

A SCHEMATIC STUDY ON MODELING AND SPRAY FLASH EVAPORATION BASED ON DROPLET ANALYSIS

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ABSTRACT:

Extreme flash evaporation happens whilst superheated liquid is sprayed into a low strain area. This approach has excessive capability to enhance the performance of thermally-pushed desalination flowers. To permit a better expertise on flash evaporation of a superheated feed water spray, a theoretical version has been advanced with key considerations given to droplet motion and droplet length distribution. The model has been established in opposition to 14 experimental facts units from literature sources to within 12% discrepancy. This version may want to provide correct information for the droplet pyrolysis and help to optimize the answer precursor plasma spray manner. We show that the fragmentation of the liquid inventory and its vaporization in particular dominate the spraying information and may be decisive to the coating satisfactory. We similarly inspect their position in SPPS and one by one probe their inner hyperlink with the glide discipline regarding the one-of-a-kind place while droplets are flying via the thermal float field.. The blended experimental and numerical investigation provided specified know-how of the gasoline injection manner and the spray conduct.

Keywords: Superheat, Flash vaporization, flashing efficiency, Saturation temperature, Spray nozzles

1.0 Introduction:

Accurate spray nozzle drop length is an vital aspect inside the ordinary effectiveness of your spray operation. Drop length is especially important in spraying programs along with gasoline conditioning and in the cooling of liquids and solids. To correctly determine drop length for a given nozzle, the evaluation and information collection techniques need to be absolutely understood. The form of instrument, method of collection, way of

interpretation of raw facts, and reporting procedures all play a chief function in figuring out drop size performance.

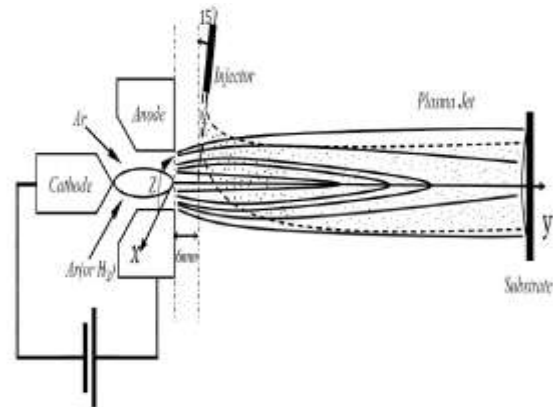


Figure: A schematic view spray splash droplet unit

Nozzle flow and near-nozzle spray flash characteristics:

The first set of consequences to be offered refers back to the internal nozzle waft and its impact on the near-nozzle spray characteristics. Since in this location reliable measurements are very hard to be acquired, the laptop model has been used to provide a demonstration of the distinctive -segment glide strategies the inner nozzle drift is in particular decided by the strain drop on the needle seat area and the entrance to the injection holes. For the specific injector design investigated here, the needle seat pressure drop can be huge relative to the rail pressure, as proven in Figure for a needle raise of forty. This is pondered within the spray speed and the resulting droplet length at some point of the brief segment of the needle beginning and last. During that length, droplet

velocities are much smaller than inside the main injection segment and droplet diameters notably large. Also, even at full elevate, the actual injection pressure is set ninety% of the rail strain

Description of initial spray conditions:

The spray computations facilitate the use of multiple fuel injectors. The same or a different type of liquid fuel can be specified for each one of different injectors. The initial droplet temperature is assumed to be the same for all different droplet groups of a given injector. The liquid fuel injection is simulated by introducing a number of discretized parcels of liquid mass at the beginning of every fuel-injection time step; the initial droplet distribution for a given injector could be specified by making use of one of the three available options:

- by providing a complete specification of the initial conditions by means of a spray table,
- by means of some available correlations, or
- by means of some available primary atomization models

Spray flash imaging:

Spray images have been obtained using a CCD camera, which was synchronized with the injection pulse. The images revealed that the injector needle opening delay time relative to the triggering signal was about 0.6ms, while the end of injection was at about 1.8ms. This resulted in actual injection duration of 1.2ms for a triggering signal of 1.5ms duration. The needle opening and closing delay times proved to be quite independent of the injection pressure and chamber pressure. These effects can be clearly seen in the needle lift curve in the figure. The spray cone angle and tip penetration data were obtained by post-processing of the images,

which quantified their dependency on injection conditions.

