

Economic Advantages of the Riserless Pump System

(by Clem Rowe, Managing Director, Inflatable Packers International Pty Ltd)

23/10/00

1) Riserless Pump System Introduction

The Riserless Pump System was introduced by AGE Developments to allow the casing itself to be used as the riser for an electric submersible pump by sealing and supporting the pump in the casing with an inflatable packer. This system eliminates the need for a separate riser column providing a broad range of contingent advantages such as:

- Fast, efficient installation and removal
- Removal without dismantling piping
- Low frictional head loss
- Lower power consumption due to high electrical power efficiency and low frictional head loss
- Protects pump assembly
- Prevents chaffing of casing and pump
- Less corrosion
- Reduced maintenance costs
- Improved well bore hydraulics
- Suitable for wells with severe dog-legs
- Ensures potentially polluted surface water and upper aquifers are excluded from produced water
- May allow reduced hole diameter
- May allow use of thinner wall casing

It is ideally suited to large, deep bores and offers even more advantages in new wells where the original casing and drilled hole diameter can potentially be reduced without any reduction in bore production rate.

This article explains these advantages and investigates the economic justification for using a Riserless Pump System to replace the old riser based system in a variety of situations.

2) Production Water Wells

There are two main situations to be considered:

- 1) New wells – where using a Riserless system allows you to drill a smaller diameter well with smaller diameter casing.

For example, the Water Corporation of Western Australia recently installed two new large diameter water production wells in the north of Perth, WA. They chose to use a Riserless Pump system because this allowed them to drill smaller diameter bores than would otherwise have been the case. The wells are each pumped at 230 litres/sec using 260 mm diameter (12") high-voltage electric submersibles set at a depth of 200 metres. If they were completed using a riser, they would have required a 250 mm (10") riser and the minimum casing size would have been 400 to 500 mm (16 - 20") to allow room for cables, couplings, etc. By using a Riserless completion both wells were able to be completed with 350 mm (14") casing. The economic justification in this case was simply based on the difference in well drilling and completion costs.

