The Right Connection®

The All-In-One Solution: One-Piece Iron Intake Manifolds Reduce Downtime and Cut Costs in Fracking Operations

A dramatic increase in fracking activity has revealed a number of weaknesses in the process leading operators to scrutinize all facets of the process. Intake manifolds that feed the fracking pumps have been recognized as one source of failure.

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CONTENTS

INTRO

To the casual observer, hydraulic fracturing – commonly known as “fracking” – might be considered a relatively new drilling technology that has leapfrogged the United States into the top spot in oil and gas production in just five or ten years’ time.

But fracking isn’t a new phenomenon. Oil and gas industry author John Manfreda reminds us that the history of fracking dates back more than 150 years to the Civil War era. During the Battle of Fredericksburg, the use of explosive artillery to remove the obstruction of a narrow canal led to the discovery of superincumbent fluid tamping.

As a direct outgrowth of that discovery, the first patent for an “exploding torpedo” for artesian wells was granted as early as 1866. By the 1930s, drillers started using a non-explosive liquid substitute in lieu of nitroglycerin, which further increased oil well productivity while reducing safety risks.

Modern-day fracking is a product of the 1990s, with the adoption of new technologies that combine geology-led directional horizontal drilling with hydraulic fracturing, allowing explorers to tap into huge shale oil reserves in the United States.

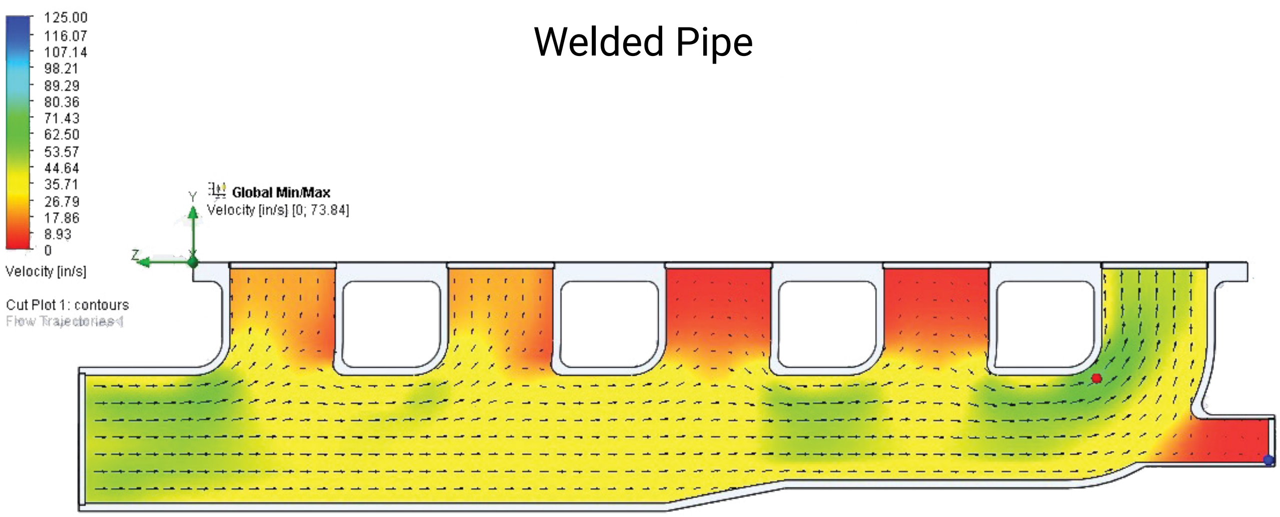
After 20 years of only modest growth, by 2012 higher producer oil prices finally created the conditions for fracking activity to take off in a major way – ultimately enabling the United States to soar past Nigeria, Venezuela, Saudi Arabia, and Russia as the world’s leading producer of oil and gas by 2018.

RAPID GROWTH REVEALS OPERATIONAL WEAKNESSES

The dramatic increase in fracking activity revealed a number of weaknesses in the process. Recognition of these shortcomings has become even more pronounced over the past several years as increased oil production began to exert downward pressure on commodity prices.

This has led operators to scrutinize all facets of the fracking process to stay safe and efficient, including the pumping systems used to introduce fracking fluids to the wells. Intake manifolds that feed the fracking pumps have become recognized as one source of failure. Their role is crucial in conveying injecting fluids into the shale to start the extraction process. The makeup of the injecting fluids varies from project to project – and is typically closely guarded. But the constituents always include sand, water, various chemicals, and gel.

