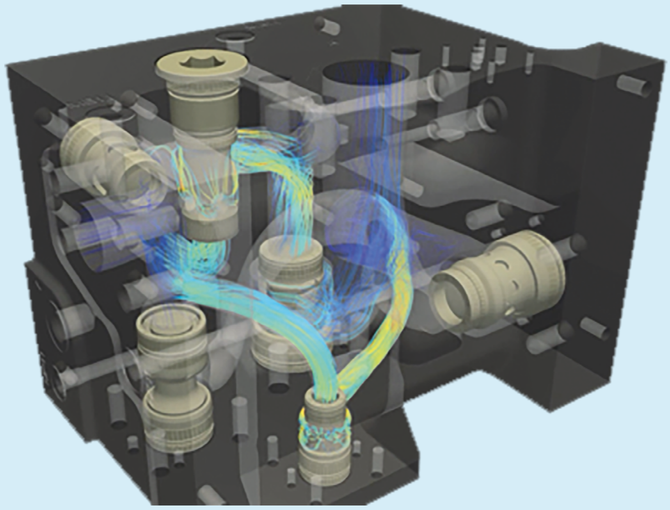
How manifolds produced using additive manufacturing reduce energy consumption and CO_2 emissions.

Manifolds produced using 3D sand core printing help to ensure greater sustainability in industrial hydraulics. The benefits of optimally designed inner and outer geometries can be seen over the entire life cycle. They range from conservation of resources and easier assembly and maintenance to reduced energy consumption and CO_2 emissions with higher process quality.

Climate change is one of the biggest challenges of our time. More than ever before, industrial companies need to develop solutions for reducing CO_2 emissions on a permanent basis. Next-generation hydraulics offers three key levers for greater sustainability: Less energy, less fluid and less material.

When it comes to manifolds, the key to greater energy efficiency and conserving resources lies in the use of additive manufacturing technologies. With these technologies, inner and outer geometries can be designed with greater freedom than normally possible, resulting in flow-optimized systems with integrated functions in perfect harmony with the desired machine design. In industrial hydraulics, two types of additive manufacturing are mainly used: Selective laser melting (SLM) and indirect printing using the sand core technique. 3D sand core printing is the method most commonly used for manifolds. This is discussed below.



▲ **Flow-optimized inner geometry of a manifold.**

OPTIMIZED ON THE COMPUTER

Before the actual 3D printing of the cast sand core for the individual manifold, the manufacturer first calculates the optimum inner geometry using flow simulations. With the help of CFD simulations (Computational Fluid Dynamics (CFD)), the individual flows can be better understood and it is possible to find out how pressure losses and cavitation can be avoided with minimal use of materials in order to achieve optimum energy efficiency and extend the operating life. At the same time, integrated functions and the position of the connections are taken into account in the simulation.

To further reduce the weight and material required and to make it easier to install the system in the machine, the outer geometry is also optimized. As a result, resources are conserved over the entire life cycle: From production and operation to recycling.

During the next step, a 3D printer constructs the negative of the manifold in thin layers of 280 micrometers. This core model is used to cast the rough block, which into which threads and sealing surfaces are machined.

ADVANTAGES THROUGH 3D SAND CORE PRINTING

The attraction of 3D sand core printing for the individual production of control blocks is, on the one hand, to improve energy efficiency and reduce the use of resources. It also offers users attractive benefits when it comes to functionality and assembly. This is thanks to the design degrees of freedom which additive manufacturing offers. Compared to the conventional process, much more complex forms can be cast, for example variable pipe diameters.

1. Greater efficiency during assembly, operation and maintenance

Thanks to the constructive freedom offered by 3D sand core printing, outer geometries through which manifold better fits into tight installations spaces can be created. They also allow easy assembly and easier maintenance. During the construction phase, all connections are positioned precisely and for optimum accessibility.

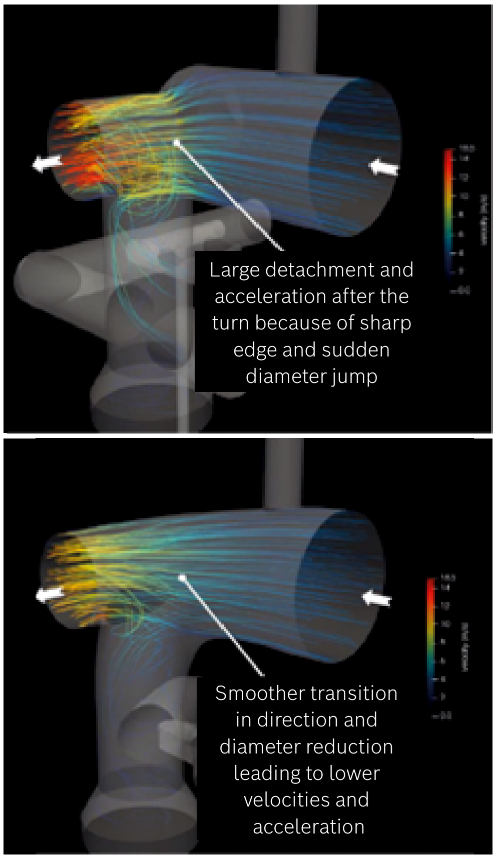
The inner design focuses on flow optimization. As a result of the CFD simulation, the inner geometry is optimized. Pressure losses und cavitation are minimized, while control quality increases because there is less dead volume. Thanks to this new constructive freedom, right-angled channel redirections are now a thing of the past. This ultimately leads to an improvement in process quality too.

