Ink Ejection Performance Analysis for a Picojet Printhead

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ABSTRACT

A transient three-dimensional conservation equations of mass and momentum was developed to simulate the droplet ejection behavior for a commercially avialable Picojet printhead. The interfacial flow characteristics including the ink infusion, ejection, and droplet formation are discussed in detail. In the analysis, the VOF method in conjunction with the PLIC Calculation procedure is adopted to determine the evolution of the ink surface movements. To verify the present formulation, the predictions of droplet ejection development are found to be in good agreement with micrographs.In addition, the influence of internal flow field on the droplet formation and the ink ejection performance can be exploved through the simulated results. Keywords: Picojet Inkjet Printhead , ejeting-process, inner fluid field, numerical simulations

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Table of Contents

REFERENCES

[1] Rayleigh F. R. S.,“ On the instability of jets, ” in Proc. London Math.. Soc. Vol. 10 No. 4, 1878, pp.4-13.

[2] Elmqvist R.,“ Measuring instrument of the recording type, ” U. S. Patent 2566443, 1951.

[3] Sweet R. G.,“ High frequency recording with electrostatically deflected ink-jets, ” Rev. Sci. Instrum. 36, 1965, pp.131-136.

[4] Buehner W. L., J. D. Hill, T. H. Williams, and J. W. Woods,“ Application of ink-jet technology to a word processing output printer, ” IBM J. Res. Dev. 21, Vol. 21 No.1, 1977,pp. 2-9.

[5] Hertz C. H. and Simonsson S. I.,“ Ink-jet recorder, ” U. S. Patent3416153, 1968.

[6] Heinzl J.,“ Printing with ink droplets from a multi-nozzle device, ” in Adv. In Non-Impact Printing Technologies for Computer and Office Applications, Joseph Gaynor, Ed., , 1981 pp.1191-1201.

[7] Zoltan S. L., (Clevite Corp.),“ Pulse droplet ejection system, ” U. S. Patent 3683212, 1974.

[8] Kyser E. L. and Sears S. B., (Silonic Inc.),“ Method and apparatus for recording with writing fluids and drop projection means therefore, ” U. S. Patent 3946398, 1976.

[9] Endo I., Sato Y., Saito S, Nakagiri T., and Ohno, S. (Canon),“ Liquid jet recording process and apparatus there for, ” Great Britain Patent 2007162, 1979.

[10] Vaught J. L., Cloutier F. L., Donald D. K., Meyer J.D., Tacklind C.A., and Taub H. H., (Hewlett-Packard),“ Thermal ink-jet printer, ” U. S. Patent4490728, 1984.

