

Vibration Attenuation Characteristics of Victaulic Couplings

The prevention of the transmission of objectionable vibration induced by piping systems to the building structure, has become increasingly crucial as vibration induced noise is a major complaint by building occupants. The increased use of lightweight construction in modern buildings, and mechanical room locations at intermediate levels or penthouses, has increased disturbing vibrations which can be heard in other remote areas. (1)

All piping systems have vibration which is generated by equipment. In addition, some movement can be expected from pressure thrusts during operation, and even greater movement can be expected during the startup and shutdown of equipment due to the use of resilient pipe hangers and supports, and equipment mountings. The piping system must be made flexible enough to permit equipment movement, or thermal expansion/contraction without reducing the performance of vibration isolators, and to prevent damaging stresses at connections. (1)

In mechanical rooms, pumps, chillers, cooling towers, fans and boilers frequently create noise and vibration which can be difficult to contain. For example, oscillatory forces can be generated due to the lack of balance of rotating components such as from pump vanes. This can be reduced by "field balancing," however, this requires the use of specialized equipment, which generally becomes difficult, expensive and impractical. (1)

For pumps, every time the vane passes a given point, the fluid receives an impulse at that point. The repetition rate, or vane frequency contributes to the vibration, and is typically associated with the pump speed and the number of vanes on the impeller. Doubling the number of vanes, or doubling the rate at which it rotates, doubles the vane frequency. For most pumps, speeds are usually 1200, 1800, 2400 or 3600 rpm, which can yield frequencies of 20, 30, 40 or 60 Hz.

To isolate this vibration, designers frequently specify the use of the following products at pumps, chillers, fan coil units and other rotating equipment:

1. Victaulic Couplings

Victaulic flexible couplings such as the Styles 75, 77, 791 and others, provide allowances for controlled pipe movement; expansion/contraction/deflection, "absorbing" movement from thermal changes, settling or seismic action, as well as dampen noise and vibration. A resilient elastomeric gasket conforms to the internal cavity of the coupling housing and seals against the pipe. It is pressure responsive and creates a permanent leak-tight seal.

Victaulic rigid couplings, such as the Styles HP-70 and 07 Zero-Flex®, provide positive clamping of the pipe to resist flexural and torsional loads. Both of these rigid couplings utilize the same resilient elastomeric gasket as Victaulic flexible couplings, which aid in dampening noise and vibration.

2. Elastomeric Flexible "Arch Type" Connector

Arch type connectors have one or more arches (convolutions) and are commonly constructed of nylon, Dacron® or polyester and neoprene. They employ a spheroidal shape to permit deflection in all directions. Because the spheroidal shape allows pressure to exert in all directions, control units (restraining rods and plates) are required to prevent excessive stretching of the connector due to system pressure thrusts. Overextension of these connectors will cause failures.

3. Flexible Metal Hose

Metal hose connectors are constructed with a corrugated inner core and a braided cover to eliminate the need for control units. Although claims are made that the braided cover prevents axial movement, expansion does occur upon pressurization.

All three of these products have traditionally been incorporated by engineers and contractors in piping systems, with few manufacturers providing details of performance. Many manufacturers of elastomeric flexible connectors and flexible metal hoses have relied solely upon the traditional acceptance of their products, and have been unable to quantify the vibration attenuation characteristics claims of their products. Victaulic, therefore, completed a test program at an independent laboratory, which examined their various characteristics and compared them to that provided by Victaulic products.

The testing was performed by NUTECH Testing Corporation/SE Laboratories, Inc., an independent test laboratory which specializes in environmental testing and field mechanical tests. Tests routinely performed by this laboratory include vibration, mechanical shock and in-situ vibration analysis, and they have performed tests for a wide range of client products including computer peripherals, work stations, microwave components, large circulation pumps, valves and motor-generator sets.

The test program involved imparting a vertical acceleration to one end of a pipe assembly and measuring the resultant responses. A Gen Rad 2514 Vibration Control System (VCS) was used to control the shaker and impart a defined acceleration characteristic to the pipe assembly. Specifically, a Gen Rad SINE program version 1.1 was used. This program controls the acceleration (displacement) at the shaker at each frequency over a defined frequency range. The vibration is started and then the VCS sweeps over the frequency range at a programmed rate with the following key parameters and equipment:

Frequency range:	3-2000 Hz
Sweep rate:	3 octaves/minute
Reference spectrum:	0.5 inch peak-peak 3-9 Hz
	1g 9-200 Hz

Equipment	Serial Number
Gen Rad 2514 VCS	9760
PCB Acceleration	481 100mv/g
PCB Acceleration	484 100 mv/g
PCB Acceleration	9632 107.9 mv/g
PCB Acceleration	9631 106.7 mv/g
PCB Acceleration	484 94 mv/g
Dytran Acceleration	244 9.63 mv/g
Dytran Acceleration	247 9.30 mv/g
Dytran Acceleration	242 9.53 mv/g
ISI HV-33-6	
Hydraulic Shaker	1983-8

The Gen Rad 2514 is calibrated by Gen Rad and the calibration is NBS traceable. Accelerometer calibrations were performed using a standard accelerometer which was calibrated by an outside independent calibration service, in accordance with NBS standards.

