



COMPARISON OF MULTI-PUMP VARIABLE SPEED SYSTEMS

This paper is prepared to offer comparisons between cascading multi-pump VFD and Hybrid systems. There are many multi-pump VFD systems and the claims for each method of operation can create confusion between the actual operation and the claims for one system against the other.

The main advantage of a VFD constant pressure pumping system is to provide constant pressure i.e. $\pm < 2\%$ and running cost savings that will provide a capital repayment period no more than 12 months.

There are 2 systems of VFD pumping, which have varying results for both of the above criterion. Actual calculations and operational descriptions form the reasons for this paper.

DEFINITION

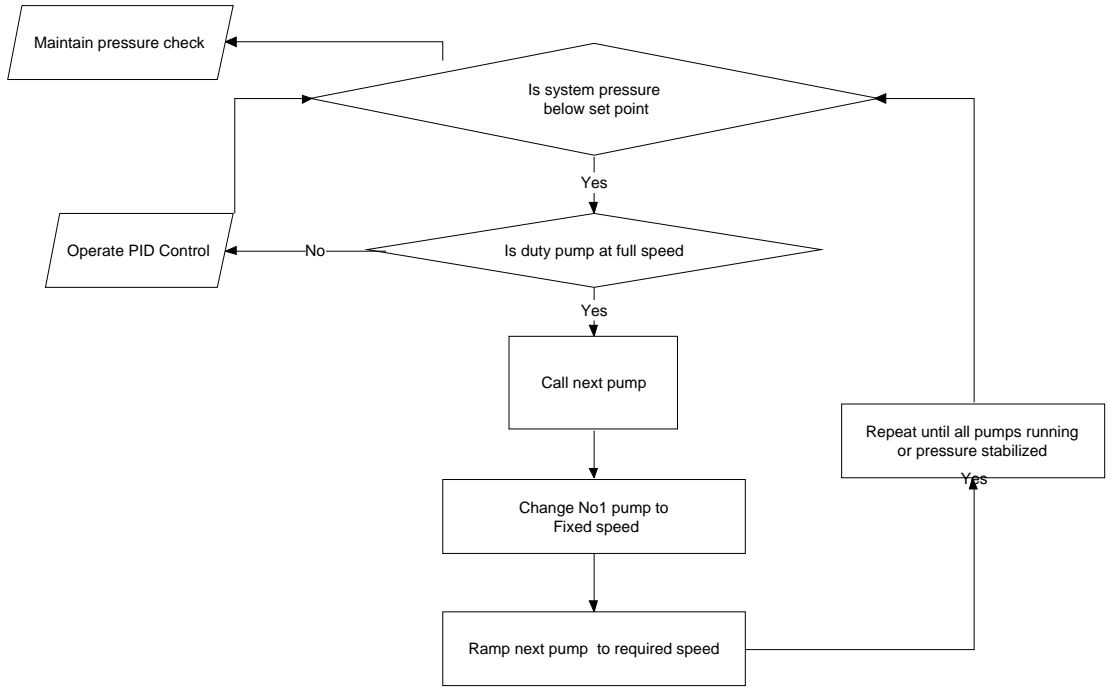
- A cascading VFD system is one, which operates with all pumps ramped up on the VFD according to the pressure requirements of the system..
- A hybrid system is one, which has one pump operating on VFD and the remaining pumps start and stop according to the system requirements. This system is called the Hybrid, as it is a mix of a VFD system and a pressure system.

