the OSD will be out of the dispersive oil in the actual sea state, which make the oil float on the sea, or even re-aggregate.

CONCLUSION

The dynamics characteristic of the OSD was investigated at different wave's conditions in this study. The conclusions are listed below.

The changes of the OSD in the oil slick were analyzed by the gas chromatography, which manifested the OSD will move away from the oil slick whatever the conditions are.

Waves play a key role in the combination stability of the OSD and the oil, which mainly reflects the wave intensity. The intensity of the waves is more severe. The OSD is harder to separate from the oil slick.

The test result of the concentration of the oil in the seawater manifests fluctuation characteristics, which shows that the OSD moving away from the oil slick is gradually emerging into the seawater with entrained seawater during the process that the oil droplets repeatedly disperse and float.

The mechanism obtained in the experiment can infer the OSD will move away from the oil slick in the actual sea conditions, which may make the dispersive oil floats again and eventually aggregates.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

The work was supported by the National Natural Science Foundation of China (41206095), Ph.D. Programs Foundation of Ministry of Education of China (20122125120010), and the Fundamental Research Funds for the Central Universities (No. 3132013091). The work was also supported by the project "Research on the characteristics, drifting prediction and recovery technology of the Bohai submerged and sunken oil". The authors wish to thank the Hebei Maritime Safety Administration of China for their help.

REFERENCES

[1] M.F. Fingas, *Use of Surfactants for Environmental Applications. Surfactants: Fundamentals and Applications to the Petroleum Industry*, In: L.L. Schramm, Ed., Cambridge University Press, 2000, pp. 461-539.

[2] J. Nilson, A. Naess, and Z. Volent, *Measurements of Oil Concentrations in the Water Column Under Breaking Waves, Report STF 60 A 85079,* Norwegian Hydrotechnical Laboratory, Trondheim, Norway, 1985.

[3] J.M. Shaw, "A microscopic view of oil slick break-up and emulsion formation in breaking waves", *Spill Science & Technology Bulletin*, vol. 8, pp. 499-501, May-June 2003.

[4] P. Tkalich, and E.S. Chan, "Vertical mixing of oil droplets by breaking waves", *Marine Pollution Bulletin*, vol. 44, pp. 1219-1229, Nov. 2002.

[5] M.F. Fingas, "Dispersants: a review of effectiveness measures and laboratory physical studies", In: *Proceedings of Alaska RRT Dispersant Workshop,* U.S. Minerals Management Service: Anchorage, Alaska, 1991.

[6] National Research Council (NRC), *Understanding Oil Spill Dispersants: Efficacy and Effects*, The National Academies Press: Washington, DC, 2005.

[7] M. Li, and C. Garrett, "The relationship between oil droplet size and upper ocean turbulence", *Marine Pollution Bulletin*, vol. 36, pp 961-970. Dec 1998.

Received: December 15, 2014 Revised: January 04, 2015 Accepted: February 25, 2015