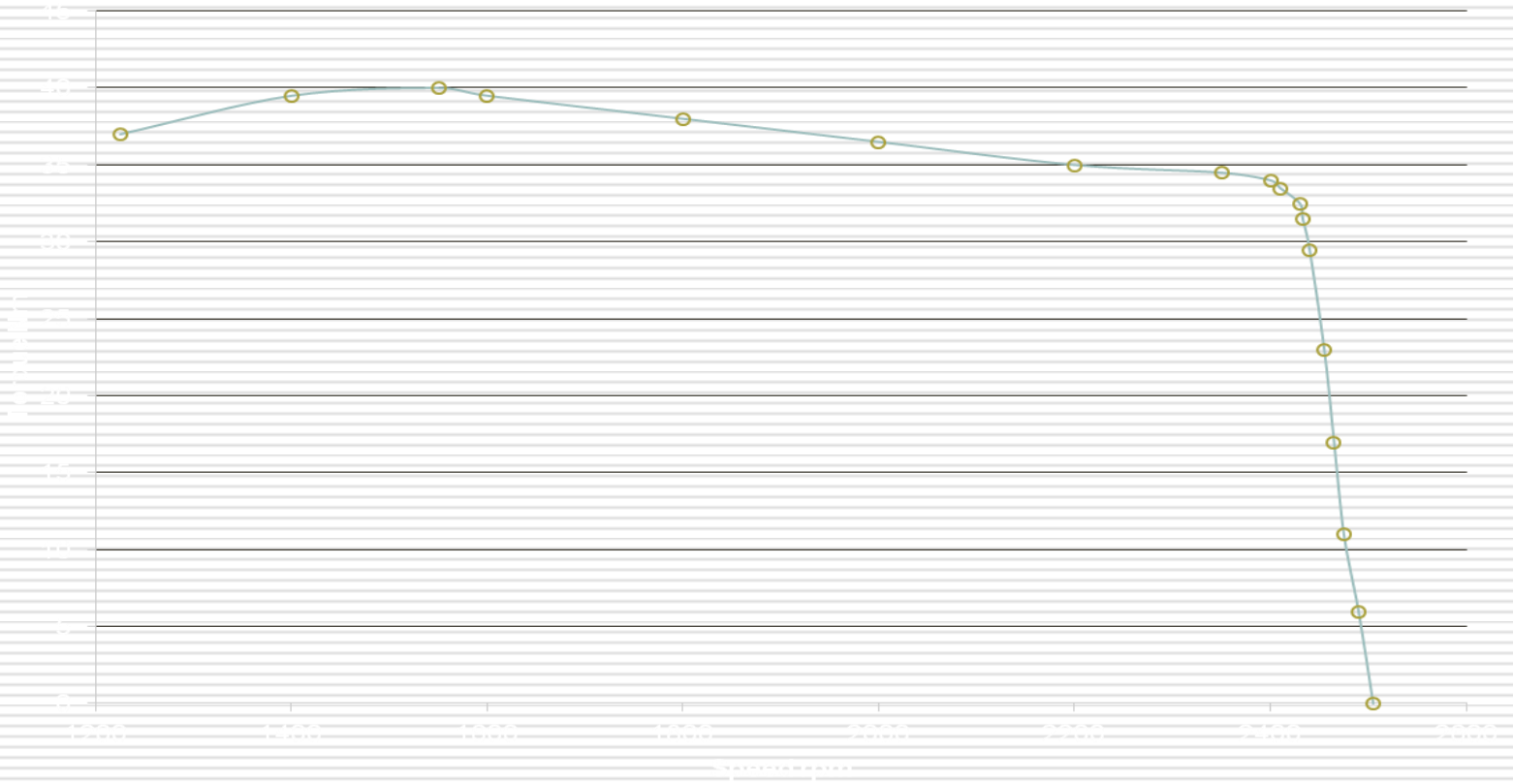
$$P = Power\ in\ W$$

$$T = Torque\ in\ Nm$$

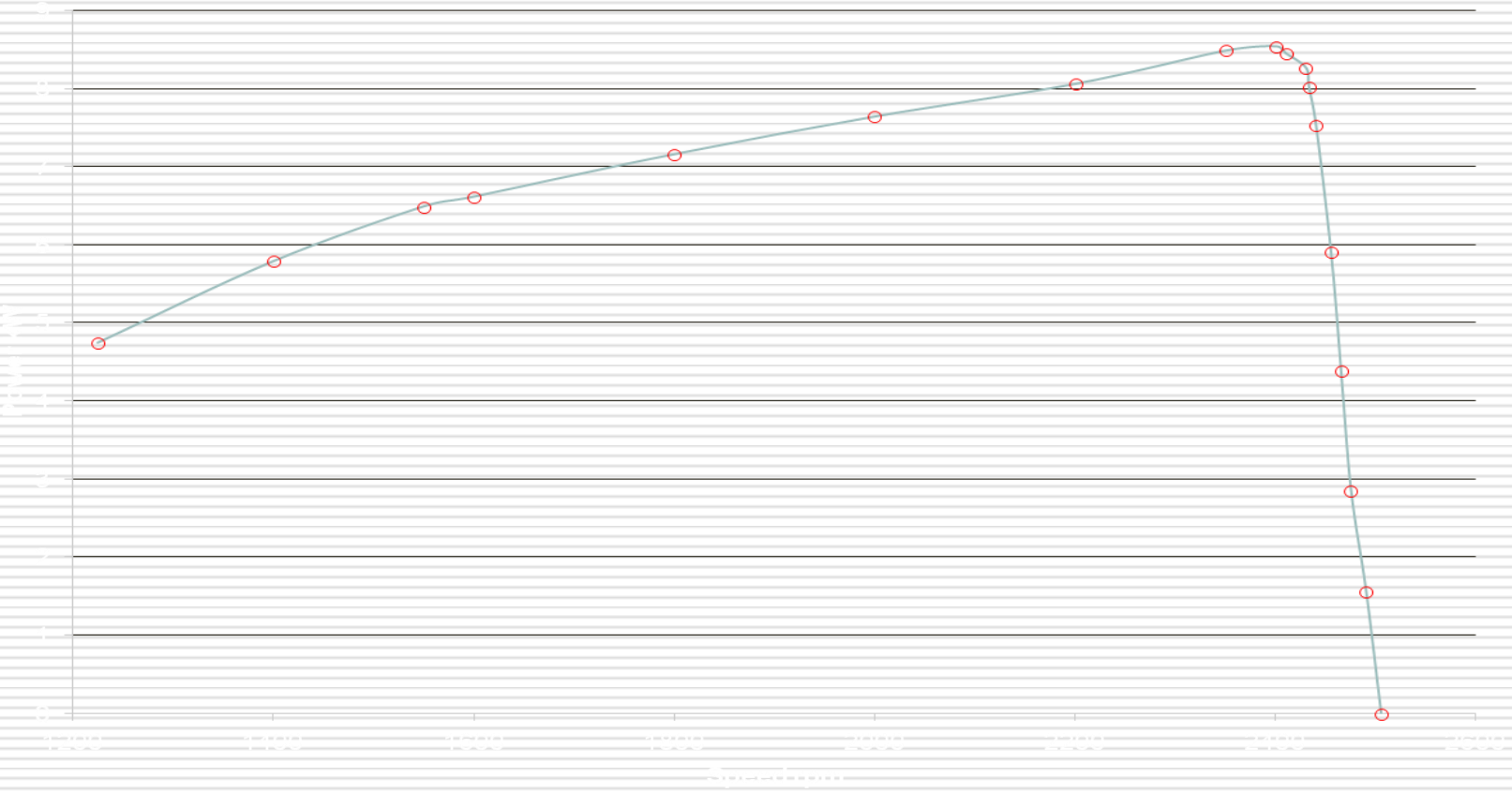
$$\omega = angular\ velocity\ in\ rad/s$$

$$\omega = \frac{revolution/\min}{60} \times 2 \times \pi$$

Typical speed torque-for power tiller



Power torque for power tiller



Requirements at Max power point

1. The Point of maximum power is “searched”
2. Maximum Power normally occurs at rated speed.
3. The dynamometer should hold the load in a steady state

