

# UniFlo AFD™

## INFLOW CONTROL SCREEN



# UniFlo AFD™

## INFLOW CONTROL SCREEN

### Situation

Long horizontal wells are common for oil production, because they increase efficiency. An offshore platform may have several wells aimed at producing from a common reservoir. In addition, each well can produce more oil with increased reservoir contact increasing the permeability thickness or  $kh$  value. However, long horizontal wells are subject to water or gas coning. These fluids exist naturally in the reservoir, or are injected for pressure maintenance and improved oil recovery. Due to their greater mobility under high pressure differences, water and gas migrate through the oil layer and reach the wellbore before the oil, creating coning. To prevent this, there are several types of passive Inflow Control Devices (ICDs) that can be placed within the horizontal part of the well and function by restricting the flow. Production rates are normally higher at the heel of the well than at the toe, because although the same energy in the reservoir exists in both locations, the fluids entering at the toe have to overcome frictional losses along the tubular flow path before reaching the heel, thus limiting the influx from the toe. One way to combat this issue is to make more perforations in the production tubing near the toe while decreasing the number of perforations near the heel.

A more viable option to perforating the tubulars in the completion is the evolution of ICD technology that provides choking along the length of the well's horizontal section to balance the effects of heel to toe flow and variations in permeability along the reservoir's open hole section. The ICDs are no more than chokes or flow restriction devices that avoid water coning in wells irrespective of trajectory type, following the Bernoulli law for low-viscosity fluids.

### A few questions and answers pertaining to ICD technology

**Q: If I use 10 small nozzles instead of one large nozzle what is the difference in behavior?**

A: If the sum of the nozzle areas of the small nozzles equals the one large nozzle, they will behave exactly the same.

**Q: Will the commercial ICD also work well in a depleted phase of a reservoir?**

A: No. The flow inside the long horizontal tubing is complex flow regime with laminar flow at the toe transitioning to turbulent flow towards the heel; when flow decreases, ICDs may no longer be optimal. Water coning will occur at a later stage of depletion.

**Q: Will the flow rate change after water breakthrough in the heel of the well?**

A: Yes. From the Bernoulli relation, if the incoming water has 15% higher density than the produced oil, flow rate will decrease by 8%.

**Q: Although the density is often constant in a field, the viscosity may vary significantly during the life of the field. How important is the viscosity?**

A: The variations in viscosity are not important. The nozzle alone controls the pressure drop, and because this has a high turbulent flow, variations in viscosity have no effect.

**Q: Some ICD suppliers argue that they are viscosity sensitive because they are also passing the oil through some tubes in addition to the nozzle. Is this not correct?**

A: Not for the common ICD scenario. Computer simulations have shown that for viscosity to dominate the pressure drop, the tubes must be much longer than a 10-meter standalone screen section, which is difficult to implement in practice.

**Q: If suppliers advertise a combined solution, such as an ICD consisting of a tube and a nozzle in series, is this not an improvement?**

A: Technically speaking it is correct, but usually the nozzle dominates such that variations in viscosity are negligible.

**Q: You mean that most brands of ICDs actually behave exactly alike?**

A: Yes, most ICDs are passive choke devices aimed at reducing the flow.

**Q: Limiting ourselves to simple mechanical devices, how can we improve the ICD function?**

A: An ICD can be considered a first generation flow control, with the limitation that it is statically fixed. The next generation would be an autonomous control valve that by sensing the reservoir pressure using hydraulic feedback could maintain constant flow even during reservoir depletion.