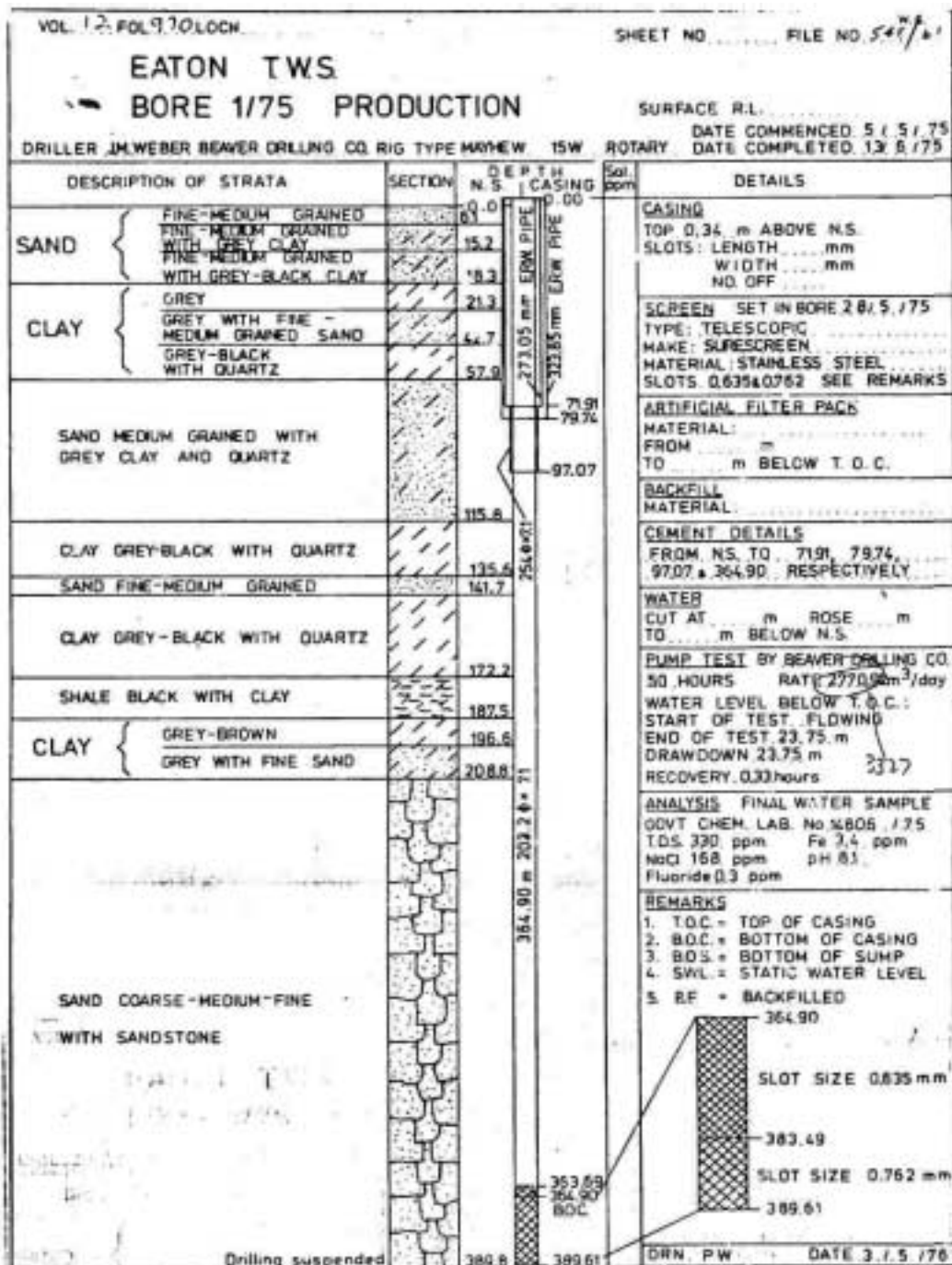


Figure 1 - Eaton 1/75 bore data

- 2) Existing wells – where using a Riserless system allows access to the benefits listed above and the economic justification is based on:
- Replacing the standard riser pipe
 - Lower initial installation costs
 - Lower removal and re-installation costs for maintenance
 - Power savings due to lower frictional head loss
 - Power savings due to lower electric cable temperature and resulting lower voltage resistance.

The savings available here are obviously applicable to the new bore situations as well. Moreover, in new bores there are other potential savings which improve the initial capital cost comparison of the Riserless system with the old riser system such as those indicated above.

3) An Example for Existing Wells

To investigate the economic benefits of a Riserless system consider Eaton 1/75, an existing town water supply well located in the South West of Western Australia. It was originally completed in 1975 and in 1996 it was re-completed with a Riserless Pump system. The schematic drawings, Figures 1 and 2, show the existing well data and the new Riserless system.

As can be seen, from Figure 2, the new top of pump depth is 84.58 metres and a further 10 m discharge head is required to pump the output to an elevated storage tank. The bore hole production rate is 32 litres/sec and the duty cycle is 75% i.e. operating for 6570 hours per annum. The other pertinent fact is that the original riser pipe was 125 mm or 5" NB.

It can be calculated that the frictional head losses for the 5" riser and the Riserless system are 5 m and 0.2 m respectively. This produces a power saving of 2.16 kW from an overall consumption of 44.62 kW i.e. 5%. Measurements of power loss due to cable resistance have indicated that the additional cooling due to the motor cable being immersed in flowing rather than stagnant water represents a power savings of a further 3 to 5%.

Thus, in the first year, the power consumed by the 5" riser based system is $44.62 \times 6570 = 293.2\text{MWh}$. For the Riserless system this reduces to $265.0 - 270.6\text{MWh}$. At a regional retail power cost of A\$0.1588/kWh this represents A\$46,554 and A\$42,959 - A\$42,073 per annum respectively. Over 20 years, the net present value of power consumption for the two systems at 7.5% interest is thus A\$474,597 and A\$428,919 - A\$437,949 respectively.

The Eaton 1/75 bore is owned and operated by the Water Corporation of W.A. Their specifications for riser pipe for this bore, in the absence of the Riserless option, would have lead to the use of 5" Fibreglass riser at a cost of A\$822 per 6 metre length. For

the purpose of this exercise and allowance of an additional A\$500 has been made for crossovers at each end of the FRP riser and a further A\$2000 has been allowed for a stainless steel headworks assembly. Thus the total equipment cost is A\$14,075.

