

Larry Peterson,¹ B.S.

Evaluation of Refractive Index Values for Permout®

ABSTRACT

The refractive index (RI) values of Permout® may be important depending on the sample under examination. The evaporation of the toluene solvent in this product raised the refractive index of the media while thinning of this media using xylene lowered the refractive index. The RI values of neat Permout® did not vary significantly between lots which spanned several years and was measured as approximately 1.522. The set/cured RI value was estimated to be approximately 1.526. The neat to set RI difference of approximately 0.004 should not affect fiber examinations. Dilution of thickening Permout® in a dispenser bottle should not affect relative RI evaluations or its use to identify generic fiber types. Dilution would significantly change the RI values if used to extreme levels.

Keywords: Permout®, Refractive Index

INTRODUCTION

Permout® is a common mounting media for forensic trace materials to include textile fibers and hair. Examinations may involve the comparison of the refractive index (RI) of a textile fiber relative to the mounting media in order to classify the generic type of the fiber or the comparison of known and questioned fibers by their relative relief to the mounting media using a comparison microscope. The extent of the changes in RI, brought about by evaporation or thinning, has not been uniformly or recently reported in the literature.

The container labeling and Safety Data Sheet information obtained from Fisher Scientific® lists Permout® as a histological mounting media consisting of 45% by volume of a “beta-pinene polymer” (listed on container) or a mixture of polymeric

¹ U.S. Army Criminal Investigations Laboratory, Defense Forensic Science Center, Defense Forensic Science Center

Neither the Department of Defense, the Army, nor the DFSC endorses or recommends any commercial products, processes, or services. The views and opinions of authors expressed in this article do not necessarily state or reflect those of the U.S. government and may not be used for advertising or product endorsement purposes.

materials containing pinenes (detailed in the MSDS available online by Fisher) which is in solution with 55% by volume of toluene. Since Permout® is a solvent born mounting media, dilution or thinning often needs to be performed due to the evaporation of the solvent from the mounting media over time while stored in a dispensing bottle. No RI values are listed or referenced by the manufacturer on the container label or in its MSDS. Changes in the RI of this media would be expected to occur upon drying or dilution due to the volatile solvent base of toluene used in the product. Therefore, it seems pertinent to determine, or confirm, accurate RI values of neat Permout® and the changes upon evaporation or dilution.

LITERATURE SEARCH

Four references listing RI values of Permout® were found. One reference [1] lists the RI value to be 1.518–1.521 at 20° C. It is assumed that this refers to neat media from the bottle. Reference [2] refers to dried Permout® as having a RI range of 1.524 to 1.526 based on studies of various batches. One reference listed the RI of neat Permout® as 1.520 [3]. None of these references discuss the effects of dilution or the change in RI over a specific time period due to evaporation.

SAMPLES

Three samples of Permout®, each purchased from Fisher Scientific, were analyzed for the study. The manufacturers date (Mfg. date) and the expiration dates were printed on the bottles (see * below for bottle 3). The date received (Rec'd) is the date the bottle came into the lab as new and the “Collection date” is the date of testing. No dilutions occurred in the bottles prior to collection. The samples were:

	Bottle 1	Bottle 2	Bottle 3
	<u>Lot 096403</u>	<u>Lot 114955</u>	<u>Lot 155508</u>
Mfg. date	12/29/09	11/03/11	11/01/15*
Date Rec'd	5/21/10	1/23/12	5/07/16
Expiration date	Dec. 2011	Oct. 2013	Oct. 2017
Collection date	1/26/12	1/26/12	5/10/16

Note: The sample from bottle 1 was expired at the date of testing but there remained approximately 20% of the volume of Permout in the bottle at the time of sampling.

*Bottle 3 Mfg. Date: Not listed on bottle but estimated based on the two year date spacing for the Mfg. and expiration dates listed for bottles 1 and 2.

TEST METHOD AND RESULTS

Refractive Index Test Method

Refractive index determinations were performed using a Leica DMLP microscope equipped with a 590 nm filter at room temperature using traditional RI immersion techniques (See reference [4] for additional information on glass refractive index determinations using the Becke line test).

A series of reference glasses were used for the RI determinations (Locke Scientific, Basingstoke, UK) and internal USACIL reference glass samples analyzed from past casework.

