Savings from pump selection and installation

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Overview

- It is relatively simple to order a submersible pumpset. Most people are happy when the required flowrate is reliably achieved.
- We shall examine some finer details in achieving this, using less energy and costing less.
- My experience began in East Malaysia, from 1994. At Veolia Water Central, we abstract in excess of 500 Million litres per day.

1. Firstly we shall look at specifying flow / pressure requirements.
2. Secondly consider the advantages of Vertical Spindle Pumpsets.
3. Finally we shall examine inefficiencies in submersible installations.

- Please ask questions throughout.

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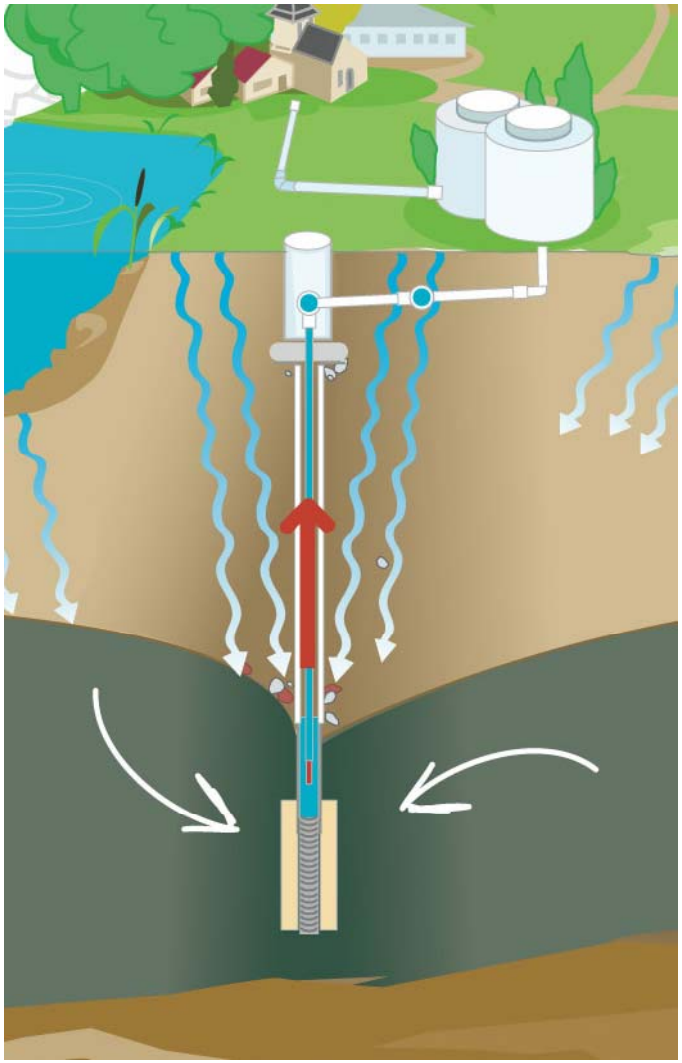
“It’s simple to order a submersible pumpset”



- **Ordering a replacement pumpset:**
  - Copy Nameplate Details.
  - Confirm cable length.
  - Get some quotations, inc. all works.
  - Choose the lowest capital cost.
  - Check it starts & stops.
  - On to next job……