The Riserless system costs were as follows:

- Stainless steel headworks including special flange and bolts – A\$6,100
- 81 metres of 5/8” stainless steel wire rope c/w end terminations – A\$3,800
- Riserless packer assembly – A\$15,000.
- TOTAL = A\$24,900

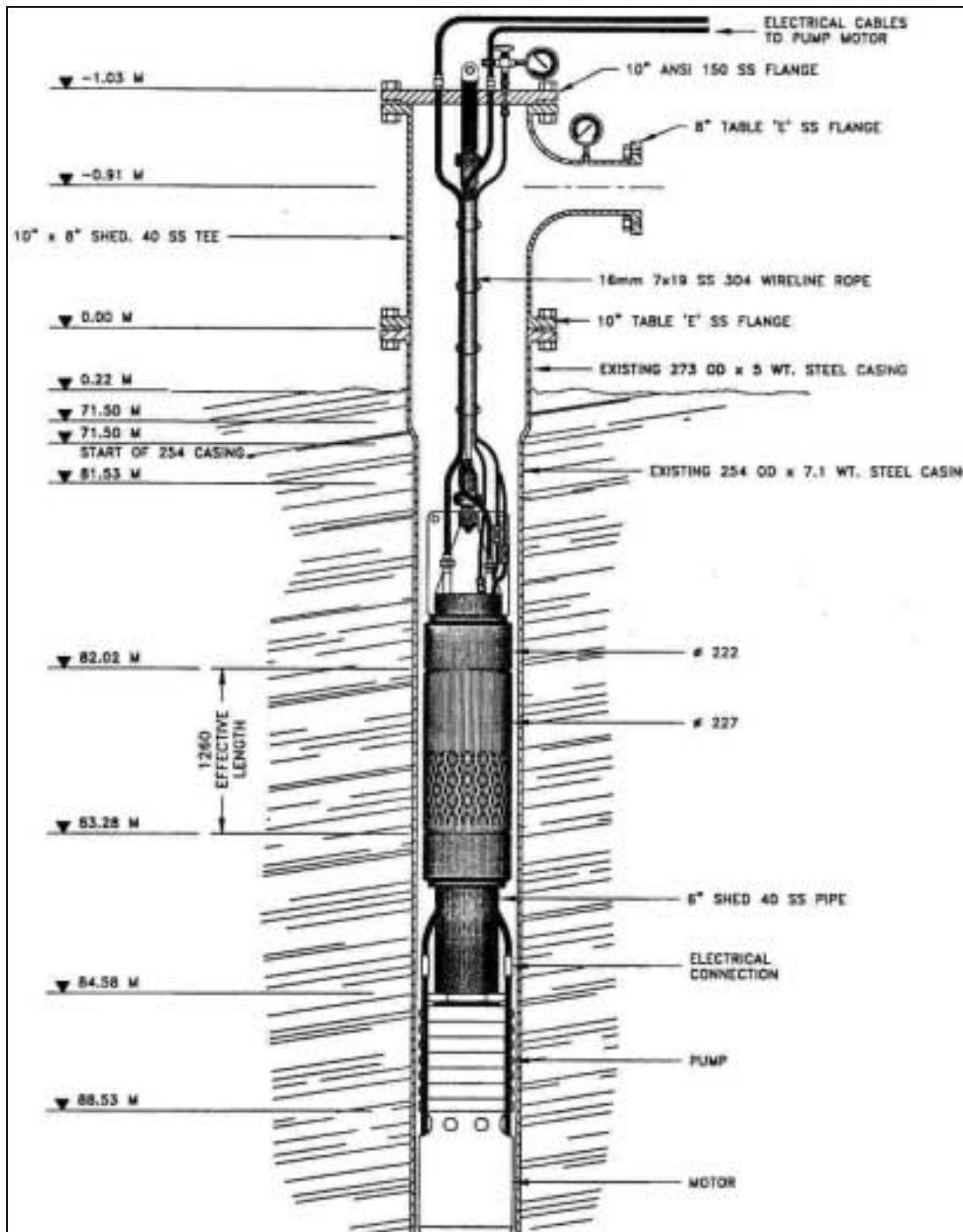


Figure 2 - Riserless System for Eaton 1/75 ore

The relative costs of initial installation for the two competing systems were estimated at A\$4,000 for the 5” riser system and A\$1,600 for the Riserless system. Furthermore, it is expected that the pump will be required to be pulled for maintenance every 2 years and it has been assumed that removal & re-installation costs would both be equal to the initial installation costs.

