DATA SHEET

HALLIBURTON

SAND CONTROL | INFLOW CONTROL TECHNOLOGY

EquiFlow® autonomous inflow control devices

Increase hydrocarbon reserves and rate of recovery

FEATURES

- Operates autonomously
- No moving parts, electronics, dynamic sealing surfaces or connections to the surface
- Functions as a passive ICD prior to water/gas breakthrough
- Requires no intervention
- Functionality or efficiency not affected by downhole orientation
- Each device functions independently for precise response to the reservoir
- Allows injection of reservoir treating fluids
- Self-regulating depending on produced fluids

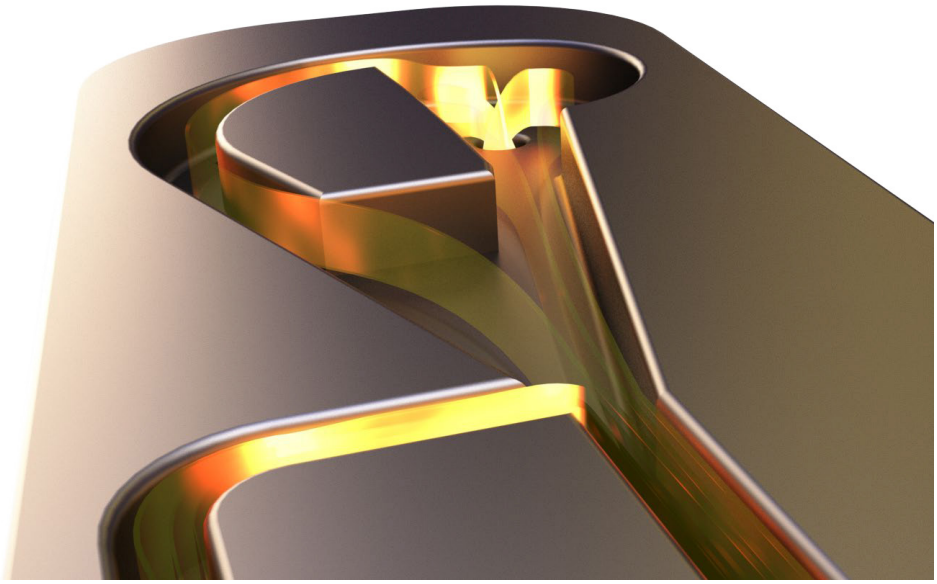
BENEFITS

- Facilitates accelerated recovery
- Maximizes ultimate recovery
- Increases reliability through design simplicity
- Minimizes undesired fluid production
- Helps reduce cost and risk associated with unwanted fluid production
- Delays onset of unwanted water or gas production

Overview

Horizontal wellbores provide access to narrow, oil-bearing formations for maximum contact with pay zones. But when production causes unwanted water and/or gas to migrate to the wellbore, or creates uneven production distribution, operators turn to Halliburton EquiFlow® autonomous inflow control devices (AICDs) to help delay and reduce the flow of unwanted fluids and stimulate balanced production throughout the entire interval.

EquiFlow AICDs are Type 2* inflow control devices that use innovative dynamic fluidic diode technology to distinguish the types of fluids flowing through the device in order to optimize oil production and recovery. They function as passive ICDs during oil production, while restricting the production of water and gas upon breakthrough to minimize water and gas cuts dramatically. EquiFlow AICDs use no moving parts, require no downhole orientation and use the dynamic properties of the fluid to direct flow. All these features enhance long-term functionality and reliability.



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Fluid dynamics technology

EquiFlow® AICD technology employs a system of flow paths and channels to regulate fluid flow. More specifically, Halliburton AICDs incorporate three individual dynamic components—a viscosity selector, a flow switch, and a flow restrictor—all functioning together to allow or restrict flow of fluid without moving parts.

The **viscosity selector** uses a system of flow paths which, based on fluid viscosity, density and velocity, "identifies" the fluid(s) that are flowing through the AICD, and then divides the total flow between two open flow paths. Based on the fluid selector's output, the **flow switch** passively directs the majority of the selected fluid down one of the two paths depending on the fluid's properties. Finally, the **flow restrictor** restricts the contributing ratio of unwanted fluid (water and/or gas) from entering the wellbore, while providing minimal restriction to the production of the desired fluid.