[11] Hue L. P., " Progress and trends in ink-jet printing technology, " IS&T, V.42, No.1, 1998, pp.49-62.
[12] Pimbley, W. T., " Drop Formation from a Liquid Jet: A Linear One-dimensional Analysis Considered as a Boundary Value Problem, " IBM J. Res. Develop, Vol. 20, 1976, pp. 148- 156.
[13] Curry, S. A. and Portig, H., " Scale Model of an Ink Jet, " IBM J. Res. Develop, Vol. 21, No. 1, 1977, pp. 10- 20.
[14] Adams, R. L. and Roy, J., " A One-dimensional Numerical Model of a Drop-on- Demand Ink Jet, " Journal of Applied Mechanics, Vol. 53, No. 1, 1986, pp. 193-197.
[15] Asai, H., Toshitami, H., and Ichiro, E., " One-dimensional Model of Bubble Growth and Liquid Flow in Bubble Jet Printers, " Journal of Japan Society of Applied Physics, Vol. 26, No. 10, 1987, pp. 1794-1801.
[16] Fromm, J. E., " Numerical Calculations of the Fluid Dynamics of Drop-on- Demand Jets, " IBM J. Res. Develop, Vol. 28, No. 3, 1984, pp. 322- 333.
[17] Shield, T. W., Bogy, D. B., and Talke, P. E., " Drop formation by DoD Ink-jet Nozzles: A Comparison of Experiment and Numerical Simulation, " IBM J. Res. Develop, Vol. 31, No. 1, 1987, pp. 96- 110.
[18] Asai, H., " Three-dimensional Calculation of Bubble Growth and Drop Ejection in a Bubble Jet Printer, " ASME, Journal of Fluids Engineering, Vol. 114, No. 4, 1992, pp. 638 – 641.
[19] Chen, P. H., Chen, W. C., and Chang, S. H., " Bubble Growth and Ink Ejection Process of a Thermal Ink Jet Printhead, " International Journal of Mechanical Sciences, Vol. 39, No. 6, 1997, pp. 683 – 695.
[20] Chen, W. C., Chen, P. H., and Chang, S. H., " Development of Droplet String Injected by Thermal Bubble Printhead, " Proceeding of 14th Mechanical Engineering Conference, R.O.C., 1997, pp. 70 – 77.
[21] Chen, P. H., Peng, H. Y., Liu, H. Y., Chang, S. L., Wu, T. I., and Cheng, C. H., " Pressure Response and Droplet Ejection of a Piezoelectric Inkjet Printhead, " International Journal of Mechanical Sciences, Vol. 41, No. 2, 1999, pp. 235 – 248.
[22] Rembe, C., Wiesche, S., and Hofer, E. P., " Thermal Ink Jet Dynamics: Modeling, Simulation, and Testing, " Microelectronics Reliability, Vol. 40, No. 3, 2000, pp. 525 – 532.
[23] Liou, T. M., Chau, S. W., Chen, S. C., and Shih, K. C., " Numerical Investigation of Droplet Behavior in Inkjet Printing Process, " The 9th National Computational Fluid Dynamics Conference, Tai-Nan, Taiwan, August, 2002.
[24] Liou, T. M., Chau, S. W., Chen, S. C., and Shih, K. C., " Three-Dimensional Simulations Of The Droplet Formation During The Inkjet Printing Process, " Int. Comm. Heat Mass Transfer,Vol. 29, No. 8, 2002, pp. 1109-1118 [25] Yeh, J. T., " A VOF-FEM and Coupled Inkjet Simulation, " Proceedings of ASME Fluids Engineering Division Summer Meeting, FEDSM2001-18182, New Orleans, LA, 2001 [26] Yang, J. C. , Chiu, C. L. , Wu, C. L. ,Chen, C. T. , Chen, H. L. ,Yang, M. D. , Mo, C. Y. , Lo, C. B. , Chen, C. J., " The Simulation Of The Viscosity And Surface Tension For The Inkjet Print Head, " IS&T`s NIP19: International Conference On Digital Printing Technologies, 2003 [27] Welch, J .E., Harlow, F.H., Shannon, J.P., Daly, B.J., " The MAC Method: A Computing Technique for Solving Viscous Incompressible, Transient Fluid Flow Problems Involving Free Surface, " Report LA-3425, Los Alamos Scientific Report, CA, USA.
[28] Hirt, C. W. and Nichols, B. D., " Volume of fluid (VOF) method for the dynamics of free boundaries, " Journal Computational Physics, Vol. 39, No. 1, 1981, pp. 201-225.
[29] DeBar, R., " Fundamentals of the KRAKEN Code, " Technical Report UCIR-760, LLNL, 1974.
[30] Ashgriz, N., and Poo, J. Y., " FLAIR: Flux Line-segment Advection and Interface Reconstruction, " Journal of Computational Physics Vol. 93, No. 2, 1991, pp. 449-468.
[31] Youngs, D. L., " Time-Dependent Multi-Material Flow with Large Fluid Distortion, " Morton, K.W., and Baines, M.J., editor, Numerical Methods for Fluid Dynamics 1982, pp. 273-285 [32] Pilliod, J. E., and Puckett, E. G.. " Second Order Volume-of-Fluid Interface Tracking Algorithms. " Journal Computational Physics, Vol. 188, No. 1, 2003, pp.100-122 [33] Noh, W. F., and Woodward, P. R., " SLIC (Simple Line Interface Method), " In A.I. Van de Vooren and Zandbergen, P. J., editors, Vol. 59, Springer-Verlag, 1976, pp. 330-340.
[34] Van Doormaal, J. P., and Raithby, G. D., " Enhancements of The SIMPLE Method for Predicting Incompressible Fluid Flows, " Numerical Heat Transfer, Vol. 7, No. Heat Transfer, 1984, pp. 147-163.
[35] Kothe, D. B., Rider, W. J., Mosso, S. J., Brock, J. S., Hochstein, J. I., " Volume Tracking of Interfaces Having Surface Tension in Two and Three Dimensions, " Technical Report AIAA 96-0859, [Presented at the 34th Aerospace Sciences Meeting and Exhibit, Reno, NV, Jan. 1996, 15-18.
[36] Suhas V. Patankar, " Numerical Heat Transfer and Fluid Flow, " Hemisphere Publishing Corporation, New York, 1983.
[37] Parker, B. J., and Youngs, D. L., " Two and Three Dimensional Eulerian Simulation of Fluid Flow with Material Interfaces, " Technical Report AWE 01/92, Atomic Weapons Establishment (1992). Presented at the Third Zababakhin Scientific Talks, Kyshitm, Russia (1992).
[38] Dukowicz, J. K. " Efficient Volume Computation For Three-Dimensional Hexahedral Cells. " Journal Computational Physics, Vol. 74, No. 2, 1988, pp. 493-496.
[39] Zemach, C. " Notes on the Volume of a Ruled Hexahedron Behind a Truncating Plane. " Unpublished Manuscript, Los Alamos National Laboratory, 1993.
[40] Brackbill, J. U., Kothe, D. B., and Zemach, C. " A Continuum Method for Modeling Surface Tension, " Journal Computational Physics,

Vol. 100, Issue 2, 1998, pp. 335-354 [41] 工研院光電所計畫編號FY93,B331AB9320,2004