PERFORMANCE IMPROVEMENT ON WATER JET NOZZLE BY END HENCING NOZZLE SPREAD AREA

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ABSTRACT:

In this paper we present a 'Computational Fluid Dynamics (CFD)' based simulation model for design of fixed nozzle and our primary aim is analyse the flow characteristics of a fixed nozzle for effective atomization at the outlet through CFD analysis. Our proposed simulation model is implemented in the 'ANSYS-Fluent* software solution system. Simulation model is structured in step-wise modules and consists of three steps: Step 1 – Computer Aided Design Model of the nozzle in 'CATIA', Step 2 – Flow simulation model for the inside flow of the nozzle to predict the mass flow rate values at the exit of the nozzle, and Step 3 – Analysis model for the effect of atomization process that happens at the nozzle outlet. These three steps follow for three different design of nozzle and Analyses are utilized to compute the optimum size of the droplets and their distribution, and nozzle spray cone angle, etc.,

1. INTRODUCTION:

The Gorlov wind turbine is a type of vertical axis wind turbine (VAWT) consists of helical blades which is a unique design optimized for areas where the air flow is low and erratic. It is

As India is said to be an agriculture-based country, we can observe that the farmers are using conventional equipment which have little to no development in past few years [1]. One of such equipment is Pesticide sprayer. Due to increase in labour cost and decrease in labour availability there is a need to increase efficiency and decrease in time consumption for such equipment. So, to minimize human effort by maximizing working efficiency of conventional pesticide pump by altering pumping actuation mechanism is our goal. The pumping function is done by two individual piston pumps which are operated by a self-design bell crank-based actuation mechanism connected to individual legs/thigh. This can spray twice as much as fluid as of a conventional single piston hand operated pump. This will help saving time and human efforts. To investigate the flow, pressure, and structural durability we used ANSYS Fluent and ANSYS static structural model. (For such we used no slip streamline model for CFD).

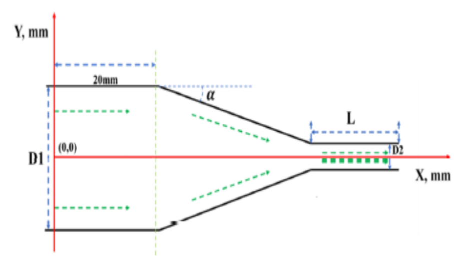
1.1. WATER SPRAY NOZZLE

Water jet is an emerging technology developed rapidly in recent years and used in many fields. This

cut materials, perforate, break coalbeds and rock, and wash wellbore.1−6 Tailored to different applications, several nozzle structures or shapes have been proposed, such as a self-excited oscillation jet nozzle and a venturi nozzle. The self-excited oscillation jet nozzle including the Organ nozzle and the Helmholtz nozzle7 can generate both pulsing and cavitation jets. Venturi nozzles are often used in the aerospace industry, energy, and metering, for instance, in the transmission of flow standards,8 gas flow measurement, and the maximum flow limitation of the flow system.9 Spray nozzles are used in irrigation due to their better atomizing ability. The rotating multi-orifice nozzle can be used in drilling in petroleum fields.10,11 Some other non-circle nozzles have been investigated in recent years for abrasive jet cutting and spray irrigation.12−14 Among these, cone-straight nozzles are most widely used in the petroleum field due to their relatively simple processing.

Nozzle geometry directly affects the performance of jets, which are further used for subsequent applications such as cleaning, cutting, and drilling. The cone-straight nozzle's geometry comprises a converging section, a throat section, and a reaming section. The converging section is used to concentrate the fluid and energy,

The primary parameters of the nozzle geometry are the converging angle and throat length and have been investigated by experiments and simulations. Many researchers have investigated the influences of various parameters on a jetting



angle, jetting length, and impact force,15−17 especially in breaking rocks, such as coalbed,3 sandstone, and gas hydrate. The researchers concluded that the nozzle has a critical converging angle and throat length that can obtain the longest flow core. The better converging angle is 13−15°, and the better throat length is 2−4 times the nozzle diameter. Some researchers focused on the studies of the nozzle outline, and a streamlined curve (e.g., Sine curve, Gaussian curve, and Wyszynski curve18) is used as the nozzle geometry. Many simulations are simulated to discover the difference in flow speed distributions and pressure loss between the cone straight nozzle and streamlined nozzle. Jiang et al. investigated the internal flow characteristics with simulations but only focused on one type of nozzle and analysed the near-wall flow field.19 They found that the pressure loss is lower when the fluid flows through a streamlined nozzle

Nozzles:

Nozzles are the last elements traversed by the flow of chemicals during the spraying operations. Nozzles are made of different materials (aluminium, copper, brass, stainless steel, ceramic and nylons), and different types (flat fan, cone type, hollow cone, straight etc.)

