Introduction

At the nexus of these demands for testing productivity and instrument reliability lie the fluid handling systems that facilitate diverse testing, buffering, washing, and waste removal. Connectors are a critical component in a fluid handling systems, and using the ideal connectors and other system components can increase ease of use, minimize operator error, and increase testing safety — all important factors in the drive toward higher productivity and reliability.
Following are 10 tips for applying advanced connector features and technologies to help device manufacturers design world-class fluid handling systems for diagnostic instruments.

Credit: Tyler Grubb, Design Engineer, Medical Business Unit, Colder Product Company
http://www.mdtmag.com/article/2015/10/10-tips-connect-fluid-handling-ivd-technology

1. Ensure Material and Media Compatibility

Material compatibility between connectors or other fluid handling components and the fluids used in the test setting is often overlooked, and a mismatch can be the root cause of costly maintenance due to leaks, contamination, or corrosion. In IVD applications, consider any cleaning solutions or other chemicals (e.g., bleach, hydrogen peroxide, or isopropyl alcohol) that may be flushed through the fluid lines or wiped on the exterior. Some high-end applications involving stronger acids or solvents may require components to be made of engineered polymers such as PEEK or PVDF to maintain compatibility..

2. Specify Non-Spill/Dry Break Valved Connections

Connectors with integral valves create a cleaner and safer connection, eliminating the need for clamps or secondary shutoff valves and enhancing the overall perception of the instrument. Valved connectors prevent spills upon disconnection and also prevent the entry of air into the system. There are many styles of valves with varying flow rates and pressure drops

3. Track Reagent Batches at the Point of Use

Connectors with radio frequency identification (RFID) capabilities help facilitate safe and efficient fluid connections while avoiding harmful and expensive mistakes, reducing liability and improving process management. Intelligent RFID-enabled coupling applications include real-time reagent inventory monitoring, batch identification, brand and product protection, and expiration date tracking.
These types of couplings are currently being used with clinical diagnostic lab equipment. Thanks to the RFID-enabled connection, labs can track the amounts of reagents used on each piece of equipment to confirm appropriate inventory levels and ensure the availability of sufficient reagent to complete the testing cycle. In addition, the couplings confirm that the right reagent is being used with the diagnostic equipment, which eliminates errors and mitigates equipment downtime due to the use of “off brand” consumable products..

4. Connect Multiple Fluid Lines at Once

Consolidating multiple fluid lines into a single connection can greatly improve serviceability and prevent misconnections. Lines can include dissimilar fluids or gases and use either pressure or vacuum to drive fluid through an instrument. Multi-line connections on waste containers are particularly valuable in providing the necessary supply, empty, and vacuum lines all in a single interface. New technology even allows electrical lines to be integrated into a hybrid connection point where fluids and data can be hooked up in a single quick operation..

5. Use Disposable Packaging

Although reagents are typically provided in disposable packaging with easy access ports, it often makes sense to implement a similar packaging strategy on bulk fluid or waste containers as well. Using bag-in-box style packaging to store bulk reagents and wash or buffer solutions eliminates inaccessible fluid below a dip-tube and allows for nearly 100% fluid utilization. It can also mean eliminating expensive, reusable caps or port fittings in exchange for cost-effective puncture seal connectors that streamline interchanges..

6. Implement Gravity Fed Plumbing w/Shutoff Valves

Why specify expensive and complex pumps onto the instrument when gravity can feed on-board fluidics? Using couplings with shutoff valves eliminates the risk of spilling fluids during inverted installation and ensures 100% evacuation of fluids from the bottle or reservoir. In this setup, non-spill valves also minimize air inclusion (the volume of air introduced into the system each time the coupler is connected). Venting to the bottle can easily be accomplished with a similar dip-tube as right-side up bottle systems..

7. Color Code/Physically Key Multiple Fluid Lines

Another critical variable that plays into human factors engineering is the potential for misconnecting dissimilar fluid lines. This can be a costly mistake that leads to extensive washing and flushing of supply lines if a biohazardous waste line is inadvertently connected to a reagent line heading to test vessels. Using color-coded or physically keyed connectors to prevent connection errors is especially critical on fluid lines in large automated immunoassay instruments where multiple reagent supply lines are co-located with rinse and waste lines..

8. Don’t Let Particulates Clog Your System

Along with the obvious concern over invalidating a test due to foreign particulate, fluid systems also rely on clean flow paths. Pumps, filters, valves, and microbore tubing are at risk of becoming clogged by particulate that can originate from fluid system components. It is important to review the quality standards of fluid-handling component suppliers and to ensure that machining burrs or other foreign particulates will not contaminate fluid lines and wreak havoc on instrument components downstream..

9. Cost Effective Level Sensing for Bulk Fluids

Detecting fluid levels in bulk solutions and waste containers is essential to avoid instrument downtime and extra operator maintenance time. Float switches provide cost-effective, single-point detection when a bottle is full/empty or can be used in a modular design to detect multiple critical points in a bottle. Alternatively, many systems use load cells or conductive probes that provide continuous level detection and more precise measurements. For applications that require level sensing capabilities but involve particularly caustic media or are sensitive to microbial contamination, products like capacitance and optical sensors can provide non-contact level sensing. These products can be particularly valuable when handling fluids with a tendency to produce salt build up or bottles that are extra vulnerable to damage from a user..

10. Seek Help from Supplier Experts

Have a fluid handling question? Ask the experts at fluid handling component companies for advice on common issues, improving fluidics designs, or customizing standard products for unique applications. Suppliers usually employ design engineers and application specialists who can answer questions and help design seamless fluid handling solutions for specific instrument needs.