Static Mixer Application Notes

Selecting the Right Size Mixer Cartridge

ASI offers static mixers with volumes that range from 0.5 µL to 15 mL. Choosing the right size mixer is a trade off between delay volume, mixing noise, gradient fidelity and chromatographic performance. ***Please refer to the data "Effect of Mixer Volume on Gradient Accuracy with a Constant Flow Rate" for more information on gradient accuracy as a function of flow rate and mixing volume.***

The following observations will provide some guidelines to help choose the right size mixer.

- For any given flow rate, the more the mixing volume the better the mixing, and the lower the baseline noise.
- The smaller the mixing volume, the better the definition and sharpness of linear gradients.
- Multi-pump high pressure gradient systems typically require far less mixing volume than low pressure single pump gradient systems when running linear gradients.
- An *ASI* 150 µL in-line static mixer can be added in addition to the standard onboard mixer to further reduce mixing noise.

Multi-pump High Pressure Gradient Systems

Linear Gradients

If a larger mixing volume can be tolerated for a particular flow rate, the larger the volume will lower the mixing noise. The upper limits to mixing volume will be the maximum delay time that can be tolerated, and possible distortion (tailing) of the gradient at the beginning and end of the gradient. The lower limit will be defined by the amount of mixing noise that can be tolerated. ***Please refer to a table, Mixer Selection Guide for specific recommendations.***

Binary or Ternary – Steady State Composition

Always select the largest volume that will still provide an acceptable delay volume. In general, the more mixing volume, the better the mixing will be. For most pump systems, a 150 µL cartridge will provide adequate mixing.

Examples of this type of pump system include: Shimadzu LC-10AD and LC-10ADvp, Gilson Model 305, Agilent Model 1100, 1200, Waters Alliance, Acquity, Perkin Elmer Flexar

Single-pump Low Pressure Mixing Gradient Systems

Linear Gradients

These systems generally require more mixing volume to perform linear gradients than multi-pump high pressure systems. The following will explain why this is the case. In a low pressure system the composition can only be changed once every pump stroke. Since the pump stroke volume of most pumps is 100 µL, and it takes a mixer volume that is about 3 times the batch volume to provide adequate mixing, we need 350 µL of mixer volume, at least, to do adequate mixing. More insoluble combinations may require even more mixing volume.

In general, choose the largest size mixer cartridge that will still provide an acceptable delay volume. For most applications this will be at least 350 µL.

Binary or Ternary – Steady State Composition

Always select the largest volume that will still provide an acceptable delay time. In general, the more mixing volume, the better the mixing will be. For most applications this will be at least 350 µL.

Examples of this type of pump system include: Agilent 1100, Perkin Elmer series 200, TSP Spectra Vision®.

TFA Mixing Noise

Eliminating mixing noise from TFA requires either a dynamic mixer, or a large static mixer. In the Agilent 1100 system, we recommend using the ASI 1.00 mL dynamic mixer, Part Number: 462-1000A. An equivilent result will be obtained with the ASI 1.5 mL static mixer, Part Number: 431-1500. Consult ASI technical support for recommendations.

Mixer Cartridge Selection Guide for High Pressure Mixing

Linear Gradients - High Pressure Mixing

Larger mixing volume can be tolerated for a particular flow rate, with the larger the volume the lower the mixing noise. The upper limits to mixing volume will be the maximum delay time that can be tolerated, and possible distortion (tailing) of the gradient at the beginning and end of the gradient. The lower limit will be defined by the amount of mixing noise that can be tolerated. The following cartridge volumes are a compromise between these two limits.

Table 1.

Flow	Mixer Cartridge Volume
< 1 µL/min.	0.5 µL
0.5 µL/min. - 2 µL/min.	1 µL
1 µL/min. - 5 µL/min.	2 µL
2 µL/min. - 10 µL/min.	5 µL
5 µL/min. - 20 µL/min.	10 µL
10 µL/min. - 50 µL/min.	25 µL
20 µL/min. - 100 µL/min.	50 µL
100 µL/min. - 250 µL/min.	150 µL
200 µL/min. - 500 µL/min.	250 µL
500 µL/min. - 2 mL/min.	350 µL
1 mL/min. - 5 mL/min.	500 µL
2 mL/min. - 10 mL/min.	800 µL
5 mL/min. - 20 mL/min.	1.0 mL
10 mL/min. - 30 mL/min.	1.5 mL
20 mL/min. - 50 mL/min.	3.0 mL
30 mL/min. - 80 mL/min.	6.0 mL
50 mL/min. - 100 mL/min.	9.0 mL
80 mL/min. - 1 L/min.	15 mL