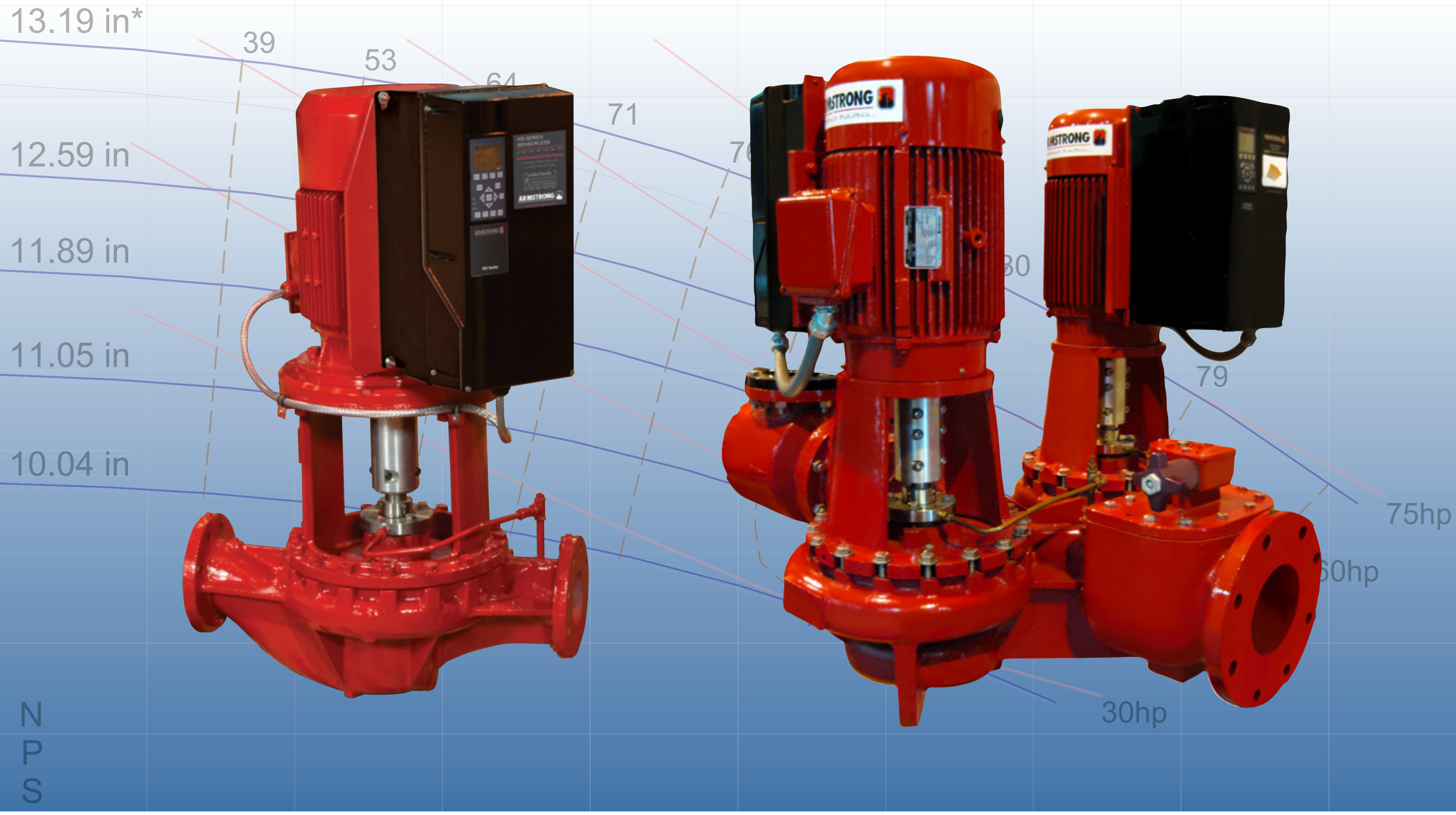
IVS & IVS Sensorless Series



Intelligent Variable Speed Pumps

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Innovative Solutions for Heating and Air Conditioning Systems


Series 4300 IVS


Series 4302 IVS dualARM


Series 4380 IVS

IVS Sensorless pump technology provides complete pump and controls integration that presents a unique value proposition when compared with traditional design approaches.