From the test results, the following observations and conclusions were obtained:

For any given pipe diameter, vibration isolation increases as the number of Victaulic couplings increases (i.e., less vibration is transmitted with each additional Victaulic coupling), regardless, whether Victaulic flexible or rigid couplings are used.

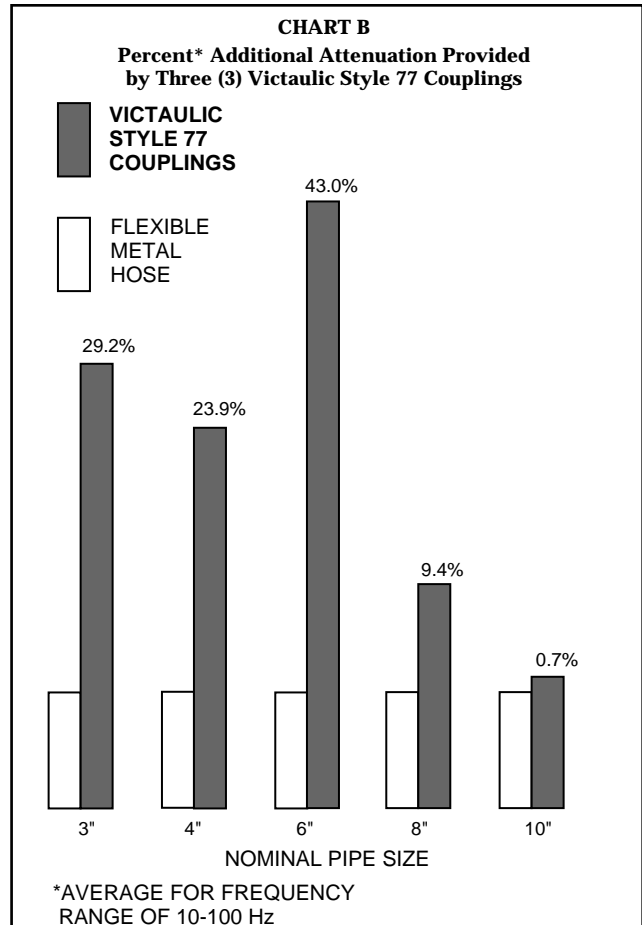
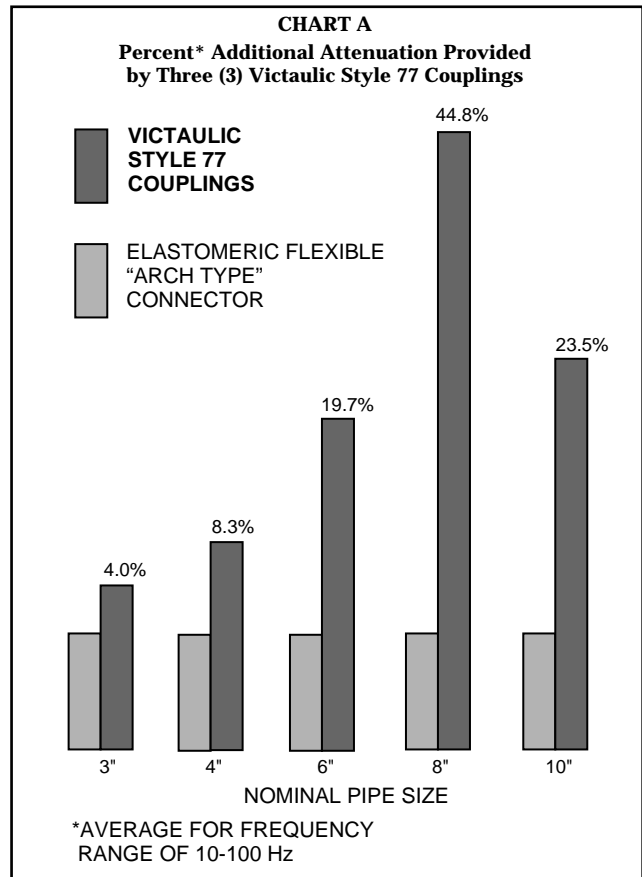
The Victaulic Style 77 three coupling arrangement exhibited the best vibration isolation/attenuation characteristics over all pipe diameters, which exceeded that of the Flexible Metal Hoses and the Elastomeric Flexible "Arch Type" Connectors. Charts A and B depict the superior attenuation characteristics of the Victaulic Products.