2. Stable operation – stability of speed, torque is held constant by the dynamometer

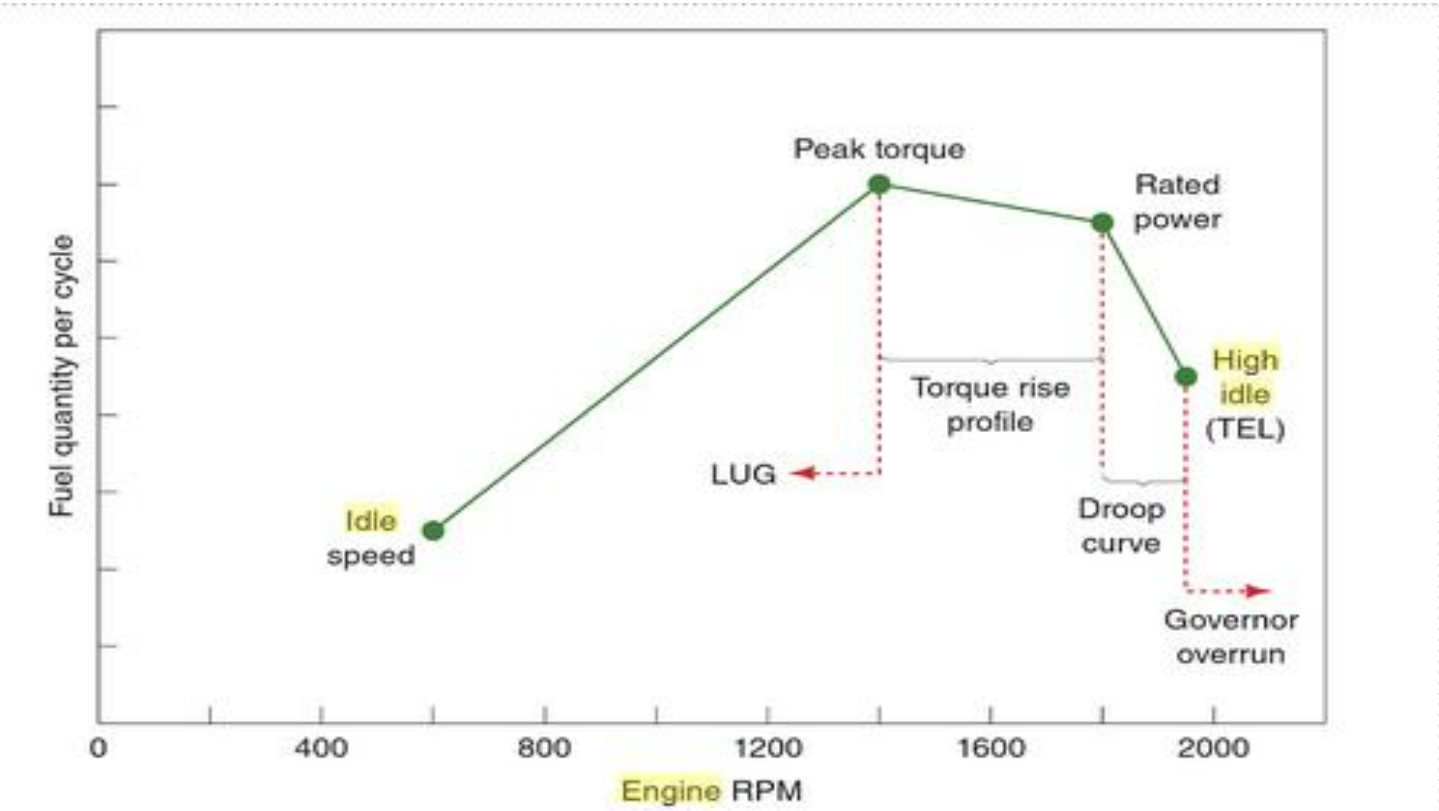
3. The main criteria is the temperature. The temperature of the engine should be in thermal equilibrium at the Max power point to enable continuous operation.

4. The mechanical systems of the engine should be capable of transmitting the power without failure of components.

Power at Rated Engine Speed

- The measurement of power at rated engine speed is done only if the Maximum power does not occur at the rated Engine speed.
- The procedure is same as that of the Maximum power test, only difference being the max power point is achieved by lowering the torque to allow the engine to produce rated speed
- This test is optional and done for 1h

Simplified governor map- speed- fuel/cycle relation



Medium/Heavy Duty Truck Engines, Fuel & Computerized Management Systems By Sean Bennett

Peak Torque

- Peak torque in a diesel engine is produced when ever cylinder pressures peak.
- Peak torque speed is important in understanding governor operation because in most cases it represents the lowest speed within the normal engine operating range.

Idle and High idle

- The term *idle* in reference to a diesel engine, **it** means there is no load on the engine.
- The low idle is the speed that a diesel engine runs without any input from the accelerator pedal.
- High idle speeds exceed rated speeds by something between 5% and 20%. This is the maximum speed under control of the governor- When the throttle is in maximum position and the load is reduced to zero, the engine will reeve to maximum speed under control of governor. Though the high idle speed is under control of governor, The engine should not be put to High idle continuously, to void failure.