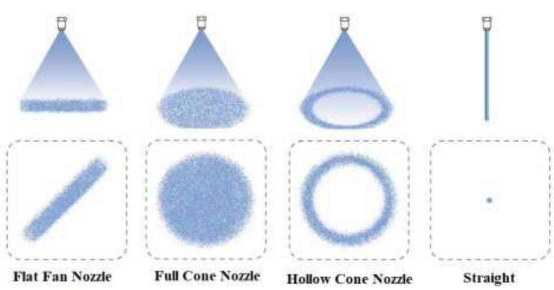


Figure 1.3 Different shapes of nozzles

The main role of the nozzle is to provide uniform application of spray at the target surface. Nozzle selection depends upon different factors such as crop type, crop height, crop growth stage, pressure requirement, and droplet size and velocity (Fig. 1-4)

Losses during field spraying operations constitute a significant problem. Previous research showed that uniform distribution of spray is very important, 30% of agricultural pesticide sprayed is lost during spraying due to the non-uniformity of droplet size and off-

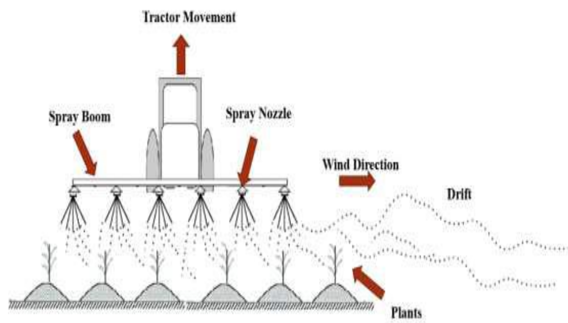


Figure 1.4 Demonstration of spray drift during field operation.

2.LITRAURE REVIEW

1. VaricoticVasanthRao B. et al (1) In this paper, the authors discuss the design and fabrication of an innovative multiple power supplied fertilizer sprayer A two stroke petrol engine which conventionally used to power the sprayer is replaced DC which is run using a battery unit that can be externally charged. The application of the unit is done for spraying fungicides, pesticides, etc.

2. Liukin P. Raut et al (2) The authors in their paper bring forth the ability of mechanization towards the conservation of agriculture inputs, losses prevention thereby reducing the labor cost per unit and thus attain the best productivity. The authors also show the disadvantages of the conventional agriculture practices in spraying and weeding and propose a combination machine for the spraying and weeding activity.

3. Sumit d. Raut et al (3) The authors in their study describe a pedal operated reciprocating pump for application in drainage lines, orchards and large irrigation projects. In order to evaluate performance of the pumps for various suction heads different pump models were tested. The said pump was proposed to replace the conventional backpack sprayer which is in traditional use with the objective to reduce the human effort. The proposed pump was said to need less power input there by operated continuously over a span of more than 2 hours by an adult labor in agriculture field continuously without getting tired. The authors also stress the importance of pump in generating local employment as it can be made from locally available materials, using simple skills ofskills of manufacturing at low cost. The pump shows utility in irrigation of vegetables, seed beds etc. for low to medium plot size.

4. Shiva raja Kumar et al (4) Application of pesticide is for killing insects or control their rate of reproduction. Through optimum performance with minimum efforts the sprayers are used to apply these pesticides, and herbicides, fertilizers are applied to crops in agriculture in order toto obtain the maximum output as agricultural produce. Authors show some difficulties in development of sprayers such as increase in tank capacity results in cost augmentation, labour cost as well as spraying time. Authors propose various solutions targeted to reduce the above-mentioned problems and also target to reduce the fuel cost in pump operations, the proposed wheel operated pesticide spraying equipment consumes less effort and time and avoids the person who sprays pesticides with any contact of pesticide ejecting front of the nozzles. The mechanism incorporated in this sprayer is reciprocating pump, which is driven by the wheel system.

5.M. V. Acheta, SainathChandran, Natraj G.K.), concept design and analysis of multipurpose farm equipment. , International journal of innovative research in advanced engineering (IJIRAE) ISSN: 2349-2763 ISSUE 02 , Volume 3 (February 2016). From this paper we learned about the agricultural scenario of INDIA. We learned about the spraying methods protect crops and trees against deceases and insects Shailesh Malone.

