Vaporization order of crude oil during in-situ burning on water

van Gelderen, Laurens; Malmquist, Linus M.V.; Christensen, Jan H.; Jomaas, Grunde

Publication date:
2016

Document Version
Peer reviewed version

Vaporization order of crude oil during *in-situ* burning on water

Laurens van Gelderen[a*], Linus M.V. Malmquist[b], Jan H. Christensen[b], Grunde Jomaas[a]
[a]*Department of Civil Engineering, Brovej 1, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark*
[b]*Department of Plant and Environmental Sciences, Thorvaldsensvej 40, University of Copenhagen, 1871 Frederiksberg C, Denmark*
*Corresponding author: lauge@byg.dtu.dk

Experiments were carried out in order to improve the understanding of the vaporization order during *in-situ* burning of crude oil on water. Such knowledge is integral for estimating the quantities of the chemicals that can be expected in the water layer, residue and smoke plume of burning crude oil in order to predict the burning efficiency and the environmental impact. First, the vaporization order of crude oil was studied qualitatively in relation to its hydrocarbon composition before, during and after the burning. The surface temperature, burning rate, flame height and burn residues of: 1) three alkanes (n-octane, dodecane and hexadecane), 2) a mixture of the alkanes (volumetric ratio of 1:1:1) and 3) two crude oils (DUC and REBCO) were studied to assess their gasification order.

The results showed a clear distinction between the burning characteristics of the three fuel groups. After ignition, the alkanes and the alkane mixture reached a burning state with steady values for the surface temperature, the burning rate and the flame height. Contrarily, the crude oils did not reach a steady burning state, but instead showed an increasing surface temperature and decreasing burning rate and flame height after the ignition phase. These results suggest that the components in crude oil vaporize in the order of increasing molecular weight during the burning. This hypothesis was supported by the residue composition of the crude oil, which had reduced concentrations of the middle fractions and was depleted of all hydrocarbons up to tetradecane. A comparison with conceptual vaporization order models for multicomponent fuels showed that the crude oils best matched the diffusion-limited gasification mode, in which compounds vaporize in order of decreasing volatility, resulting in a constantly changing gas composition.

To confirm the proposed model, more crude oil burns on water will be conducted where the experiments will be stopped manually at fixed times. Samples of the residue, smoke and water will be analyzed with GC-MS to identify their chemical composition. Chemometric analysis should then reveal the chemical composition of the crude oil as a function of the burning duration. Preliminary results are promising and seem to confirm the proposed vaporization mode.