

Optimizing Effect of Venturi Size on Integration of Hybridized Drip and Sprinkler Irrigation System

Dr. Lakshmi Kunhikrishnan¹, Dr.J.Elanchezhian², Dr.K.Karnavel³, Mrs.P.Aruna⁴,
Dr.V.V.Rajasegharan⁵, Mr. Dhianeshwar, J⁶

^{1,2,4,5}Associate Professor, ³Professor, ⁶Research Scholar

¹Department of Chemistry, Chettinad Institute of Technology, Chettinad Academy of Research & Education, Chennai, India.

^{2,6}Department of Mechanical Engineering, Anand Institute of Higher Technology, Chennai, India.

³Department of Information Technology, Anand Institute of Higher Technology, Chennai, India.

^{4,5}Department of Electrical & Electronics Engineering, Anand Institute of Higher Technology, Chennai, India.

Abstract- A proper irrigation system is considered as the back bone of agriculture. To provide a channelized irrigation system various irrigation setups and techniques are targeted to meet different yields and for different purposes. Cheyyur has two major types of crops cultivated in two different seasons with two different irrigation setups. The irrigation setups need to be changed whenever the crops are changed. These difficulties not only cause wastage of water but also decreases the overall yield of the crops. To improve the improvement facilities a hybridized setup was modelled fabricated and implements in and around the parts of Cheyyur district to improve their irrigation abilities. The proposed project was accepted by the department of science and technology. The hybridized model was designed and fabricated. Optimization of the flow of the suction pressure was conducted and simulation has been carried out using Genetic Algorithm and performance was analysed using Fminconalgorithm in MATLAB to hybridized and integrate the two different irrigation system. Modelling studies were carried out to improve the suction and the control flow rate of 986 litres per hour to 70 Litres per hours to the agricultural field. This applied optimization technique proves to improve the yield of the crops.

Keywords- Irrigation, Sprinkler Irrigation, Drip Irrigation, Venturi.

I. INTRODUCTION

Agricultural activities are considered as the most important occupation in India. One factor that contributes to an effective agricultural performance is the Irrigation process used in the agricultural setup. Many parts of the county are reliant only on natural sources such as surface water, ponds, and municipal water. Some areas have drilled wells to support their irrigation system. Due to unreliable sources available for irrigations, there is a non-uniform usage of water affecting the efficiency of irrigation process [1]. An effective irrigation system is highlighted only where there is minimum loss of water. Minimum loss of water is achieved by proper management of irrigation. There is various water management system for different geographical conditions [1].

Effective use of water is achieved by proper planning of the irrigation systems. We have used 2 types of the irrigation systems to offer a better water management in and around parts of the Cheyyur. Wide survey on the different groups of the

individuals shows that there are 2 types of crops in their agricultural processes. The 2 crops were groundnuts and watermelon. Watermelon is cultivated and harvested in between the months of January and April. Similarly, groundnut is cultivated and harvested in between the months September and November. In the parts of Cheyyur, the major source of income is through harvest from these major crop sources. So the farmers in that zone are dependent on the profits that they achieve from harvest. Since the harvest of these 2 major crops are three to four months in par with each other, the farmers are in a verge of creating profits for investing on the crops for the next cycle.

Most of the Farmers in the targeted region are does not have the proper irrigation system to provide a better yield to their cultivation. Also since we have 2 crops in 2 different seasons, the demand for 2 different irrigation system is contributing to further more pain to farmers. It is to be highlighted that farmers do not adopt to any modern irrigation technique due to this very reason. With the change in the crops with respect to the seasons,

the farmers cannot invest in the irrigation systems. This pressurizes the farmers to follow traditional irrigation systems. The traditional irrigation systems on [2] the other hand leads to higher requirements of water. Water is channelized through manmade cavities to the crops. This can either cause over supply of under supply of water. When there is over supply of water, the natural nutrients of the soil are lost and when there is under supply of water to the crops, the function yield decreases. In order to counter their needs and provide them an ample irrigation supply, we targeted identified the targeted villages and studies their cultivation patterns.

This study has led to the proposed an intervention wherein we have integrated both the sprinkler and the drip irrigation systems for maximum efficiency. This integration processes will not only help the farmers to counter different crops on different seasons but also to save water. The proposed project was accepted and is funded by the Department of Science and Technology (DST) Science for Equity Empowerment and Development (SEED) division. Though the implementation of both the sprinkler and drip is the primary, we wanted to control the flow of water that is supplied from the source so as to save water. The flow optimization is done through optimization MATLAB software.