Speed Droop

- Droop is the reduced speed from High idle
- Droop curve runs from rated speed to High idle speed
- The purpose of droop is to avoid sudden change in Engine fuel supply when the rated speed is exceeded
- The governor droop curve is designed for graduated fuel de rating to occurring between rated and high idle speeds. Abruptly cut off fueling a diesel engine the Instant the rpm exceeded rated speed could be potentially dangerous.
- Droop curve fueling ensures that fueling adjustments at speeds exceeding rated are gentle
- Droop curve is expressed as a percentage by diesel engine OEMs. The percentage is typically between 5% and 20%.

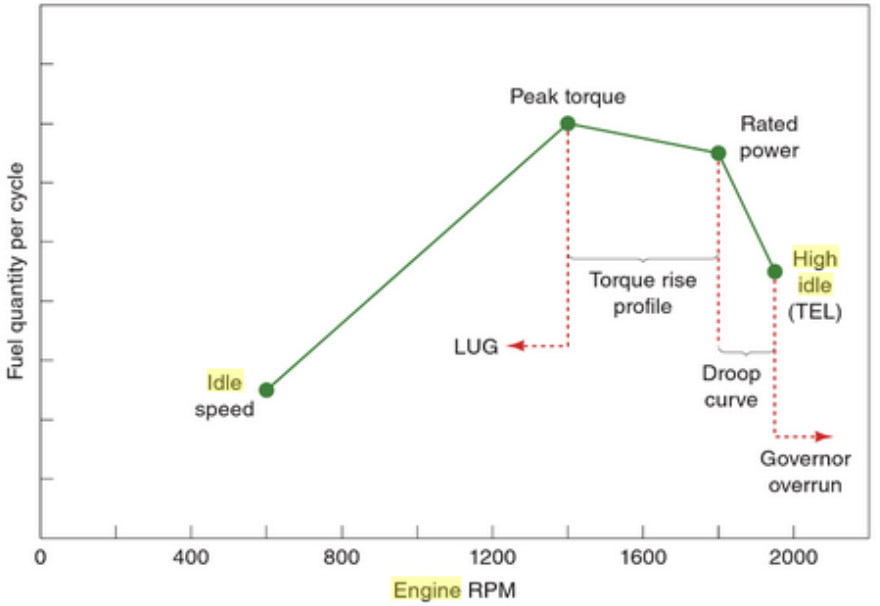
Lugging

- An engine is put into a lug mode when the rpm drops below the lowest rpm in the intended engine-operating range. This is known as lugging. and it occurs when engine load drops the rpm below the base rpm of torque rise.
- Conventional engines could labor and produce dangerously high cylinder pressures while attempting to pull out of a severe lug condition.

Speed range of regular operation

The Engine under normal operation runs at speeds between rated speed (Max power point) and Max torque speed.

In this range, the torque always increases with reduction in speed



Varying Speed at Full Load

- This test maps the speed torque curve form Maximum power point to maximum torque point-as stated above.
- The throttle (rack position) is set to full load point and the load is varied to obtain series of speeds
- Power, torque and fuel consumption are measured
- Minimum 6 readings shall be taken between rated rpm and speed at maximum torque.
- The minimum speeds at which measurements are made shall be at the speed of maximum torque and, if possible, 15 percent below that speed (6.1.3 IS 12036: 1995 and 5.3.2 GB/T 6229-2007).

Varying Load Tests

- The throttle position is set to the full load position and the load is varied to obtain series of points on the full load line.
- The engine throttle position is set to maximum and the dynamometer load are adjusted to obtain equilibrium at different speed- torque combinations.
- The power, speed and fuel consumption are measured.

Torque levels

- The torque corresponding to maximum power available at rated engine speed ,(a)
- 85 percent of the torque obtained in (a)
- 75 percent of the torque obtained in (b)
- 50 percent of the torque obtained in (b)
- 25 percent of the torque obtained in (b)
- Unloaded [with the dynamometer disconnected if the residual torque is greater than 5 percent of the torque defined in (b)].

Five Hours Engine Rating Test
(IS 12036: 1995)

- Run continuously for 5 hours.
- For the first 4 hours, the engine shall be run at 90 percent of load (torque) corresponding to maximum power
- During the 5th hour, the engine shall be run at a load corresponding to maximum power.
- Record Power, torque and fuel consumption every half-an-hour during the first 4 hours and after every 15 minutes during the 5th