



Mercury Extraction with LIX26 and LIX84 Ionic Exchangers in n-Heptane



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Project Objective:

The goal of the project is to study the capacity of two commercially available ionic exchangers (LIX26, LIX84) to remove Hg (II) from surface water, by performing a series of batch experiments that will enable the determination of the maximum binding capacity of each surfactant, the efficiency of the ionic exchangers at a given concentration of Hg and the fixed percentage (by volume) of the surfactant. Likewise, the change in total organic carbon (TOC) in the aqueous layer due to the use of surfactants, as well as the time dependence of the surfactants' efficiency, are of interest.

Background

The streams of the EFPC watershed must comply with TN State's criteria for recreational use of surface waters, which requires a mercury concentration lower than 51 parts per trillion (ppt). Ten years (7/1/1997 to 10/29/2007) of mercury concentration data collected at Station 17 (EFK 23.4 according to DOE's classification, see Figure 1a) shows average discharge rates of 14 cfs and average mercury concentrations of 500 ppt with peaks up to 17,300 ppt, which considerably exceeds the requirement of < 51 ppt (Figure 1b). Therefore, 90% reduction of mercury is required to comply with the state law.

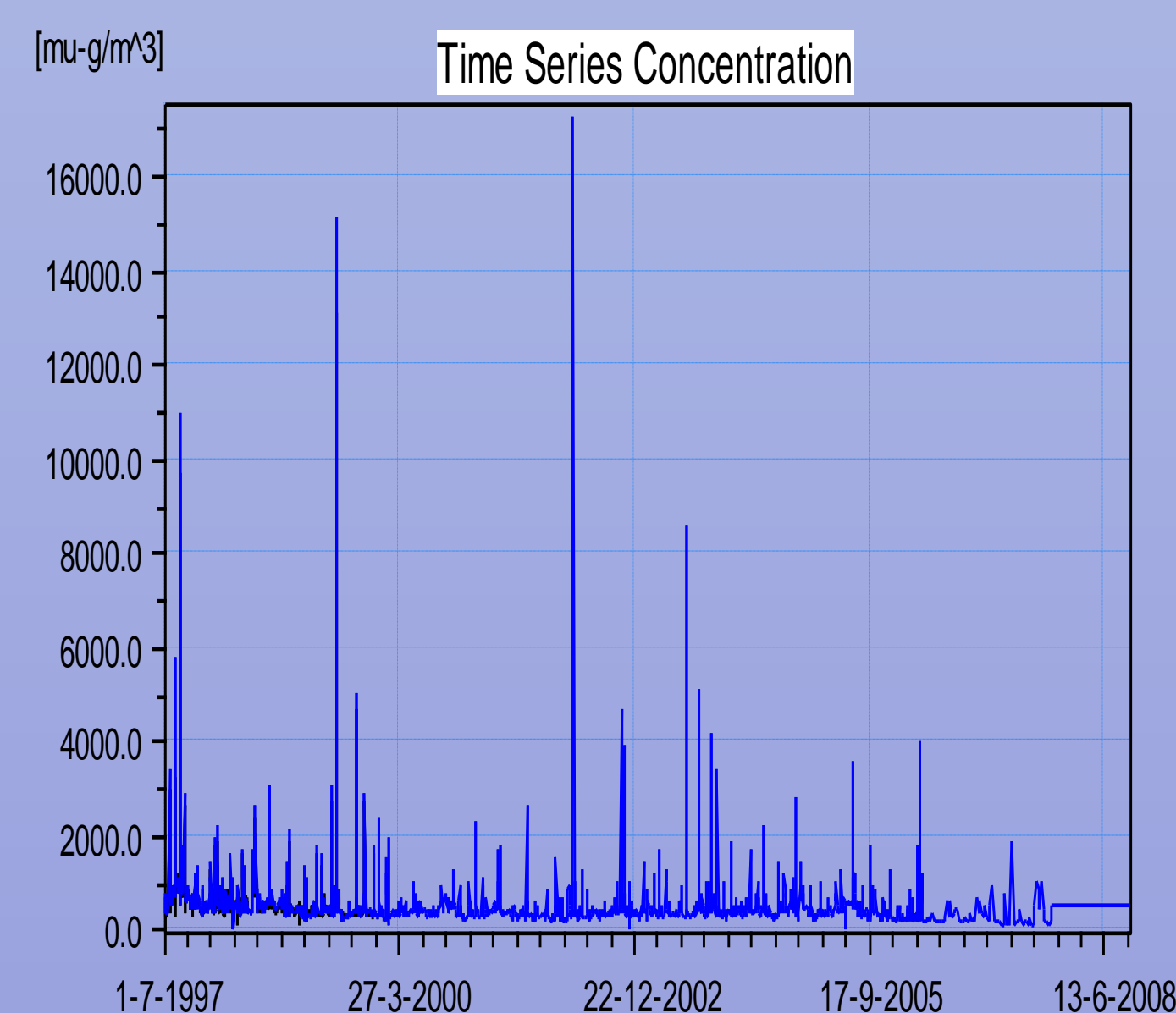
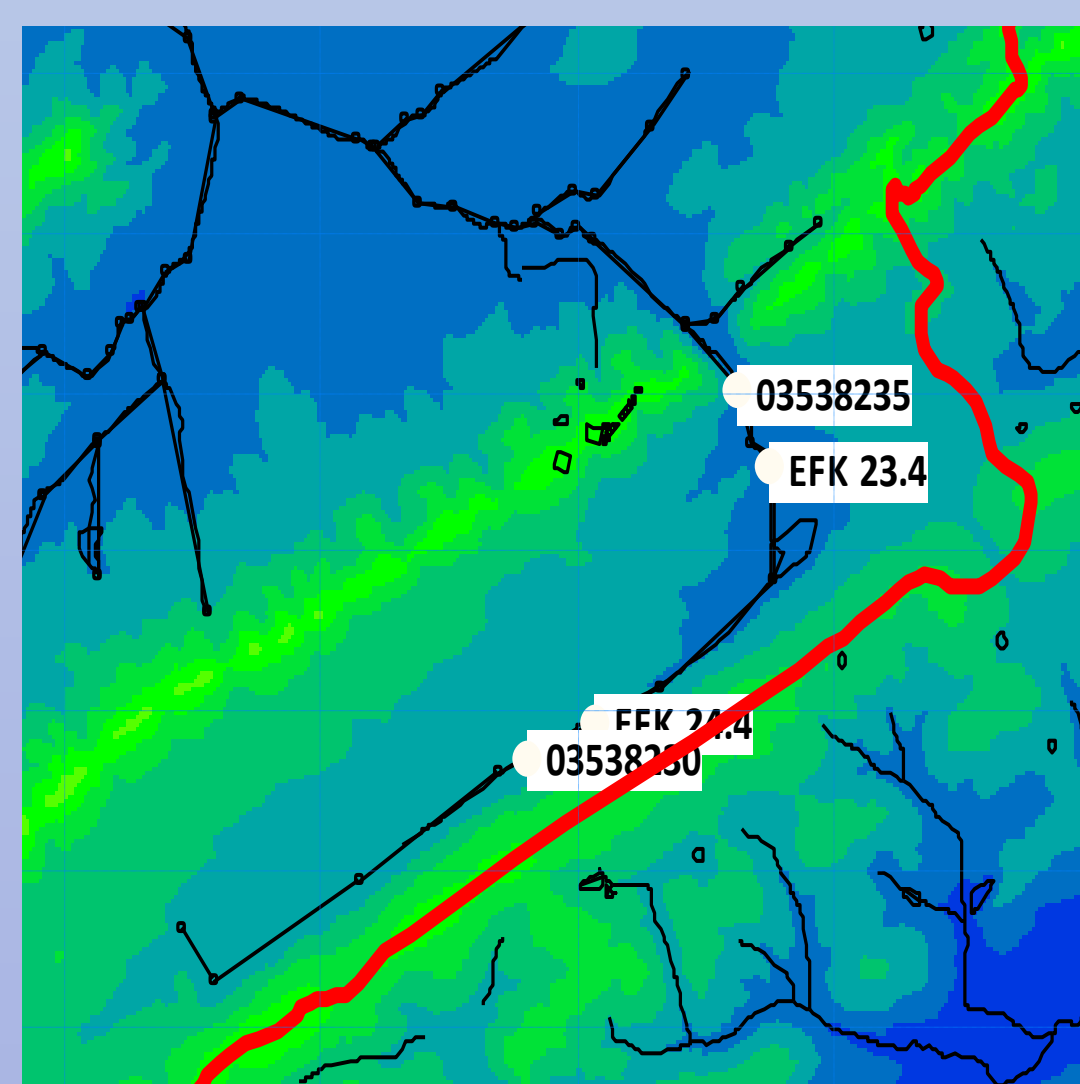