Demography

Cheyur, the Assembly constituency of Chengalpattu district in Tamil Nadu is reserved for candidates from the Scheduled Castes have been identified as the ideal area to implement STI Hubs. Cheyur is a gate of Chennai in south. The detailed demographical studies suggest that as per the estimates of 2011 census, out of total 270552 population 81.77% is rural and 18.23% is urban population. The Scheduled castes (SC) ratio is 45.64% out of total population. Cheyur taluk comprises of 117 villages. In this block, the livelihood of the people mainly depends on agriculture and some having the traditional skills of weaving. Based on the availability of raw materials, the villages in the target block have been chosen for the interventions.

Cheyur is one of the coastal villages where agriculture and fishing are the important occupations in the coastal tract. Red Non-Calcareous soils occurrence facilitates the growth of Paddy both under semi dry and in wet conditions. Groundnut, millets and vegetables are other crops grow in the target area. Black soils are occurring in Madurantakam, Cheyur, Uthiramerur and Chengalpattu taluk and they occur in isolated

patches in other taluks. Alluvial soils are predominantly occurring in Kancheepuram taluk.

They are found in isolated patches in Chengalpattu taluk. Casuarinas are found plenty in the target block. Total agricultural land in Cheyur block is 16500 hectares approximately. In the total hectares, 6650 hectares are identified as barren lands because of water scarcity. So the remaining 8650 hectares are divided into farm lands and cultivating lands. The total area covered by coconut farms is around 3000 hectares and in the remaining hectares, Paddy, groundnut, watermelon, gingelly, banana, millets and vegetables are grown in this block. Among these crops, paddy is the most important and extensively grown food crop. It is cultivated widely varying conditions of rainfall and climatic conditions.

II. LITERATURE REVIEW

To study more about water management, we started with literature survey on the different criteria for effective irrigation system. Some Criteria required for the farming were 1, Land suitability, 2, Effective rainfall 3, water requirement for crops, 4, Methods for irrigation. Based on the various criteria we have designed and fabricated a hybridized sprinkler irrigation system.

Agricultural must be made strong enough to self-compose for good productivity. Water availability is the major challenge that the agriculturist must consider in order to have an effective productivity. Based on the various ecological conditions and fluctuating water levels, many regions have adopted different mediums to conserve and use water more effectively. This will help the preserve the water available and use them to the maximum extent [1]. Therefore, it is necessary to adopt a conservative irrigation system and integrate it will another seasonal irrigation system to promote irrigation in all seasons and in a conservative manner [24]. The primary requirement in the integration is drip irrigation technique. Drip irrigation is in existence for limited crops in the past several years and its latest technological developments have facilitated to extend it to wide-ranging crops that yield flowers, fruits, vegetables, spices, coconut, wheat, paddy etc [1-3].

Several methodologies have been adopted by many researches in optimizing the arrangements of the drip irrigation system such as variability analysis, discrete optimization solutions on

the distribution of the water channels, [2], Convex optimization techniques and factor analysis in the optimization of the water and the fertilizers, hierarchical fuzzy process for yield monitoring in order to improve the irrigation's efficiency [2]. These methodologies can provide an insight for better irrigation feed, agricultural efficiency and good crop productivity [23]. Along with the optimization techniques, fertigation techniques must also be adopted to continually irrigating the irrigation system [3].

Integrating the fertigation technique with drip and sprinkler irrigation techniques will improve the efficiency in all the seasons and for all the crops in different parts of India. This efficiency can be observed in the increase in the nutrients in the soil. Drip irrigation techniques and but also the fertilizer feeding efficiency of water is adequate to enhance the crop productivity, thus this improvement can be shown with integrating both the drip and sprinkler design along with fertigation techniques [21]. MATLAB is proprietary multi-paradigm programming language and numeric computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages. We have used Genetic Algorithm to illustrate the reduced flow of water.

According to FAO, land suitability is the ability of a certain type of land for a particular use. Land is considered as the root study for the implementation of the irrigations system to get the best output out of the irrigation that is implied [4]. Water management varies with different soil types. So the appropriate irrigation system has to implemented in the appropriate soil to have the best outcome. As per FAO, the suitability of the soil is found using different classes of soil [5]. The suitability of the order is based on suitability orders, based on degree of suitability of orders, Land suitability subclasses and land suitability units. Some of these orders include order "S", Order "N" and "Not Suitable".

The suitability measured using the degrees of suitability with orders include "S1 – Highly suitable", Class "S2 Moderately Suitable", "Class S3 Marginally Suitable", "Class N1 Currently Not Suitable", Class N2 Permanently Not Suitable"). The suitability measured using the degrees of suitability with respect to subclasses which includes reflecting kinds of limitation, or main kinds of improvement measures required, within Classes [4-5].

