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Pharma

Determination of zinc oxide in sunscreen

Authors

Hua Yang and Jeffrey Rohrer

Thermo Fisher Scientific
Sunnyvale, CA, USA

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Introduction

The United States Pharmacopeia (USP) has updated General Chapter <591> «Zinc Determination»[1] to include ion chromatography (IC) as a method for a quantitative determination of zinc in drug substance and drug product monographs containing zinc (zinc oxide,[2] zinc oxide neutral,[3] zinc sulfate ophthalmic solution,[4] insulin,[5] and zinc oxide powder[6]). Zinc oxide is used in various skin care creams, drugs, and drug products and is one of the active ingredients approved (up to 25%) by the U.S. Food and Drug Administration (FDA) for sunscreens.[7]

The development and validation of an IC method for the zinc oxide assay in sunscreen has been demonstrated in Thermo Scientific Application Note (AN) 72680.[8] The IC method involves separation of zinc followed by post-column reaction and subsequent UV detection. The method was validated following the guidelines in USP General Chapter <1225>,[9-12] Validation of Compendial Methods,[9] International Conference on Harmonization (ICH) guidelines,[10-11] and the USP General Chapter <621> Chromatography[12].

In this application proof note, the method in AN72680 is demonstrated on a Thermo Scientific™ Dionex™ Inuvion™ ion chromatography system, a new integrated, single-channel compact IC system, with a Thermo Scientific™ Dionex™ AXP-MS auxiliary pump used to deliver the post-column reagent.

Method

Reagents, standards, and solutions

- Degassed deionized (DI) water, 18 MΩ·cm resistance or better
- Hydrochloric acid 37% (Sigma-Aldrich, P/N 258148)
- Thermo Scientific™ Dionex™ MetPac™ PDCA Eluent Concentrate (5X) (P/N 046088)
- Thermo Scientific™ Dionex™ MetPac™ PAR Post Column Diluent (P/N 046094)
- Thermo Scientific™ Dionex™ PAR Reagent (4-(2-Pyridylazo) resorcinol monosodium salt, Monohydrate) (P/N 039672)
- Samples: Sunscreens purchased from a local store
- Zinc Oxide USP reference standard (Sigma-Aldrich, P/N 1724747-2G)

Preparation of solutions

Prepare all solutions (eluent, post-column reagent, calibration standard, and sample) according to AN72680.[8]

System setup

Figure 1 shows the flow diagram of a Dionex Inuvion IC system for determining zinc oxide.

Instrument method parameters

Instrument	Dionex Inuvion IC system
Autosampler	Thermo Scientific™ Dionex™ AS-AP autosampler (P/N 074921)
Columns	Thermo Scientific™ Dionex™ IonPac™ CS5A and CG5A, 2 mm i.d. column set (P/N 052576, 052836)
Eluent (PDCA)	7.0 mM pyridine-2,6-dicarboxylic acid, 66.0 mM potassium hydroxide, 5.6 mM potassium sulfate, 74.0 mM formic acid in DI water. Prepared from Dionex MetPac PDCA eluent concentrate (5X) (P/N 046088)
Eluent flow rate	0.3 mL/min
Inj. volume	2.5 µL (full loop)
Column temp.	30 °C
Post column reagent (PAR)	0.5 mM 4-(2-pyridylazo)resorcinol (PAR) monosodium salt (P/N 039672) in 1.0 M 2-dimethylaminoethanol, 0.50 M ammonium hydroxide, and 0.30 M sodium bicarbonate (Dionex MetPac PAR Post Column Diluent, P/N 046094)
PCR flow rate	0.15 mL/min
PCR reaction	2 mm PEEK mixing tee (Fisher Scientific P/N 06-611-699) and 125 µL PCR knitted reaction coil (P/N 053640)
Detection	Visible absorbance (530 nm)
Run time	12 min
System backpressure	Dionex Inuvion pump: ~2,000 psi, (100 psi = 0.6894 MPa) Dionex AXP-MS pump: ~2,000 psi (add tubing before tee to increase the pressure)
Software	Thermo Scientific™ Chromeleon™ Chromatography Data System (CDS) software version 7.3.2 or higher

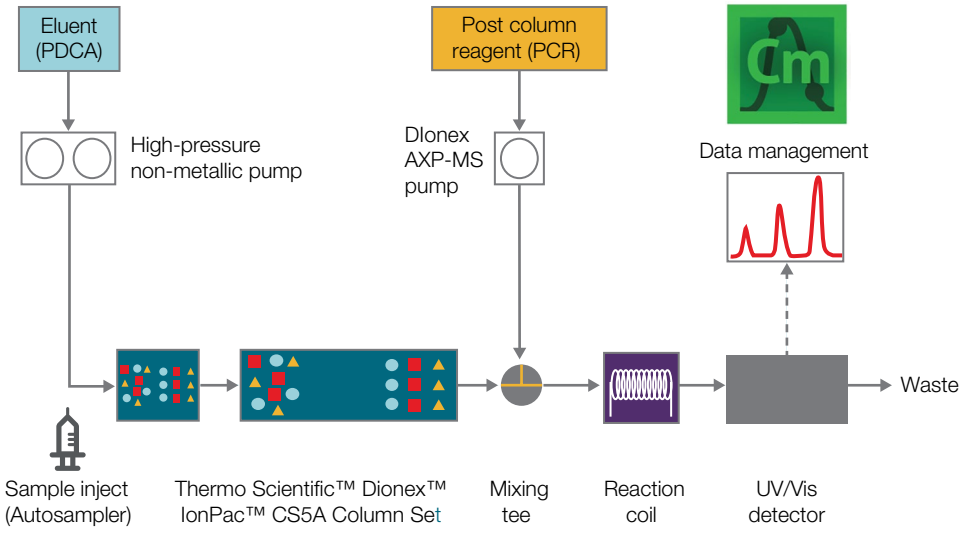

Figure 1. Illustration of the IC system flow path

Results

Figure 2 shows chromatograms of zinc oxide standard and sunscreen samples. Zinc elutes at 8.11 min.