3.METHODOLOGY:

The following methodology is being adopted to carry out the above-mentioned objectives:

1. The ANSYS achieved by nozzle performance and CAD model was designed by CATIA V5

2. Using ANSYS the solver the performance improvement from existing design

3. All these designs are designed using Catia v5R20 software

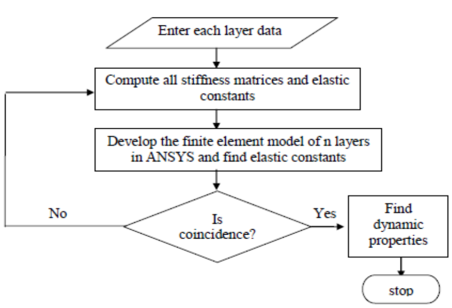


Fig.3.1 shows present methodology.

3.1 INTRODUCTION TO CATIA

CATIA which stands for computer aided three dimensional interactive applications is the most powerful and widely used CAD (computer aided design) software of its kind in the world. CATIA is owned/developed by Dassault system of France and until 2010, was marketed worldwide by IBM.

The Following general methodologies and best practices can be followed in the modelling of components in CATIA. The Below methodologies and Best practices followed will help in capturing the design intent of the Feature that is to be Modeled and will make the design robust and easy to navigate through.

4. COMPUTATIONAL ANALYSIS

ANSYS CFX software is a high-performance, general purpose fluid dynamics program that has been applied to solve wide-ranging fluid flow problems for over 20 years. ANSYS CFX is more than just a powerful CFD code. Integration into the ANSYS Workbench platform provides superior-directional connections to all major CAD systems, powerful geometry modification and creation tools with ANSYS Design Modeler, advanced meshing technologies in ANSYS Meshing, and easy drag-and-drop transfer of data and results to share between applications. For example, a fluid flow solution can be used in the definition of a boundary load of a subsequent structural mechanics simulation. A native two-way connection to ANSYS structural mechanics products allows capture of even the most complex fluid–structure interaction (FSI) problems in the same easy-to-use environment, saving the need to purchase, administer or run third-party coupling software. For more

than 20 years, companies around the world have trusted ANSYS CFX technology to provide

reliable and powerful computational fluid dynamics (CFD) solutions. ANSYS CFX combines

advanced solver technology with a modern user interface and an adaptive architecture to make CFDaccessible to both designers with general engineering knowledge and fluid dynamics specialists requiring in-depth model control and options. It is used in a vast array of industries to provide detailed insight into equipment and processes that increase efficiency, improve product longevity and optimize processes.

Object Name	*Solid*
State	Meshed
Graphics Properties	
Visible	Yes
Transparency	0.1
Definition	
Suppressed	No
Coordinate System	Default Coordinate System
Reference Frame	Lagrangian
Material	
Assignment	
Fluid/Solid	Defined By Geometry (Fluid)
Bounding Box	
Length X	2100. mm
Length Y	900. mm
Length Z	1320. mm
Properties	
Volume	2.4843e+009 mm^3
Centroid X	-301.26 mm
Centroid Y	-1.1157e-014 mm
Centroid Z	360.08 mm
Statistics	
Nodes	47433
Elements	245156
Mesh Metric	None

Coordinate Systems

TABLE 4
Model (A3) > Coordinate Systems > Coordinate System

Object Name	*Global Coordinate System*
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	0.
Origin	
Origin X	0. mm
Origin Y	0. mm
Origin Z	0. mm
Directional Vectors	
X Axis Data	[1. 0. 0.]
Y Axis Data	[0. 1. 0.]
Z Axis Data	[0. 0. 1.

TABLE 3

Object Name	*Mesh*
State	Solved
Display	
Display Style	Body Color
Defaults	
Physics Preference	CFD
Solver Preference	CFX
Relevance	0
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Fine
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
Curvature Normal Angle	Default (18.0 °)
Min Size	Default (0.38520 mm)
Max Face Size	Default (38.520 mm)
Max Size	Default (77.040 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	20.0 mm
Inflation	
Inflation Option	Smooth Transition
Transition Ratio	0.77
Maximum Layers	5
Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Patch Independent Options	
Topology Checking	No
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Shape Checking	CFD
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	
Pinch Tolerance	Default (0.346680 mm)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (0.19260 mm)
Statistics	
Nodes	47433
Elements	245156
Mesh Metric	None

SETUP:

The ANSYS CFX physics pre-processor is a modern and intuitive interface for the setup of CFD analyses. In addition to a general mode of operation, predefined wizards are available to guide users through the setup of common fluid flow simulations. A powerful expression language gives users the ability to customize their problem definition in numerous ways, such as with complex boundary conditions, proprietary material models or additional transport equations. The adaptive architecture of CFX-Pre even allows users to create their own custom GUI panels to standardize input for selected applications, and thereby ensure adherence to established best practices. In this context as mentioned earlier the boundary conditions are definenditions were all.