2.0 Literature review:

Allocca, G. Valentino, (2001) the insulated chamber sits on top of a heating plate with a temperature control and an operating range between 20°C and 100°C. Considering the low injection repetition rate of 1Hz and the low fuel quantity injected during the 0.8ms injection duration, nominally 10 and 7 mg per shot for the 60° and 90° injectors respectively, it was assumed that conductive heat transfer through the injector was the main physical process affecting the temperature of the fuel injected into the chamber. Hence injector temperature was equal to the temperature of the chamber.

Stansfield, M. Mojtabi, (2007) Research on spray formation from pressure-swirl injectors has attempted to explain the reasons behind spray collapse. Work carried out by using fluorescent particle image velocimetry showed that interaction between the spray and the surrounding air caused the formation of vortices on the inside and outside of the spray cone. The inner vortex was seen to pull in air from the outside of the cone and these dragged relatively small droplets with it, causing the edge of the spray to curve and eventually collapse.

Delay, R. Bazile, G. Charnay (2004) the spray streams about the injector axis. Inspection of the 0.5bar image shows that there is no physical rotation of the spray, rather, additional interstitial streams develop between the main streams and the main streams themselves disperse, as observed by once the pressure has reached 0.2bar, the original streams are almost invisible and the interstitial streams dominate the spray. As the pressure is further reduced these streams extend in the radial direction and increase in width. It is

also noticed at 0.1bar that more streams grow in between the interstitial streams

Chen, H., M. Xu, G. Zhang, (2010)

When the droplet temperature is slightly higher than the boiling point, the evaporation rate is moderate and its controlling parameter would be the vapor diffusion rate. However, the droplet could be heated dramatically in the plasma jet with the core gas temperature as high as ten thousand degrees, and reach a droplet temperature much higher than the boiling point. Then, flash evaporation occurs and results in a large evaporation rate. In this case, the evaporation rate mainly depends on the heat transfer rate.

3.0 Methodology:

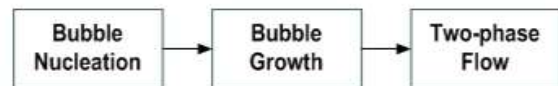
The process of droplet vaporization is of great importance in many energy systems involving spray combustion such as diesel engines, gas turbines, liquid rocket engines, industrial furnaces, etc. In a general way, without accounting for droplet burning at injection, the liquid fuel atomizes into multiple droplets of different sizes, creating a polydispersed spray, the fuel droplets vaporize, the gaseous fuel mixes with the oxidant and then burns. In this type of studies the prediction of the gaseous fuel concentration is of primary importance for the correct evaluation of critical parameters, such as flame position and heat release another approach is to study the evaporation of single droplets, under different conditions, as a first step towards the understanding of the process in a spray. An isolated droplet represents an ideal model of the physical phenomena involved in the diluted regions of the spray

Droplet Velocity: Measurement of droplet velocity throughout the spray would help confirm whether the collapse is due to movement of particles inwards towards the spray axis due to air movement caused by formation of vortices, similar to the

collapse of pressure-swirl injector spray. All the three multi-hole injectors, used in the plume interaction study described in section have established sprays at a height of 20mm below the injector nozzle

Flash Boiling Theory:

Flash boiling occurs when a sub-cooled liquid is rapidly depressurized to a pressure sufficiently below the saturation pressure of the liquid the fuel is then defined as superheated. Such a system is in a state of thermodynamic non-equilibrium and thus unstable. The system regains equilibrium by undergoing flash boiling summarized current knowledge on the flash boiling mechanism. It was found that there are three stages to flash boiling



Bubble nucleation is classified into two groups:

- Homogeneous, in which nucleation sites form within the liquid itself, in the absence of any bubble nuclei, with a homogeneous distribution this process becomes predominant when the liquid pressure is greatly reduced.
- Heterogeneous nucleation occurs when gas and solid phases appear at an interface or a boundary rather than in the liquid
- Whilst the bubble is still relatively small, the rate of growth is low and restricted by surface tension of the bubble.

