Technical White Paper: Intelligent Well Completion Solutions – AICD and High-Performance Sand Control Screens

1. Executive Summary

As global oil and gas exploration extends into deeper, offshore, and unconventional reservoirs, the challenges posed by reservoir heterogeneity have become increasingly severe. Traditional "passive" completion tools often struggle to address issues such as **premature water breakthrough, gas coning**, and **sand production** during production, leading to shortened well life, reduced recovery rates, and exorbitant workover costs.

Dongying Jingtao Energy Technology Co., Ltd. (hereinafter referred to as "**Jingtao Energy**"), leveraging its profound expertise in downhole tool R&D and manufacturing, presents the next-generation "**Intelligent Adaptive Completion System**." The core of this solution comprises two product series: the **Autonomous Inflow Control Device** (AICD) and **High-Performance Sand Control Screens**.

Jingtao Energy’s AICD utilizes a unique fluid dynamics design to automatically inhibit the inflow of high-mobility fluids (water/gas) based on viscosity differences, while maintaining high crude oil production. This is achieved without manual intervention or surface control systems, truly realizing "intelligent oil selection." Paired with Jingtao Energy’s independently developed **multi-layer composite sand control screens** (employing laser slotting, sintered metal fiber, or ceramic coating technologies), this system delivers exceptional sand control performance and long-term stability under complex geological conditions.

This white paper details the technical principles, product advantages, manufacturing processes, and field case studies of Jingtao Energy's AICD and screen systems, demonstrating how they help global operators achieve **production stabilization, extended well life, and maximized Estimated Ultimate Recovery** (EUR) in complex reservoirs.

2. Industry Challenges

In the development of horizontal and extended-reach wells, operators commonly face the following core challenges:

- "Short-Board Effect" in Heterogeneous Reservoirs: Due to permeability variations, high-permeability zones often experience water or gas breakthrough first, leaving low-permeability oil-bearing zones underutilized and resulting in low overall recovery.
- Premature Water Breakthrough & Gas Coning: Traditional open-hole or standard screen completions cannot control zonal flow rates. Once a high-perm zone breaks through to water, large volumes of water occupy production channels, increasing disposal costs and potentially killing the oil zone.
- Severe Sand Production Risks: Unconsolidated sandstone reservoirs are prone to sand production under production drawdown, causing pump wear, pipeline blockages, or even wellbore collapse, forcing frequent workovers.
- Limitations of Conventional ICDs: Traditional fixed-orifice Inflow Control Devices (ICDs) provide only constant throttling resistance and cannot dynamically adjust to changing fluid properties, making them ineffective in later production stages.
- Equipment Failure in Harsh Conditions: High temperature, high pressure, high salinity, and corrosive environments (H_2S/CO_2) impose extreme demands on the materials and sealing performance of completion tools.

3. Core Technical Principles

3.1 Autonomous Inflow Control Device (AICD)

Jingtao Energy’ s AICD is a purely mechanical, moving-part-free intelligent flow control tool. Its core principle relies on **pressure drop responses generated by fluid viscosity differences**.

- Fluid Dynamics Design: The AICD interior features specialized spiral flow paths or labyrinth structures. When fluid passes through, low-viscosity fluids (water/gas) generate intense turbulence and extremely high frictional pressure drops, while high-viscosity fluids (crude oil) maintain laminar flow with minimal pressure drop.
- Adaptive Regulation Mechanism:
  - ◆ Oil Production Phase: High-viscosity crude oil encounters low resistance in the AICD, maintaining high flow rates.
  - ◆ Water/Gas Breakthrough Phase: Once water or gas (significantly lower viscosity) enters the zone, fluid velocity within the AICD increases sharply, causing an exponential rise in local pressure drop. This high backpressure automatically throttles the inflow from that specific zone, forcing fluids to divert to other unswept, low-permeability oil-bearing zones.
- No External Intervention Required: The entire process is driven solely by the physical properties of the fluid, requiring no sensors, cables, or surface commands, ensuring extremely high reliability.

3.2 High-Performance Sand Control Screen Technology

Jingtao Energy offers various types of sand control screens optimized for different reservoir characteristics:

- Precision Laser Slotted Liner:
  - ◆ Utilizes high-precision laser cutting to create trapezoidal slots on the base pipe. The "narrow-outside, wide-inside" design effectively prevents sand plugging, offering superior anti-clogging capabilities.
  - ◆ Suitable for gravel pack assistance or standalone sand control, with slot widths precisely controlled at the micron level.
- Sintered Metal Fiber Screen:

◆ Constructed from multiple layers of sintered stainless steel fiber felt, creating a 3D pore structure.

◆ Advantages: High filtration precision (down to 10-20 microns), high permeability, exceptional strength, impact resistance, and excellent backwash recovery capabilities.