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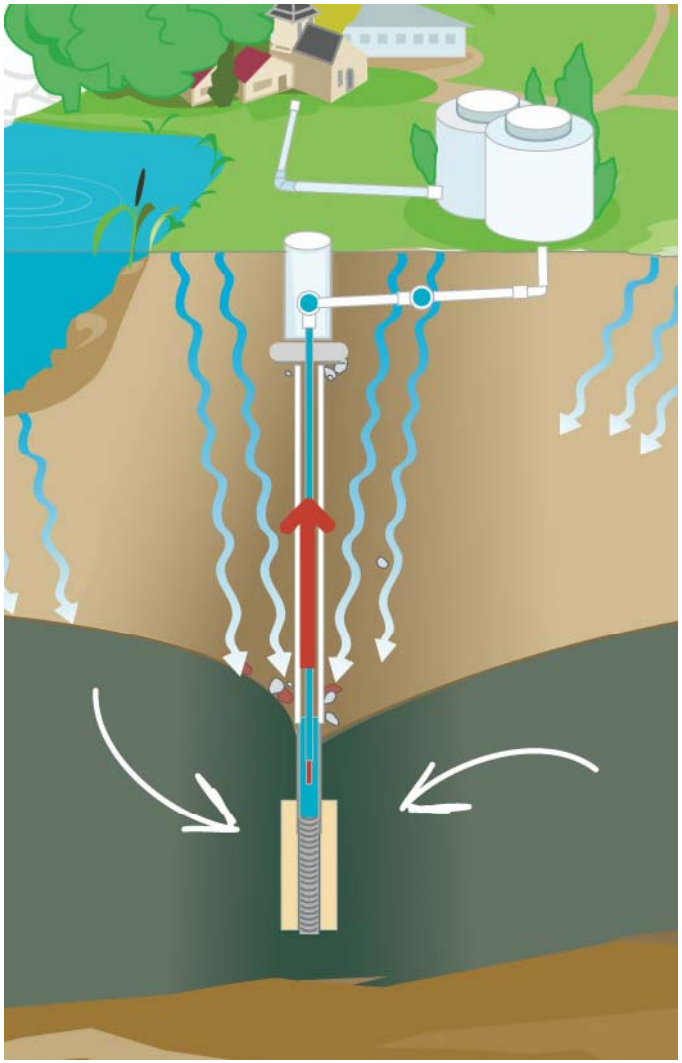
“It’s too simple to order a submersible pumpset !!!”



- **Problems:**
  - The flow has gone up a bit, so the operators throttle the outlet valve.
  - The energy bill is still high.
  - The pump satisfies daily demand in 12 hours.
  - The motor still trips on high temperature.
  - We are used to this.
  - Isn’t electricity expensive!

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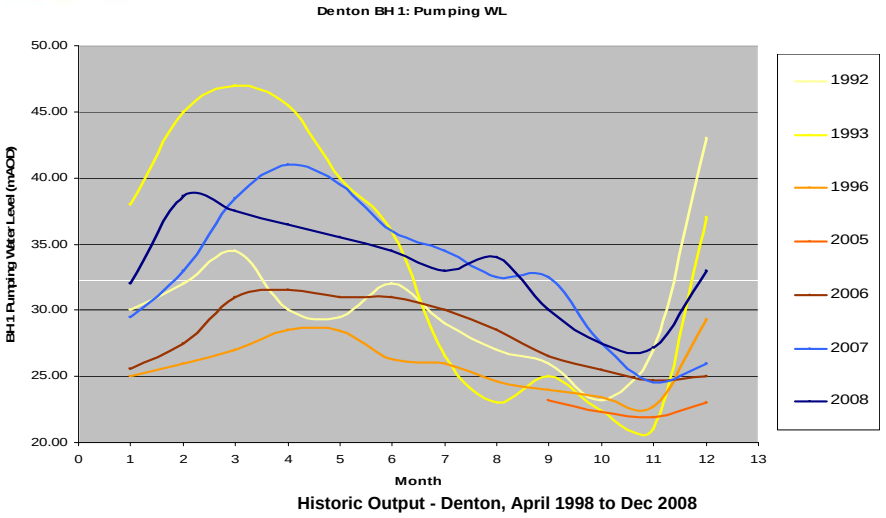
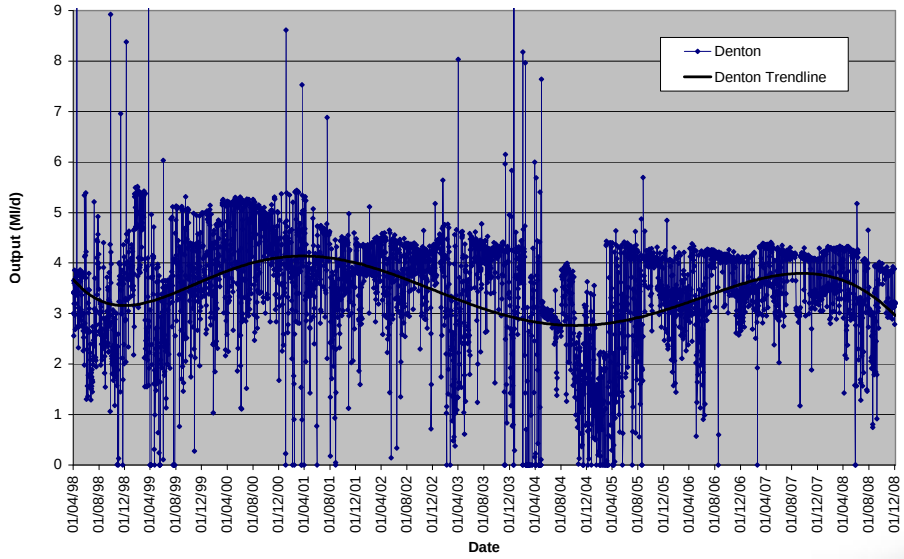
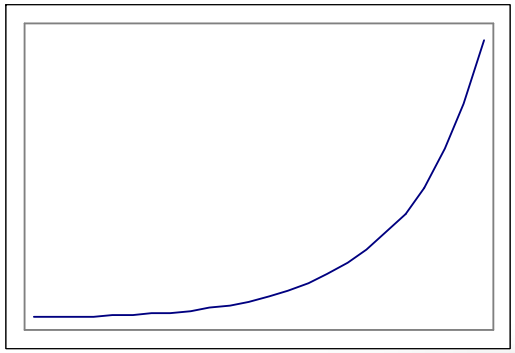
Specifying flow / pressure requirements.



