Study the behaviour of highly flammable liquid pool fires in varying ventilation conditions

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ABSTRACT

Flammable liquid pools are believed to be one of the potential fire hazards in various industries especially in oil and gas industries. Following an ignition, in an enclosure or open space, the sustainability and growth of pool fires largely depends on certain factors viz. type of flammable liquid, rate of vaporization, and availability of fuel in the pool and oxygen from the atmosphere. The temperature rise within an enclosure chiefly depends on the heat release rate of the fire hence the heat release rate will keep on increasing until it reaches a steady state. In contrast to the enclosed pool fires, open space pool fires will dissipate heat radiation more to their surroundings and vigorously burn due to availability of ample amount of oxygen. The main purpose of this research is to understand the differences in fuel consumption rate for various flammable liquids while combustion is ongoing and with respect to different ventilation conditions.

INTRODUCTION

A liquid pool fire undergoes the following stages, initially heat-up of the liquid is required, following evaporation process and finally combustion will take place. There is a strong interaction between fuel evaporation and combustion. The burning rate follows two behaviours either a fuel controlled[1] or ventilation-controlled[1] fire. Fuel controlled is when the available fuel vapor produced mixed with oxygen is enough for the fire to continue burning. When so much fuel vapor is produced compared to the amount of oxygen available, the fire becomes ventilation controlled. As a fire becomes ventilation controlled, its rate of fire growth and heat release rate will decrease, and the fire may extinguish itself[2, 3].

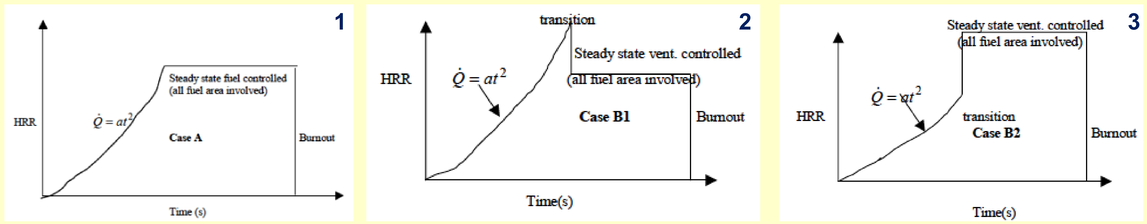

Figure: 1. Fuel controlled steady state fire scenario, 2. Ventilation controlled steady state (zero oxygen), 3. Ventilation controlled steady state (critical heat flux)

METHODOLOGY

A series of experiments will be conducted involving highly flammable liquids, probably two to three types of pure liquids and their blends. The fuels will be ignited in a controlled environment and in a limited quantity which may not pose hazard to the surroundings.

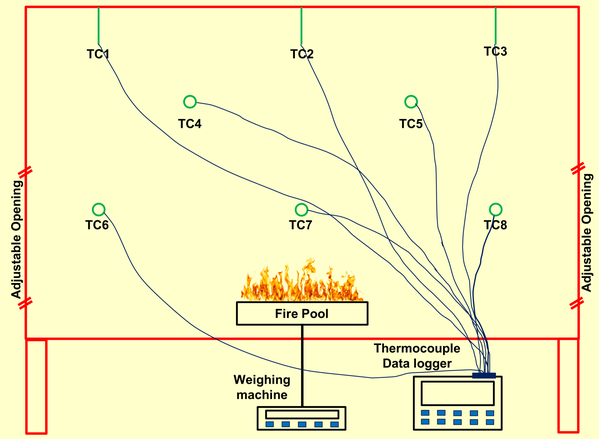

Figure 4: Pool fire experiments using an enclosure.

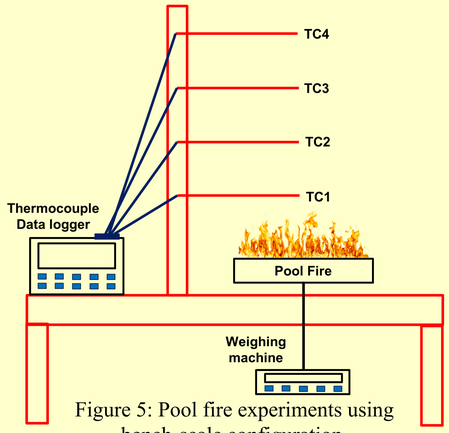

Figure 5: Pool fire experiments using bench-scale configuration.

EXPECTED OUTCOMES

Understanding liquid pool fire characteristics and its fuel consumption rate, flame temperature, heat release etc. are significant aspects of fire dynamics. An understanding of the rate of mass burning from a series of small-scale flammable liquid pool fire tests will be helpful to fetch substantial information. The experiments and will enable us to understand fire dynamics evolve with flammable liquid pool fires.

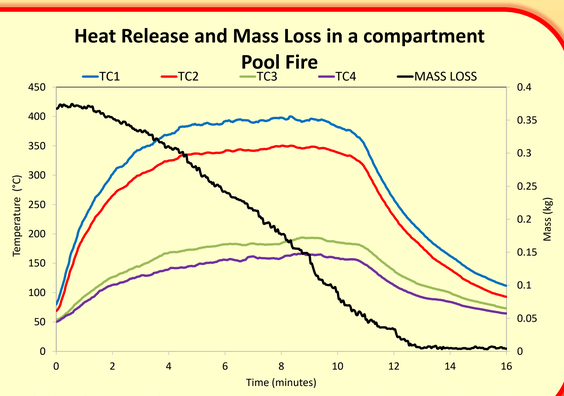

Figure 6: Heat Release and Mass Loss in a compartment pool fire through pilot experiment.