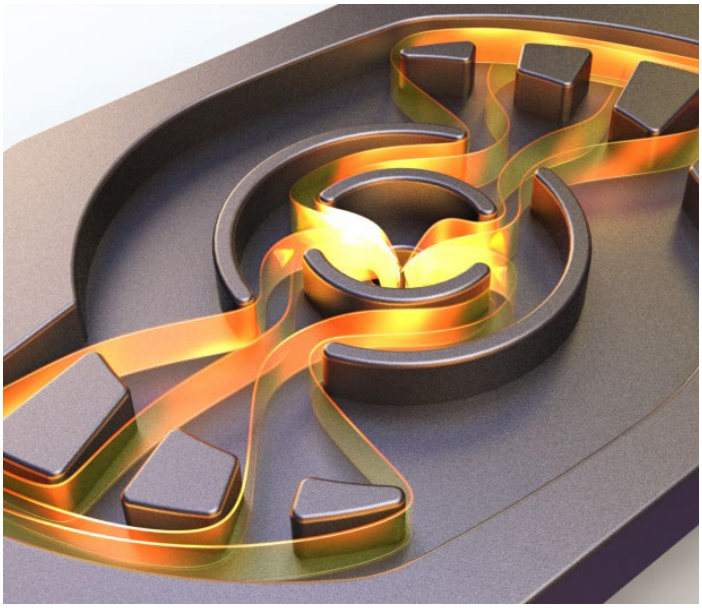
*Per Advanced Well Equipment Standardization Group (AWES)

Increase well npv with aicd completion

Advanced completions modeling capabilities

Proper design and modeling to address potential knowns and unknowns and life of the well conditions are critical for optimizing ICD and AICD completions. Characteristic equations, based on full scale flow data, have been created to describe flow performance. Halliburton has embedded EquiFlow AICDs performance into

a suite of numerical simulators including NETool®, QuikLook®, and Nexus® software to model everything from near-wellbore performance to full field evaluation, and perform dynamic coupling with other industry reservoir software as needed.



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What makes an ICD truly autonomous?

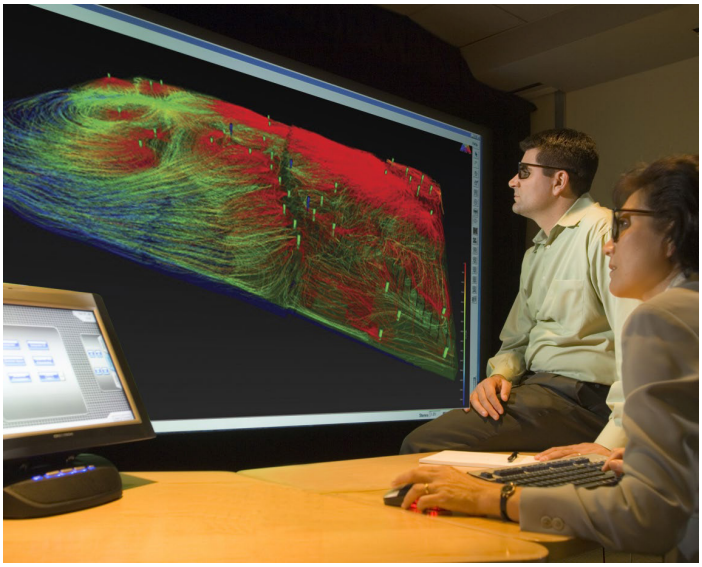
Simply saying an ICD (inflow control device) is autonomous doesn't mean it's true. Putting nozzles in series does not make an ICD autonomous; it must do more. To be autonomous, the flow characteristics inside the device must actually change. An autonomous ICD must have a geometry that alters the flow path preferentially restricting the flow of unwanted fluids.

An autonomous ICD has the ability to respond to changing well conditions without any action by the operator. When unwanted fluids reach the wellbore, the autonomous ICD changes the way the fluid is moving through the device. This results in increased restriction to flow while other zones producing oil continue production with minimal restriction.

NETool® is a steady-state wellbore simulator capable of modeling multiphase flow from near-well region, passing through complex completions up to the wellhead. Dynamic wellbore/reservoir coupling with several industry-standard reservoir simulators is available for recovery prediction and optimization of the entire field.

QuikLook® software is a transient analysis that allows long-term study of the AICD completion in a reservoir.

Nexus software is a full physics simulator that couples flow models across the surface and subsurface to accurately model multiple reservoirs and their interaction with surface facilities.