So, for the two alternatives we have:

Operation/Item	Costs in A\$	
	5” Riser based system	Riserless System
Purchase initial equipment	14,075	24,900
Initial installation	4,000	1,600
Present value of power consumption over 20years	474,597	428,919 – 437,949
Present value of maintenance cost over 20 years	51,031	20,412
Total Costs over 20 years	543,703	475,831 – 484,801

Thus, over the life of the well, it can be seen that the Riserless Pump System offers a potential savings of A\$58,842 – A\$67,872 for this example, even though the initial equipment cost is about 75% higher. Even for a discount rate of 10% the Riserless System is still a minimum of A\$49,824 cheaper.

4) Generally

From the preceding example it can be seen that many factors effect the economic justification for using a Riserless System in place of the old riser pipe. The main criteria for consideration are:

- Comparative initial capital investment per system
- Labour costs
- Equipment hire costs (internal or external rates)
- Retail power costs
- Depth to pump
- Size of casing and riser pipe
- Pumping head and flow-rate
- Investment discount rate
- Projected installation life
- Frequency of pump removal/re-installation
- Combined motor/pump efficiency

To investigate this further we can make some reasonable assumptions about some of these variables and check the comparative cost in relation to variation of others. To this end and using the Eaton 1/75 example as a model, we make the assumptions indicated in Table 1.

Table 1 - Given and assumed quantities for system comparison

Variable Item	Assumed Quantity	Units or comment
Depth to top of pump =	100	m
Production rate =	50	L/sec
Riser pipe diameter =	125	mm
Casing dia =	250	mm = 2 times riser pipe diameter
Frictional head loss for riser =	9.76	m/100m
Frictional head loss for casing =	0.31	m/100m = 1/32 of riser headloss
Duty cycle =	75%	
Reduction of cable resistance =	4%	
Retail power cost =	\$0.1588	A\$/kWh
Cost of riser pipe =	\$137.00	per metre
Capital cost of riser system =	\$16,200.00	= pipe cost + A\$2,500
Cost of pump hanger rope or pipe =	\$50.00	per metre
Capital cost of Riserless system =	\$28,050.00	=1.5 x 100 m riser cost plus hanger
Initial riser system installation cost =	\$4,000.00	= removal cost
Initial Riserless system installation cost =	\$2,000.00	= 1/2 riser system cost
Maintenance removal/installation cycle =	2	years
Design life of the installation =	20	years
Discounting interest rate =	10.00%	
Combined pump & motor efficiency	70%	

The above scenario yields the following lifetime cost figures:

Table 2 - Calculated quantities and costs comparisons

Calculated Quantities	Riser system	Riserless system	Comments
Pump pressure output (m) =	119.76	110.31	pump depth+10 m+friction
Pump power consumption (kW) =	83.92	74.20	
Power cost in the 1st year =	\$87,552.52	\$77,414.67	
Present value of lifetime power cost =	\$745,383.92	\$659,074.73	
Total number of maintenance events =	9	9	
Present value of lifetime maintenance cost =	\$46,072.19	\$23,036.10	
TOTAL LIFETIME COSTS =	\$811,656.11	\$712,160.83	
Riserless System Savings =		\$99,495.28	

The charts shown in the figures numbered 3 to 7 indicate the effect of various variables on the overall cost savings available with the Riserless Pump system by comparison to the old pump riser system.

Figure 3 plots the variation of savings depending on the riser pipe size and pump depth for a constant frictional head loss of 5 metres per 100 metres of pipe. It is readily apparent that larger diameter, deeper bores yield the greatest savings as previously asserted.