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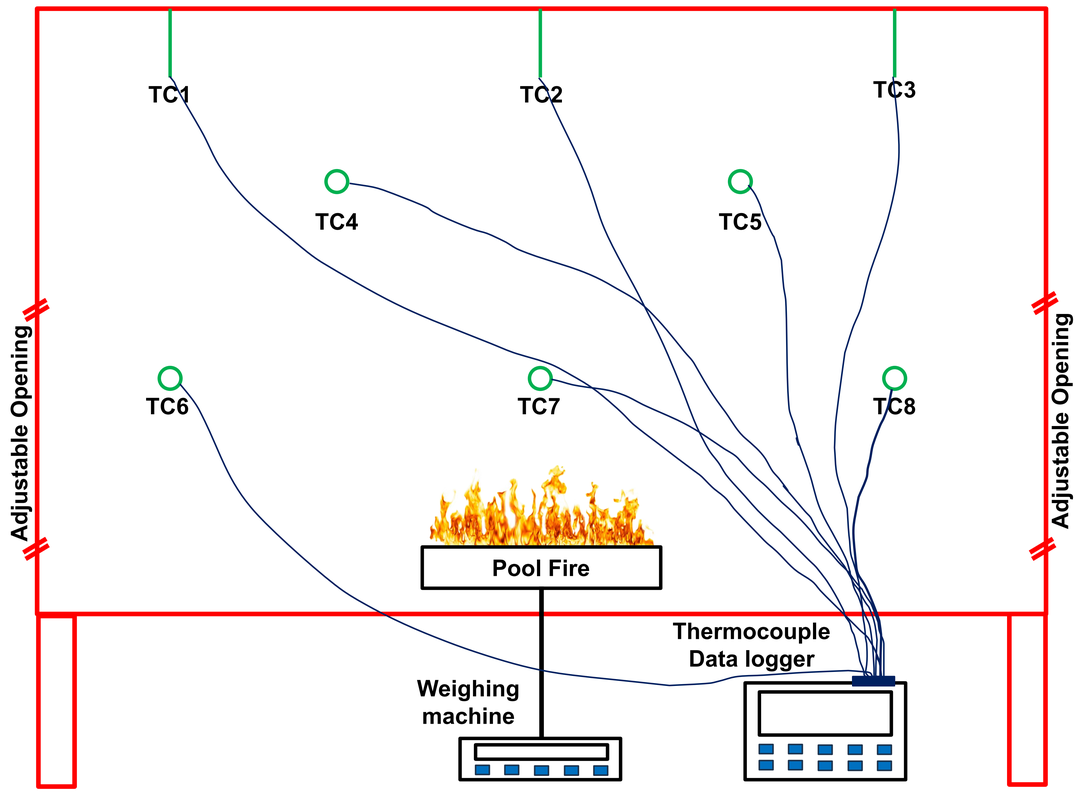
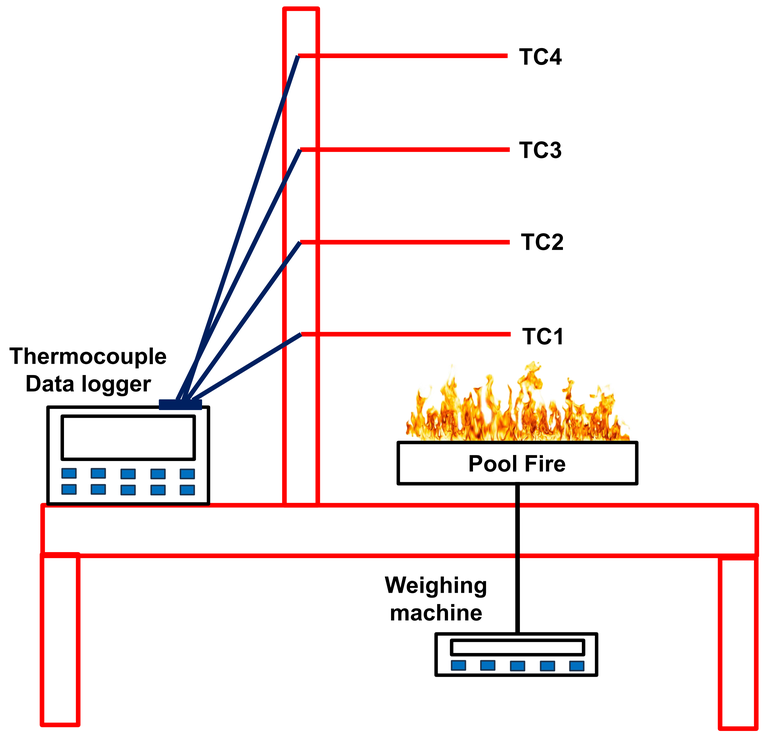

TC1
TC2
TC3
TC4
TC5
TC6
TC7
TC8
Adjustable Opening
Adjustable Opening
Pool Fire
Weighing machine
Thermocouple Data logger


TC4
TC3
TC2
TC1
Thermocouple Data logger
Pool Fire
Weighing machine

Heat Release and Mass Loss in a compartment Pool Fire