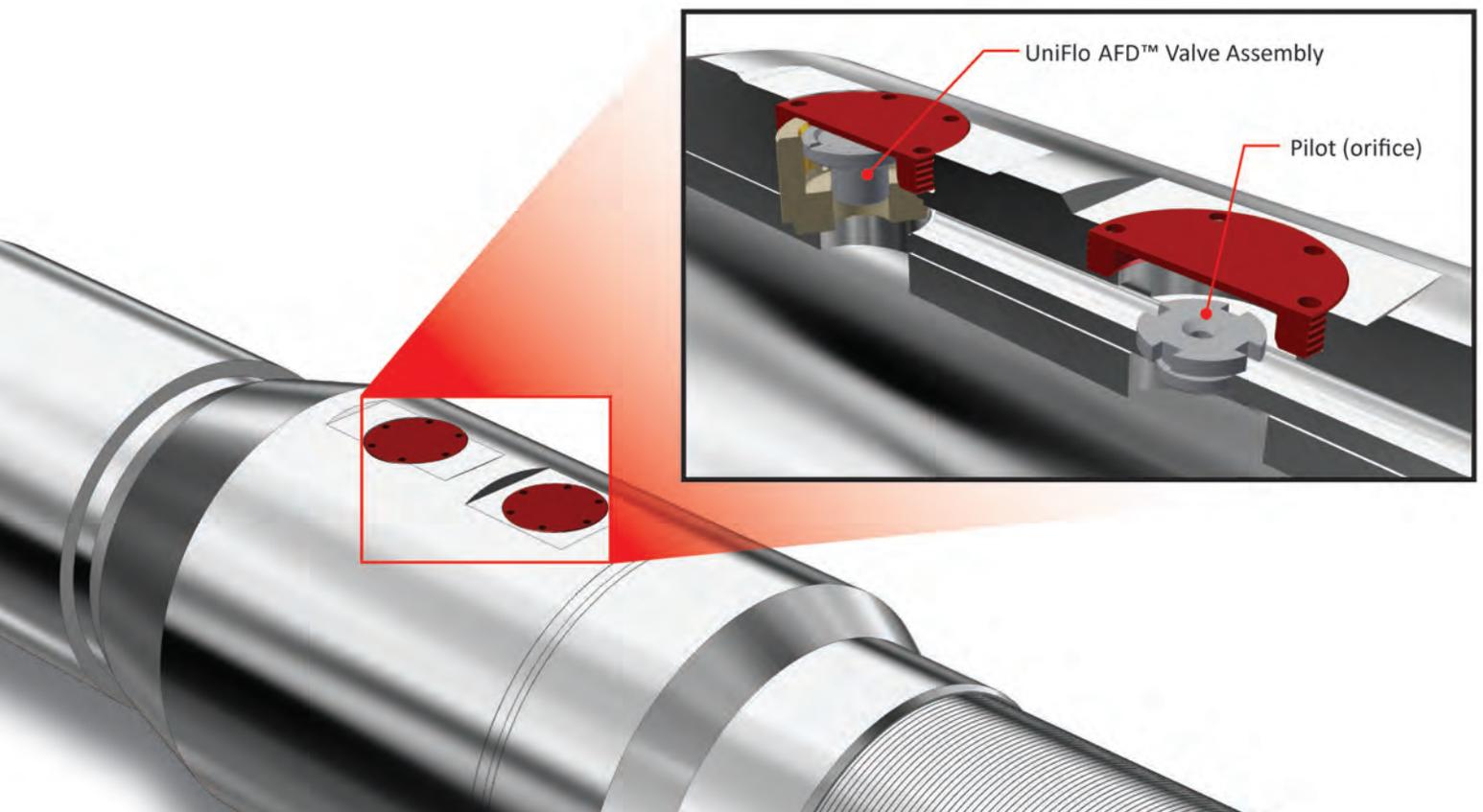
# A SIMPLE SOLUTION — JUST SET IT AND FORGET IT

## Solution

Superior Energy - Completion Services has taken a patented idea and fully developed it into a solution named the UniFlo Autonomous Flowcontroller Device (AFD). The UniFlo AFD addresses many of the concerns and issues related to the performance of ICDs and AICDs available on the market.

