E-BOOK

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manufacturing solutions

A GUIDE TO CUSTOM WATER MANIFOLD ASSEMBLIES

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Many industrial processes require the removal of waste heat to protect equipment from damage (electronics and power supplies) or to maintain stability in a process (plastics processing / bio-pharma). Effective heat removal can improve equipment performance and overall productivity. Manifolds are a key component in the removal of waste heat, yet little thought is given to their layout or assembly. Here is what to consider for best results.

Custom Water Manifold Overview

The purpose of a manifold is to distribute fluids to various circuits connecting components within a system or within a machine. The fluid is delivered at specific temperatures and flow rates to provide heat transfer (cooling / heating) to those components. The addition of valves, flow meters and sensors on the manifolds allow monitoring and isolation of the circuits. Distribution manifolds are utilized primarily for cooling applications across a variety of industries, including:

- Plastics processing
  - For water up to 250° F
  - For water from 250° F to 450° F
  - For oil from 300° F to 600° F
- Other machinery, including (but not limited to):
  - Semiconductor equipment
  - X-rays and MRI equipment
  - Computers and servers
  - Welding equipment
  - Furnaces
  - Lasers
  - Particle accelerators (mirrors and magnets)
  - Video and broadcasting equipment

Common Manifold Challenges

The layout and assembly of a fluid distribution system comes with numerous challenges. As prefabricated manifold assemblies are not readily available, it's important to design, arrange and assemble them properly to ensure optimal cooling. Improper handling can delay schedules, damage equipment, reduce productivity, and impact quality.

Choosing the correct manifold for your application requires consideration of factors that include system operating pressure, required flow rates, and space requirements.

System Design

Ideally, before selecting a manifold, the heat load for each circuit should be defined. The lengths and cross-sectional areas of each circuit should then be optimized for heat transfer where the flow through the circuit is turbulent. Not having turbulent flow drastically reduces the heat transfer capacity of the system.

Turbulent flow is dependent on circuit diameter, fluid viscosity and velocity to achieve a Reynolds number (Re) greater than 4000. Reynolds number calculations are complex, but the flow required in the circuits can be determined by using available charts and reference guides. The pressure drop in the cooling circuits can also be calculated to help determine the total pumping capacity needed.

Often, the circuit geometry, flow rate and pump size are pre-determined and optimization is not possible. In such cases, the designer should focus on selecting and arranging a manifold that supplies fluid with minimal flow restrictions. The design/layout should also consider:

- Manifold material
- Manifold size
- Connection type
- Circuit isolation / regulation requirements
- Fluid monitoring requirement

Material Selection

Manifolds can be fabricated from a variety of materials such as brass, steel (carbon and stainless), aluminum, and numerous plastics. When selecting the manifold material, considerations include compatibility with the fluid, the system's operating temperatures/pressures, and the expected life span of the system.

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The manifold's chemical compatibility can impact the life span of both the manifold and the fluid itself. For instance, aluminum manifolds may be fine for applications involving municipal water, but deionized water would corrode the aluminum in a short period of time. Carbon steel is suitable for heat transfer oils, but brass will impact the chemical composition of the heat transfer fluid. Plastic manifolds are best suited for chemical solutions which may corrode metal manifolds.

Your system's operational temperatures and pressures should also be considered when determining the choice of material. Plastic is suitable for fluids with temperatures and pressure up to 120° F / 120 PSI. Thin-wall stainless steel manifolds have a rating of 250° F / 250 PSI (liquid). Aluminum manifolds work well for fluids up to 300° F / 150 PSI. Stainless steel pipe manifolds have ratings up to 550° F / 500 PSI.

Life expectancy of the manifold should also be considered when selecting materials. Plastic and stainless steel have extremely good corrosion resistance and generally have the longest life span. Aluminum and steel are usually coated to increase their corrosion resistance.

Manifold Size

When selecting a manifold, its inlet should be sized to support the flow required for all the circuits in the system. A simple method is to add the flow rates for each circuit and then select a manifold inlet based on that total. Typical manifold inlet sizes are 3/4", 1" and 1-1/2" and you can assume they will support a total flow rate of at least 15, 25 and 60 GPM (gallons/minute), respectively. However, at a minimum, the manifold should be similar to the connected piping, ensuring flow is not restricted at that connection point. This assumes the piping to the manifold is sized correctly for the total flow required.