- Ceramic Coated/Wrapped Screen:

◆ Features a robust filtration barrier formed by covering the base pipe with high-strength ceramic particles or resin coatings.

◆ Advantages: Superior wear and corrosion resistance, ideal for harsh environments containing sharp sand grains or corrosive fluids.

3.3 Integrated Intelligent Completion System

By integrating the AICD and sand control screen into a single sub-assembly, we form an integrated "**Sand Control + Water/Gas Control**" solution. Fluids first pass through the screen to filter out solids, then enter the AICD for viscosity-selective throttling, ensuring that the fluid entering the tubing string is both clean and intelligently optimized.

4. Product Portfolio & Specifications

4.1 Jingtao Energy AICD Series

- Model Classification:

◆ JT-AICD-L (Light Oil): Optimized for light oil reservoirs; highly sensitive to gas coning.

◆ JT-AICD-H (Heavy Oil): Optimized for heavy oil reservoirs; balances high-viscosity oil flow with water suppression.

◆ JT-AICD-V (Variable): Variable resistance type, adaptable to a wider range of viscosity changes.

- Key Features:

◆ No Moving Parts: Eliminates the risk of mechanical sticking; lifespan matches that of the tubing.

◆ Wide Operating Range: Adapts to dynamic changes in water cut (0% - 90%+).

◆ Materials: Body made of 316L/Duplex/Super Duplex Steel;

seals made of FFKM (Perfluoroelastomer). Rated for temperatures up to 150℃-180℃ and pressures up to 10,000 psi.

◆ Connection: Threaded (API standard) or welded, perfectly compatible with various screen base pipes.

4.2 Jingtao Energy Sand Control Screens

roduct Type	Application Scenario	Filtration Precision	Core Advantages
Laser Slotted Liner	Uniform sandstone, Gravel pack assist	100 - 500 μm	Strong anti-clogging, high throughput, cost-effective
Sintered Metal Fiber	Unconsolidated sand, Fine silt, Wells requiring backwash	10 - 100 μm	Extremely high strength, large dirt holding capacity, reusable
Ceramic Coated	High corrosion, High abrasion, HPHT wells	20 - 200 μm	Superior corrosion/abrasion resistance, longest lifespan
Wire-Wrapped Screen	Conventional sand control, Large hole sizes	150 - 600 μm	Classic reliability, excellent collapse resistance

- Base Pipe Options: Perforated, slotted, or drilled base pipes. Materials include J55, N80, L80, P110, 13Cr, Duplex Steel, etc.
- OD Range: 2-3/8" to 9-5/8", supporting non-standard customization.

5. Key Advantages & Value Proposition

Dimension	Traditional Completion	Intelligent System (AICD + Screens)	Customer Value
Fluid Control	Passive inflow, dominated by high-perm zones	**Active Adaptive**, suppresses water/gas, balances oil production	**Increases EUR by 10%-20%**
Water Response	Sharp production drop after breakthrough; requires water shutoff jobs	**Instant automatic throttling**, delays overall water cut rise	**Extends water-free production period**; reduces water handling costs
Sand Control	Single filtration; prone to clogging or failure	**Deep filtration + Self-cleaning**, long-term sand control	**Reduces workover frequency**; ensures continuous production
Operational Complexity	May require multi-string or electro-hydraulic systems	**Single-trip completion**; no cables/hydraulic lines needed	**Lowers completion costs**; shortens well construction cycle
Reliability	Electronic/hydraulic components prone to failure	**Purely mechanical**; withstands HPHT and corrosion	**Maintenance-free throughout lifecycle**; minimal risk
Adaptability	Struggles with dynamic reservoir changes	**Real-time response** to fluid property changes	**Maximizes asset value**; manages uncertainty

6. R&D Capabilities & Manufacturing Quality

As a leading downhole tool manufacturer, Dongying Jingtao Energy Technology Co., Ltd. possesses a complete industrial chain advantage:

- R&D Platform:
  - ◆ Hosts a provincial-level enterprise technology center and fluid simulation laboratory.
  - ◆ Equipped with CFD (Computational Fluid Dynamics) simulation systems to optimize AICD flow paths through billions of iterations, ensuring theoretical model accuracy.
  - ◆ Operates a High-Temperature/High-Pressure Flow Loop Test Bench capable of full-scale testing simulating real formation conditions (temperature, pressure, multiphase flow).
- Manufacturing Process:
  - ◆ Precision Machining: Utilizes 5-axis CNC machining centers to ensure micron-level precision for AICD flow paths and screen slots.
  - ◆ Specialized Welding: Features automated laser and electron beam welding lines to guarantee integrity and corrosion resistance in dissimilar metal joints.
  - ◆ Heat Treatment: Operates proprietary large-scale heat treatment furnaces to strictly control material microstructure, enhancing resistance to Sulfide Stress Corrosion Cracking (SSCC).
- Quality Assurance:
  - ◆ Strictly adheres to international standards such as API Spec 5CT and API Spec 11D1.
  - ◆ Equipped with CMMs, Spectrometers, Ultrasonic Flaw Detectors, and Helium Mass Spectrometer Leak Detectors.
  - ◆ Every AICD unit undergoes rigorous flow characteristic testing before shipment to ensure performance curves meet design specifications.
- Certifications:
  - ◆ ISO 9001 / ISO 14001 / ISO 45001 System Certifications.
  - ◆ API Monogram License.
  - ◆ Holder of multiple national invention and utility model

patents.

7. Applications & Case Studies

7.1 Typical Application Scenarios

- Long Horizontal Sections: Mitigates the "heel-toe effect" caused by frictional pressure loss, balancing the production profile across the entire wellbore.
- Bottom-Water / Edge-Water Reservoirs: Effectively delays water cresting and coning, significantly extending the time to water breakthrough.
- Gas-Cap Reservoirs: Suppresses gas coning from high-gas-saturation zones at the top, maintaining reservoir pressure.
- Unconsolidated Heavy Oil Reservoirs: Combines sand control with AICD to improve steam injection/production profiles during cyclic steam stimulation or cold production.
- Old Well Revitalization & Sidetracking: Addresses high water cut in mature wells without the need for expensive hydraulic fracturing or chemical water shutoff.

7.2 Representative Case Studies

(Note: The following data represents comprehensive application performance of Jingtao Energy in similar domestic and international reservoirs)

- Case 1: Horizontal Well in an Offshore Heavy Oil Field

◆ Challenge: Strong reservoir heterogeneity; water breakthrough occurred 3 months after production, with water cut rapidly rising to 60% and production plummeting.

◆ Solution: Applied the Jingtao JT-AICD-H + Sintered Metal Fiber Screen combination in a sidetrack well.

◆ Result: After 12 months of production, water cut remained below 15%. Daily oil production was 45% higher than neighboring wells (completed with traditional screens), with an estimated 18%

increase in EUR.

- Case 2: Onshore Bottom-Water Sandstone Reservoir
  - ◆ Challenge: Active bottom water; average water-free production period for traditionally completed wells was only 6 months.
  - ◆ Solution: Large-scale deployment of the Jingtao Energy AICD completion system.
  - ◆ Result: Average water-free production period extended to over 24 months. Cumulative oil production per well increased by 35,000 tons, significantly reducing the load and investment in water treatment facilities.
- Case 3: HPHT Gas Well with H_2S and Sand
  - ◆ Challenge: Gas stream contained H_2S and trace sand; conventional screens suffered rapid corrosion and plugging.
  - ◆ Solution: Utilized Jingtao Duplex Steel Ceramic Coated Screens.
  - ◆ Result: Operated continuously for 3 years with no sand production and no corrosion perforation, maintaining stable high-rate gas flow.

8. Technical Service & Support

Jingtao Energy provides a one-stop, full-process service from design to after-sales:

- Reservoir Simulation & Design:
  - ◆ Uses professional software (e.g., Eclipse, tNavigator) combined with client reservoir data to simulate the effects of different AICD placement scenarios.
  - ◆ Provides optimized recommendations for AICD type selection, quantity configuration, and installation positioning.
- Customized Manufacturing:
  - ◆ Customizes exclusive products based on wellbore geometry, casing dimensions, and special conditions (HPHT, corrosion).
- On-Site Technical Support:
  - ◆ Deploys senior engineers to supervise tool running, setting, and completion operations, ensuring zero-error execution.
- Post-Sales Monitoring & Evaluation:

◆ Assists clients in analyzing production data to evaluate AICD performance, providing a basis for subsequent development adjustments.

9. Conclusion

Facing an increasingly complex oil and gas development environment, **Dongying Jingtao Energy Technology Co., Ltd.** offers an efficient, reliable, and cost-effective intelligent completion solution for global oilfields through its innovative **AICD autonomous flow control technology** and **high-performance sand control screens**.

Our system represents not just an upgrade in tools, but a revolution in development philosophy—shifting from "passive acceptance" to "active management." By balancing production profiles, suppressing (ineffective) fluid production, and ensuring long-term sand control, Jingtao Energy empowers clients to unlock maximum potential in every reservoir, achieving a **dual leap in economic benefits and resource recovery rates**.

Looking ahead, Jingtao Energy will continue to deepen its expertise in intelligent completions, driving development through technology and striving to become the most trusted partner in the global energy industry.

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