# Electrically Actuated Valves for Flow Chemistry

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This project focuses on modifying commercially available valves from IDEX Corporation for electrical actuation. The modification enables fast, precise control of fluidic pathways without the delays typically caused by manual operation of valves. The valve model modified in this project is the V-101D from IDEX, but the same approach can be applied to other models with similar casings (e.g., V-101L, V-101T).

An approximate 3D model of the valve was first created and then used as a template for designing a custom holder that accommodates both the valve and the servo mechanism (figure 1).

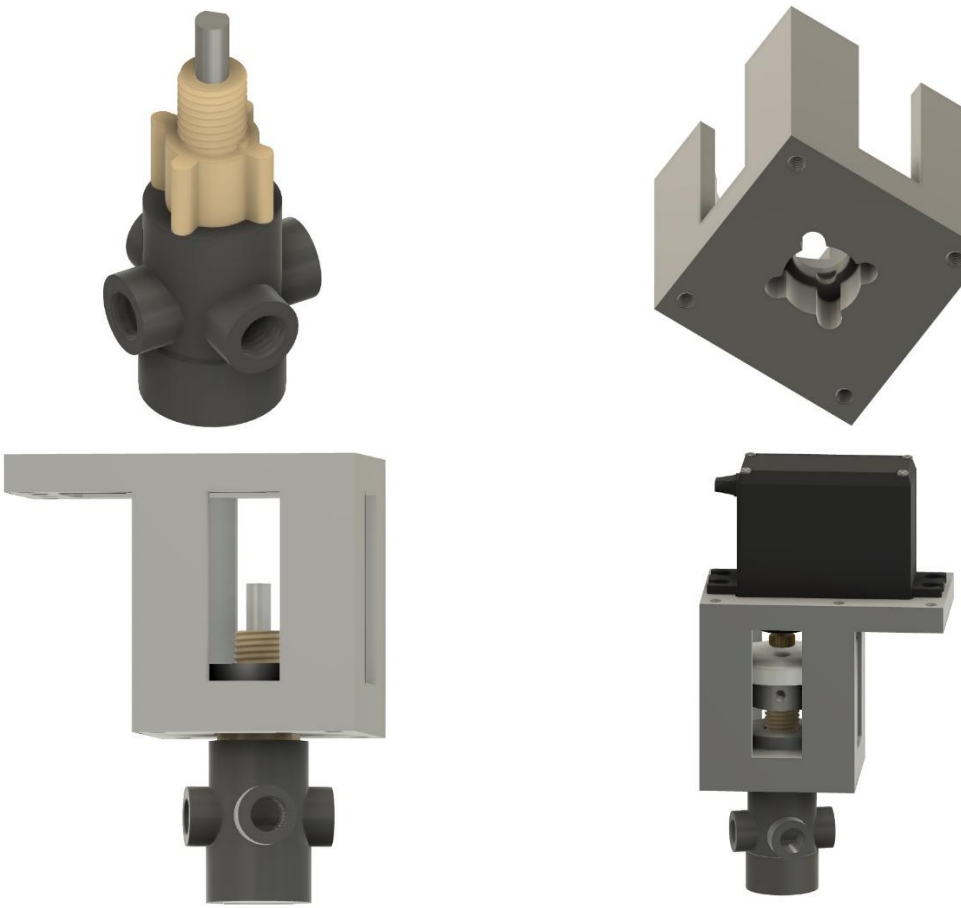

*Figure 1. Top left: Created 3D model of the IDEX valve, used to as a reference for designing its holder. Top right: Valve holder, specifically shaped to provide a secure grip on the valve body. Bottom left: Valve model positioned in the holder, along with the servo-holding frame. Bottom right: Overview of the assembly, showing the servo and a rotation coupler (plastic servo coupler plate not shown).*

List of parts:

| **Name** | **Part no.** | **Vendor** |
|---|---|---|
| 4-Way Valve PEEK Bulkhead Diagonal Flow | V-101D | IDEX Corporation |
| 4mm Aluminum Mounting Hub for 60mm Mecanum Wheel | RB-Nex-79 | RobotShop Inc. |

| | | |
|---|---|---|
| EzRobot Heavy Duty Servo | RB-Ezr-17 | RobotShop Inc. |
| 3D-printed elements (PLA) | | Self-made |

**Detailed description**

The servo used in this project provides 180° of rotation. If necessary, servos with 270° rotation can be used, especially for accessing all positions of an "L"-type 4-way valves.

During assembly, the IDEX valve knob must be removed by loosening the Allen screw (the valve comes with the appropriate Allen wrench). As you remove the knob, record the valve's position according to the axle's orientation to ensure correct alignment when attaching the servo coupler. The nut and spring washer on the threaded section below the axle also need to be removed. Once disassembled, the IDEX valve can be secured to the 3D-printed holder using the same spring washer and nut.