Historic Output - Denton, April 1998 to Dec 2008



- **Data to specify duty points:**
  - Peak Flow at lowest/ highest Lowest Lift.
  - drought and highest Pumping Water Level (PWL).
  - riser losses to headworks
  - Discharge Pressure, system curve, as below:



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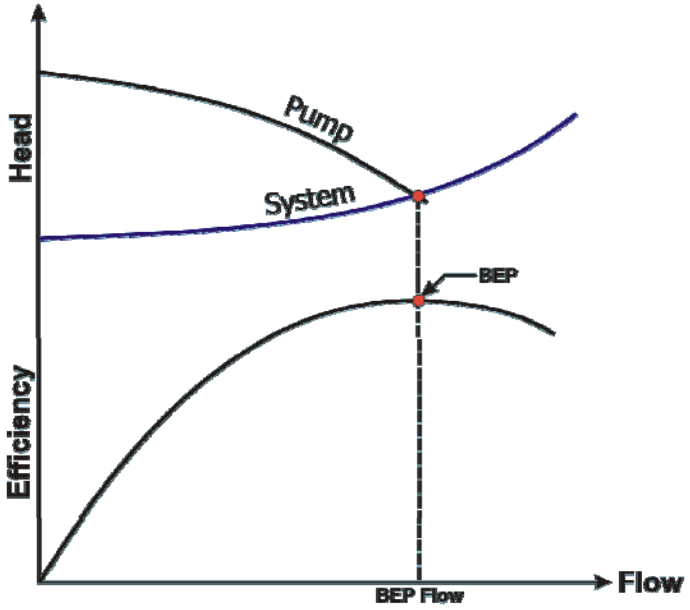
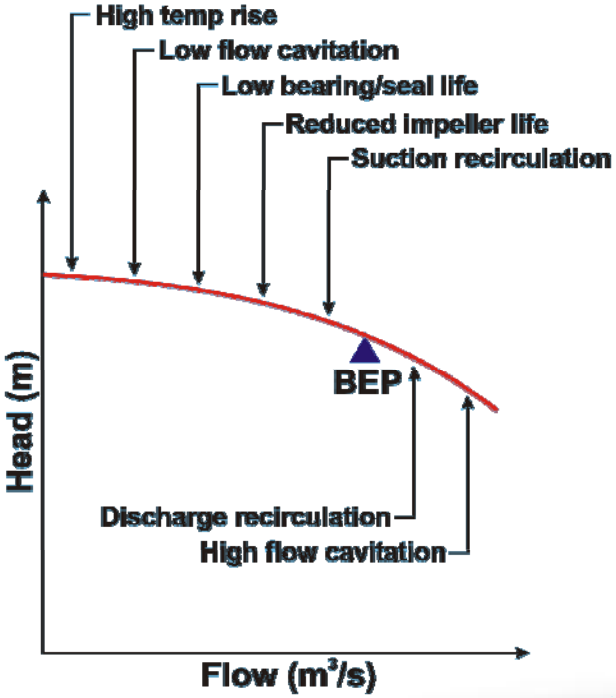
Pumps consume energy, sometimes efficiently.