The IVS Sensorless pump has been designed to meet the need for energy-efficient pumping systems in today's buildings. Traditional pumping systems incorporating constant-speed pumps waste energy through crude flow control via throttling valves. Lifetime cost analysis shows that the capital cost of a constant-speed pump is typically only 5% of the lifetime cost. Maintenance and energy consumption make up most of the remaining 95% of the cost, which IVS Sensorless pumping technology will reduce significantly.

▸ Capital and Installation Costs are Reduced

- Reduced capital cost - no differential pressure sensor to procure
- Reduced installation cost - no mounting or wiring of remote variable speed drive (VSD) and no system feedback sensor to install
- Reduced commissioning cost - no sensor positioning issues or installation errors to slow down the process
- Reduced plant room space cost - drive and controls are generally within the footprint of the pump

▸ Increased Energy Savings

- Armstrong IVS pumps provide all the savings of state-of-art variable speed pumping with a reduced installation cost
- Drive and controls are optimized to the motor at the factory, ensuring perfect integration and peak performance
- Control curve optimization eliminates the energy lost when using an incorrectly placed sensor

▸ Project Risk Minimization

- Integration of the drive and controls reduces the risk of radio frequency interference/electromagnetic compatibility (RFI/EMC) problems
- The drive and controls are matched to the pump, eliminating commissioning delays
- Single source of responsibility for variable speed pumping plant with optimized control
- Easily connects to Building Management Systems (BMS)

▸ Primary/Secondary Hydronic HVAC Systems

Figure 2 shows a typical heating or chilled water system with constant-speed primary pumps and variable speed secondary pumps in a duty/standby arrangement. The secondary pumps in a primary/secondary chilled water system distribute the chilled water from the primary production loop to the secondary distribution loop in order to satisfy the cooling requirements of the building.

Adding variable speed drives to the secondary system results in increased control potential and significant energy savings. The system now becomes a variable volume, variable speed system in which the pumps can automatically adjust speed by responding to system pressure feedback from the sensors.

Intelligent Variable Speed Pumps

Referring to Figure 2, the variable speed drive is programmed to maintain a pressure at the location of the differential pressure feedback sensor, typically installed across a remote cooling load and two-port control valve. As demand for cooling decreases, the two-port valves start to close and the differential pressure across the valve increases. The variable speed drive then slows the pump to maintain the set value. The head/flow characteristic will follow a control curve (see Figure 1) between minimum and maximum flow due to the position of the sensor.

In addition to saving energy, reducing the speed increases the life of the pump and motor bearings. Reducing pressure across control valves increases valve life, reduces system noise and improves tenant comfort by allowing the valves to operate as designed, with mid-range lift.

The installation shown in Figure 2 has variable speed drives remote from the pumps that will occupy valuable plant room space and incur a level of mounting and wiring cost. Two pressure sensors are required so that if one sensor should fail the standby sensor would take over the duty. Again, wiring and mounting costs are incurred and the sensors may require periodic calibration.

The use of IVS Sensorless pumps shown in Figure 3 results in significant energy savings and greatly reduces capital and installation costs in variable volume chilled water or heating systems.

▶ Product Features

- ▶ Fast and easy installation - no pressure sensors required
- ▶ NEMA Premium™ efficiency motors are supplied with NEMA MG-1 Part 31 insulation, suitable for inverter applications
- ▶ Integrated NEMA/UL Type 12/IP55 enclosure controls to 75 hp/55 kW 380V-600V (60 hp/45 kW 200V-240V)
- ▶ Stand-alone drives and controls are supplied loose for larger motor sizes and other Armstrong pump types
- ▶ Graphical user interface
- ▶ Supplied with specified design pre-sets
- ▶ Compact space-saving design - as compact as a standard pump
- ▶ BMS compatible - analog/digital I/O and RS485 port with Modbus RTU
- ▶ Interchangeable with standard pumps
- ▶ Multiple control modes to adapt to system requirements
- ▶ Bypass frequency selection to eliminate system noise and vibration problems
- ▶ Programmable motor pre-heat function to prevent condensation problems
- ▶ Built-in RFI filter for EMC Directive compliance
- ▶ Built-in DC link chokes to reduce harmonics