Table: Test cases for cold spray characterization

O	T	P	P	T	
P	fuel	rail	chambe	chambe	
	[°C	[bar	r [bar]	r [°C]	
]]			
1	-10	200	15	20	0.4

2	-10	200	15	20	0.4
3	-10	100	1	20	0.4

The averaged spray images for the time instant 0.5 ms after the visible injection are displayed in Figure In all cases, almost axially symmetrical fuel sprays around the injector axis were observed. Very compact sprays with strong recirculation zones at the propagation front can be observed in the test cases OP01 and OP02, where the chamber pressure is 15 bar

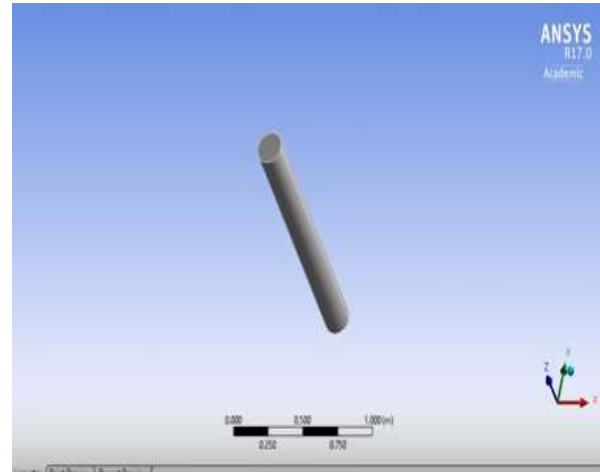


FIGURE: SPRAY FLASHDROPLET INTIAL VIEW

4.0 Results:

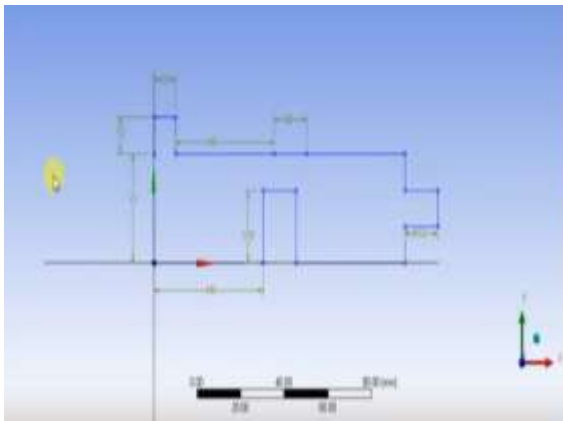


Figure: Geometric model of spray flash 3D view

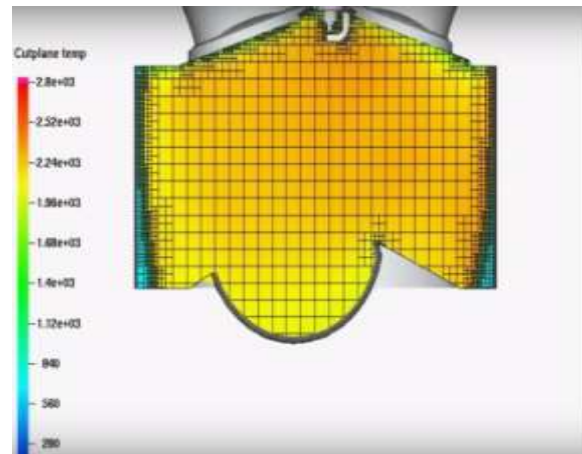


FIGURE: CUPLANE TEMPERATURES

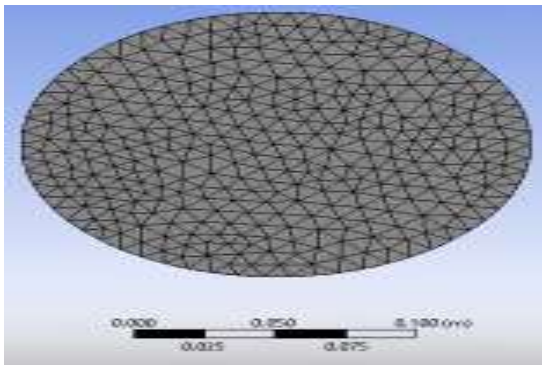


Figure: Droplet nozzle top view

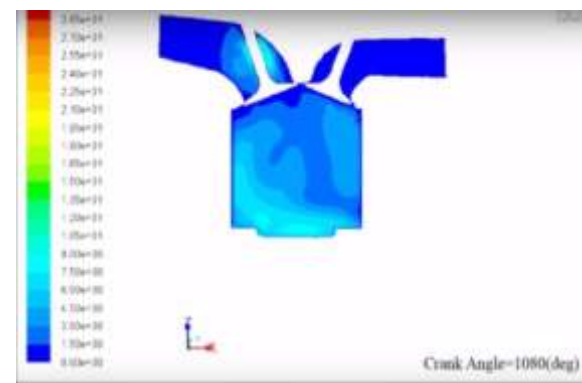


FIGURE: CRANK ANGLE

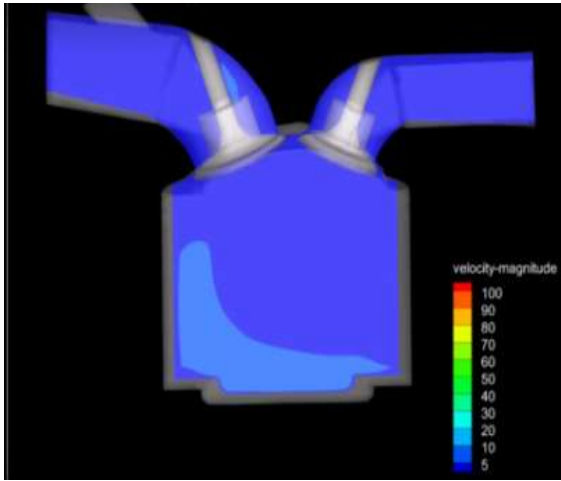