➢ Pump Operation – Fixed Speed Pumps.

Pumps operate efficiently over a relatively small operating range. Outside of this range, energy is wasted within the pump.





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Use pumping flexibility to reduce costs?

	2003 / 2004		2004 / 2005						2009 / 2010			
	<1 MW Year Av.		<1 MW Year Av.				Dec & Jan M-F 09-10	Nov & Feb M-F 09-10	Mar M-F 09-10	Weekday -other 09-10	Sat/Sun 09-10	Annual Av. 09-10
	1.713		2.883		0	to 1	5.32	5.32	5.32	5.32	5.32	5.32
	1.713		2.883		1	to 2	5.32	5.32	5.32	5.32	5.32	5.32
	1.713		2.883		2	to 3	5.32	5.32	5.32	5.32	5.32	5.32
	1.713		2.883		3	to 4	5.32	5.32	5.32	5.32	5.32	5.32
	1.713		2.883		4	to 5	5.32	5.32	5.32	5.32	5.32	5.32
	1.713		2.883		5	to 6	5.32	5.32	5.32	5.32	5.32	5.32
	1.713		2.883		6	to 7	5.32	5.32	5.32	5.32	5.32	5.32
	2.361		3.784		7	to 8	7.08	7.08	7.08	7.08	7.08	7.08
	2.361		3.784		8	to 9	9.20	9.20	9.20	7.08	7.08	7.71
	2.361		3.784		9	to 10	9.20	9.20	9.20	7.08	7.08	7.71
	2.361		3.784		10	to 11	9.20	9.20	9.20	7.08	7.08	7.71
	2.361		3.784		11	to 12	9.20	9.20	9.20	7.08	7.08	7.71
	2.361		3.784		12	to 13	9.20	9.20	9.20	7.08	7.08	7.71
	2.361		3.784		13	to 14	9.20	9.20	9.20	7.08	7.08	7.71
	2.361		3.784		14	to 15	9.20	9.20	9.20	7.08	7.08	7.71
	2.361		3.784		15	to 16	9.20	9.20	9.20	7.08	7.08	7.71
	3.375		4.564		16	to 17	13.79	12.54	9.20	7.08	7.08	8.65
	3.617		4.564		17	to 18	13.79	12.54	9.20	7.08	7.08	8.65
	3.375		4.138		18	to 19	13.79	12.54	9.20	7.08	7.08	8.65
	3.134		4.138		19	to 20	9.20	9.20	9.20	7.08	7.08	7.71
	2.361		3.784		20	to 21	7.08	7.08	7.08	7.08	7.08	7.08
	2.361		3.784		21	to 22	7.08	7.08	7.08	7.08	7.08	7.08
	2.361		3.784		22	to 23	7.08	7.08	7.08	7.08	7.08	7.08
	1.713		2.883		23	to 24	7.08	7.08	7.08	7.08	7.08	7.08
Average	2.31		3.58				8.20	8.04	7.63	6.57	6.57	7.00

- **What is cost framework ?**
  - Maximise Cheaper Night Time and Weekend Usage
  - Minimise Peak Evening Tariff Usage
  - Triad Usage ?
  - S.T.O.R. (Short Term Operating Reserve)

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Efficiencies at actual operating points.?

		Rated OP	OP1	OP2	OP3	
1	Flow (l/s) (P)	102.8	104	86.8	115.7	
	Head outside unit (m) (P)	127.4	107.5	103.5	97.5	
	Additional Lift (e.g. NRV / Line Shaft) (S)	0.7	0.7	0.4	0.9	
2	Total Differential Head (m)	128.1	108.2	103.9	98.4	
3	Pump Power Output (=pgQH)	129.18 kW	110.39 kW	88.47 kW	111.69 kW	
4	Pump Efficiency (S)	74.7%	75.2%	73.0%	76.0%	
5	Motor Efficiency (S)	87.0%	85.4%	84.9%	85.4%	
6	Inverter Efficiency (If Relevant) (P)	97.5%	97.5%	97.5%	97.5%	
7	Other Losses (If Relevant) (P)	1.5%	1.5%	1.5%	1.5%	
8	Overall Efficiency	62.4%	61.7%	59.5%	62.3%	
9	Overall Power Input	206.98 kW	178.98 kW	148.64 kW	179.18 kW	
10	Utilisation (P)	2%	60%	33%	5%	100%
11	Running Hours (Asset Life)	2104	63115	34713	5260	105192
12	Pump Power Output (Weighted Average)	103.60 kW				
13	Overall Efficiency (Weighted Average)	61.0%				
14	Overall Power Input (Weighted Average)	169.80 kW				