Cascading System	Hybrid System
Ultimate 1	Grundfos Hydromaxi
Hydrotech	PSI Flowtronics
	DP Booster Systems
	Allan Bradley Systems
	Flygt ITT

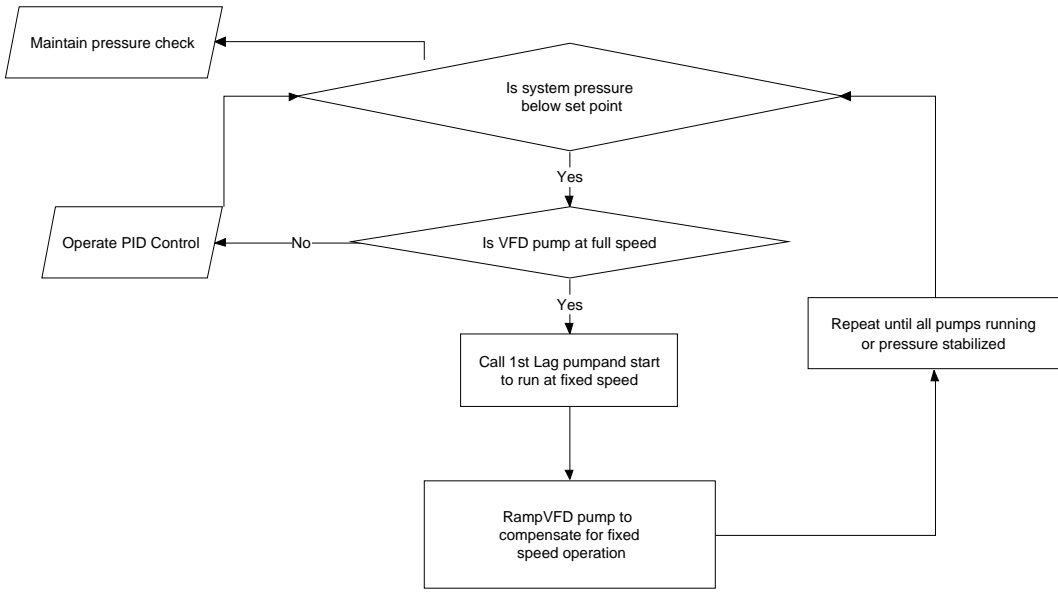
The hybrid system is offered because the technical requirements for this type of system are considerably less than for a cascading VFD system. Actually catching motors on the FLY can present some difficult technical problems but once this is resolved the actual operation is much smoother and more suitable for use with multiple pumps. There are significant advantages for the VFD system, which will be detailed further in this paper.

In general the Hybrid VFD system was developed prior to the ready accessibility of high speed lower cost microprocessor technology that allows the pumping system to be kept in a continuous optimum state.