Figure 1. Section of EFPC watershed. a) Location of Y-12 upstream of station 17, b) Mercury concentrations measured at Sta-17 (in parts per trillion).

Materials and Methods

Ionic exchangers:

- LIX 26
- LIX84
- 1000 ppm ($\pm 1\%$) Hg (II) stock solution
- N-Heptane
- 0.1 M KOH solution

Procedure

A series of standard Hg (II) solutions are prepared in 50 mL plastic vials with a concentration of Hg (II) ranging from 1 ppm to 3 ppm. To each vial, 3 mL of 86.2% n-heptane is added, containing (1%, 2% and 5%) of the ionic exchanger in a 1:10 ratio with respect to the aqueous layer. The pH of the samples is adjusted to 7 by adding the appropriate amount of 0.1 M KOH. The vials are mixed in a laboratory shaker for 15 min, after which the two layers are separated in a separatory funnel.

Measurements

The aqueous layer is analyzed for Hg (II) concentration at South MercoLAB according to the ACP method. The concentration of the total organic carbon (TOC) is analyzed with a Shimadzu TOC-V CSH/CSN Total Organic Carbon analyzer. The analysis began with a standard calibration run of six standards with known concentration of TOC, as well as using 2 blanks for every 5 samples to ensure quality control of the analysis.

Results

Sample ID	Surfactant % (v/v)	M0 Hg (ug)	Mf Hg (ug)	M (Hg) ads (ug)	% Extracted
LIX26_11	1%	30	3.21	26.79	89.3
LIX26_12	1%	60	8.04	51.96	86.6
LIX26_13	1%	90	7.27	82.73	91.9
LIX26_21	2%	30	8.04	21.96	73.2
LIX26_22	2%	60	10.07	49.93	83.2
LIX26_23	2%	90	11.59	78.41	87.1
LIX26_51	5%	30	7.53	22.47	74.9
LIX26_52	5%	60	8.29	51.71	86.2
LIX26_53	5%	90	6.51	83.49	92.8
LIX84_11	1%	30	1.06	28.94	96.5
LIX84_12	1%	60	2.77	57.23	95.4
LIX84_13	1%	90	2.20	87.80	97.6
LIX84_21	2%	30	0.78	29.22	97.4
LIX84_22	2%	60	2.20	57.80	96.3
LIX84_23	2%	90	2.48	87.52	97.2
LIX84_51	5%	30	1.06	28.94	96.5
LIX84_52	5%	60	1.63	58.37	97.3
LIX84_53	5%	90	1.35	88.65	98.5