5.RESULT AND DISCUSSION

Design 1

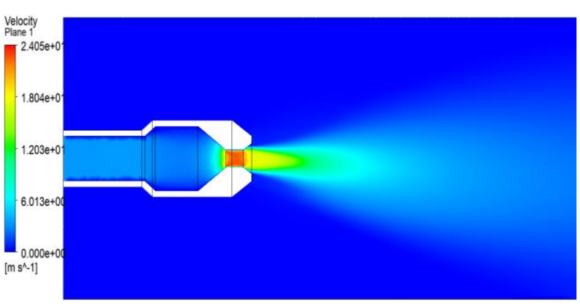


Fig 5.1.velocity flow on old design

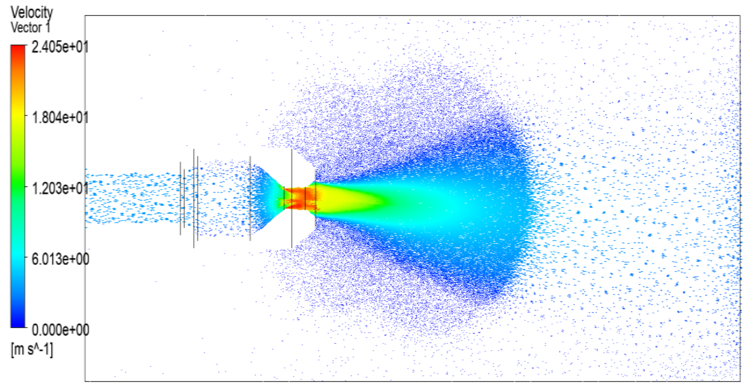


Fig 5.2. velocity flow in vector formation old design

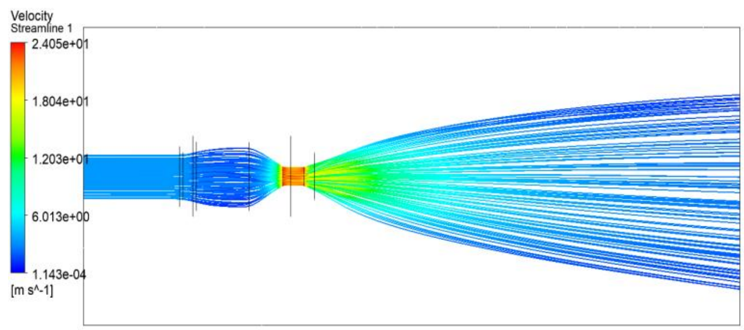


Fig 5.3. flow path stream line of old design

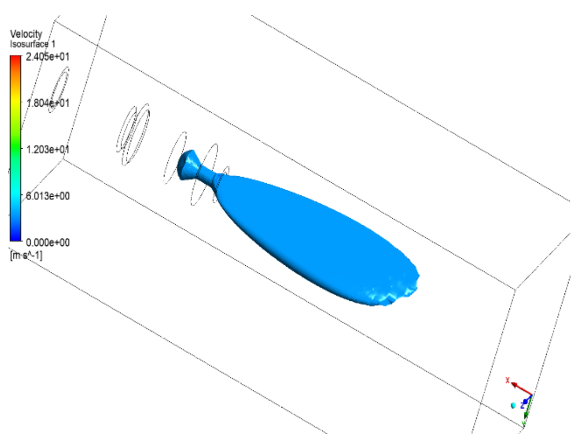


Fig 5.4. iso surface of flow of water

Design 2

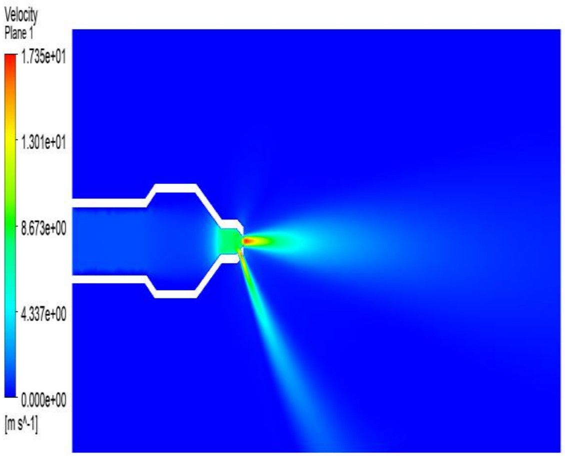


Fig 5.5. velocity flow on Design 2

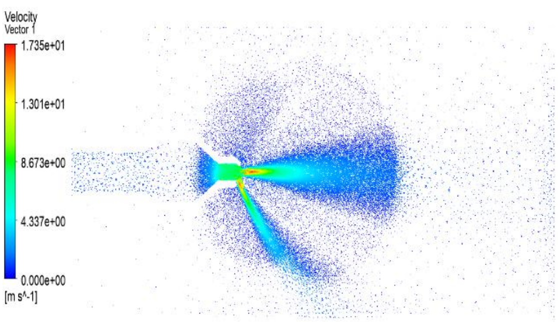


Fig 5.6. velocity flow in vector formation design 2

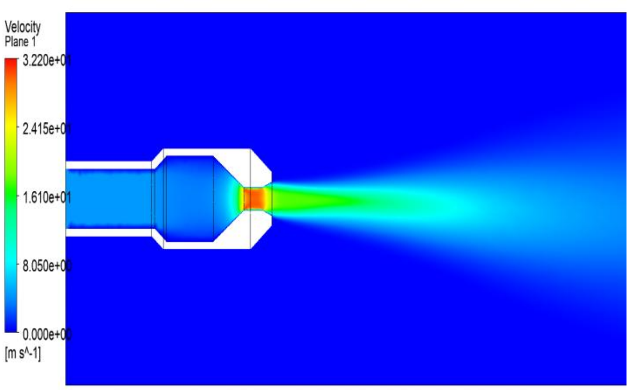


Fig 5.10. velocity flow on Design

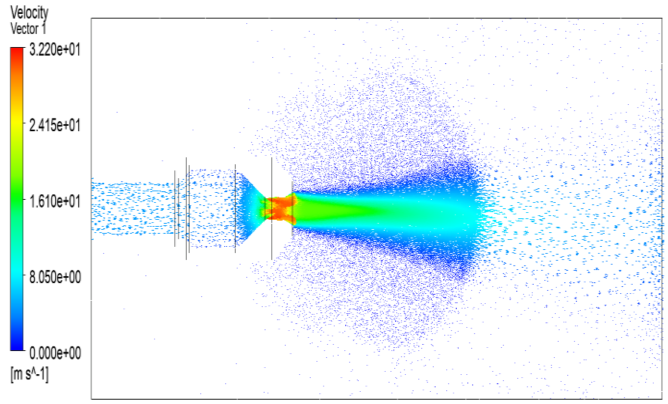
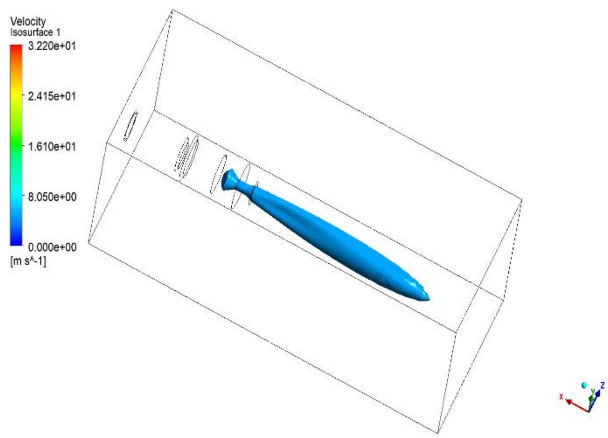


Fig 5.11 vector form of design 3 flow pattern



6.CONCLUSION

In this paper, an effective optimization of a nozzle configuration for water jetting has been performed. The superiority and reliability of the designed object, which shows better performances in terms of dynamic pressure, velocity flow area. Because the flow around the variable-area channel can dramatically change the location where particles collide and produce l, causing local resistance loss, we have inserted a pliable structure in the nozzle's inner surface in order to increases the performances of the nozzle according to the principle of a helical accelerator. Comparing all result from finite volume based method the design 2 get more are which is covering more area that flow velocity 17.35m/s this flow all holes and it reach maximum area.

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