CASCADING VFD OPERATION

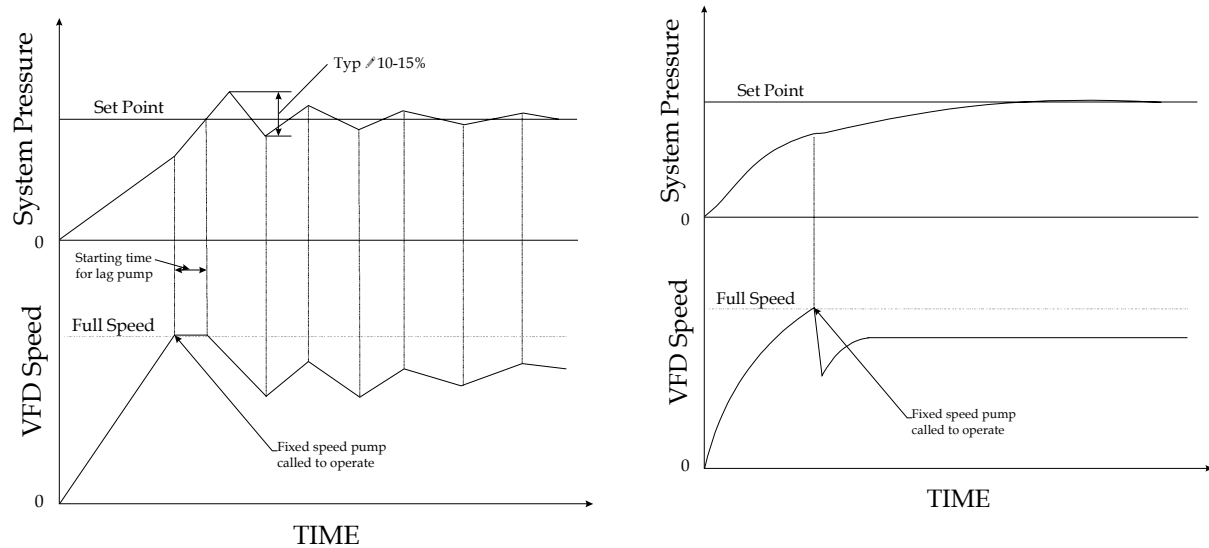


HYBRID VFD OPERATION



HYBRID OPERATION

The hybrid system is used to counter the problems with catching motors on the *FLY*. i.e. changing the VFD pump from a fixed speed pump or visa versa. This requires significant control and computing capacity. To overcome this the hybrid system must damp down the response rates significantly to allow the system to settle when pumps are either called or dropped off..



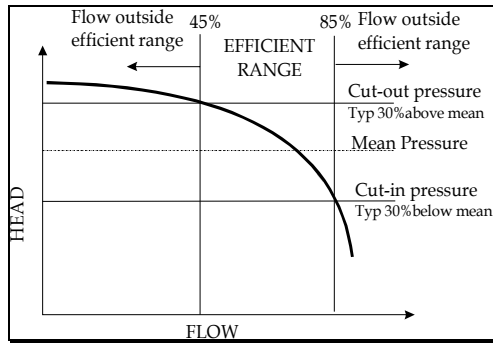
This effects both the smooth operation and system pressure and add significantly to both water hammer and running costs.

Major contributors to running costs are:

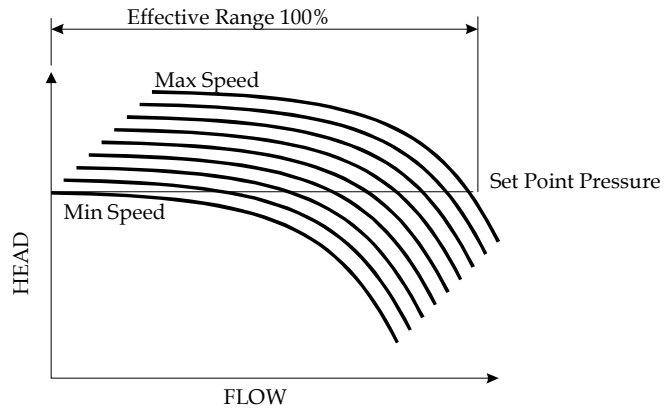
- Starting current
- Pump operation outside best efficiency range

The hybrid system operates very similarly to the cascading VFD system for approximately 70% of the time but at times when the system is demanding a significantly varying flow or at a flow of just over 1 pump capacity some very odd things occur.

At a flow demand of 1 pump capacity to 110% capacity the hybrid system can go into oscillation between the new lag pump and the VFD pump. The system demand needs to be in specific flow band ranges to stop harmonic oscillation or be damped to such an extent that the system will not react to changes in the demand. If the system is damped dramatically the any change from 1 pump to more than one pump will result in savage pressure spikes which will be accepted to cover the operational requirement of this type of system.



Lag pump operation



VFD Pump operation

The operation of the Hybrid system is a combination of the graphs above so the running cost is also a combination of the pressure system and the VFD system. This typically puts the running cost at 15-20% more expensive to run than a cascading VFD system for the same flow rate variations. This is a major factor as the initial capital costs for both systems is the same. In some cases when the lag pumps are started by soft start or expensive starting switchgear the capital cost is significantly greater.

SUMMARY

The operation of a Hybrid type system is generally a system to be avoided for the following reasons:

- The operation inherently causes pressure spikes on changeover and water hammer
- The operation range can be as much as $\pm 15-20\%$ of set point
- The running costs can blow out to be as much as 20% more than a cascading type VFD system

For these reasons it must be an exceptional system requirement to use a Hybrid system in lieu of a cascading type VFD pumping system.