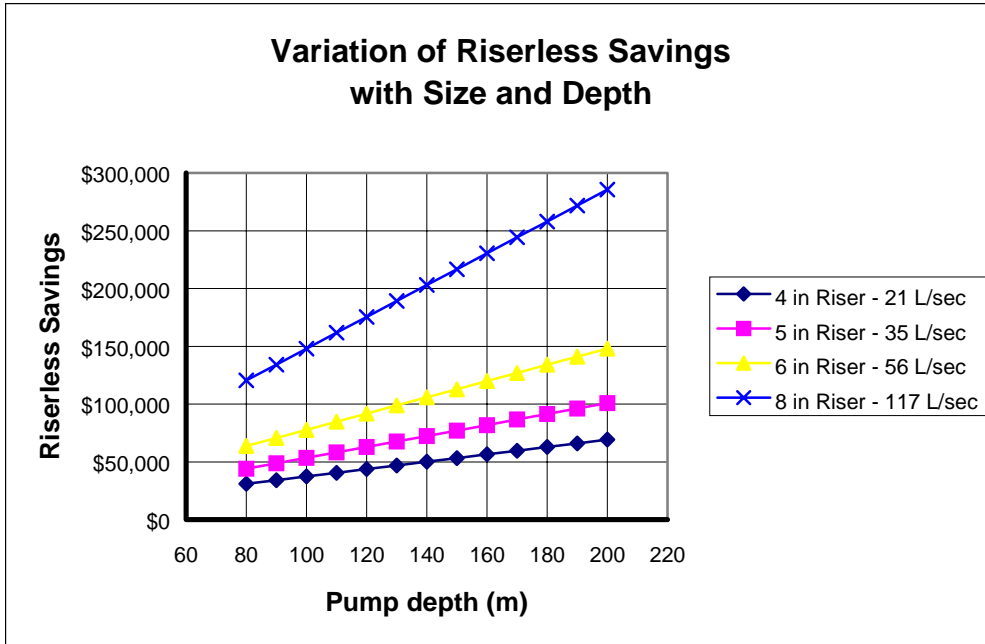


Figure 3 – Effect on savings of pump depth at constant riser headloss per 100 metres

Given the vast variation in retail power costs paid in different countries and in different regions in each county, Figure 4 was generated to show the effects of different power costs on the available savings. The plotted data is simply that shown in Table 1 (except with 35 L/sec flow rate) with the power cost varying as indicated.