2. Integrated functions

Thanks to the freedom in designing inner and outer geometry, components such as filters or accumulators, which used to be placed separately, can be connected directly to the block, even in very demanding or tight installation spaces. This not only saves time and materials when it comes to piping – it also reduces the risk of leakage as the auxiliary holes and screw plugs, which are normally used, are no longer necessary.

3. Fewer materials, reduced weight

Compared to conventional design, manifolds produced using 3D sand core printing require at least a third less material. This not only conserves resources – the lower weight also makes handling during transport and assembly easier.



▲ **CFD simulation for calculating optimum flow conditions.**

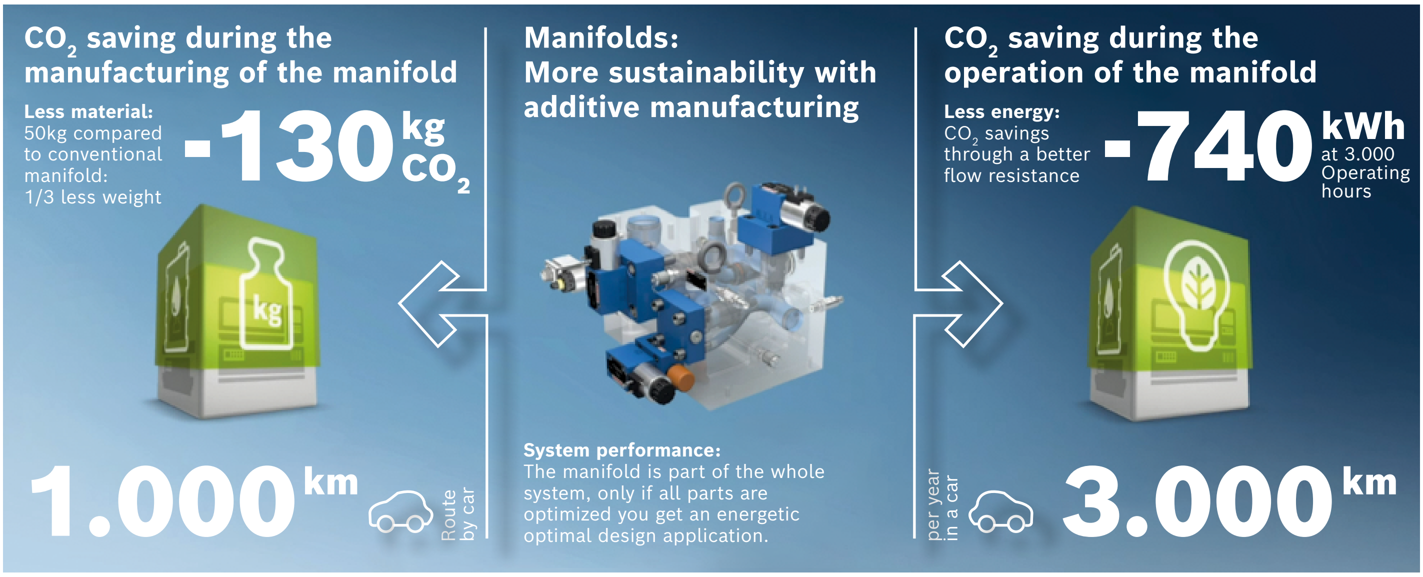
How much energy and CO_2 can be saved?

The following example shows how much material, energy and CO_2 can be saved as a result of 3D sand core printing:

A manifold produced using 3D sand core printing requires around 50 kg less material than one which is produced in the conventional manner. The lower casting volume and the resulting reduction in energy consumption reduce CO_2 emissions during production by around 130 kg – approximately one third.

This figure is comparable with the emissions from a car powered by fossil fuel traveling a distance of 1,000 km.

In the operating phase, the manifold requires much less electricity thanks to its flow-optimized inner geometry with minimal Delta p and low noise emissions. After 3,000 operating hours, the savings add up to 740 kWh, which means that the CO_2 footprint is reduced by around 450 kg. This equates to traveling around 3,000 km by car.



▲ **After 3,000 hours of operation per year, the energy savings add up to 740 kWh, and the CO_2 footprint is reduced by around 450 kg per year, which is equivalent to about 3,000 km of driving.**

Is the investment worthwhile?

Thanks to the electricity saved during the operating phase, manifolds produced using 3D sand core printing usually pay for themselves after around 3.5 years. After that, savings are ongoing. If the system benefits justify the investment, retrofitting additive manifolds is also an attractive option. This can not only reduce energy consumption and CO_2 emissions – it can also lead to significant improvements in processes too.

However, it is always advisable to look at individual components such as manifolds as part of the bigger picture. After all, the potential for saving energy and CO_2 is greatest if the system design as a whole is modernized. This applies to new designs (and improvements to existing systems alike. Variable-speed drives which allow power on demand are another important building block here. Read more about them in this white paper.

CONCLUSION: MAKING FULL USE OF THE POTENTIAL OFFERED

Together with other innovations, manifolds produced using 3D sand core printing are an important part of modern industrial hydraulics systems. As an economic investment in technology and sustainability, they have a positive effect over the entire life cycle. While the CFD-optimized inner geometry saves energy, the outer geometry which is designed to save space reduces the amount of material required. Both together reduce CO_2 emissions, make handling easier and improve process quality.

With Connected Hydraulics, Bosch Rexroth offers a complete portfolio for conserving resources and increasing energy efficiency. Anyone who would like to achieve the greatest effect and the quickest possible payback can find out about the key levers here.

Further links:

White paper – variable-speed drive solutions
White paper – three levers for greater sustainability
White paper – subsidies in Germany for greater sustainability
https://apps.boschrexroth.com/rexroth/de/connected-hydraulics/