The foremost issue was how to provide a product that would equalize the influx across the open hole lateral length during the entire production life cycle of a well including the depletion phase. UniFlo AFD delivers regulated flow as opposed to simply choking the flow to control the reservoir energy, taking into consideration the fluid properties, and heterogeneities of the rock at various points along the wellbore. Reservoir heterogeneities, fluid properties, or reservoir energy are immaterial, as long as there is sufficient energy to operate the UniFlo AFD within its regulating pressure window. UniFlo AFD's regulating window pressure is between 40 psi and 480 psi. As long as the pressure drop across the device remains within this window, it regulates flow at a constant designed rate between 0.5 gpm to 5 gpm depending on the desired rate per unit. UniFlo AFD also offers a reduction to the regulated flow rate when water is flowing instead of oil (the more viscous fluid) at a rate slightly less than 10%. UniFlo AFD can do this because the density of lighter oils, less than 100cP, is significantly less than that of water.

The second issue was how to model UniFlo AFD's performance. With conventional ICD and AICD technology it is necessary to have a thorough understanding of many of the reservoir characteristics, including fluid properties and location of the varying permeability regions throughout the open hole interval. This information is not always readily available or accurate, which could skew the design and alter the intended results. UniFlo AFD does not require any sophisticated software, Reservoir Engineers, or flow description of the hardware to be plugged into a black oil simulator in an attempt to account for the performance of the ICD/AICD over time through production forecasting. UniFlo AFD offers a very simple solution – **just set it and forget it!**



# How Does the UniFlo AFD™ Work?

UniFlo AFD is a simple valve assembly that combines the Bernoulli Principle with the basic hydraulic principle delivering the first ever downhole autonomous flow regulator.

The UniFlo AFD is composed of a piston housed in a piston body located within the UniFlo Housing upstream of the sand control media that regulates flow. The piston and piston body are both made of tungsten carbide with all metal surfaces having metal-to-metal seals polished, thus reducing the possibility of scale build up on the moving parts. As fluid flow begins, during bean up operations, the device uses the Bernoulli Principle and allows the fluid to freely pass until a predetermined rate has been achieved at very low pressure drop across device, approximately 40 psi. Once this rate is achieved, the hydraulic effect enables the piston to move back and forth across the uniquely shaped slot opening creating an adjustable orifice in real time without any human intervention. This slight movement of the piston is enabled by the insertion of a spring with a known spring constant during the assembly stage of manufacturing. This spring, along with the known piston areas, allows for a positive force above the piston by using the flowing bottom hole pressure to force the movement of the piston downward against the opposing spring, thus providing flow regulation across the slot opening. At this point in time, UniFlo AFD performs to regulate the desired flow rate at each unit, no matter the reservoir pressure, heterogeneities, or fluid properties.

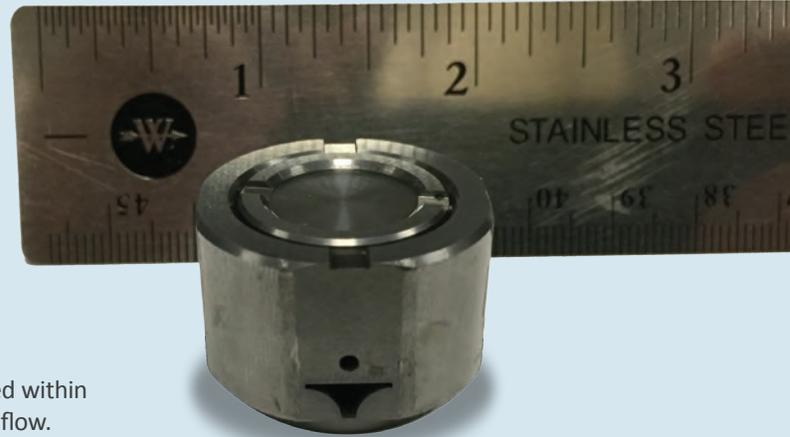
Once the drawdown exceeds the operational window of approximately 480 psi, the spring is completely collapsed, which allows the piston to completely isolate the uniquely shaped slot opening to flow. Flow continues through a very small pilot. Without pilot flow, each unit would cease to flow once the maximum pressure of regulation was reached. However, the area open to flow is much less than it was during bean up operations. When the drawdown across the device returns to its operational window, regulation recommences.