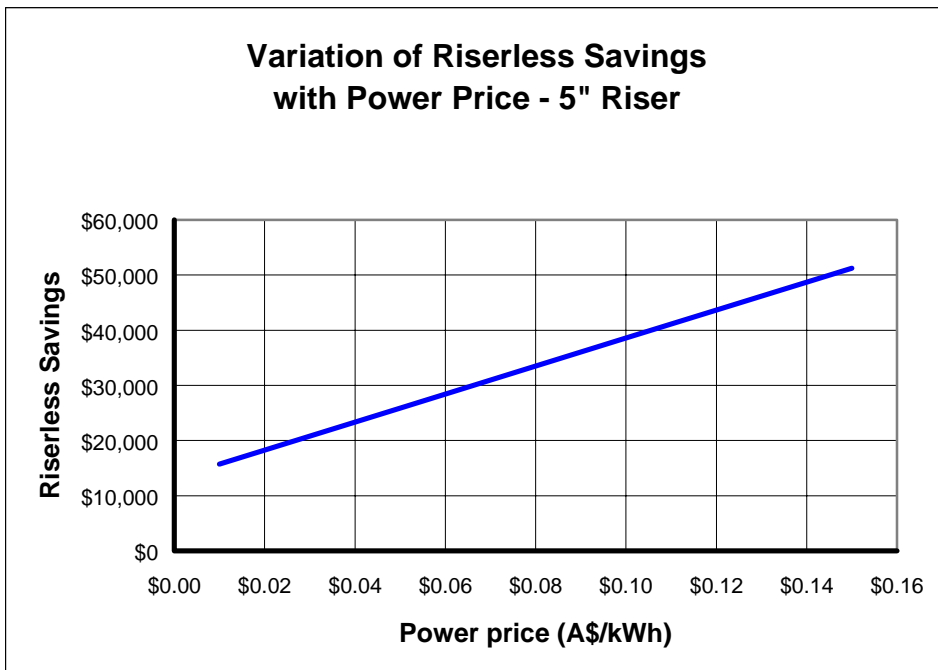


Figure 4 - Effect on savings of power price variations

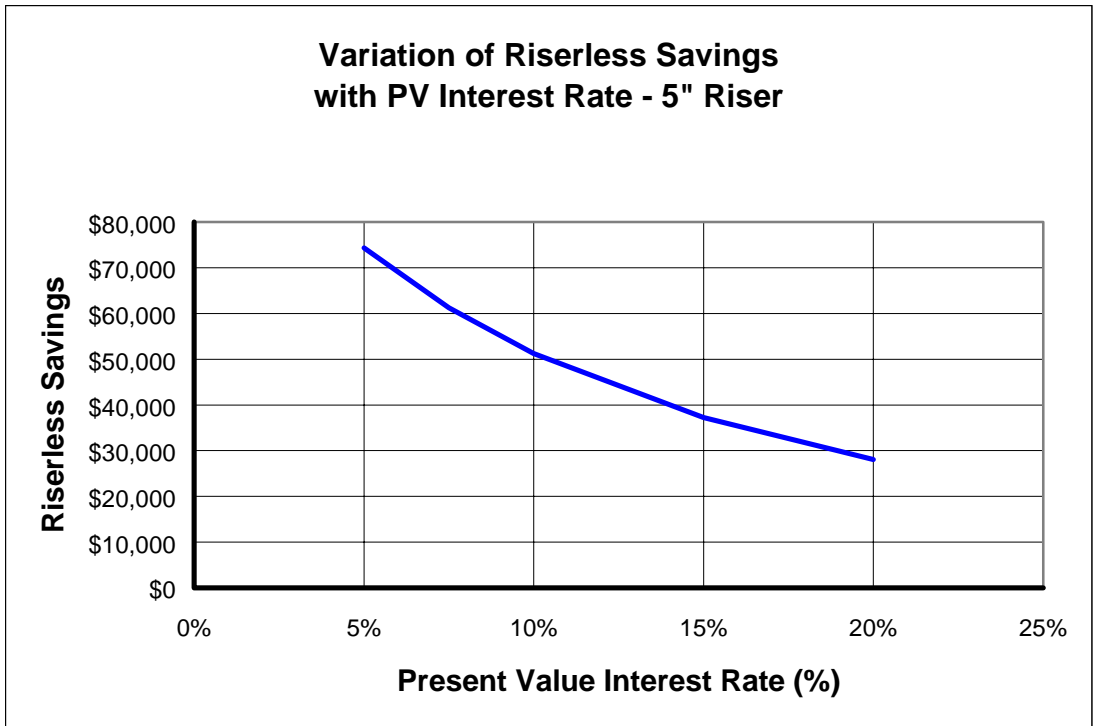


Figure 5 - Effect on savings of interest rate variations

As with the power cost, so with the interest rates used for the present value calculations. That is, such interest rates vary widely depending on location and available investment opportunities.

Figures 4 & 5 combine to show that cost savings should be realizable regardless of locality and situation.