▶ Product Options

- ▶ LonWorks® BMS protocol
- ▶ BACnet™ BMS protocol
- ▶ Integral disconnect switch
- ▶ Johnson Metasys® N2 BMS Protocol
- ▶ Seimens Apogee® FLN BMS Protocol

▶ Environmental Ratings

- ▶ Temperature: 0 - 104°F (40°C)
- ▶ Maximum Relative Humidity: 93% +2%, -3%

▶ Sensorless Technology

Sensorless control is an innovative concept for circulating pumps. Pump performance and characteristic data for up to 100 flow/head points are embedded in the memory of the speed controller during manufacture. This data includes power, pressure and flow across the flow range of the pump. During operation, the power and speed of the pump are monitored, enabling the controller to establish the hydraulic performance and precise operating position in the pumps head-flow characteristic.

These measurements enable the pump to continuously identify the head and flow at any point in time, giving accurate pressure control without the need for external feedback signals. Patented software technology within the controller ensures troublefree operation in all conditions.

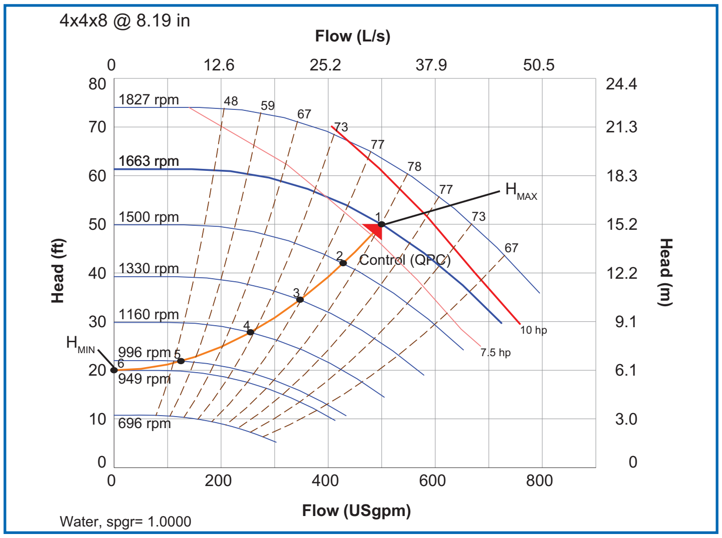

Figure 1 - System Control Curve

Incorporating the pump's hydraulic data into the controller and removing sensors results in true integration of all components and removes the risk of sensor damage, misapplication or failure. IVS Sensorless technology is applicable today for individual pumps or duty/standby applications and would not be suitable to control multiple pumps operating in parallel.

▶ Available Pump Models

Armstrong IVS integrates controls on pump units up to 75 hp/55 kW. On pumps 10 hp/7.5 kW and smaller, Armstrong offers economical close-coupled vertical in-line pumps [4380 and 4382] featuring an inside-type, single-spring mechanical seal. On larger pump sizes, Armstrong's revolutionary split-coupled pump designs [4300 and 4302] feature an external mechanical seal that can be replaced without removing the motor, drive or rotating assembly, thereby making large, integrated, variable speed pumps a viable proposition based on reduced maintenance costs and reduced system downtime.

Pumps fitted with motors from 1 hp to 75 hp/0.75 kW to 55 kW are available with the integrated IVS Sensorless control on the following pump types:

- 4300 IVS split-coupled Vertical In-Line (to 75hp / 55 kW)
- 4302 IVS dualARM split-coupled Vertical In-Line (to 75hp / 55 kW)
- 4380 IVS close coupled Vertical In-Line (to 10 hp/7.5 kW only)
- 4382 IVS dualARM close coupled Vertical In-Line (to 10 hp/7.5 kW only)

All Armstrong IVS Sensorless Vertical In-Line pumps are designed for pipeline mounting, thereby eliminating the need for an inertia base, anti-vibration mounts and flexible pump connections. This feature can reduce the installed cost by 30% over equivalent base mounted units and save significant amounts of mechanical room space and piping.