Not only does the UniFlo AFD adjust to downhole conditions in real time autonomously, it is also adjustable at the surface, enabling the end user to make flow rate changes at the last minute by removing and rotating the piston body to the appropriate slot setting. There are four flow rate options per unit, optimizing regulated flow product performance.

Balanced or regulated flow per unit is achieved by setting the appropriate flow rate per unit and maintaining the drawdown across the reservoir completion, while staying within the operational window of the UniFlo AFD. This results in regulated flow from heel to toe regardless of the energy available, reservoir heterogeneities, and fluid properties.

In applications requiring sand control, the screens can be configured to retain either the formation material or the gravel-pack sand. In more competent rock applications, such as carbonates, the screens can be configured as debris filters only.

This simple autonomous design eliminates the need to predict performance. No simulation work is required to model the performance or expected performance of the UniFlo AFD. Simply set it and forget it!



## Patented UniFlo AFD Valve Assembly

### Features and Benefits

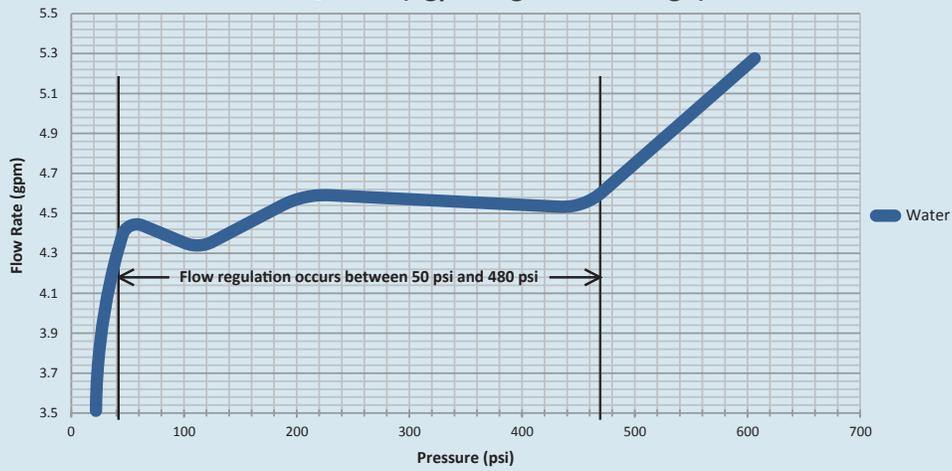
- » Valve assembly is an integral piece of the sand control screen delivering autonomous flow regulation in each joint
- » Metal-to-metal seals enables the product run in high temperature applications such as Steam Assisted Gravity Drain (SAGD), Cyclic Steam Stimulation (CSS), or Steam Injection (SI)
- » Removable valve assembly of finished good enables the desired flow rate per unit to be adjusted as required prior to installation
- » UniFlo AFD autonomously adjusts itself based on the drawdown pressure across the valve assembly providing constant flow rates at each unit
- » Unique designed regulator eliminates the need for extensive reservoir simulation modeling to predict its performance, **“A Simple Solution – Just Set it and Forget it”**