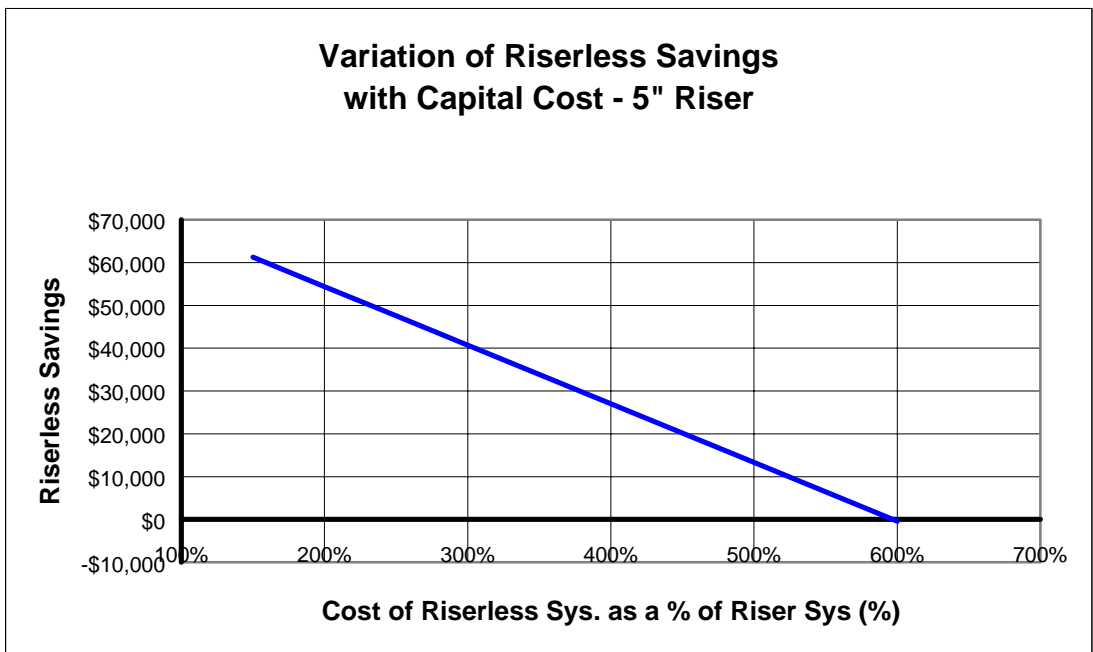


Figure 6 - Effect on savings of initial capital cost

Figure 6 plots the capital cost of a Riserless system as a percentage of the corresponding riser based system (5" riser used in this case) cost against the savings realizable over the lifetime of the installation. This figure provides the most powerful argument for the Riserless System as it is clearly superior even at over 5 times the original capital cost.

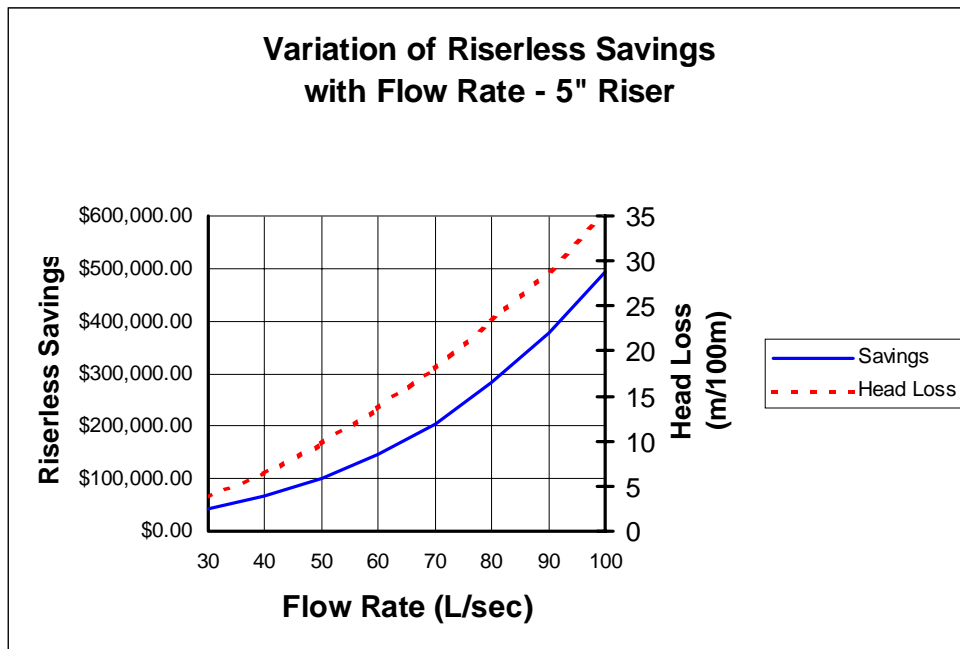


Figure 7 - Effect of flow-rate on savings for 5" system

Figure 7 shows the dramatic effect that flow rate and hence, frictional head loss, has on the savings available using the Riserless system. A similar though less pronounced effect was seen on Figure 3 which also illustrated the overall effect of increasing frictional head loss though in that case, due to increasing riser length or depth to pump.