▶ The Sensorless Solution

In Figure 3 the pumps and remote variable speed drives have been replaced by Vertical In-Line IVS Sensorless pumps. The pressure sensors are no longer required as the IVS Sensorless pump is pre-programmed to follow a control curve (Figure 1) between the head point at design duty (H_{MAX}) and the head required at minimum flow (H_{MIN}). The control curve is fully adjustable on-site and gives the installer the flexibility to replicate sensor positions at varying distances from the pump. This feature removes the problems associated with incorrect sensor placement and allows optimum energy savings to be realized.

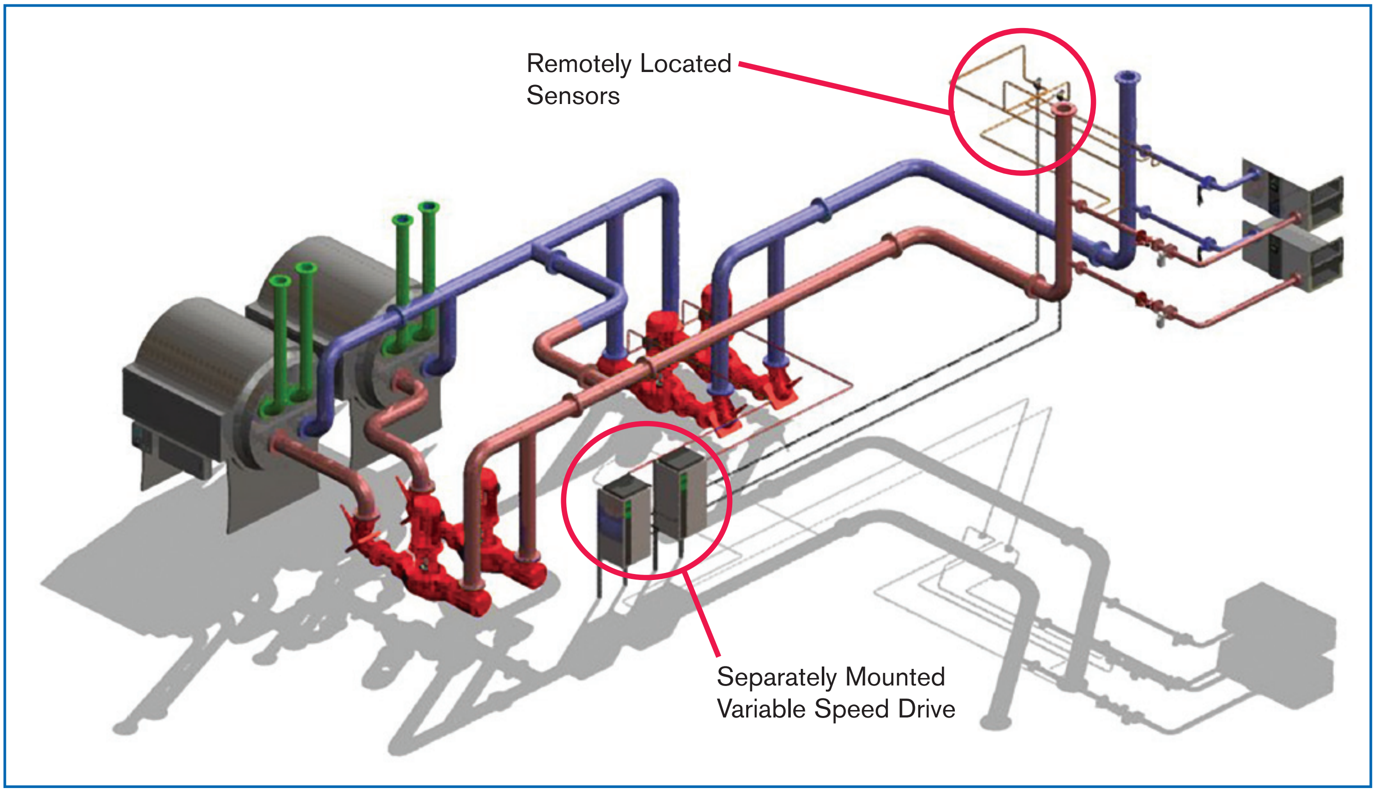

Figure 2 - Typical Primary/Secondary Chilled or Heating Water System Incorporating Variable Speed Drives

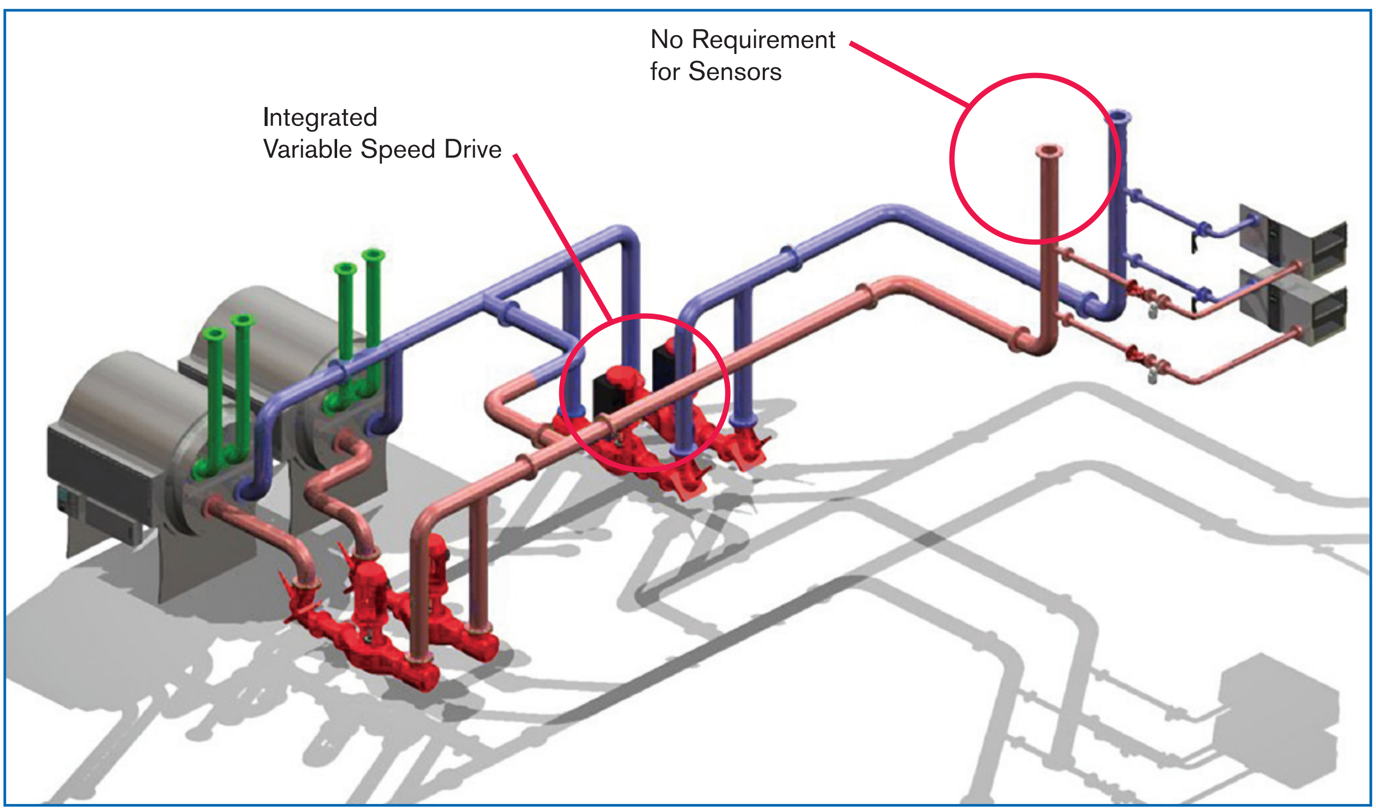

Figure 3 - Primary/Secondary Chilled or Heating Water System Incorporating Armstrong IVS Sensorless Pumps

