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EFFECTS OF WATERY VAPOR CONCENTRATION ON DROPLET EVAPORATION IN HOT ENVIRONMENT

M. J. LEE[1)*], Y. W. KIM[2)], J. Y. HA[3)] and S. S. CHUNG[3)]

[1)]Department of Automotive Engineering, Yangsan College, Yangsan 626-740, Korea
[2)]Nexen Co. LT., Yangsan 626-230, Korea
[3)]Department of Mechanical Engineering, Dong-A Univ., Pusan 604-714, Korea

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ABSTRACT–A study has been conducted to clarify the effect of watery vapor concentration in hot ambient on droplet evaporation. Droplets of water, ethanol, n-hexadecane and n-heptane were used in this experimental study. Ambient conditions are fixed at 470 K in temperature, 0.1 MPa in pressure and 2 m/s in velocity of ambient air. Watery vapor concentration was changed 0%~40% by 10% by add water to air. To obtain the time histories of droplet diameter after exposed in ambient, a suspended droplet in hot and humid ambient stream was synchronized with a back flash light, and enlarged droplet images were taken by a CCD camera. The evaporation rate constant of water droplet decreases slightly with the vapor concentration because diffusion velocity reduction of droplet vapor occurs on the surface. The values of ethanol and n-heptane droplet actively increase by effect that water from condensation of vapor flows into the droplet. The evaporation rate constant of n-hexadecane which has higher boiling point than water increases within around 30% of the concentration.

KEY WORDS : Droplet, Evaporation, Micro-explosion, Evaporation rate constant, Watery vapor, Condensation

1. INTRODUCTION

Many analytical and theoretical studies on evaporation of a liquid fuel droplet have been conducted over a long period of time to elucidate the mechanism of spray combustion (Kiyoshi, 1954; Agoston *et al.*, 1956; Seiichiro, 1952). As results of these studies, the effects of ambient temperature, pressure, and velocity on droplet evaporation have been reported in detail (Chung *et al.*, 1996; Chung *et al.*, 1995; Hiromitsu, 1997). On the other hand, since water or vapor is injected with liquid fuel into the combustion chamber of a diesel engine and a gas turbine to decrease NOx, not a little concentration of vapor is existed in combustion field of fuel spray. Generally, in a case of existence the vapor of same kind of evaporating fuel in combustion field, evaporation rate constant of droplet is regarded to decrease. But, when the watery vapor exists with practical fuel in combustion field, the watery vapor effecting evaporation is not clarified yet sufficiently, and it is important phenomena to analyze the mechanism of spray combustion. By an experimental result about diesel engine efficiency, there was a report that engine efficiency is elevated by the suction of watery vapor with air so as to burn the injected fuel. From the result, watery vapor could be considered as a factor influencing the evaporation of droplet.

In this study, the evaporation rate constant of single suspended droplet by quartz glass fiber in hot and humid environment are reported, aiming at showing the effect of vapor concentration. The CCD camera was provided so as to measure the droplet diameter variation concerned with elapsed time. Water and other liquid samples, i.e., ethanol, n-hexadecane, and n-heptane were selected for the test fuels. With the result obtained, the influence of watery vapor on evaporation rate constant was investigated regarding its relations to hydrophile and dehydrophile property and boiling point of each droplets. The boiling point of ethanol and n-heptane is lower than that of water, and that of n-hexadecane is 560 K.

2. EVAPORATION RATE CONSTANT

When a droplet is exposed to high temperature environment, it is heated and evaporation phenomenon is generated along on its surface. And then, if volume increase rate by heating is higher than volume decrease rate by evaporation, droplet diameter increases. As droplet temperature increases with time elapse, droplet diameter decreases since partial pressure of droplet vapor on its

**Corresponding author*. e-mail: leemj@mail.yangsan.ac.kr