Table 1. Mercury extraction data

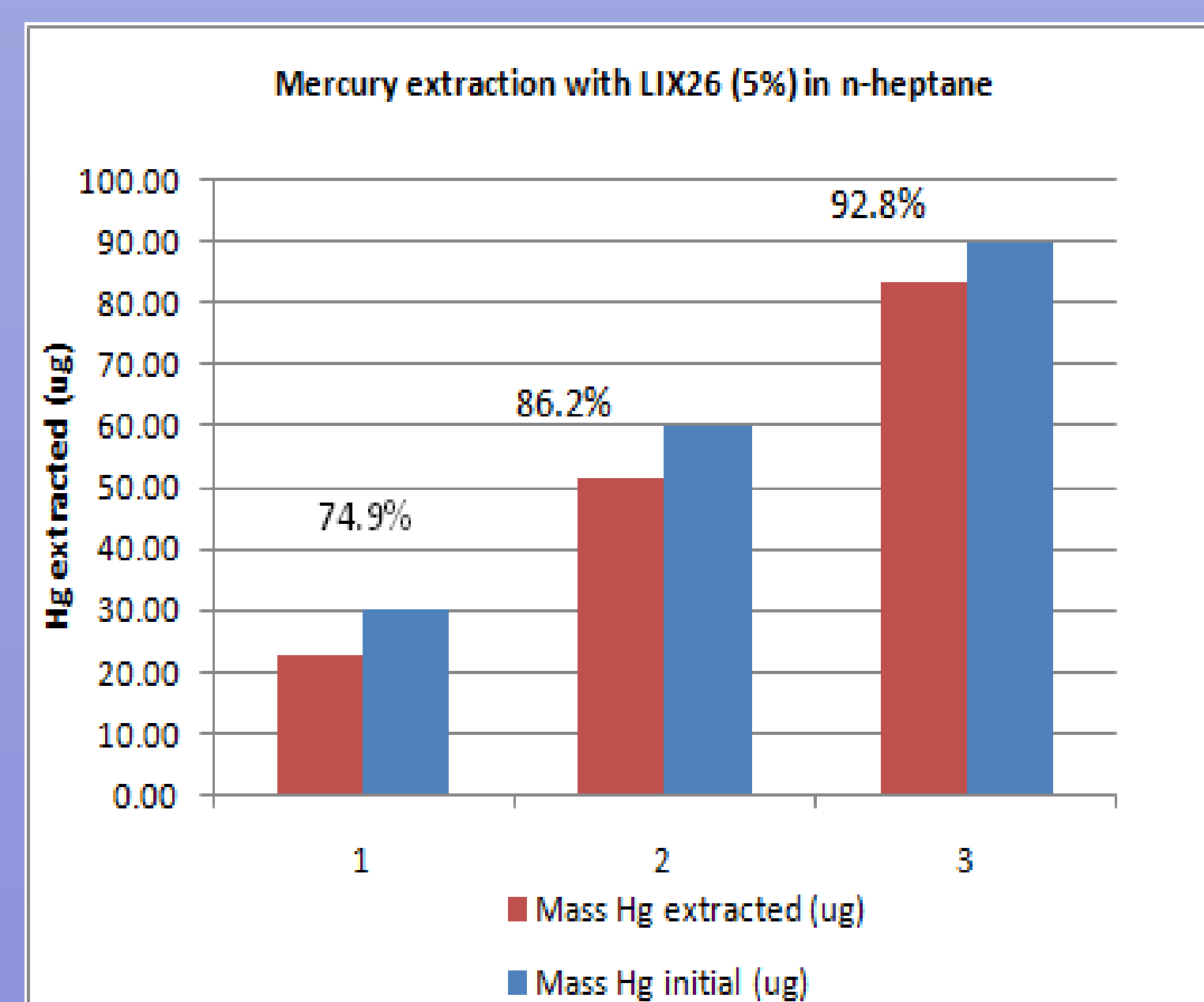


Figure 2. Mercury extraction with Lix26

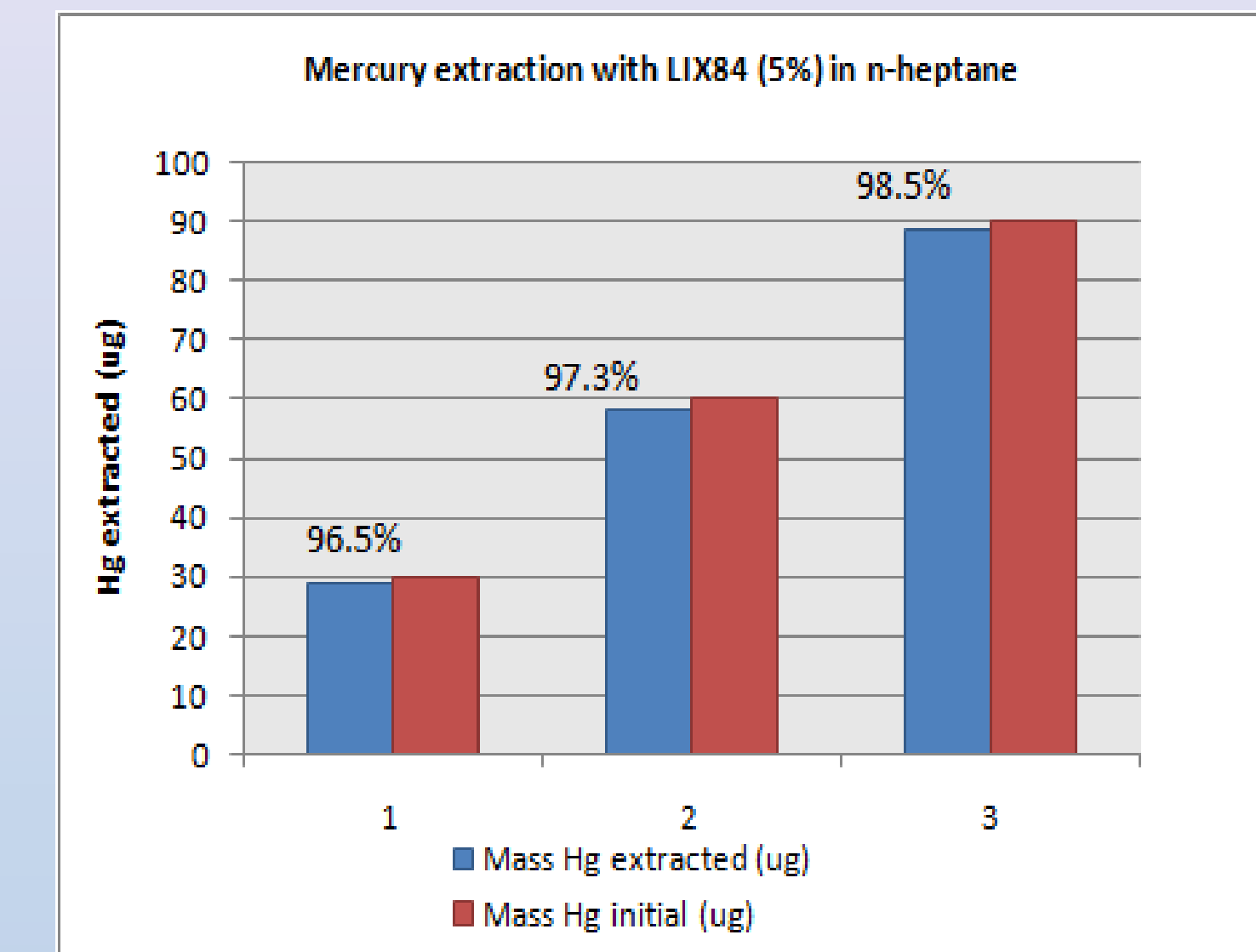


Figure 3. Mercury extraction with LIX84

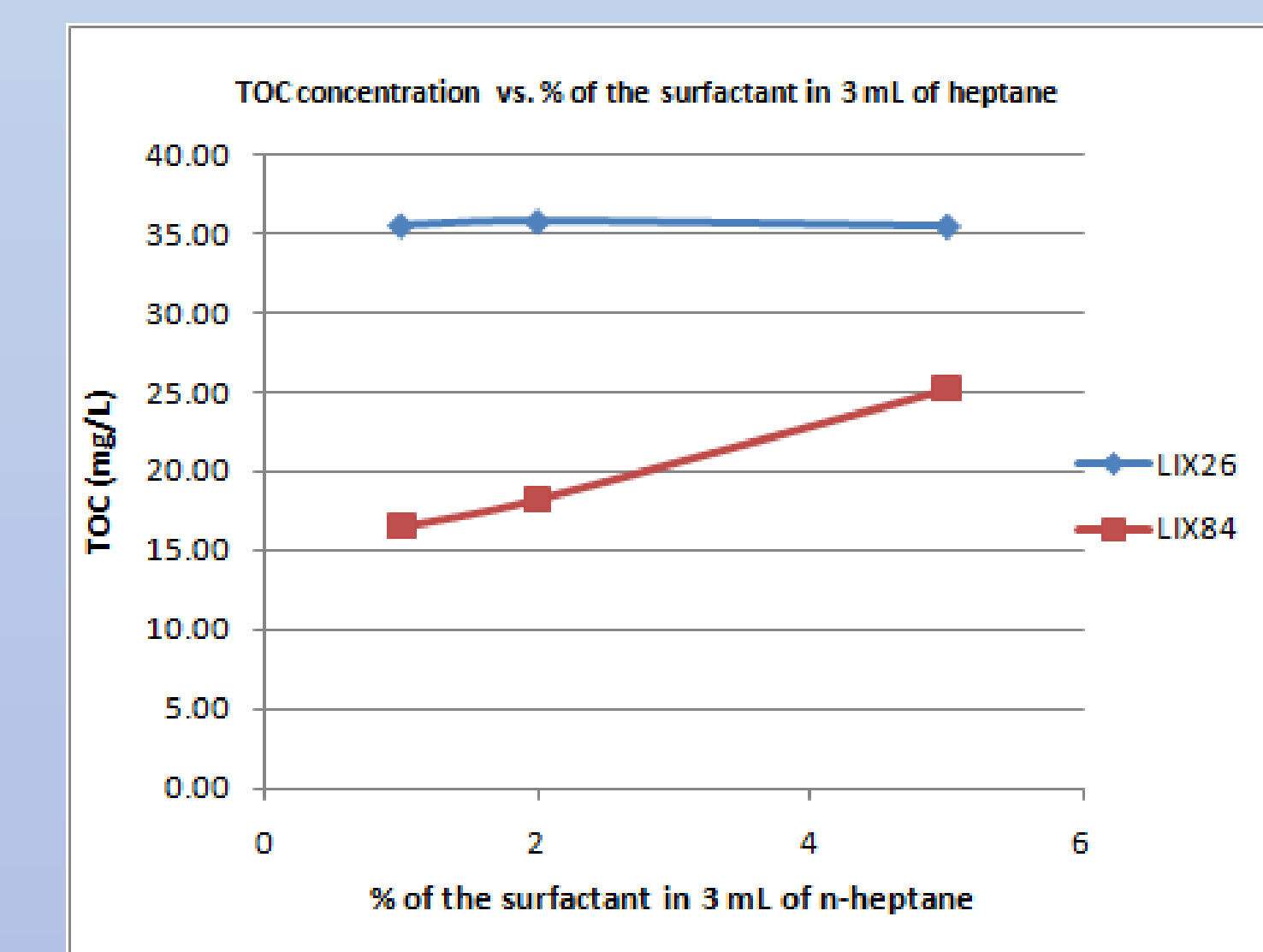