FIGURE: VELOCY MAGNIUDE

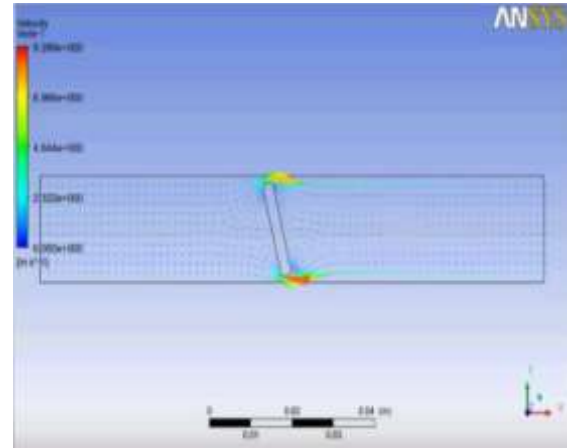


FIGURE: SINGLE WHOLE VELOCITY 1

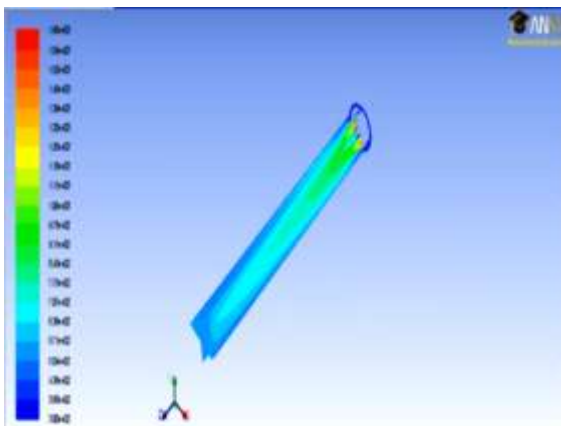


FIGURE: CONTUR OF STAIC TEMPERATURE

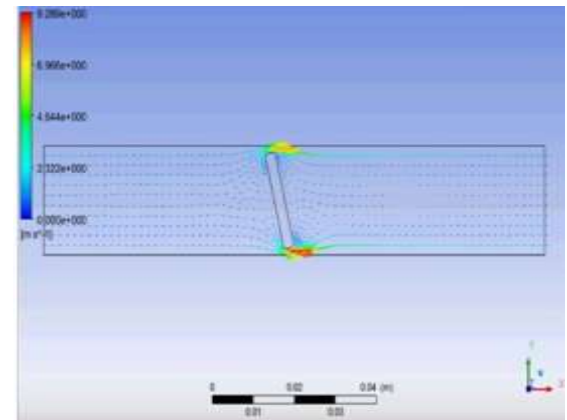


FIGURE: BOTH SIDE FLOW VELOCITY COUNTER-1

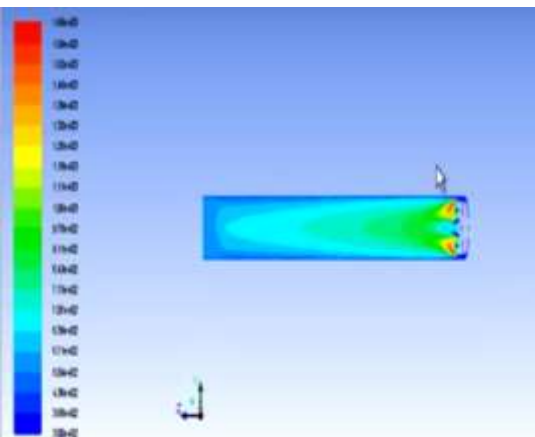


FIGURE: CONTOUR OF STAIC TEMPERATURE HORIZONTAL FLOW

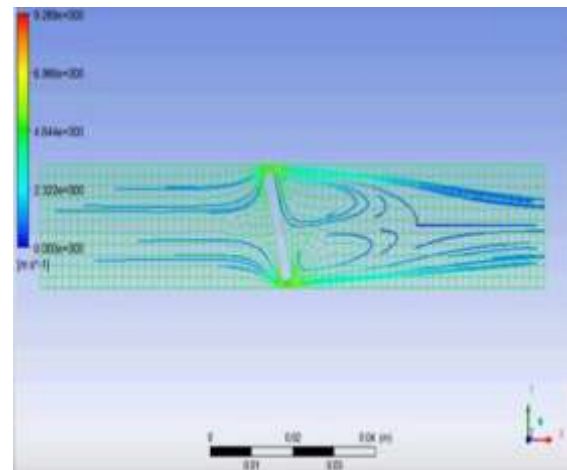


FIGURE: VELOCITY STEAM LINE1

Table 4.1 Spray flash analysis different variation

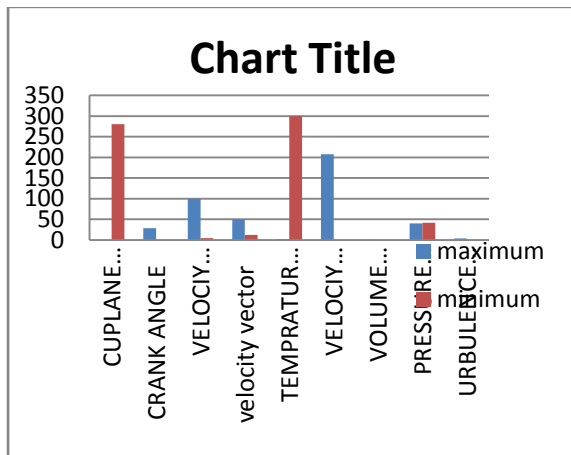
Spray flash single whole analysis:

parameters	maximum	minimum
cuplane temperatures	2.83+03	280
crank angle	2.85e+01	0.00e+000
velocity magnitude	100	5
velocity vector	50.000	12.500
temperature counter	2.640e+000	3.000e+002
velocity counter	2.072e+002	0.00e+000
volume counter	1.000e+000	0.000e+000
pressure counter	4.0610e+001	4.211e+001
turbulence kinematic energy	3.763e+000	4.857e-002

injection system, the sac-volume and injection holes and a phenomenological nozzle whole cavitation. In addition, a cavitation-induced atomization model was used to provide estimates of the liquid velocity increase due to whole cavitation and the corresponding effect on the size of the droplets formed during the atomization process of the injected fuel. The results have shown that cavitation is the main flow factor that determines injection velocity and initial droplet size. At the same time, internal flow simulations have shown that multi-hole injectors with a central hole have an uneven flow distribution which results to an over penetrating and unstable spray flash, as also confirmed by CCD spray images.

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Graph: 4.1 Spray flash analysis different variation CONCLUSION:

The internal nozzle flow and the near nozzle spray characteristics have been estimated by employing a combination of computer models. Those comprised a 1-D model simulating the flow inside the