Analyzing Samples As Per USP 23 Using Shimadzu TOC-5000A

Introduction:

The United States Pharmacopoeia has established guidelines for determining system suitability for the analysis of purified water and water for injection (USP Revision 23). This guideline also provides a means to qualify unknown samples as passing or failing.

The qualification for passing the system suitability test is to obtain results for the control standard minus the reagent water that are within ± 15% of the sucrose minus the reagent water as shown in equation 1.

$$\%R = [(r_{ss}-r_w) / (r_s- r_w)] * 100 \qquad \textbf{(equation 1)}$$

Table 1	
r_{ss}	1,4 Benzoquinone (area counts)
r_s	Sucrose (area counts)
r_w	Reagent Water (area counts)
%R	Percent Recovery (%)

Samples are acceptable for Purified Water (PW) or Water For Injection (WFI) if equation 2 is true.

$$\textbf{(Sample Area Counts)} \pounds (r_s - r_w) \qquad \textbf{(equation 2)}$$

Procedure:

Standard Prep

Sucrose and 1,4-Benzoquinone were obtained from USP. Both arrived in vials approximately 15 mL in size. The sucrose vial contained 100 mg and the benzoquinone vial contained 200 mg. The sucrose mother solution was prepared by quantitatively transferring the entire contents of the vial into 200 mL of DI water in a 250 mL volumetric flask. The solution was then brought to volume with DI water to give a concentration of 400 ppm:

$$\textbf{100 mg / .250 L = 400 mg/L = 400 ppm} \qquad \textbf{(equation 3)}$$

From this 400 ppm sucrose solution, the concentration of carbon was calculated to be 168.4 ppm using the formula $C_{12}H_{22}O_{11}$ as shown in Table 2 and equation 4.

Table 2			
Element	Molar Mass (g/mol)	# of Atoms in Sucrose	Sucrose Formula Mass (g/mol)
Carbon	12.01	12	144.1
Hydrogen	1.008	22	22.18
Oxygen	16.00	11	176.0
		Total	342.3

400 ppm sucrose *[(144.1 Carbon) / (342.3 sucrose)] = 168.4 ppm carbon (equation 4)

The formula $C_1V_1 = C_2V_2$ was used to calculate how much of the 168.4 ppm carbon was needed to prepare 100 mL of 500 ppb (0.500 ppm) carbon:

$168.4ppm * V_1 = 0.500\ ppm * 100\ mL$ (equation 5)
$V_1 = 0.2969\ mL = 296.9\ mL$

The benzoquinone mother solution was prepared by dissolving the entire contents of the vial obtained from USP as was done with the sucrose. The concentration of the benzoquinone in the mother solution was found to be 800 ppm as in equation 6.

200 mg / .250 L = 800 mg/L = 800 ppm (equation 6)

From this 800 ppm benzoquinone (1,4BQ) solution, the concentration of carbon was calculated to be 533.3 ppm using the formula $C_6H_4O_2$ as shown in Table 3 and equation 7.

Table 3			
Element	Molar Mass (g/mol)	# of Atoms in 1,4BQ	1,4BQ Formula Mass (g/mol)
Carbon	12.01	6	72.06
Hydrogen	1.008	4	4.032
Oxygen	16.00	2	32.00
		Total	108.1

800 ppm 1,4BQ *[(72.06 Carbon) / (108.1 1,4BQ)] = 533.3 ppm carbon (equation 7)

The formula $C_1V_1 = C_2V_2$ was used to calculate how much of the 533.3 ppm carbon was needed to prepare 100 mL of 500 ppb (0.500 ppm) carbon:

$533.3ppm * V_1 = 0.500\ ppm * 100\ mL$ (equation 8)
$V_1 = 0.09376\ mL = 93.76\ mL$

Standard Analysis

The standards where analyzed on the Shimadzu TOC-5000A. The instrument was setup as shown in Table 4.

Table 4	
Analysis	NPOC
Injection volume	1066 µL
Sparge time	3 minutes
Sparge gas flow	150 mL / min
Acid added	100 µL
Concentration of acid	2 N
Injections	3
Max injections	5
Carrier gas flow	150 mL / min
Furnace temp	680 °C
Range	1
Catalyst	High Sensitivity

Standard Results

Table 5	
Standard	Mean Area Counts
r_w	2630
r_s	42864
r_{ss}	43492

System Suitability

$$\%R = [(r_{ss}-r_w) / (r_s- r_w)] * 100 \qquad \textbf{(equation 1)}$$

$$\%R = [(43492 - 2630) / (42864 - 2630)] * 100 \qquad \textbf{(equation 9)}$$

%R = 101.6%

Conclusion

According to the requirements suggested by USP, the Shimadzu TOC-5000A is suitable for the analysis of purified water and water for injection.