Institute of Environmental Sciences and Technology

IEST-RP-CC042.1

Contamination Control Division
Recommended Practice 042.1

Sizing and Counting of Submicrometer Liquid-borne Particles Using Optical Discrete-particle Counters

Arlington Place One
2340 S. Arlington Heights Road, Suite 100
Arlington Heights, IL 60005-4516
Phone: (847) 981-0100 • Fax: (847) 981-4130
E-mail: information@iest.org • Web: www.iest.org

This Recommended Practice is published by the Institute of Environmental Sciences and Technology to advance the technical and engineering sciences. Use of this document is entirely voluntary, and determination of its applicability and suitability for any particular use is solely the responsibility of the user. Use of this Recommended Practice does not imply any warranty or endorsement by IEST.

This Recommended Practice was prepared by and is under the jurisdiction of Working Group 042 of the IEST Contamination Control Division.

First printing, October 2011

ISBN 978-0-915414-09-3

PROPOSAL FOR IMPROVEMENT: The Working Groups of the Institute of Environmental Sciences and Technology are continually working on improvements to their Recommended Practices and Reference Documents. Suggestions from users of these documents are welcome. If you have a suggestion regarding this document, please use the online Proposal for Improvement form found on the IEST website at www.iest.org.

Institute of Environmental Sciences and Technology
Arlington Place One
2340 S. Arlington Heights Road, Suite 100
Arlington Heights, IL 60005-4516
Phone: (847) 981-0100 • Fax: (847) 981-4130
E-mail: information@iest.org • Web: www.iest.org

Sizing and Counting of Submicrometer Liquid-borne Particles Using Optical Discrete-particle Counters

IEST-RP-CC042.1

CONTENTS

SECTION

1 SCOPE AND LIMITATIONS 7
2 REFERENCES 7
3 TERMS AND DEFINITIONS 8
4 BACKGROUND AND PURPOSE 9
5 LIQUID-BORNE PARTICLE MEASUREMENT—CHALLENGES AND RECOMMENDED PRACTICES 9

FIGURE

1 SCHEMATICS OF THE OPTICAL SYSTEM OF A LIQUID-BORNE PARTICLE COUNTER BASED ON LIGHT SCATTERING 10
2 TYPICAL POWER LAW DISTRIBUTIONS FOUND IN MANY LPC APPLICATIONS 13
3 STATISTICS OF PSL STANDARDS 14
4 50/50 SPLIT CALIBRATION OF AN LPC 14
5 50/50 SPLIT CALIBRATION OF AN LPC (ALL CHANNELS CALIBRATED THE SAME WAY) 14
6 COUNTING EFFICIENCY OF REAL-WORLD PARTICLES 15
7 PARTICLE SIZE DISTRIBUTION AT DIFFERENT CONCENTRATION LEVELS—EFFECT OF COINCIDENCE ERROR 16
8 A TYPICAL PULSE HEIGHT DISTRIBUTION FOR A SPECTROMETER 17
9 EFFECT OF EXCESSIVE BUBBLES ON THE SIZE DISTRIBUTION OF PARTICLES 18
10 SCATTERED LIGHT INTENSITY BY A PARTICLE (0.2 μm AT 633 nm WAVELENGTH) AS A FUNCTION OF REFRACTIVE INDEX CONTRAST 20
11 EXCESSIVE BASELINE NOISE EFFECT 22
12 PROPER INSTALLATION OF AN LPC TO MONITOR A PARTS-CLEANING ULTRASONIC BATH 23
13 PROBABILITY DENSITY FUNCTION FOR 10-MIN SAMPLE TIME 26
14 PROBABILITY DENSITY FUNCTION FOR 30-MIN SAMPLE TIME 27

TABLE

1 ADVANTAGES AND DISADVANTAGES OF BATCH SAMPLING INSTRUMENT TYPES 11
2 DATA FORMAT FOR AN LPC ILLUSTRATING DIFFERENTIAL AND CUMULATIVE COUNTS 12
3 INDEX CONTRAST OF CERTAIN PARTICLE-FLUID COMBINATIONS 21
4 SENSOR-TO-SENSOR COUNT CORRELATION (AT CONCENTRATION LEVELS WITH LOW COINCIDENCE ERRORS) 24
5 STANDARD DEVIATIONS OF LOW-CONCENTRATION SCENARIOS BASED ON POISSON DISTRIBUTION 25
6 PROBABILITY THAT A SAMPLE WILL CONTAIN A GIVEN NUMBER OF PARTICLES 26
7 CUMULATIVE PROBABILITIES OF AN ALARM BEING FALSE AS A FUNCTION OF AVERAGE PARTICLES PER SAMPLE 28

APPENDIX

A EXAMPLE: EVALUATING THE LIKELY NUMBER OF FALSE ALARMS PER DAY FOR A GIVEN SAMPLE TIME 29
B BIBLIOGRAPHY 30

Institute of Environmental Sciences and Technology
Contamination Control Division
Recommended Practice 042.1

Sizing and Counting of Submicrometer Liquid-borne Particles Using Optical Discrete-particle Counters

IEST-RP-CC042.1

1 SCOPE AND LIMITATIONS

1.1 Scope

This Recommended Practice (RP) addresses the sizing and counting of submicrometer liquid-borne particles using optical discrete-particle counters with a focus on applications in the semiconductor, flat-panel display, and data storage industries. Topics covered include the following:

- Overview of light-scattering technology
- Liquid particle counter (LPC) instrument types
- Data interpretation
- Coincidence level or maximum concentration limit
- Particle-size detection limit
- Bubble issue
- Refractive index effect
- Flow rate
- Calibration verification
- Instrument noise and false counts
- Practice of minimizing sensor contamination
- Sensor correlation
- Particle counting statistics

1.2 Limitations

This RP does not address the measurement and identification of living organisms, e.g., bacteria.

This RP does not address the measurement of extremely high particle concentrations, e.g., chemical-mechanical polishing (CMP) slurry.

This RP does not address the calibration of LPCs.

2 REFERENCES

The cited editions of the following documents are incorporated into this Recommended Practice to the extent specified herein. Users are encouraged to investigate the possibility of applying the most recent editions of the references.

2.1 Reference Documents

IEST-RD-CC011.2: A Glossary of Terms and Definitions Related to Contamination Control

ISO 21501-2:2007 Determination of particle size distribution—Single particle light interaction methods—Part 2: Light scattering liquid-borne particle counter

2.2 Sources and Addresses

IEST
Institute of Environmental Sciences and Technology
2340 S. Arlington Heights Road, Suite 100
Arlington Heights, IL 60005-4516, USA
Phone: 847-981-0100
Fax: 847-981-4130
www.iest.org

ISO
International Organization for Standardization
1, ch. de la Voie-Creuse, Case postale 56
CH-1211 Geneva 20, Switzerland
Phone: +41 22 749 01 11
Fax: +41 22 733 34 30
www.iso.ch