Herein lies the challenge: Fracking operators have experienced failures caused by sand building up and blocking the free movement of the injecting fluids as they attempt to enter the fluid end of the pump. Almost always, the reason for the failure comes down to the design of the intake manifold. However, “bad” sand has also been identified as a

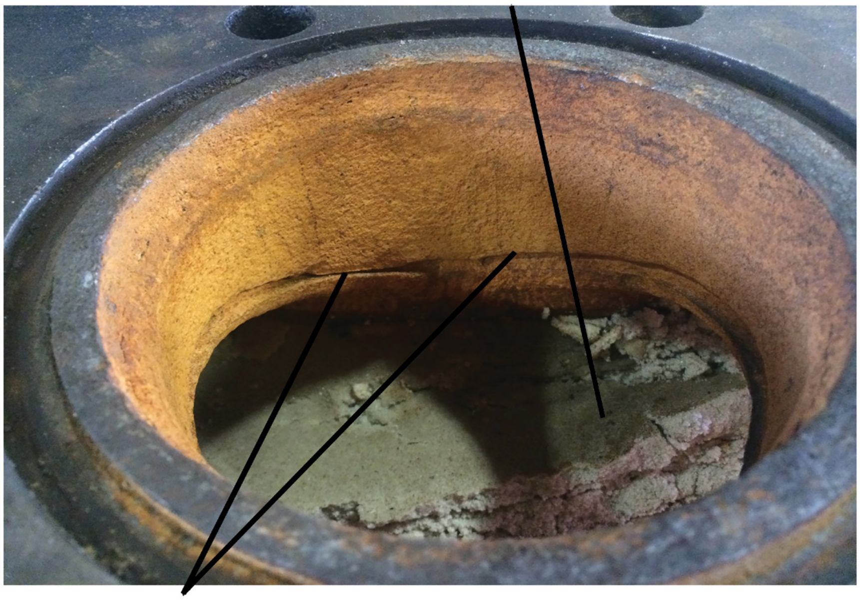


This diagram shows, in the red areas, where flow slows in a typical welded pipe intake. The flow snapshot is taken when the final port valve is completely open and ports 1 thru 4 are either partially open closed due to the firing order of the pump.

potential source of downtime. “Bad” sand is sand that contains larger rocks that can plug up the intake manifold. This plugging up normally occurs at the final port and can starve the last cylinder in the pump, which leads to valve failures and other fluid end problems.

Typically, intake manifolds have been made from standard steel pipe fittings welded together. For several reasons, that kind of design isn’t ideal given the media fluids that are being conveyed:

- Corroded, cracked, and washed-out areas where the individual components are welded together, along with leaks due to cracks in the welds themselves.



Damaged welded intake manifold showing weld wash out and built-up sand from poor flow.

Preventing this from happening requires extensive knowledge of pre- and post-heat treatments and proper weld geometry.

- Washed out and leaking areas due to exposed threads from threaded fittings, which are then prone to abrasion and leakage – even if the part is welded following assembly.

Other shortcomings of conventional intake manifold products relate to their inherent design. They include:

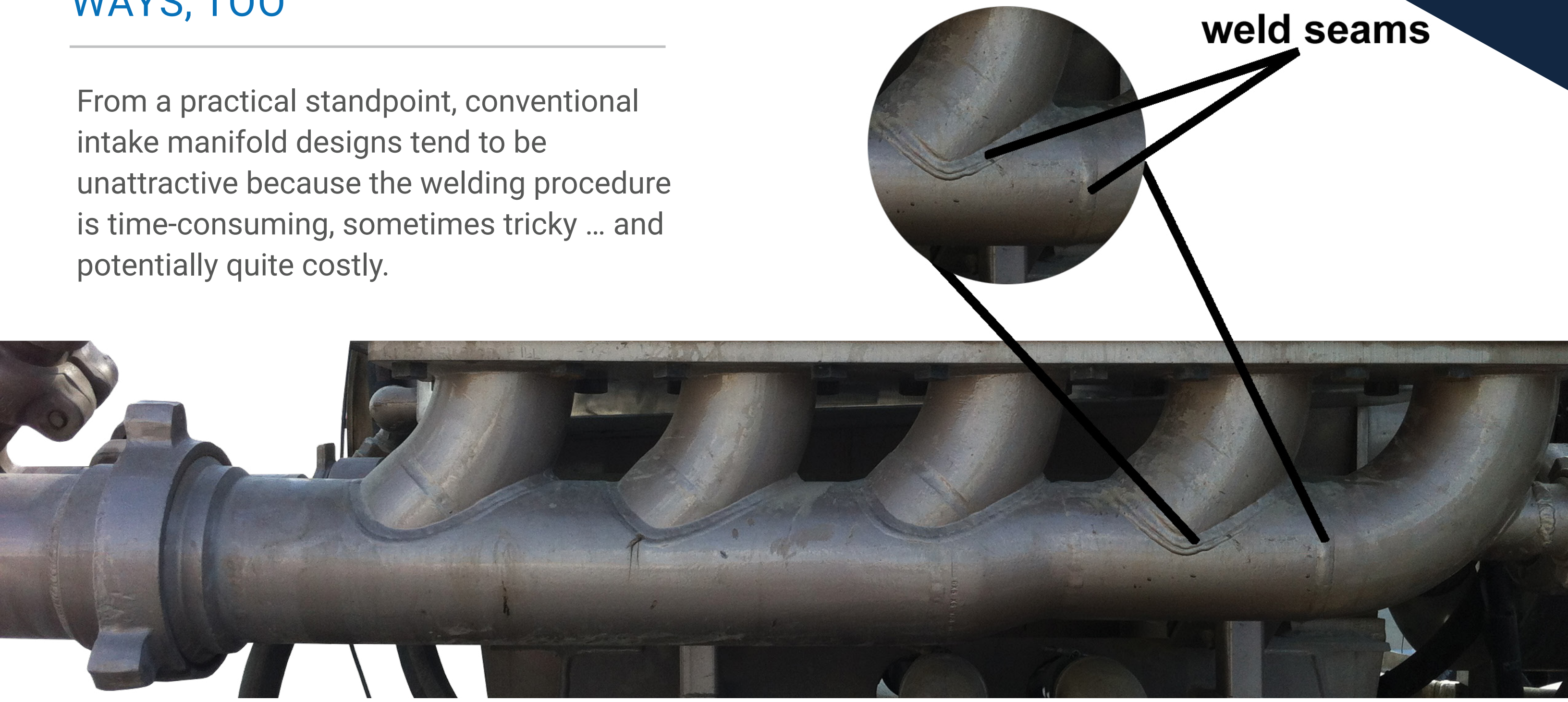
- The poor location of cleanout ports designed to allow access to fluid end valves for draining, which leads to fluid remaining in the fluid end bores. This fluid can freeze in the winter months and even if freezing doesn’t occur, the residual fluid can lead to corrosion. That corrosion, in turn, causes stress risers that can eventually lead to cracking of the fluid end wall.

- Poor fabrication tolerances relating to the machined base plate where the pipe sections are welded to it. The resulting distortion of the base plate often results in poor sealing to the fluid end and/or difficulty installing the manifold.

On top of these issues, the overall size and height of welded intake manifolds make them difficult to install.

UNAPPEALING IN OTHER WAYS, TOO

From a practical standpoint, conventional intake manifold designs tend to be unattractive because the welding procedure is time-consuming, sometimes tricky … and potentially quite costly.



Weld seams clearly visible on a 5-port intake manifold. This technique is time consuming to fabricate, subject to early failures, and causes expensive issues with the fluid end.

Worse yet, substandard welding can cause leaking and degrading of the base materials.

Adding to concerns beyond these design shortcomings, conventional intake manifolds aren't strong performers when it comes to fluid flow. Since the geometry of the flow path is predetermined and inflexible in off-the-shelf standard parts, it isn't possible to adjust the flow path for optimum performance.

Subpar flow paths contribute to slow fluid movement, lack of consistent pressure, and increased wear at certain key points along the passageway. When that happens, a variety of problems can result, including:

- Insufficient fluid velocity, particularly at the #5 or final bore – Slow-moving fluid means that sand will drop out, further restricting fluid flow, which could result in cavitation and severely damaged valves, seats, and springs – and even worse, to cracked fluid end walls.

- Inability of the manifold to flow "bad" sand – Sand that has oversized rocks or clumps can drop out and plug up flow. This leads to valve failures, cracks, and early fluid end failure.

- Increased pressure drops along the intake manifold – also leading to cavitation

- Unacceptable levels of wear – particularly at bore #1 as a result of being exposed to the additional sand and chemical abrasion
- Uneven distribution of sand in the proppant – leading to uneven or excessive valve and seat wear (especially at bores #4 and #5)
- Unacceptable downtime – owing to the need to clear sand blockages and repair damaged fluid ends

THE ONE-PIECE SOLUTION

As it turns out, nearly all of the issues associated with the conventional design of intake manifolds can be remedied by switching to a one-piece product design. Allowing for a “dedicated” design that possesses structural and material integrity throughout, the resulting intake manifold effectively does away with operating issues.

Dixon’s one-piece cast 3-port and 5-port intake manifolds are designed and manufactured to eliminate issues found with welded manifolds and to increase fluid end life and up time.