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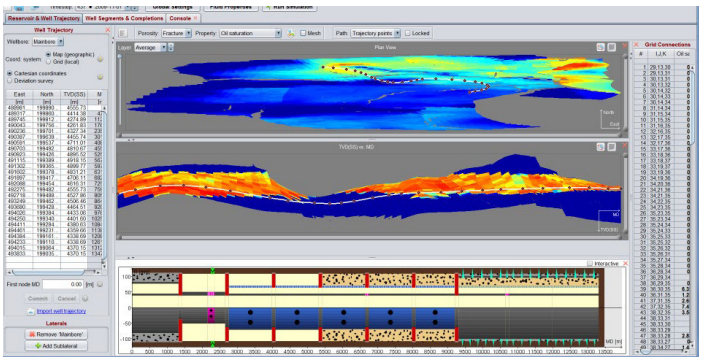
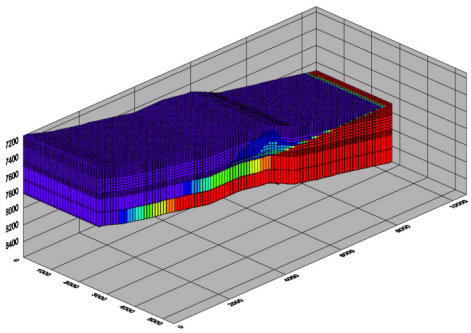
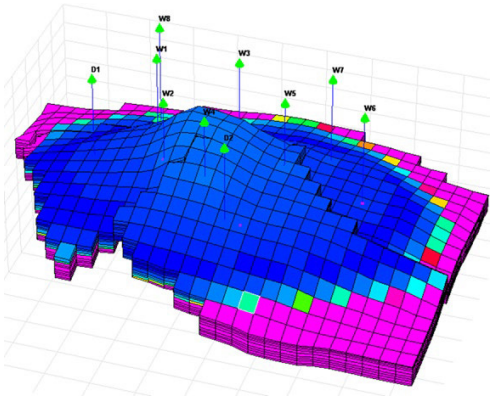
Collaborative reservoir analysis





Applications

When water/gas breakthrough occurs, the EquiFlow AICD significantly restricts unwanted fluid production from that specific section while promoting increased oil production from other compartments in the completion. It is installed as part of the completion string and is highly beneficial for wells needing production to be balanced over long horizontal reservoirs or in formations with high permeability variances. A through-tubing solution using an AICD inner string is also available. Typical applications include wells experiencing heel-toe effects, breakthrough of water/gas, permeability differences, and water or gas challenges in horizontal or layered reservoirs.



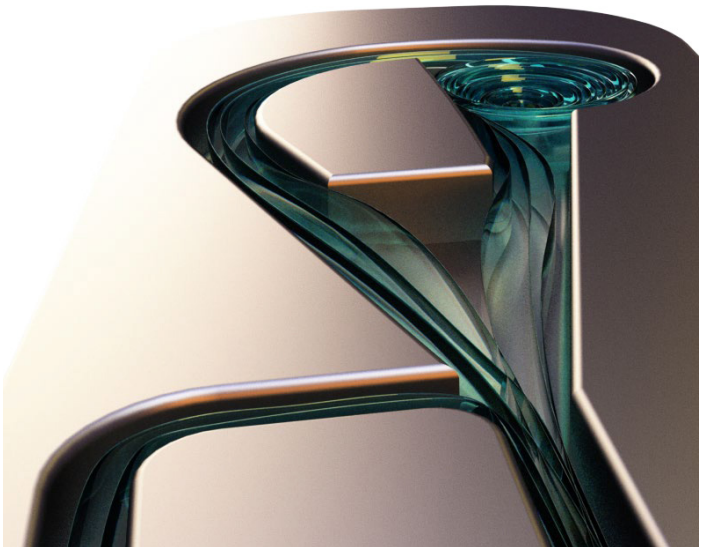
An EquiFlow AICD comes in four different versions that address viscosity oil ranges from very light oil to very heavy oil.