Next comes the selection of the manifold ports by size and quantity. How many ports you need depends on the system design and how you want to provide fluid to your system. Flow rates of 3, 6 and 10 GPM can be reasonably assumed through ports sizes of 1/4", 3/8" and 1/2", respectively. Typically, port sizes are kept the same across the entire length of the manifold and sized for the largest flow rate.

Connection Type

Thread type must also be considered for components that will be installed into the manifold. Some of the more typical thread types are National Pipe Thread (NPT), British Standard Pipe (parallel, BSPP / tapered, BSPT) and Metric (parallel, tapered). When possible, use the same type of threads between the manifold and the components to eliminate the need for thread adapters.

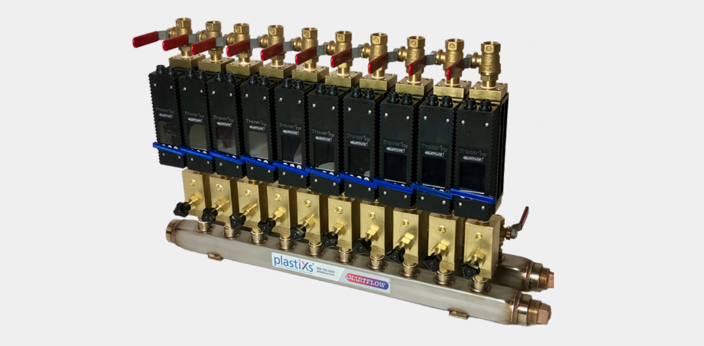
Circuit Isolation / Regulation

It's important to determine the features needed for each circuit given the system design. Valves in each port allow operators to isolate a circuit for maintenance. In systems where the circuits have widely varying flows, regulation may be needed. Since fluids follow the least resistant path, circuits with high flows can impact low-flow circuits. Regulation helps operators balance flows across circuits.

Fluid Monitoring

Monitoring allows system operators to verify that fluid flow, temperatures and pressures are being maintained. Flow meters are important when initially setting flow regulation, as discussed previously, but can be installed permanently to allow periodic verification.

Many designs use flow meters or flow switches to confirm fluid flow prior to process start-up. This provides an equipment/process safeguard against damage due to lack of coolant. Pressure gauges allows operators to monitor the differential pressure between manifolds where changes over time may indicate a clog in one of the circuits.



Supply and return manifold pair with electronic flow meters and brass flow regulators for monitoring and flow balancing

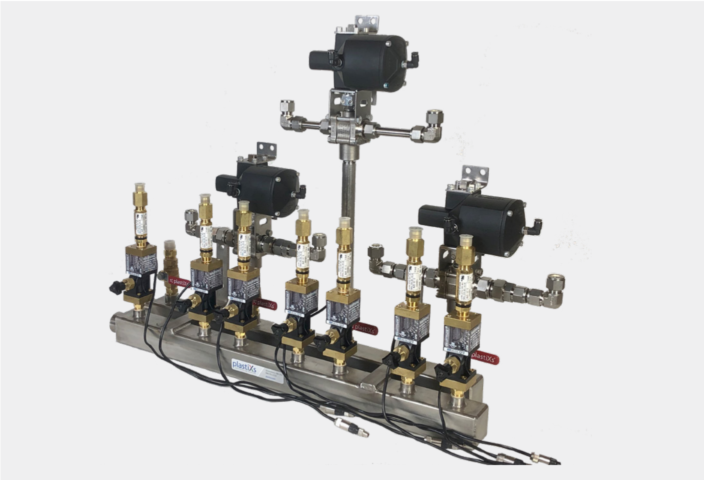
Temperature measurements between manifolds is another way to monitor the system where changes may indicate an increase in heat load (a change in the process/equipment), or a decrease in heat transfer of the circuit (scale build-up).

Manifold Layout

Port spacing is defined as the center-to-center distance between ports. This dimension must be considered when thinking about the final assembly of the manifold. Will the manifold accessories fit next to each other? Can they be threaded on or will they interfere with the adjacent port? Stock manifolds have typical port spacing of 1-1/2", 2", and 3" for port sizes of 1/4", 1/2" and 3/4" respectively but can be customized for your particular application.

How will the hoses be routed to the manifold? Where will the manifold be located on the machine? The manifold layout can address these issues by locating ports where they are needed and providing mounting points that easily integrate into the machine.

How accessible will the manifolds be? Will operators be able to reach valves or view the flow meters easily? If not, consider linking the valves so they operate together and using an electronic flow meter with a display that can be moved to a remote location.