Refractive index values are listed to five places but accuracy would diminish beyond four places. Testing was performed on the same day as collection of media to reduce errors due to evaporation.

	Bottle 1	Bottle 2	Bottle 3
	<u>Lot 096403</u>	<u>Lot 114955</u>	<u>Lot 155508</u>
Refractive Index	1.52130	1.52180	1.52155

Refractive Index Changes During Drying

The refractive index of drying samples of Permout® were made by mounting a series of reference glasses with RI values higher than that for the neat RI value for the Permout® from Bottle 2 on day 1. Becke line RI evaluations were recorded periodically for the next 15 days.

<u>Day</u>	<u>RI</u>	<u>Delta RI (Δ)</u>
Day 1 (neat)	1.52180	
Day 4	1.52366	(+ 0.00186)
Day 7	1.52410	(+ 0.00230)
Day 11	~ 1.526	(+ 0.00420; slightly higher than 1.52580)
Day 15	~ 1.526	(no apparent change from Day 11)

Refractive Index Changes with Dilution

The study of changes in refractive index was performed by the addition and mixing of ACS grade xylenes with measurement of the RI on the same day as the dilution. The nD listed on the xylenes container was 1.4970. Therefore, the RI of neat Permout® (RI ~ 1.522) would be expected to decrease with increasing (v/v) xylene dilution. If toluene was used for dilution, the change in RI values would not be expected to be significantly different than xylene due to the listed RI value of toluene (1.496, Fisher Scientific) and xylene being almost the same. The RI values for diluted Permout® were determined

using the sample from Bottle 2 and using a series of reference glasses and RI immersion techniques as noted earlier. The results are as follows:

<u>Sample Condition</u>	<u>RI</u>	<u>Delta RI (Δ)</u>
Neat Permout	1.52180	
80% Neat Permout	1.52030	(- 0.00150)
66% Neat Permout	1.51800	(- 0.00380)
57% Neat Permout	1.51510	(- 0.00670)
50% Neat Permout	1.51300	(- 0.00880)

CONCLUSIONS

The RI of neat Permout® appears very uniform for these three lots which span a wide range of years. This includes Permout® that had expired from the date listed on the bottle (see Bottle 1). This would indicate uniformity in Permout® production and that the continued use of Permout® beyond the expiration date may be warranted. No information was found that indicated what properties would be lost or affected by Permout® over time or how one could measure/observe media failure. The label on the bottle listed the possibility of the media becoming “cloudy” and, if this occurs, to add toluene or xylene to clarify the material.

The observed data supports that dilution of Permout®, if not extreme, does not significantly alter the refractive index of the media and, therefore, does not have a deleterious effect on its use in performing Becke line tests for generic fiber type determinations/evaluations. A dilution of neat Permout® would not be an expected normal practice; however, the reconstitution of thickened Permout in a dispenser bottle would be expected. Based on the dilution study, RI values from reconstitution would not be expected to vary greatly from the original neat value (assuming the xylene addition/mixing was visually performed to approximate the neat viscosity). Even if neat Permout® is thinned to 80%, the RI remains at approximately 1.52. Even the difference between 80% diluted neat Permout® and the “dried” value (approximately 0.0055), would not be a critical difference when used for generic fiber identifications. However, the refractive index difference could be problematic when performing fiber comparisons and evaluating the relative RI of fibers to the Permout® for mounted slides which had “dried” or cured for several days compared with freshly made slides.

REFERENCES

1. Haude ME. Identification of colorants on maps from the early colonial period of New Spain (Mexico). *Journal of the American Institute for Conservation*. 1998;37(3):240-270.

2. Petraco N, Kubic T. Color Atlas and Manual of Microscopy for Criminalists, Chemists, and Conservators. Boca Raton (FL): CRC Press; 2004. Chapter 7, Synthetic fiber identification; p. 77–88.
3. Roe GM, Cook R, North C. An evaluation of mountants for use in forensic hair examination. *Journal of the Forensic Science Society*. 1991;31(1):59–65.
4. Scientific Working Group for Materials Analysis (SWGMAT). Glass refractive index determination. *Forensic Science Communications*. 2005 [accessed 2007 June 4]; 7(1). <https://archives.fbi.gov/archives/about-us/lab/forensic-science-communications/fsc/jan2005/standards/2005standards9.htm>