Workshop Exercise - Solar Water Pumping Systems

- 1. A small community consists of 20 people, assuming the daily water requirement is 60 litres per person. What is the total daily water requirement in litres/day and m³/day?
- 2. The designer has determined that the site requires 1.2m³ of water per day and the total dynamic head has been estimated as 20m. Assume the graph below gives the pumping capacities of various Grundfos SQFlex irradiation of 5kWh/m² on a fixed array frame. What is the minimum Grundfos SQFlex solar water pumping system model that is suitable?



- 3. The solar water pumping system daily flow volume is based on an irradiation of 5kWh/m² per day. The daily flow volume is directly proportional the irradiation. The solar water pump curve shows for a specified head that the solar pumping system will provide 10m³ per day at irradiation of 6kWh/m², what flow will the solar water pumping system provide at an irradiation of 4kWh/m²?
- 4. A solar pumping system where the solar array is mounted on a tracking system will provide on average 1.3 times more volume of water per day for the same specified array wattage as that on the tracking system. If a tracking system will provide 13m³ per day what will a fixed array frame with same array size produce.
- 5. The designer has determined that the site requires 10m³ of water per day and the total dynamic head has been calculated as 35m. The site has irradiation of 5.5kWh/m² on a fixed array frame. Assume a tracking system produces 30% more flow than a stationary system and refer to the table below, what is the smallest array size suitable (answer in Watts)?

6.5kW/hr average performance tracking										
	System Size (watts)									
Head (m)	200	400	600	800	1200	1600				
5	33	53	102	104	110	112				
10	24	46	81	93	105	108				
15	17	39	47	79	98	104				
20	14	31	42	62	90	99				
25	11	25	36	49	80	93				
30	9	20	31	34						
35	7	16	26	30						
40	6	12	15							
45		10	13							
50		8	11							

Table 7a: Daily Flow in m³ for surface Mono Solar Water Pumping Systems

6. A village that comprises 100 people wish to use solar water pumping to meet their water requirements. The surface pump will be located 4 metres above river level. The suction pipe will be 8 metres in length. The water will be stored in a water tank that is located 50 metres away from the river and 15 metres vertically above the location of the surface pump. There will be a foot valve in the suction pipe and a gate valve in the discharge pipe. The daily irradiation is 6.5 kWh/m² and the solar array will be mounted on a tracking array frame. The village requires minimum of 5m³ of water per day.

Use the equation:

Total dynamic head = *static head* + *friction head* + *velocity head*

Assume friction head is 5 metres and velocity head of 1 metre.

Assume the Mono pump model SRX CP25 has been chosen as the pump. The pump is capable of 28L/min and has inlet and outlet diameters of 1 inch (25.4mm) (see diagram below).



Figure 1: Mono Pump SRX CP25 schematic

What is the total assumed dynamic head? _____m

Use the pipe datasheet provided. What pipe would you select so that friction losses is 5m or less?

What is the friction loss in the pipe for the given distance? _____m

What's the corresponding velocity (in metre/second) for the chosen pipe at the pump's maximum output? _____m/s

To calculate friction loss in in pipe fittings is calculated with the equation: = $K \times v^2/2g$ Where g = 9.81m/s

K Values for Some Fittings (metric)

Size (mm)	16	20	25	32	40	50	63/80	100	125	150
Foot valve	11.34	10.50	9.66	9.24	8.82	7.98	7.56	7.14	6.72	6.30
Gate Valve	0.22	0.20	0.18	0.18	0.17	0.15	0.14	0.14	0.13	0.12

If 32mm/16PN pipe is used with the corresponding the velocity of 1.1m/s, what would be the friction head of the foot valve and the gate valve?

Gate valve: _____m

Foot valve: _____m

The total frictional head loss of the water piping system = Frictional head loss of suction pipe and discharge pipe + frictional head of a foot valve + frictional head loss of a gate valve.

What would be the total frictional head loss of the water piping system? _____m

Velocity head is calculated with the equation = $v^2/2g$. What is the velocity head at this site? _____m

What is the actual total dynamic head of the water pumping system? _____m



Flow Chart for Small Bore Polyethylene Pipe

Head Loss - Metres Head of Water per 100 metres of Pipe