

AGE 504

FARM POWER II

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## Hydraulic Systems and Controls

- Lift, control, of mounted and trailed implements
- Steering system, change gear ratio, use on remote systems not directly accessible
- Components
  - Pump, motor, valve, lines & connections, heat exchanger, sump, stored energy, control, fluid, Actuators, Filters
  - System may contain all or some of the components
  - Pump is the heart of the hydraulic system

## Components Description

- Pump
- Accumulator
- Valves
  - Directional, Pressure, volume control
- Hydraulic fluid
- Reservoir/ sump usually attached with filters
- Heat Exchanger
- Lines & couplers strength dependent on diameter and inner reinforcement
- Actuator cylinders and motors for manifesting effect of hydraulic system
  - Single acting and double acting cylinders

## HYDRAULIC CONTROLS

- Nudging
- Auto- position control
- Auto- draft control
  
- Power steering
  - Hydro-mechanical power
  - Hydrostatic power

## TRACTION & TRACTION DEVICES

- Ability to develop drawbar pull thro wheels and tracks called tractive devices
- Drawbar least efficient
- Wheels most predominant
- Traction depends on
  - Type of device
  - Amount of ballast
  - Lug design
  - Hitch mechanism
- Traction developed by interaction of tractive devices with soil
  - Theoretical, experimental & field tests to analyze and design tractive systems

## Mohr-Coulomb failure Criteria

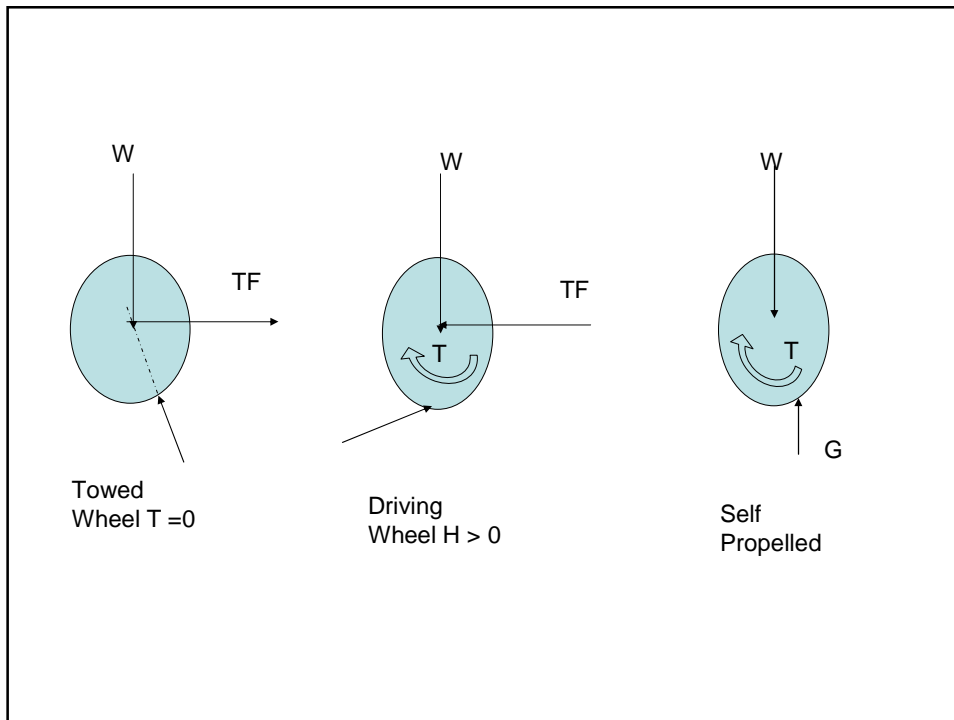
- Consider soil-plate of length  $l$ , width  $b$  acted upon by a normal force  $W$ , then force  $F$  required to shear off the plate of soil is given by
- $F = Ac + W \cdot \tan \phi$
- Applying eqn above to tracks and wheels will be
- $P = W / bL$  and
- $P = W / 0.78bl$
- \*\*\* values for  $c$  and  $\phi$  are rarely known.

