

Appendix E

Evaluation and standardization of animal driven water pump

(Venue: Lav-Kush Ashram, Karoli, Kanpur; Duration: April 26 to May 02, 2011)

1. Testing of gear-box after changing the helical gear pair:

Sl. No.	Particulars	Reading Taken after 30 minutes intervals					Remarks
		30	30	30	30	30	
1.	Gearbox Input RPM	1 rev. 30 sec.	1 rev. 30 sec.	1 rev. 29 sec.	1 rev. 30 sec.	1 rev. 30 sec.	Bullocks were driving at below average speed.
2.	Gearbox output RPM	130	122	118	120	117	V-Pulley –450MM
3.	Screw Pump RPM	442	390	408.5	391	395	V-Pulley – 150MM
4.	Screw Pump Flow Rate						No. of Bullock – Two Age Height Weight Length 1. Bullock-A- 5 Yrs. - 5'1" - Healthy - 6'3" 2. Bullock-B- 4.5 Yrs.- 4'11" - -do- - 6'2" Container size: 200 liters
	Time taken (when 200 litres container filled-up with water)	93 Sec.	110 Sec.	95 Sec.	105 Sec.	98 Sec.	
	Total water discharge in litres per hours	7742	6546	7579	6857	7347	
	Average water discharge per hours - 7215						
5.	Height of Input head (from underground water level)						10 mts. (30 feet)
6.	Internal Diameter of pipe (Suction pipe)						85 mm
7.	Internal Diameter of discharge pipe (Output pipe)						65 mm
8.	Length/Height of Screw in the pump						615 mm
9.	Length of lever						4.8 mts. (16 feet)
10.	Lever Support	With Lever Support /Wheel arrangement					Wheel arrangement is good. Adjustable and seating arrangement should be provided.

2. Testing of gear-box without lever support:

Serial No.	Particulars	Reading Taken after 30 minutes intervals						Remarks
		30	30	30	30	30	30	
1.	Gearbox Input RPM	1 rev. 25 sec.	1 rev. 24 sec.	1 rev. 23 sec.	1 rev. 28 sec.	1 rev. 31 sec.	1 rev. 32 sec.	Bullocks were driving at average speed.
2.	Gearbox output RPM	141	144	150	128	106	117.5	Same as previous
3.	Screw Pump RPM	462	475	486.50	390	321.50	355	
4.	Screw Pump Flow Rate							
	Time taken (when 200 litres container filled-up with water)	84 Sec.	83 Sec.	77 Sec.	100 Sec.	112 Sec.	103 Sec.	
	Total water discharge in litres per hours	8572	8675	9351	7200	6429	6990	
Average water discharge per hours - 7870								
5.	Height of Input head (from under ground water level)					Same as previous		
6.	Internal Diameter of pipe (Suction pipe)							
7.	Internal Diameter of discharge pipe (Output pipe)							
8.	Length/Height of Screw in the pump							
9.	Length of lever							
10.	Without Lever Support					Bullocks were tired early		

3. Testing of standardized gear-box (all gears are spur):

Serial No.	Particulars	Reading Taken after 30 minutes intervals					Remarks
		30	30	30	30	30	
1.	Gearbox Input RPM	1 rev. 23 sec.	1 rev. 22 sec.	1 rev. 23 sec.	1 rev. 26 sec.	1 rev. 28 sec.	Bullocks were driving fast as compared to previous day
2.	Gearbox output RPM	198.5	200	196.5	133	123	
3.	Screw Pump RPM	595	597	585	436.5	432	
4.	Screw Pump Flow Rate						
	Time taken (when 200 litres container filled-up with water)	66 Sec.	65 Sec.	67 Sec.	82 Sec.	85 Sec.	Same as previous
	Total water discharge in litres per hours	10909	11077	10746	8780	8471	
		Average water discharge per hours - 9997					
5.	Height of Input head (from underground water level)						
6.	Internal Diameter of pipe (Suction pipe)						
7.	Internal Diameter of discharge pipe (Output pipe)						
8.	Length/Height of Screw in the pump						
9.	Length of lever						
11.	With Lever Support /Wheel arrangement						Inside the gear-box noise was low.

4. Testing of standardized gear-box (all gears are spur) at lower pump speed:

Serial No.	Particulars	Reading Taken after 30 minutes intervals					Remarks
		30	30	30	30	30	
1.	Gearbox Input RPM	1 rev. 24 sec.	1 rev. 23 sec.	1 rev. 23 sec.	1 rev. 24 sec.	1 rev. 25 sec.	Bullocks were driving fast as compared to previous day
2.	Gearbox output RPM	135	125	131	145.5	149	Same as previous
3.	Screw Pump RPM	350	335	345	346.5	347	V-Pulley – 250MM
4.	Screw Pump Flow Rate						Same as previous
	Time taken (when 200 litres container filled-up with water)	160 Sec.	162 Sec.	170 Sec.	173 Sec.	176 Sec.	
	Total water discharge in litres per hours	4500	4445	4235	4162	4091	
	Average water discharge per hours - 4287						
5.	Height of Input head (from underground water level) in feet					Same as previous	
6.	Internal Diameter of pipe (Suction pipe) in mm						
7.	Internal Diameter of discharge pipe (Output pipe) in mm						
8.	Length/Height of Screw in the pump						
9.	Length of lever in feet						
10.	With Lever Support /Wheel arrangement					Inside the gearbox noise was low.	

5. Sample calculates to estimates power required to lift water from 10 mts. (30 feet) [Test 1]:

$$P = \delta g Q h / 3.6 \times 10^6$$

Where,

δ : 1000Kg/m³ [density (Kg/m³)]; g : 9.81 m/s² (gravity); Q = flow rate m³/h; h = head (m)

$$P = 1000 \times 9.8 \times 7215 \times 10^{-3} \times 10 / 3.6 \times 10^6$$

(where, screw pump v-pulley size-150MM)

$$= 0.1964 \text{ KW}$$

$$= \mathbf{196 \text{ Watts}}$$

Input Power to the gearbox:

Where,

$$P_{\text{input}} = P / 0.75 \times 0.65 \times 0.97$$

$$= 0.196 / 0.75 \times 0.60 \times 0.97$$

$$= 0.449 \text{ KW}$$

$$= \mathbf{449 \text{ Watts}}$$

P: Power required to lift the water from 30 feet (i.e., 10m)

0.75: gearbox efficiency;

0.60 to 0.65: pump efficiency;

0.97: V-belt efficiency

Similarly for other tests, i.e. in 2, 3, and 4 input powers to the gear-box are estimated as 490, 628 and 268 Watts, respectively.

Hence, the smaller gear-box of 650 Watt capacity is justified.