Figure 4. TOC dependence on % of the surfactant

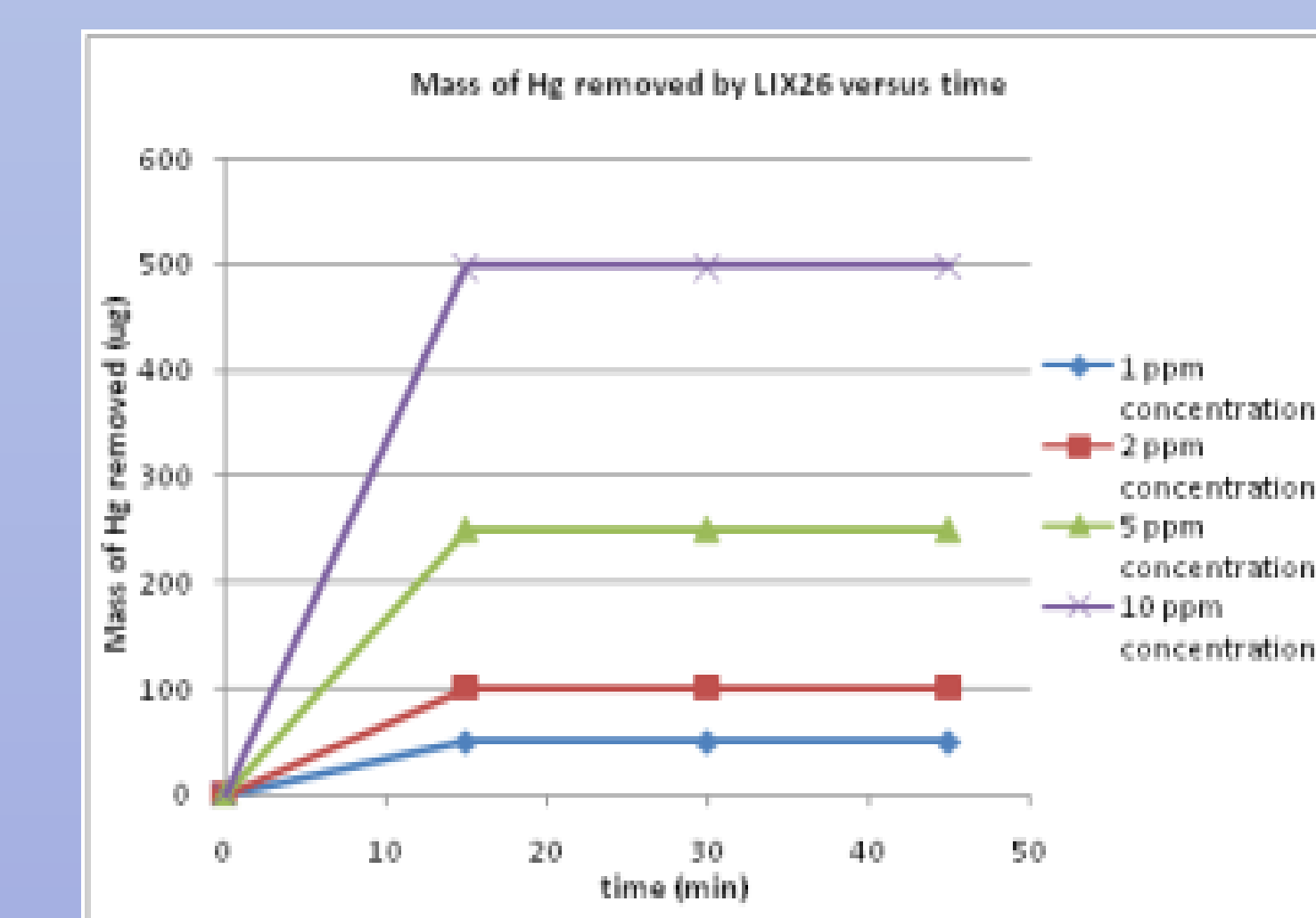


Figure 5. Mercury removal depending on time of mixing

Conclusion

The batch experiments showed that, as expected, the capacity of the ionic exchangers remains unchanged after 5 minutes, which confirms previous studies that found the equilibrium to be reached after approximately 2 minutes.

The concentration of TOC increases in the aqueous solution with increasing volume of the surfactant for LIX84, but remains unchanged for LIX26. The % of mercury extracted ranged from 72% for LIX26 up to 98.5% for LIX84.

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