Due to the small diameter and relatively high torque requirements, a metal coupler for the valve axle was chosen instead of a 3D-printed one (although harder 3D-printing materials than PLA may suffice). A commercially available coupler (RB-Nex-79, "4mm Aluminum Mounting Hub for 60mm Mecanum Wheel" from RobotShop Inc.) was modified by shortening the section that holds the valve axle (the smaller diameter cylindrical part, see figure 2). The required length should be checked in advance by assembling the 3D-printed holder with installed valve, and the servo with the servo-holding 3D-printed frame to ensure proper spacing for the servo installation (with the plastic servo shaft coupler temporarily in place).

The aluminum coupler was shortened using a hand metal-cutting saw while secured in a bench vise. To mark the locations for additional holes, the plastic element that couples to the servo axle should be used as a template. Align the plastic element with the aluminum part (from the wider plate side) by inserting a round object, such as a drill bit, through the axis of both components. After marking the correct positions, two additional holes were drilled using a 2.5 mm drill bit and tapped for M3 threads in the round plate, enabling the attachment of the plastic servo coupler. A counterbore was drilled from the flat plate side to accommodate the screw holding the plastic servo coupler to the servo's axle. The counterbore depth should be around 3 mm and can be made using a 6-8 mm drill bit. After cutting and drilling, a hand file and sandpaper can be used to smooth the edges.

Once all parts are prepared, the alignment of the valve and servo shaft must be done. First, position the servo in one of its extreme positions to allow full range of valve shaft motion. To do this, connect the servo to a 6 V DC power supply (refer to the servo documentation for maximum ratings) and send the appropriate signal to the servo, for example from a microcontroller like Arduino. The impulse length may need to be adjusted experimentally, as different servos can require varying impulse lengths. In this project, a pulse of approximately 500 µs (0.5 ms) positioned the servo in one of its extreme positions.

Next, install the modified metal coupler onto the servo motor's axle, using a plastic coupler (either the round plate or cross type of servo arm) that comes with the servo motor. After placing the plastic element, secure it to the servo shaft with a small screw which comes with the servo. If the plastic element's outer diameter is larger than the wide part of the metal coupler, trim it to ensure free rotation within the 3D-printed valve holder. Then secure the metal coupler to the valve shaft using the M3 tightening screw which came with the metal coupler. See figures 3 and 4 for the assembly.

An example of three valves modified as described, applied in Furfural Nitration Platform project realised at CiTOS (ULiege) is presented in figure 5.

*Figure 2. Modification of the RB-Nex-79 metal coupler (4 mm internal diameter with an M3 tightening screw). The photos show the original part (left) and the modified part (right). The height was reduced by approximately 5 mm, taking care to not cut through the threaded bore for the tightening screw. Two additional holes were drilled using a 2.5 mm drill bit and tapped with M3 threads in the round plate, allowing attachment to the plastic servo coupler.*

*Figure 3. The modified aluminum coupler installed on the servo axle using the plastic coupler (trimmed) provided with the servo mechanism. Two M3 screws were used to secure the assembly, utilizing the previously-tapped holes in the metal coupler. The bores in the plastic servo coupler were slightly enlarged with a drill to accommodate the M3 screws.*

