Experiments on unsteady pool fires - Effects of fuel depth, pan size and wall material

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Abstract. This paper presents specifically designed experiments to understand the effect of range of parameters on pool burn behavior with liquid fuels. Experiments have been conducted on pool fires with 0.1 to 2 m diameter pans with depths of 40, 50, 60 and 90 mm with n-heptane fuel depths up to 30 mm floated on water and without water in an indoor fire laboratory. Pans of 0.2 m diameter are made of glass, stainless steel, mild steel and aluminium and larger diameter pans only of mild steel. The experiments conducted include some with fuel initial temperature effects at 300, 319 and 343 K. Data on temporal evolution of mass burn, pan wall temperatures, temperatures inside the liquid at some depths, and gas phase temperatures at select heights from the pool surface have been obtained from the experiments.

Results show that at larger fuel depths of (~30 mm), a burn mass flux of 60 – 75 g/m²s was reached even in 0.2 mm dia pans. This flux is expected only in large pans of about 2 m size. In respect of pan material effect, glass pans show mildly increasing low flux values (10 to 15 g/m2s) and mild steel and aluminum pans show an initial low flux value (_ 10 g/m2s) and then a sharp change to large flux values depending on the depth. At larger depths, the flux values go up to 65 g/m2s. In respect of stainless steel, the mass flux variation occurs smoothly all through towards increasing values. In respect of the water depth below the fuel, the decrease in the average burn rate is about 1 % per mm water depth up to 20 mm for all pans below 0.5 m diameter. Larger size pans with burn rate controlled largely by radiation show much reduced effect of the water depth. In order to correlate the data with diverse parameters, a dimensionless number, M_{pc} has been invoked using scaling laws and a correlation that provides a good estimate of the mass burn flux including all the effects considered above has been deduced. The data set generated as above provides the basis for a more detailed model to predict the mass loss history and other parameters.

Keywords. Pan fire, Burn rate, Scaling laws