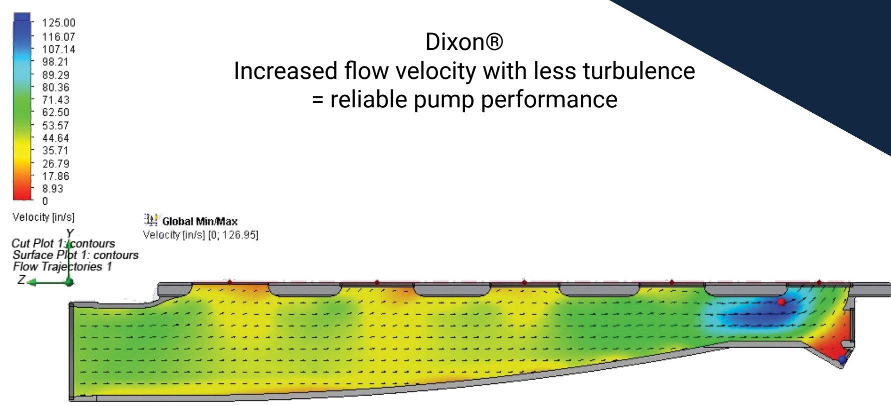
The Dixon **Innovation Center**

The mission of the **Dixon Innovation Center** in Chestertown, MD, is to find answers to the challenges faced by manufacturers and producers as they make, process, and deliver their products to customers.

Engineers at the Dixon Innovation Center are committed to providing more than "standard" product solutions. They begin by carefully studying many products already in use in the field – then using that knowledge to create new and improved solutions that are practical in their application and that often possess unique performance characteristics.

The industries and applications supported by the Dixon Innovation Center are extensive and include a special focus on the oil and gas industry.

Product development is extensive as each aspect of materials selection, sealing functionality, surface finishes, cycle testing, and other key performance factors are developed and tested. Working in concert with ISO specifications, ASTM specifications, and other guidelines is all part of Dixon's commitment to perform and control key steps in the development process for new products: designing, testing, and fabricating.



This 5-port intake manifold flow simulation shows that the fluid effectively never slows down during pumping and accelerates at the final port to eliminate sand drop out, port blockage, and damage to the fluid end.

To begin, the choice of material is important. Certain grades of iron have higher yield strength and hardness than standard A53 steel or A105 pipe. Therefore castings made of those iron grades can be stronger and more wear resistant than a welded version made of standard pipe fittings. Furthermore, machining a cast product as opposed to a welded-up construction is a more precise procedure that's less prone to damage or to a loss of product integrity.

Additional design characteristics of a one-piece iron intake manifold go right to the heart of guaranteeing rugged durability and longer-life performance. They include:

- No threads or welds that can leak or fail
- Geometrically designed flow optimization for consistent pressure at all bores, which minimizes pressure drops in an effort to keep pressure at 60 PSI at all ports, and consistent fluid velocity that keeps sand in suspension, allowing bad sand to flow without issue and minimizing abrasion at bore #1

- Tighter fabrication tolerances
- Slotted base plate holes for ease of installation and compatibility with multiple fluid-end bolt hole patterns
- Angled ports for better fluid end valve access, prolonging the life of the fluid end
- Access ports for process instrumentation, including easier access to drain cylinders during cold weather and to prevent corrosion during idle time
- A shorter overall height for easier installation

Beyond providing these fundamental design benefits, one-piece iron intake manifolds allow for customizable 6” inlets such as NPT threads or grooved connections.

Considering the numerous benefits of the one-piece design, it isn’t surprising that operators who switch to these intake manifolds experience lower overall cost-of-ownership results. The cost of new fluid ends ($50-80,000) and fluid end rebuilds ($10-20,000) can quickly skyrocket depending on how many trucks are in the fleet. A one-piece intake manifold can reduce many of the problems that lead to repair or replacement on fluid ends. These one-piece intake manifolds can provide an added degree of efficiency and safety in fracking operations along with commensurately lower risks.

CALL TO ACTION

In response to market needs, Dixon has successfully introduced a one-piece iron intake manifold design that delivers the level of performance fracking operators demand. Dixon’s field-proven product carries design and engineering patents, attesting to its superior qualities. To learn more about the performance benefits of the product, contact Dixon at engineering@dixonvalve.com or call 877.963.4966.

Jim Shifrin is Director of Product Development and Innovation at Dixon. He oversees a staff of engineers and other specialists at the Dixon Innovation Center – a facility expressly built for the mission of commercializing “first-ever” products and bringing them to market. On average, the Dixon Innovation Center introduces five new products to the market each year, and they harness new technologies such as 3D printing to bring added efficiency and cost savings to the manufacturing process – and to customers.

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Founded in 1916, Dixon is a premier U.S.-based worldwide manufacturer and supplier of hose couplings, valves, dry disconnects, swivels and other fluid transfer and control products. Dixon’s products and services support a wide range of industries including chemical processing, petroleum exploration, refining and transportation, steelmaking, construction, mining, manufacturing and processing.

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