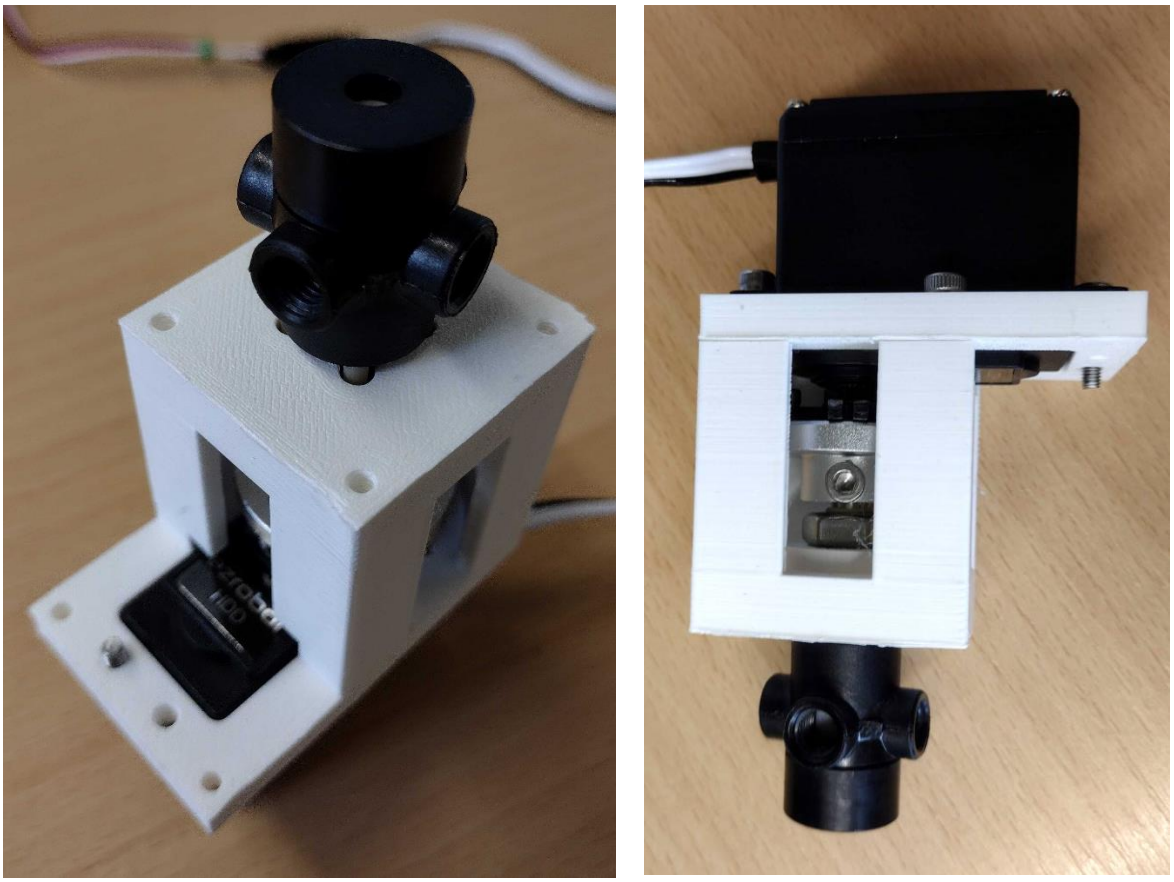

*Figure 4. Photographs of the assembled automated valve. Additional threaded holes in the 3D-printed holder can be used for installation of the valve assembly in a designated location.*

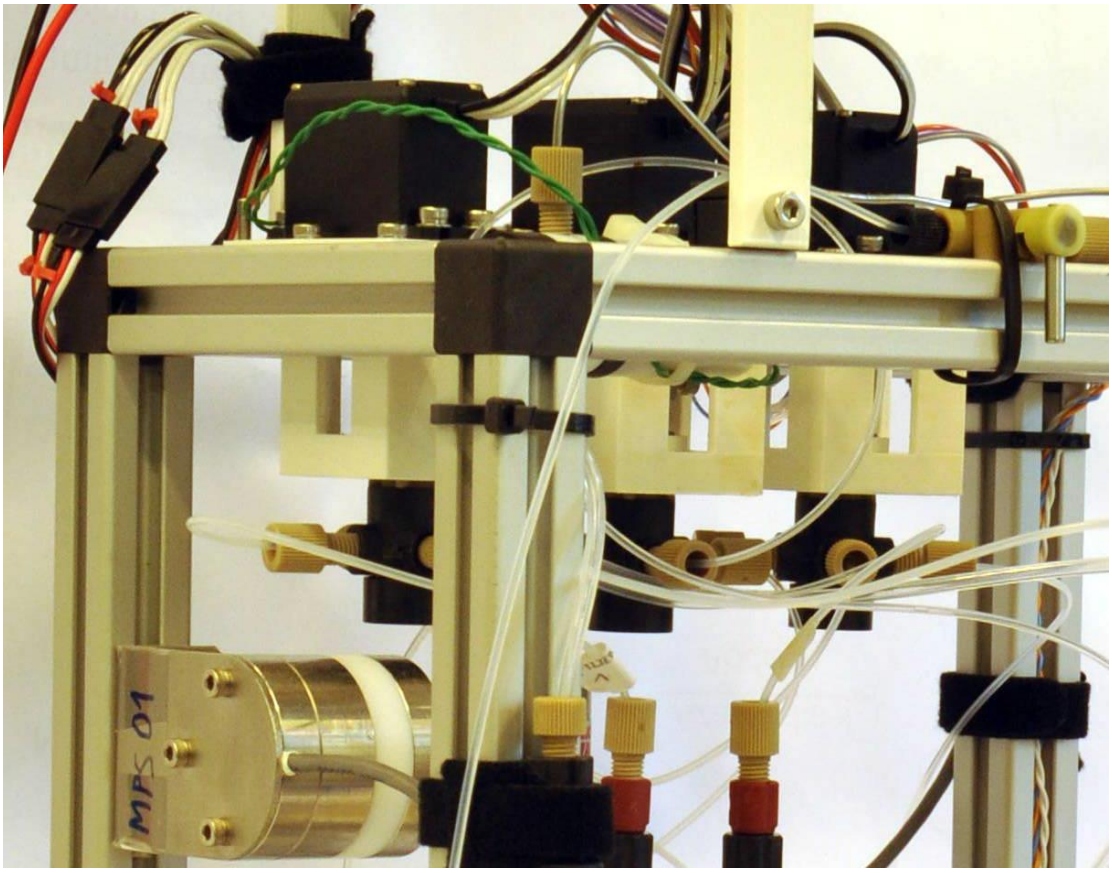


*Figure 5. An example of three of described herein valves used in a Furfural Nitration Platform project realised at CiTOS (ULiege).*

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