- **Consider efficiency for several duty points?**
  - Determine usual operating points and utilisation rates.
  - Determine best and worst pumping duties.
  - Compare average efficiencies and costs.

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Advantages of Vertical Spindle Pumpsets.

- **3 to 4 times higher capital cost, but can achieve 3 to 5 years payback on a 160kW installation at 100% duty, with opex savings £20 to £30K p.a.**
- **Submersible Pumpsets:**
  - Motors are a compromise : 85 to 90% efficient, require water cooling, are usually the source of failure (mechanically or electrically), require better quality power supply, submersible cables and associated losses.
  - Pumps: 70% to 80% efficient, typically 2900rpm rpm,
- **Vertical Spindle Pumps / Line Shaft pumps:**
  - Standard above ground motor 93% to 96% efficient, no submersible cable required, usually air cooled.
  - Pumps: 75% to 87% efficient, typically 1450 rpm. Wearing parts in shaft, lower capital cost for installation on higher PWL's.

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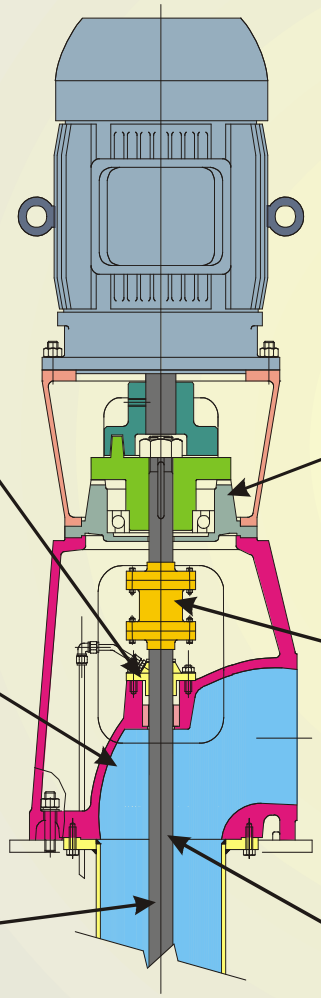
Lowest Life-cycle Cost Series



Keyed muff type couplings fitted as standard.

Easily removable, unlike lower cost screwed couplings ensuring increased component life.

Heavy duty thrust bearing assembly.

Anti-friction or Michell type thrust bearings dependant on load. Minimum L10 life in excess of 50,000 hours under all design load conditions.

Spacer Coupling as standard.

Facilitates removal of cartridge type mechanical seals without disturbing thrust bearing assembly or driver and negates the need for expensive split mechanical seals.

Stiff shaft construction.

Pumps designed to operate below first critical speed. Enhances bearing life and facilitates variable speed operation.

Customer specified mechanical seals.

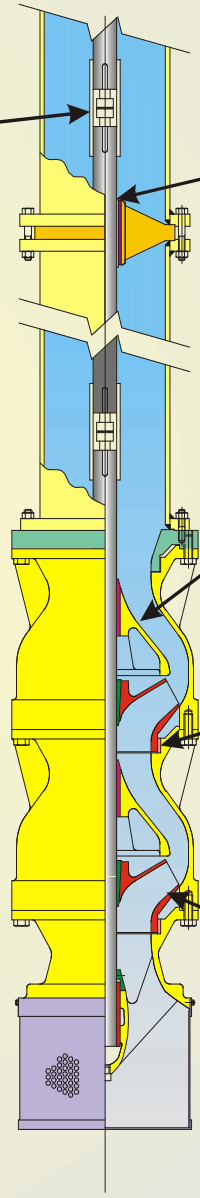
Site standards and customer specified options

Drinking water approved coatings.