5) Operational Benefits

The introduction indicated a number of benefits that more fairly fall under the banner of operational rather than economic even though every such benefit has an economic correlate. Some of these may not be immediately obvious and so some explanation is in order:

A. Fast, efficient installation and removal

This is based on the fact that in a Riserless system, the packer/pump/motor assembly is lowered into and out of the well on either a small diameter threaded pipe or on a steel cable. In either case, the handling equipment in terms of both complexity and size is greatly reduced from that required to handle the comparatively much larger diameter riser pipe. Frequently a smaller labour force is also required thus contributing to cost savings.

B. Lower head-loss and power costs

See details in sections (3) and (4).

C. Protects pump and casing

Because the inflatable packer is rigidly coupled to the pump, when it is inflated it centralises the pump/motor assembly in the bore and holds it in that position throughout the operating cycle. This prevents the usual “flapping around” of the pump equipment in the bore (particularly on start-up and shut-down) and any possible consequential damage to either the pumping equipment or the casing. Where fibreglass or plastic casing is used, it is of particular importance to prevent the possibility of the pump, in going through its normal operating cycle, from banging against the casing and thereby causing it damage.

D. Less corrosion

In a system using a pump riser, the casing is subject to changing water levels both as a result of drawdown and seasonal variations. This creates a “splash zone” along the length of the steel casing that is subjected to accelerated corrosion in comparison to the remainder of the casing. A Riserless system, by contrast, always keeps the casing water filled, thus removing any possibility of a “splash zone” and the consequent corrosion dangers.

E. Reduced maintenance

This claim is based on the fact that the pump is gently and firmly held in the bore hole and thus less likely to suffer physical damage as detailed in (C) above.

F. Improved well bore hydraulics

Because the casing is used as the riser pipe, there is hardly any casing storage effect when starting up the pump. This is particularly useful when using a Riserless system for well testing since it removes any possibility of misinterpreting the early flow data and makes this data unambiguously available for aquifer analysis.

Also under this heading is the consideration that, the added flexibility provided by the inflatable packer, in comparison to a steel riser pipe, reduces the effects of water hammer which may result from surface valves, etc.

G. Suitable for wells with severe dog-legs

Sometimes a well is drilled and after casing has been run and cemented it is discovered that the well is severely dog-legged, to the extent where running a pump on a rigid riser pipe is impossible. Clearly, the Riserless system with its light and highly flexible hanger pipe/rope can be deployed in this situation.

H. Excludes polluted water

Since, while the well is being pumped, the casing is always full of pressurised water, any casing leaks above the pump will cause water loss from the casing. While this is clearly cause for concern, it is far better than the reverse situation which applies to pump riser completions. In that case, a leaking casing introduces potential polluted surface or upper aquifer water into the produced water stream. Both situation means repairs are required but with the old riser system, you're pumping polluted water until you find out repairs are needed whereas with a Riserless system you're pumping clean water regardless.

I. Reduced hole diameter

See section (2) for details.

J. Thinner wall casing

Where using a riser based system, the water level in the casing may be reduced rapidly on pump start up leaving a significant pressure differential across the casing owing to the slower response of the aquifer. For larger diameter, thin wall wells this differential could be sufficient to collapse the casing. Using a Riserless system, since it keeps the casing pressurised, prevents this situation from developing and thus allows the use of thinner wall and more economical casing.

6) Conclusions

Although it is recognised that for any particular well design some of the assumptions listed and used in the foregoing economic analysis may be unreasonable depending on the country, region and season. This is not unusual for water wells. Each is unique and must fairly be considered as a unique situation. However, the general trends noted in this analysis should hold true for the majority of situations and so, in the majority of situations, when lifetime well cost is considered, the Riserless system offers substantial cost savings over the old riser based systems.

Consideration of the benefits that have been labelled as operational also indicates that the Riserless System may be applied in many circumstances where riser based systems are either not practical or are far from optimal.

For more information contact:

Clem Rowe

Inflatable Packers International Pty Ltd

1/6 Pitino Court

Osborne Park WA 6017

Ph: +61 (0)8 9204 2448

Fx: +61 (0)8 9204 2449

Email: clem@inflatable-packers.com.au