▶ Sensorless Control Modes

The default mode of operation for IVS Sensorless pumps is to follow a system control curve similar to that shown in Figure 1. This mode of control is also known as 'Quadratic Pressure Control' as the control curve is a quadratic curve between two operating points H_{MAX} and H_{MIN}. H_{MAX} is the design duty head of the pump and H_{MIN} is the head at minimum flow which is set to a factory default of 40% of H_{MAX}. All settings are easily adjusted in the field for as-built system conditions.

Adjusting the head at minimum flow (H_{MIN}) is effectively the same as controlling pressure at different points in the system (different sensor locations) but infinitely simpler.

The graphic programming keypad can be used to change these set-points and also the alternative modes of control. Turning the quadratic curve fit off results in a straight line between the maximum and minimum head points (see Figure 4) known as 'Proportional Pressure Control'.

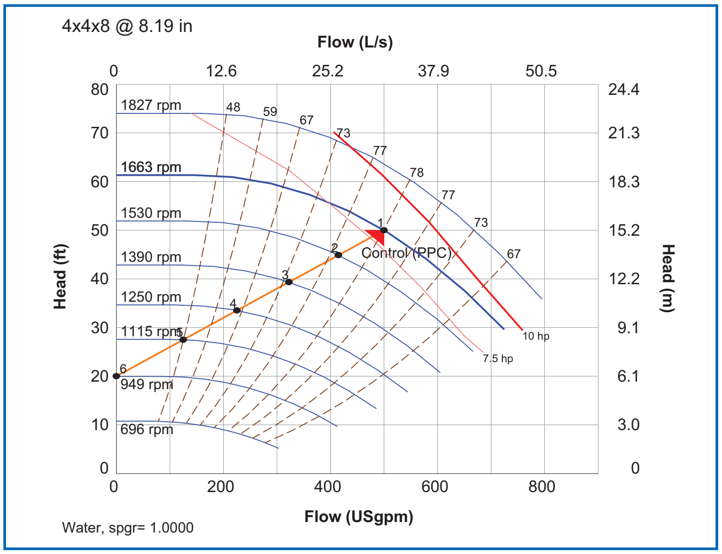

Figure 4 - Proportional Pressure Control

It is quite common to see pressure sensors located directly across the variable-speed pump. This is usually done to avoid the cost of remotely installing the sensor. However, this reduces the opportunity for energy saving, as the set-point pressure for the variable-speed drive is the constant design head of the pump (Figure 5). 'Constant Pressure Control' is available on IVS Sensorless pumps and is used where the pressure loss, before individual loads or zones, is minimal.

Constant pressure control may also be used to control system pressure for booster applications; providing there is a constant inlet pressure.