These test results substantiate the use of Victaulic flexible couplings for pump or equipment connections, not only because of their superior attenuation characteristics, but also because of their ability to accommodate misalignments and reduce stresses at pump or equipment connections. Where vibration is expected, three (3) Victaulic flexible couplings in close proximity to the source of vibration are recommended. The use of additional Victaulic couplings, whether of the flexible or rigid types, in the system will further reduce the transmission of vibration. The following are examples of typical assemblies utilizing the three (3) Victaulic flexible coupling arrangement.

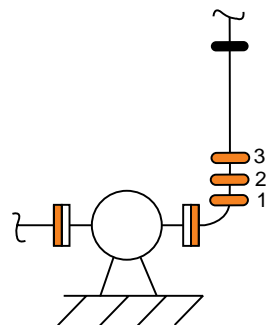
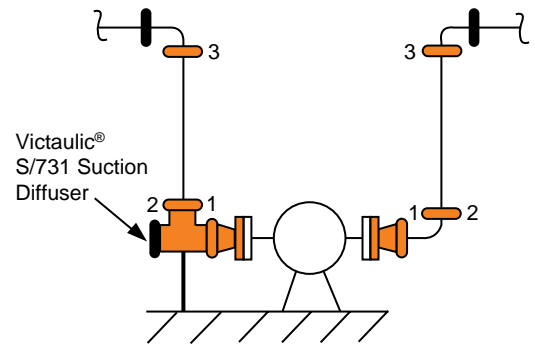
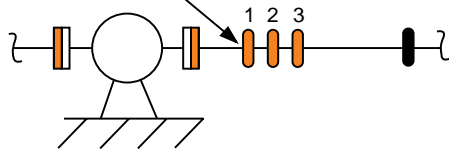
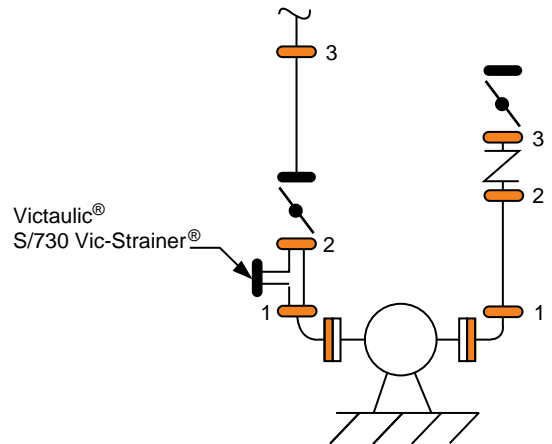
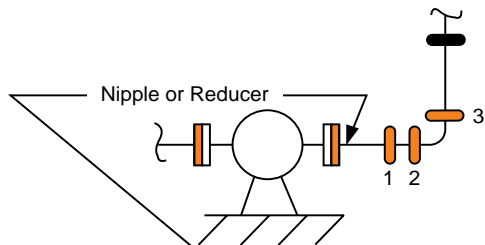
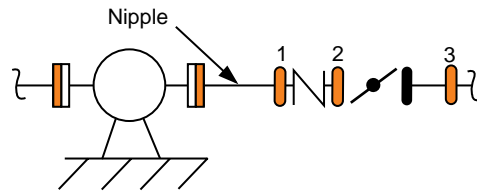
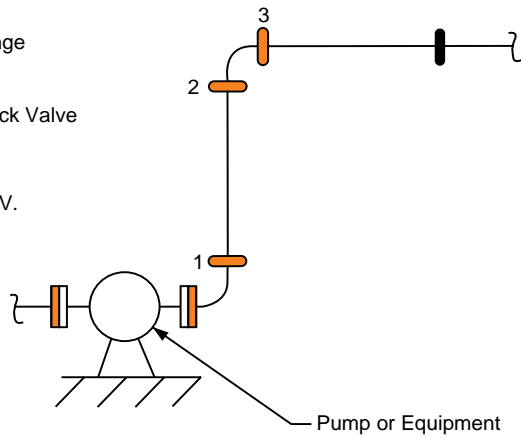
Victaulic is the originator of the Grooved Piping System, with over 70 years of experience in mechanical piping components. This experience has resulted in the technology incorporated into the proprietary design of Victaulic products. The results of the described tests performed apply only to Victaulic couplings and cannot be applied to other coupling manufacturers.

Reference:

- (1) American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. ASHRAE Handbook, 1984 Systems



-  Flexible Coupling
-  Rigid* Coupling
-  Flange
-  Check Valve
-  B.F.V.



***Note:** Flexible couplings can be substituted for rigid couplings