Supply and return manifolds, featuring flow sensing and regulation on return side and 3-way electronic valves on the supply side

Putting It All Together

Now that you've considered the various factors impacting your design, you're ready to source parts and schedule the assembly.

What are the lead times on parts needed and do they fit within your project schedule? If not, are there functionally equivalent parts that have shorter delivery times or is a re-design required?

Incorporating a knowledge of part availability into your initial design can help avoid the need for last-minute re-designs.

Managing your company's resources and tooling should also be considered once the design is finalized. With maintenance and technical staff stretched thin you'll need to make sure your project is scheduled within their workload. It's also a good idea to review the tools and sealants available. Typical plumbing tools are usually needed for manifold assembly. However, sometimes a specialized wrench for large and odd fittings are needed. Work holding devices are also required to support the manifold during assembly.

Sealants should be evaluated for compatibility with materials being sealed and the fluid they are transporting. A high-quality anaerobic thread sealer is typically recommended for metal components but is not the best choice for plastic manifolds. Thread sealing PTFE tape has its uses but is not suitable for systems in a high radiation environment. These are just a few situations where sealant selection can be critical for the performance of the system.

Before final assembly, a dry fit-up of the parts (without sealant) should be conducted to determine if a particular sequence is required. This will eliminate any potential issues with interference from one part to another during assembly. Afterward, parts should be cleaned and degreased prior to assembly. Materials may need an application of a primer for some sealants to properly cure.

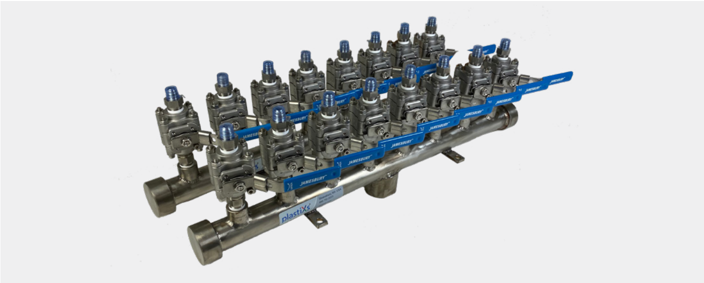
Once your manifold is assembled, a system pressure test should be conducted. Typically, the manifold is filled with water and tested to pressures ranging from 50 to 250 PSI. This type of hydrostatic testing ensures the assembly is leak-free prior to installation and can prevent damage to your finished equipment.

Outsourcing Manifold Layout & Assembly

With all the things to consider in manifold design, layout and assembly, it often makes sense to outsource these efforts to an experienced and reliable partner. During the early stages of your project, the addition of outside expertise in manifold design, layout and assembly techniques can help you avoid costly and time-consuming errors. A trusted partner will guide you through the process of determining your needs and establishing the correct design parameters, such as:

- Inlet and outlet sizes
- Temperature and pressure specifications
- Material selection
- Sensor requirements
- Connections based on flow and hardware required
- System fluid compatibility

A partner can ensure the assembly fits within the equipment using CAD models of concepts and layout drawings. These models can be incorporated directly into your equipment design for quick evaluation.



Center Port Manifolds for high temperature applications, rated for water to 450F at 350 PSI

Once the design is finalized, outsourcing the assembly can free up valuable resources within your company. With a focus on assembly, your partner will have the experience, tools and techniques to ensure a leak-free solution. They can conduct hydrostatic leak tests and system functionality tests to confirm a ready-to-install manifold.

Consider Plastixs as Your Custom Manifold Outsourcing Partner

With decades of design, fabrication and assembly experience, Plastixs partners with industrial OEMs and plastic processors to provide turnkey manifold solutions that ensure optimal cooling and fast time-to-market, including:

- Pressure and flow consultation during equipment design
- Material and component selection
- Parts sourcing
- Fabrication and assembly
- Prototyping and testing
- Shipping

With competitive pricing, expert technical assistance, and productivity-enhancing solutions, we take pride in contributing to the success of our clients.

Contact us to learn more about custom manifold assemblies.

About Plastixs

Plastics processors, original equipment manufacturers, and many other manufacturers rely on Plastixs to keep their machines running smoothly, increase productivity, eliminate downtime, and prevent small issues from becoming big problems – especially with injection molding, process cooling, and material handling.

Let the Plastixs product experts identify and deliver the right components, accessories and supplies that tie your systems together, including custom water manifold assemblies, high temperature hose assemblies, and leading products from Airtect, Slide, Smartflow, Tigerflex, Kuri Tec, Norres, Morris Coupling, and many others. More: www.plastixs.com

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