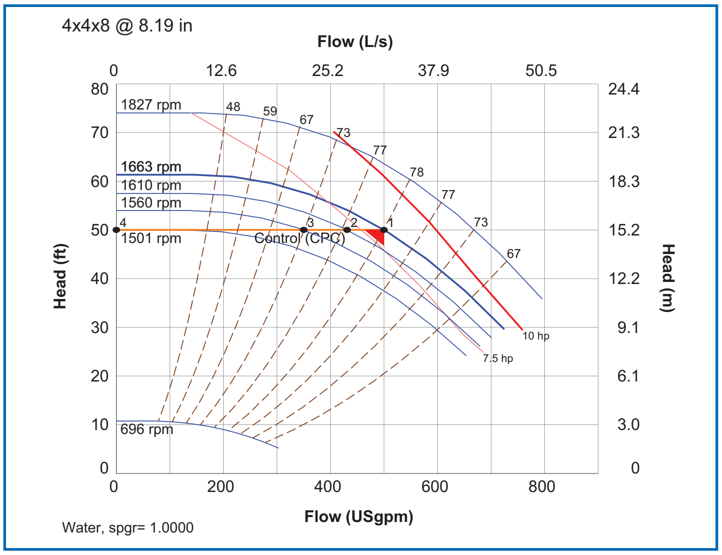

Figure 5 - Constant Pressure Control

▶ Constant Curve Control

Where a Building Management System (BMS) or a remote feedback sensor is directly used to control the speed of the pump (using a 0 - 10V signal) the sensorless control can be switched off. The pump speed will now vary according to the BMS reference signal. The graphic keypad can also be used to vary the speed reference signal allowing manual speed control of IVS Sensorless pumps in primary or secondary systems.

The Constant Curve Control mode is used, along with an Armstrong IPS Controller with multiple sensors, for multiple pump control and/or for complicated systems where a single sensor or Sensorless control would not be suitable.

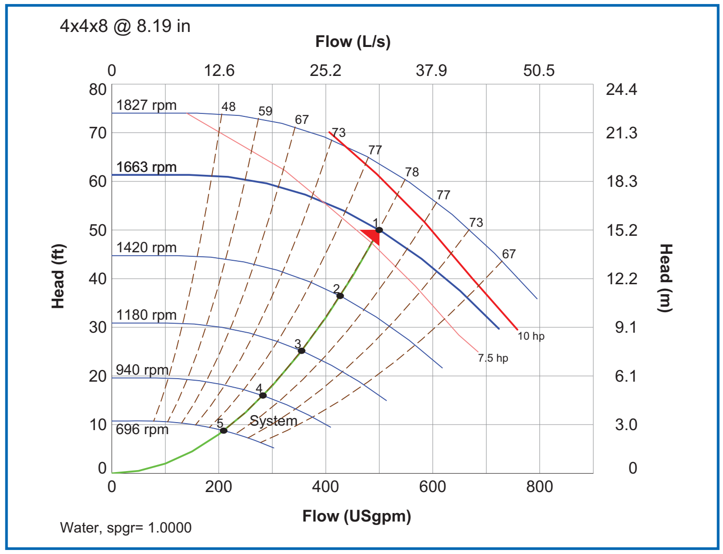

Figure 6 - Constant Curve Control

▶ Duty/Standby Operation

Duty/standby operation is available, where pumps will alternate at pre-set intervals and the standby unit will start automatically, should the duty pump fail. Alarms can also be sent to BAS on duty pump failure. Series 4302 IVS and 4382 IVS dualARM can be supplied pre-wired for duty/standby operation. Series 4300 IVS units and 4380 IVS units may be wired on-site, for duty/standby operation per the supplied installation instructions. Armstrong IPS controllers can also be used to control duty/standby units or multiple units with best efficiency staging control.

▶ Controls for Other Pump Types

Controls are available for most Armstrong commercial pump designs. Controls are typically supplied separately as stand-alone units for pump types other than those specified here. These controls are suitable for mounting in mechanical rooms adjacent to the pumping units. Stand-alone controls can be supplied in a NEMA/UL Type 1/IP-21 enclosure or a NEMA/UL Type 12/IP-54 or IP-55 (depending on the motor size and voltage) enclosure.