## Traction Performance Equations and Terms

- Traction efficiency
- $TE = \text{Output power} / \text{Input power}$ 
  - Factors affecting
  - Steering, rolling resistance, slip, friction, deflection of tractive devices
- Net Tractive Efficiency
  - Net Pull/ Dynamic Normal Load

## Analysis of Pull-torque slip relation for tractive devices on soil

- Conditions of Operations
    - Towed, driving wheel and self-propelled slip
- Slip ..... A motion loss at the tractive device wheel or track) as a result of reactions developed from soil stress
- $$S = 1 - V_a / V_t$$
- Rolling Radius..... distance traveled per revolution of the tractive device divided by  $2\pi$  when operated on a hard surface with zero drawbar load
- The three condition Towed, Driving Wheel and self-propelled is as shown



## USING DIMENSIONAL ANALYSIS

- Motion resistance ratio
  - $\rho = TF/W = 1.2/C_n + 0.04$
- Gross Tractive force
  - $\mu_g = 0.75(1 - e^{-0.3C_n})$
  - Net Traction co-efficient
  - $\mu = \mu_g - 1$
  - Tractive Efficiency
    - $TE = HV_a/T\omega$

## Traction Improvement Methods

- Weighting or Ballasting (addition of solution in wheels)
  - Prevent tipping over
  - Good steering control
- Traction Assist system
  - Built into mounted implement, hitch system of tractors

## TRACTOR TEST & PERFORMANCES

- Power delivered through
  - Drive wheel or draft of drawbar
  - Rotary power thro Pto shaft or belt pulley
  - Hydraulic power thro hydraulic system
- Maximum drawbar most useful performance criteria
- Fuel consumption
- Torque curve ..... For stability
- Drawbar pull Vs speed curve
  
- $DBP = FS/3.6$  (kW)
- $DBP = FS / 375$  ( hp)
  
- $PTOP = 2\pi T N/ 60$  (kW)
  
- Frictional Power
- Indicated Power
- Gross Indicated Power

## ENGINE TESTING

- Dynamometer .... Power determination by independent measurement of force, time and distance thro which the force is moved
- Types
  - Transmission & Adsorption
  - Adsorption measures and converts power into some other form of energy
  - Pony dynamometer
  - Others are
    - Hydraulic, Air or fan, Electric d.c, shop type & spring dynamometer

## Power Train

- Useful power transmitted thro power train
- Power train consists of
  - Traction & pto friction clutches
  - Transmission
  - Pto drives
  - Mechanical front wheel drive
  - Transmission & hydraulic pump drive
  - Spiral bevel gear set
  - Differentials
  - Final drive
  - Individual axle brakes
  - Rear axles
- \*\*Most systems have 1, 2, 7 & 8

## TRANSMISSIONS

Contained in a box shaped housing btw clutch & final drive

Consists of gears, shafts and synchronizers coupled together to meet many speed and load requirements

Provides the operator control over engine power to the rear axles

Has four or six forward speeds with accompanying one or two reverse speeds.....  
Recently there are > 10 speeds and several reverse speeds

Ability to change speed ratios without stopping or dis-engagement.....under drive

## Transmission Types

1. Sliding gear
2. Constant mesh
3. Synchronized or synchro-mesh
4. Power shift
5. Automatic
6. Hydrostatic
7. Hydro-mechanical
8. CVT COUNTINUOUS VARIABLE TRANSMISSION

1 – 4 are selective gear transmission

1 -3 are manually operated but not explicitly



## Components

- Differentials
  - Allows the two rear wheels to turn at different speeds while power is transmitted to both wheels
- Final drives
  - A gear reduction located btw power train and drive wheel.
- Power-take-off shaft
  - Two standard speeds  $540 \pm 10\text{rpm}$  and  $1000 \pm 25\text{rpm}$  with 35mm diameter shaft

## Operation, adjustment, maintenance & trouble shooting

- Adjustments
  - Fuel system
  - Ignition system
  - Valve train
- Maintenance
  - To prevent damage to engine and ensure continued good engine performance
  - Lubrication system
  - Cooling system
  - fuel/air system
  - Ignition system

### Troubleshooting

Structured procedure to determine what is wrong with a machine or system

Engine fails to start, Over heating, Engine Knock, low oil pressure

Detonation in exhaust pipe, excessive fuel consumption, Smokey

Exhaust

## TRACTOR SELECTION & COST

- **Power Selection**
  - Use of Annual cost formula
  - By computer software
- **Size selection**
- **Costs**
  - Fixed Cost
  - Variable Cost
- **Replacements**
  - Damage of implement
  - Inadequate field capacity
  - Obsolescence
  - Performance of new machine is significantly superior
  - Anticipated costs for operating old machine exceeds cost for replacement