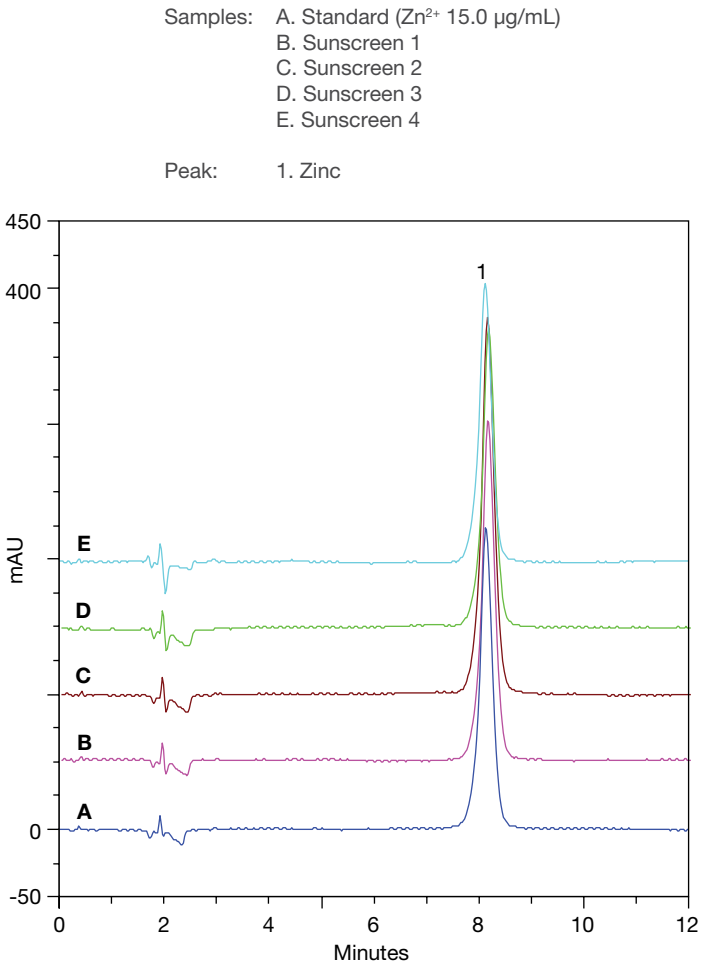

Figure 2. Chromatograms of zinc oxide standard and sunscreen samples

In this study, zinc oxide was calibrated at six concentration levels ranging from 1 to 30 µg/mL. The results yielded a linear relationship (Figure 3) of peak area to concentration with a coefficient of determination (r^2) of 1.000.

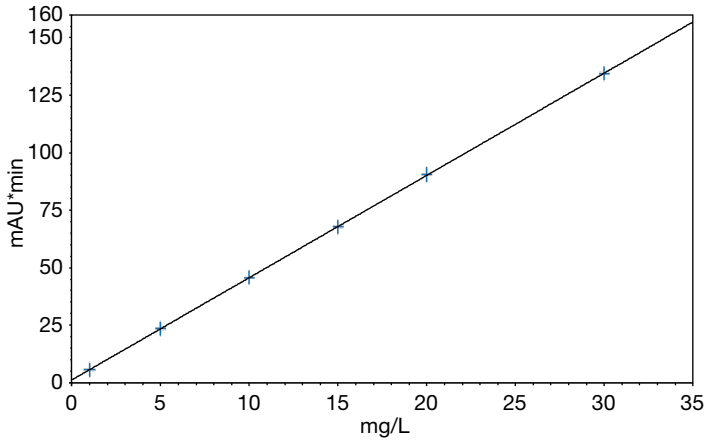

Figure 3. Calibration plot for zinc oxide

Table 1 shows the results of determining zinc oxide in four sunscreen brands. All four sunscreen brands have a sunscreen protection factor (SPF) of 50 against UVB radiation. They were measured over three days with freshly prepared samples. The results show that the method is precise (<3% day-to-day variability) and accurate (93–105% recovery).

Conclusion

This work shows the determination of zinc oxide in sunscreen in less than 12 min using a Dionex Inuvion IC system with visible absorbance detection. In this application, zinc is separated from other cations and metals using PDCA eluent on the Dionex IonPac CS5A mixed ion exchange column. PAR is added post-column for absorbance at 520 nm. The integrated Dionex Inuvion IC system, coupled with a Dionex AXP-MS auxiliary pump, provides a reliable, sensitive, and reproducible method for the determination of zinc oxide in sunscreen following the USP General Chapter <591>.

Table 1. Zinc oxide content of sunscreens

Sunscreen (brand)	SPF	Water resistance time (min)	Zinc oxide (label %)	Zinc oxide (measured %)	Interday precision* (%)	Accuracy (%) (measure/label)
1	50	80	20	20.9 ± 0.2	0.7	105
2	50	80	6.5	6.2 ± 0.2	2.7	95
3	50	80	21.6	20.1 ± 0.5	2.6	93
4	50	80	15	14.8 ± 0.4	2.9	99

*n = 3 days

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