Available for water industry applications.

Stainless steel as standard.

Enhanced corrosion resistance and component life.



Hard Stainless steel shaft sleeves fitted as standard.

Renewable hardened sleeves enhance shaft life.

Diffuser type design promotes axial rather than radial loads.

Enhanced bearing life.

Hard Metallic serrated wear rings.

Long life and reduced energy consumption.

Precision casting in austenitic stainless steel as standard.

Superior hydraulic performance and increased component life.

Examination of submersible pumpset installations.

1. **Vertical Spindle Pumps / Line Shaft pumps, use less energy, but more cost effective for larger power installations, higher PWL's and high utilisation factors. Maintenance may take longer, consider standby options.**

2. **4 Pole (1450rpm) submersible should be considered for large submersibles, although these are almost bespoke items for larger items.**

3. **Ensure the pump is designed for the liquid being pumped. Surface deterioration wear in abrasive liquids, proportional to speed$^{2.5}$.**

4. **Don't forget the losses in the rising main. Losses dependant upon velocity (diameter) and smoothness of the rising main. Ensure the rising main does not leak! (If using a vertical spindle pump, then the rising main losses will be substituted with column losses – consider capital costs.)**

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Examination of submersible pumpset installations.

1. **Motors: Submersible motor efficiencies peak at 90% efficiency, near 80% of full load. Efficiencies drop off as load is reduced, therefore the operating efficiency may be 85% or less.**

2. **Motor Shroud : A flow shroud may to be required, to ensure the water passes the motor above the minimum cooling velocity (unless the boreholes are narrow and you know the water comes from beneath the motor). The shroud will have a associated headloss. Some motors have a lower cooling velocity, negating a flow shroud.**

3. **The head loss through the Non Return Valve (NRV) supplied with the pumpset is NOT included by most manufacturers. Even though they supply the pumpset and NRV, they assume the designers allow for this loss in the rising main loss calculation. A cheap NRV will have a headloss of 0.5m to 4m. Some manufacturers have low head loss NRV's (these are a longer and cost more, but have only 10% to 20% of the head loss).**

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Examination of submersible pumpset installations.

1. **Submersible cables are usually designed with two considerations. The capacity of the cable, to prevent damage to the insulation and the total voltage drop. A voltage drop of 3% may be present. This is a direct heating load. Ensure that comparable quotes have comparable cable sizes and request a larger size if needed.**

2. **Power Filters: If using Variable Speed Drives (VSD) "Line Reactors" are required. One manufacturer reluctantly advises 'Sine Wave Reactors' are required for some motors. Additionally with cable lengths being so long, other manufacturers may prefer these too. This question should be asked and the solution should include this (often not the case). These all have losses (1% to 3%).**

3. **Installation depths: If possible, a higher installation depth will reduce the losses in the rising main and the cable will have lower losses / possibly be smaller diameter.**

4. **Choice : A well known manufacturer may have two types of submersibles, One costs 50% more and takes longer to deliver, but they can be 5% more efficient.**

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Examination of submersible pumpset installations.

1. **Witness test the pumps, to ensure the efficiency is actually realised, and not just a sales ploy, since the salesmen may have the facility in their software to nudge up the efficiency a few % points, to win the bid.**

2. **Pump Performance drop off : If using a variable speed, or fixed speed, then allow for capacity in the motor and drive for an increased load. Pump performance will eventually drop off, too, how will you deal with this.**

3. **Consider live efficiency monitoring data, to enable long term monitoring and spot poor operation, as setpoints / water levels change. kW/Ml & Live £/Ml information is useful from a source selection decision. Live efficiency is useful to ensure the pumpset is in good condition.**

4. **All pumps drop off in performance. It will be cost effective to replace a standard pumpset every 2 to 5 years at 100% duty operation. This is why it is important to have a live efficiency data available.**

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Summary

- It is relatively simple to order a submersible pumpset and have it installed. Most people are happy when the required flowrate is reliably achieved.
- Specifying flow / pressure requirements.
- The energy advantages of Vertical Spindle Pumpsets.
- An examination of inefficiencies in submersible pumpset installations.
- Any Questions?

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