



MISSOURI  
**S&T**

# CENTER FOR TRANSPORTATION INFRASTRUCTURE AND SAFETY

## **Acquisition of Equipment for Composite Manufacturing Laboratory**

by

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**NUTC  
RE252**

**A National University Transportation Center  
at Missouri University of Science and Technology**

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16. Abstract An interdisciplinary team of faculty was formed to upgrade the Composite Manufacturing and Testing Facilities at Missouri S&T. The Metering Unit is useful to manufacture composite pultruded parts using two part polyurethane resin system. Prior to the equipment acquisition, the pultrusion manufacturing facility was restricted to epoxy, polyester and vinyl ester resin systems. The Metering Unit enables us to manufacture composite parts using polyurethane resin system. Composite test fixtures are required to conduct specialized tests like Compression after Impact, Open Hole Compression and Interlaminar Shear.			
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**MISSOURI S&T – NATIONAL UNIVERSITY TRANSPORTATION CENTER**  
**ADVANCED MATERIALS AND NON-DESTRUCTIVE TESTING TECHNOLOGIES**

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**Project Title:** Acquisition of Equipment for Composite Manufacturing Laboratory

**Matching Research Agency:** Missouri University of Science and Technology

**Principal Investigator:** K. Chandrashekhara, Curators' Professor, Department of Mechanical and Aerospace Engineering

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**Project Summary:**

Polyurethane (PU) resin system offers several advantages compared to traditional resin systems (polyester and vinyl ester) due to superior damage resistance and higher interlaminar shear strength. The current pultrusion manufacturing facility at Missouri S&T is restricted to epoxy, polyester and vinyl ester resin systems and the pultrusion of PU resin system requires the use of metering unit. Missouri S&T has acquired a customized metering unit from Magnum Venus Plastech. The metering unit has been integrated with the pultrusion machine using a injection box. Pultruded PU samples have been successfully manufactured using this modified setup. This facility is located in the Pine Street building.

**Description of Metering Unit:**

The metering unit is shown in Figure 1. The system consists of a hydraulic motor to operate the metering cylinders. This hydraulic system enables an extremely consistent quantity of raw materials even at low flow rates not possible with a pneumatic drive system. Cylinders can displace 29.35 cc for each stroke and have the maximum capacity of 1790 cc/min at 1:1 ratio of the raw materials. Both fluid sections are adjustable for ratio variations, though typical applications only require a 1:1 ratio. The control panel includes a single turn potentiometer to control the speed of the metering system, and an LCD rate indicator for speed reference. Two thermoplastic 5 gallon, gravity feed containers with angle base bottoms are used as raw material containers. Both tanks are sealed to minimize exposure to humid atmosphere and liquid nitrogen is pumped into the isocyanate container to avoid crystallization of isocyanate. Polyol component is mixed rigorously to maintain homogeneity. Each container feed-line includes filter housings with 30-mesh screens.

An automatic 1:1 gun is used for mixing of the polyol and isocyanate materials using a pneumatic actuator for open/close position. Both the raw materials only come into contact at the static mixer. The mixhead controls the on-off flow of

resin, combining the polyol and isocyanate streams to begin the mixing process. Check valves are incorporated at the entrance to the mixhead to prevent any back-flow into the hoses. A 3-gallon solvent tank with air purge selector valve makes the cleanup or system shut-down an easy process. Pressure regulators are installed to control air pressure in the solvent tank. The flush solvent is introduced into the mixhead through a three-way ball valve near the gun.



**Figure 1.** Metering unit setup for pultrusion process

**Anticipated Benefits:**

The metering unit can be used to manufacture various composite parts using pultrusion process. Faculty and students of Mechanical and Aerospace Engineering, Civil, Architectural and Environmental Engineering, and Chemistry will be able to use this equipment. The equipment will also be available for NUTC projects and other research projects at Missouri S & T.