

tion lines with calibration compounds and allows the selective and rapid turning on and off of calibration solution flow. The use of multiple solution inlet probes in APCI sources can also be used to introduce mixtures of chemical components in the gas phase to investigate atmospheric pressure gas phase interactions and reactions of different samples and solvents without prior mixing in solution.

[0070] One embodiment of the invention is an APCI source, interfaced to a mass analyzer, configured with two sample inlet nebulizers assemblies shown in FIG. 9. APCI source 210 is configured with a heater or vaporizer 211, corona discharge needle 212, a first APCI inlet probe assembly 213, a second APCI inlet probe assembly 214, cylindrical lens 215, nosepiece 216 attached to endplate 217, counter current gas heater 218 and capillary 220. Solution introduced through connecting tube 221 into APCI inlet probe assembly 213 is sprayed with pneumatic nebulization from APCI inlet probe tip 222. Nebulization gas is supplied to APCI nebulizer probes 213 and 214 through gas delivery tubes 227 and 228 respectively. APCI inlet probe assembly 213 is configured to spray parallel ($\theta_{213}=0^\circ$) with the APCI source centerline 223 into cavity 224. The sprayed liquid droplets traverse cavity 224, flow around droplet separator ball 225 and into vaporizer 211. The sprayed liquid droplets evaporate in vaporizer 211 forming a vapor prior to entering corona discharge region 226. Corona discharge region 226 surrounds corona discharge needle tip 234. Additional makeup gas flow may be added independently into region 224 or through APCI inlet probe assemblies 213 or 214 to aid in transporting the droplets and resulting vapor through the APCI source assembly 210. An electric field is formed in APCI source 230 by applying electrical potentials to cylindrical lens 215, corona, discharge needle 212, endplate 217 with attached nosepiece 216 and capillary entrance electrode 231. The applied electrical potentials, heated counter current gas flow 232 and the total gas flow through vaporizer 211 are set to establish a stable corona discharge in region 226 around and/or downstream of corona needle tip 234. The ions produced in corona discharge region 226 by atmospheric pressure chemical ionization are driven by the electric field against counter current bath gas 232 towards capillary orifice 233. A portion of the ions produced are swept into vacuum through capillary orifice 235 where they are mass analyzed. In the embodiment shown, cavity 224 is configured with a droplet separator ball 225. Separator ball 225 removes larger droplets from the sprays produced by the nebulizer inlet probes preventing large droplets from entering vaporizer 211. Separator ball 225 is installed when higher liquid flow rates are introduced typically ranging from 200 to 2,000 microliters per minute. Separator ball 225 can be removed when lower solution flow rates are sprayed to improve sensitivity. A second APCI inlet probe assembly 214 is configured to spray at an angle of 45 ($\theta_{214}=45^\circ$) relative to APCI source centerline 223 into cavity 224 as shown in FIG. 9. Solution flow delivered to both APCI inlet probes 213 and 214 through liquid delivery lines 221 and 236 respectively can be controlled so that both APCI inlet probes can spray solution simultaneously or separately into cavity 224. Nebulizer spray performance for APCI probes 213 and 214 can be optimized by adjusting solution delivery tube exit position with adjusting screws 237 and 238 and locking nuts 239 and 240 respectively.

[0071] Different liquid flow rates and different solution types can be simultaneously or separately sprayed through

APCI inlet probes 213 and 214. For example, the output of a liquid chromatography separation system can be sprayed through APCI inlet probe 213 at a flow rate of 1 mL/min, while simultaneously a calibration sample solution is sprayed from APCI inlet probe 214 at a flow rate of 10 μ L/min delivered through connecting tube 236. The sprayed droplet mixture forms a vapor mixture as it passes through vaporizer 211. A mixture of ions is formed from the vapor mixture as it passes through corona discharge region 226. A portion of the mixture of ions produced is swept into vacuum along with neutral gas molecules through capillary orifice 235 and the ions are mass to charge analyzed by a mass spectrometer. The acquired mass spectrum contains peaks of ions from the calibration sample which can be used as an internal standard to improve mass measurement accuracy and quantitation of the unknown sample peaks in the acquired mass spectrum. Alternatively, the second APCI inlet probe 214 can be used to introduce a sample solution that will create a desired solvent or ion mixture which will interact favorably in vaporizer 211 or corona discharge region 226 with the sample vapor resulting from the solution sprayed from APCI inlet probe 213. It may not be desirable to mix the second solution with the sample solution prior to spraying. Spraying different solutions from multiple APCI probes can improve the APCI signal for an unknown sample or interactions of gas phase mixtures of neutral molecules or ions can be studied with atmospheric pressure chemical ionization. To avoid mixing vaporized samples molecules or ions in the gas phase, APCI probes 213 and 214 can spray solutions in a sequential manner. For example, a calibration solution flow delivered to APCI inlet probe 214 can be turned off while a mass spectrum is acquired from a sample solution delivered to the APCI source through APCI inlet probe 213. The calibration solution flow delivered through connecting tube 236 to APCI probe 214 is then turned on to acquire an external standard calibration mass spectrum while the sample solution flow is turned off. Calibration mass spectrum can be acquired sequentially and/or simultaneously with the mass spectrum acquired for an unknown sample by turning on and off the appropriate solution flows during APCI source operation. Introducing calibration solution through a separate APCI inlet probe avoids contaminating the sample solution inlet line and probe in analytical applications requiring APCI. The mass spectra of the known and unknown samples can be added together in the data system to create a pseudo internal standard. Alternatively, sequentially acquiring mass spectra with and without an internal standard allows a direct comparison between the acquired sample mass spectra to check for any undesired effect that the calibration solution may cause to the acquired sample ion population.

[0072] An example of the APCI-MS operation of a dual probe APCI source as configured in FIG. 9 is shown in FIG. 10. Mass spectra 250, 252 and 255 shown in FIG. 10 were acquired with dual probe APCI source interfaced to a quadrupole mass analyzer. Mass spectrum 250 of a sample solution was acquired while infusing 2 pmole/ μ L of leucine enkephalin in a 1:1 solution of methanol:water with 0.1% acetic acid at a flow rate of 100 μ L/min. The leucine enkephalin solution was delivered from a syringe pump through liquid delivery line 221 to APCI inlet probe nebulizer 222 during APCI operation. No liquid flow or nebulizer gas was delivered to APCI probe 214 during the acquisition of mass spectrum 250. Mass spectrum 250 contains protonated