▶ Typical Specification

1.0 Products

1. Provide Armstrong Series 4300 IVS (IVS Sensorless) split-coupled type Vertical In-Line HVAC pumping units, with rigid spacer-type couplings and supplied with NEMA Premium efficiency motors and Armstrong NEMA/UL type-12 enclosure integrated controls. Refer to pump schedule for pump flows and heads and motor speed, enclosure and power requirements and other system conditions.
2. Self-contained pumping unit and integrated control combinations shall be supplied to 75 hp/55 kW to ensure optimum component matching and protection from motor overloading at any operating point. The pumping package shall be labeled with ETL listing certification that the product conforms to UL Std 778 and is certified to CSA Std C22.2 No.108. Controls for motors above 75 hp will be supplied as separate items.
3. Pump Construction: Pump Casing - Cast iron with ANSI-125/PN16 flanges for working pressure to 175 psig (12 bar) at 150°F (65°C) or ductile iron with ANSI-250/PN25 flanges for working pressures to 375 psig (25 bar) at 150°F (65°C). Suction and discharge connections shall be equally sized ANSI/PN flanges, and shall be drilled and tapped for seal flush and gauge connections.
4. Impeller - Bronze, fully enclosed type, dynamically balanced. Two-plane balancing is required where installed impeller diameter is less than 6 times the impeller width.
5. Shaft - Provide stainless steel pump shaft.
6. Coupling - Rigid spacer type of high tensile aluminum alloy with a fully enclosed ANSI B15.1 Sect 8 and OSHA 1910.219 compliant guard
7. Mechanical Seals - Shall be stainless steel multi-spring outside balanced type with Viton® secondary seal, carbon rotating face and silicon carbide stationary seat. Provide a 316 stainless steel gland plate.

2.0 Drives and controls

1. The Armstrong drive shall be of the VVC-PWM type, providing near unity displacement power factor without the need for external power factor correction capacitors at all loads and speeds. The VFD shall incorporate DC link chokes for the reduction of mains borne harmonic currents to reduce the DC link ripple current, thereby increasing the operating life of the DC link capacitor. The drive shall be UL and C-UL Listed & CE Marked showing compliance with both the EMC Directive 89/336/EEC and the Low Voltage Directive 72/23/EEC. RFI filters shall be incorporated within the drive to ensure it meets the emission and immunity requirements of EN61800-3 to the 1st Environment Class C1 (EN55011 unrestricted sales class B). The drive and motor protection shall include: motor phase to phase fault, motor phase to ground fault, loss of supply phase, over voltage, under voltage, motor over temperature, inverter overload, over current. Over current is not allowed, ensuring 4300 IVS units will not overload the motor at any point in the operating range of the unit.
2. The integrated control shall incorporate an integrated graphical user interface that shall provide running and diagnostic information and identify faults and status in clear English language. Faults shall be logged/recorded for review at a later date. It shall be possible to upload parameters from one drive into the non-volatile memory of a computer and download the parameters into other drives requiring the same settings. The key pad shall incorporate Hand-Off-Auto pushbuttons to enable switching between BMS and manual control. The drive shall incorporate a USB port for direct connection to a PC and an RS485 connection with Modbus RTU protocol. Optional protocols available should include BACnet and Lonworks.
3. Sensorless control software shall be available in the IVS unit to provide automatic speed control in variable volume systems without the need for pump mounted (internal/external) or remotely mounted differential pressure system feedback sensors. Control mode setting and minimum/maximum head setpoints shall be set at the factory and be user adjustable via the programming interface.
4. The control shall have the following additional features: Sensorless override for BMS, Armstrong IPS pump controller, manual pump control or closed loop PID control; programmable skip frequencies and adjustable switching frequency for noise/vibration control; auto alarm reset; motor pre-heat function; six programmable digital inputs; two analog inputs; one programmable analog/digital output; two volt-free contacts.

3.0 System Control

The 4300 IVS shall be capable of operating in any of the following control modes:

- Duty pump and standby pumps with Sensorless control
- Multiple pump with multiple sensors system control, such as Armstrong IPS Controller
- Duty pump and standby pumps with remote sensor or building system (BAS) control

For full details on the Armstrong 4300 IVS control modes and performance and operating logic, visit the Armstrong website at: www.armstrongpumps.com

For Series 4380 IVS (or 4382 IVS) specifications, replace all '4300' references with '4380' (or '4382'). In 1.0 Products, delete all references to 'couplings' in 1.1 and delete items 1.5, 1.6 & 1.7. For Series 4302 IVS (or 4382 IVS) dualARM specifications, replace all '4300' references with '4302' (or '4382') and add section 1.8 so that the text reads: Two pumps shall be installed with one inlet and one outlet connection. Each connection shall be fitted with an isolation valve to allow one pump to be isolated for service with the other pump still operating, and shall be sized for true double-flow parallel operation of the two installed pumps.

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