EquiFlow® AICD specialized designs

DESIGN	OIL VISCOSITY RANGE	OIL TYPE	FLUID RESTRICTION
Range 1	0.3 – 1.5 cP	Very Light	Water and Gas
Range 2	1.5 – 10 cP	Light, Medium	Water and Gas
Range 3	3 – 200 cP	Light, Medium, Heavy	Water and Gas
Range 4	150+ cP	Heavy, Very Heavy	Water and Gas

Range 1 and range 2

- Fluidic sensor highly sensitive to fluid properties to differentiate from very light oils
- On/off switch upon water or gas breakthrough
- Bi-stable switch: two stable flow patterns, which can freely alternate depending on the produced fluids
- Flow pattern has direct path to the exit resulting in low pressure drop
- Second divergent path induces spinning, thus increasing pressure drop and reducing flow rate



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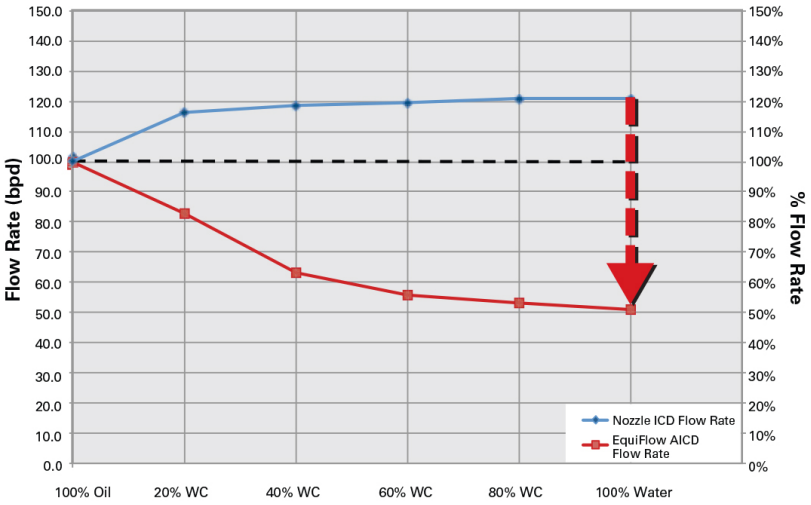
EquiFlow® AICD Range 2

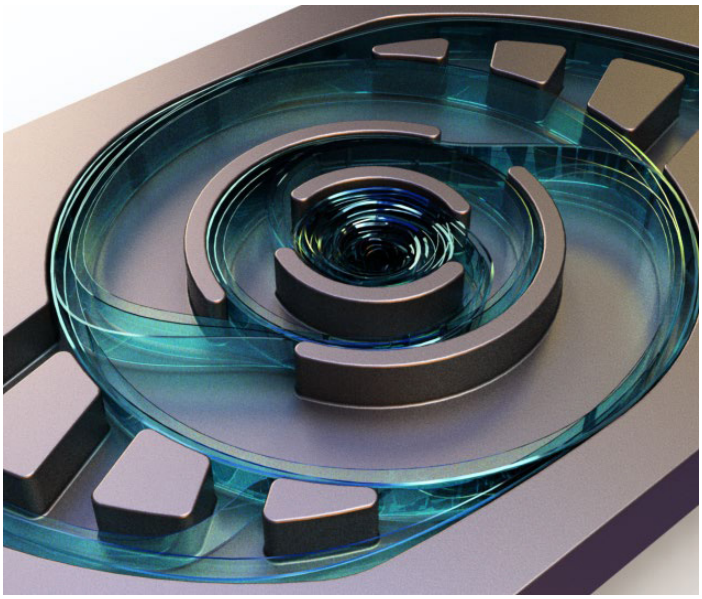
Flow reduction EquiFlow® AICD range 2 vs nozzle ICD



Comparison of an EquiFlow AICD to a nozzle ICD at 200 psi pressure differential, 2.8 cP oil, 0.6 cP water

Range 3 and range 4

- Gradual change in restriction of unwanted fluid
- High pressure drop for low viscosity fluids and low pressure drop for high viscosity fluids
- Two possible paths: tangential path to induce rotational motion/spinning or multiple radial passages toward a direct exit, which can freely alternate depending on the produced fluids