### Applications

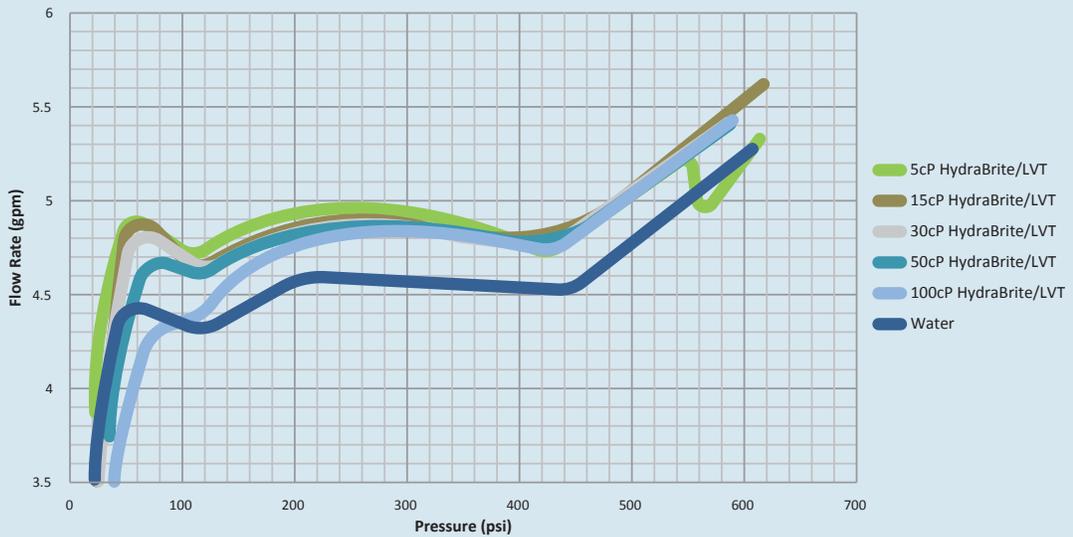
- » Long horizontal open hole completions
- » Producers
- » Injectors
- » Sand control environment
- » Non-sand control environment
- » Anywhere flow regulation is desired!

# UniFlo AFD™ Flow Performance Curves

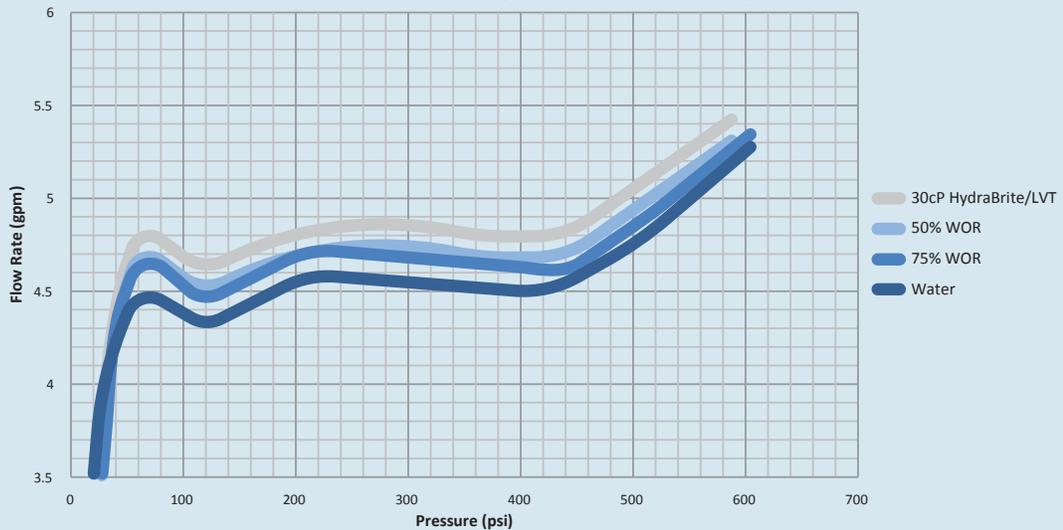
## Water @ 70°F (5gpm regulation design)



## Various Viscosities @ 70°F (5gpm regulation design)



## Oil/Water Mixture @ 70°F (5gpm regulation design)





[www.superiorenergy.com](http://www.superiorenergy.com)

**Superior Energy Services - Completion Services**

16610 Aldine Westfield

Houston, TX 77032

Phone: 281 784 5700

Fax: 281 784 5746