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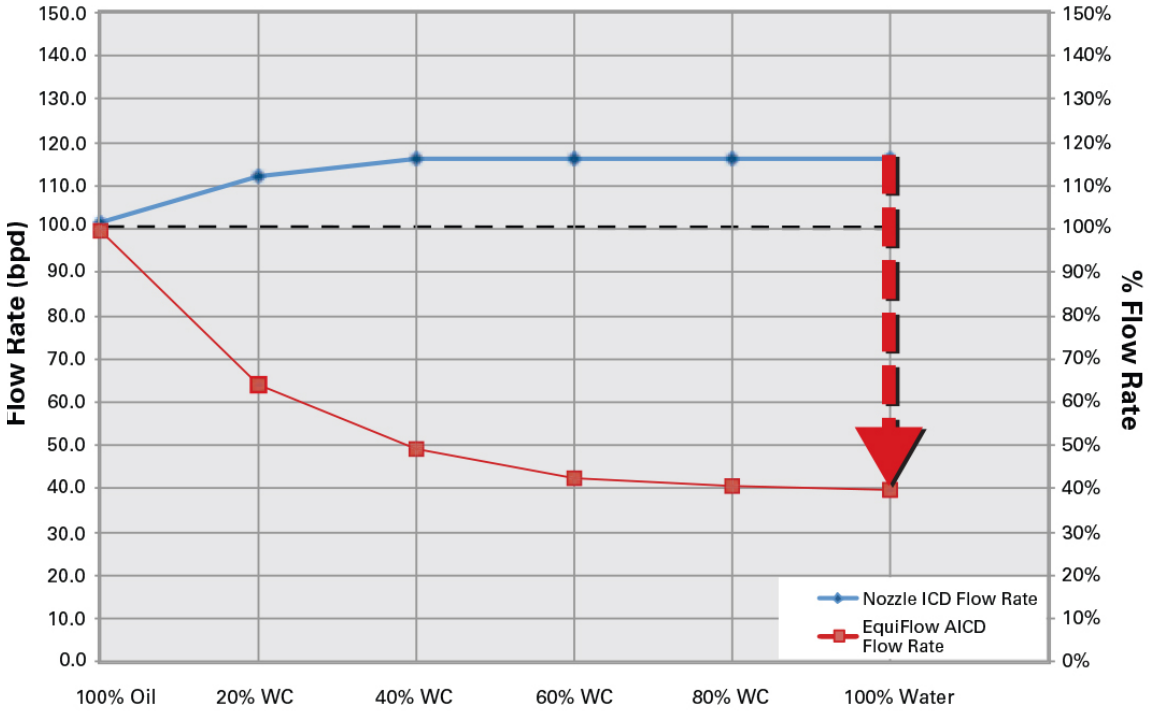
EquiFlow® AICD Range 3

Flow reduction EquiFlow® AICD range 3 vs nozzle ICD



Comparison of an EquiFlow AICD to a nozzle ICD at 30 psi pressure differential, 80 cP oil, 0.6 cP water

Available sizes

DESIGN	BASEPIPE SIZE (IN.)	MAX OD (IN.)
Range 1 and range 2	4 1/2	5.875
	5 1/2	6.875
	6 5/8	8.000
	6 5/8	8.290
Range 3 and range 4	2 7/8	3.795
	3 1/2	4.670
	4 1/2	5.670
	5 1/2	6.670
	6 5/8	7.830

None of the EquiFlow® AICD designs have any protrusion into the basepipe

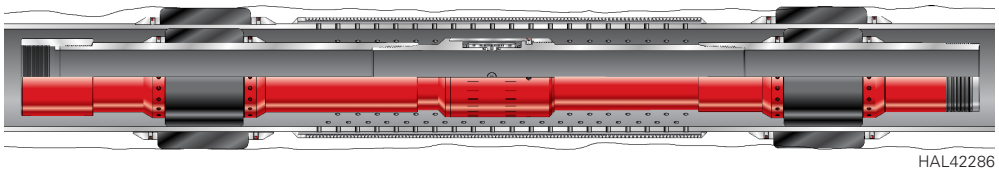
EquiFlow® AICD through-tubing solution

The EquiFlow AICD can also be deployed as an inner string within existing completions having a slotted liner or screens in place. The tool is paired with a slotted shroud that protects the AICD and acts as a coarse debris filter. This provides the capability of better reservoir management through the deployment of the AICD technology into existing wells and fields in order to increase the reserves.

Performance and field case studies

The EquiFlow AICD has been installed in very light to very heavy oil reservoirs and a variety of unique field applications:

- Ecuador: decreased water cut 34%, increased oil recovery 16% (SPE 166495)
- UAE: decreased water cut 47%, increased oil production 400% (SPE 177927)
- Brazil: successful horizontal openhole gravel packs with EquiFlow AICDs



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For more information, contact your local Halliburton representative or visit us on the web at www.halliburton.com