Land Suitability Subclasses: reflecting kinds of limitation, or main kinds of improvement measures required, within classes [6].

Land Suitability Units: reflecting minor differences in required management within Subclasses. This criterion is used to ascertain the fitness given for the type of land for the defined use [7]. It helps to denote the present use of the land.

Effective Rainfall: Effectiveness of the rainfall during the growing period of a crop is dependent on the precipitation falling during the growing period to cover evapotranspiration required by the crop [7].

Crop water requirement (CWR):
 Crop Water requirement or (CWR) is defined as the total depth of water that is required to match the water consumed through evapotranspiration for a disease-free crop under any type of soil conditions. Once the conditions of the CWR are maintained the full production potential is obtained. Water helps in improving the turgidity of the plant cells [8]. The growth of the plant is determined using the cell enlargement of the turg or pressure. The right amount of water is provided only using the right irrigation methods. CWR varies for different crops [8]. This factor influences the average flow of water to the crops through

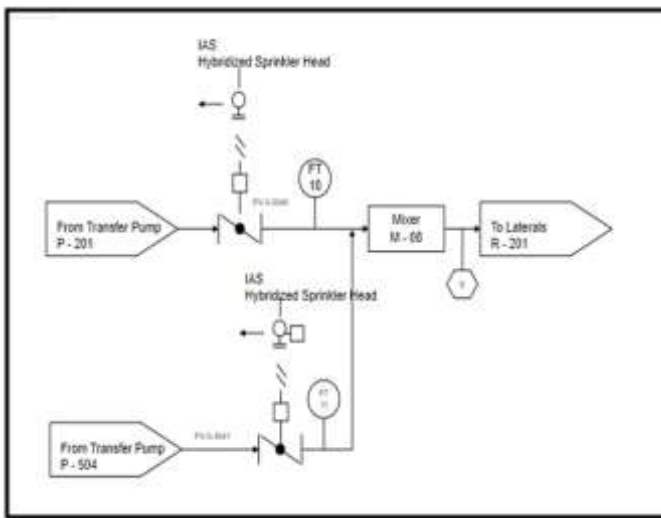


Fig. 1: Water Flow Framework

Land suitability

The Land Suitability Classification

Land suitability is the 1st criteria to measure the quality if the land masses to find the best yield for the crops to be cultivated.

the selected irrigation system. Once the CER is calculated, the water requirement of the crops is found out and appropriate irrigation system is selected. This improves the yield of the crops [8].

Methods for irrigation: Suitable irrigation system must be adopted in order to get the optimum results or outcomes from the cultivation. Different irrigation systems are adopted for different crops setups [9]. We have targeted 2 different irrigations systems that could be useful for our targeted villages. We have identified Drip and sprinkler type irrigation systems could be the optimum techniques that can adapt to any seasons and to any crops.

Materials

The aim of this study is to improve the drip irrigation system fertilizer suction rate without compromising the flow rate of water (4000 litres per hour) in the main pipe of inner diameter 59 mm to the field. Along the water flow, fertilizer solution is to be injected at the rate of 565 to 465 litres per hour (l/h). This is accomplished by fixing a venturi parallel to the main pipe and by improving the suction rate through venture design modifications like Condition 1- 90° inlet & 90° outlet, Condition 2 - 45° inlet & 45° outlet and Condition 3 - 65° inlet & 65° outlet as shown in the Fig 1. Therefore, 3 cases (41mm, 55mm and 65mm venture inlet diameters) have been considered in all the three conditions selected for study. F. 1(a-c) shows the first case (41 mm diameter) for all the three conditions [10].

The working fluid for the analysis with a kinematic viscosity of 1e-06 [m²/s]. The standard numerical solver simple Foam was used for steady state fluid flow analysis [11]. All the results obtained from this analysis were viewed and analysed using Para View, an open source, multi-platform data analysis and visualization application.

III. METHODOLOGY

We have framed the following steps for getting the optimized solution. The first solution is obtaining the designing variables. The variables include pressure temperature and velocity. We formulated the objective variables using the interrelations of Euler’s Equation. Since the suction velocity optimization is related to the flow of the fluid. Some of the constraints include the lateral pipe inlet, venture outlet, main pipe outlet, sprinkler head outlet. We choose GA algorithm and Fminconoptimization [12]. We went through GA optimization

solution to get the suitable optimization solution a displayed in the Fig 2.

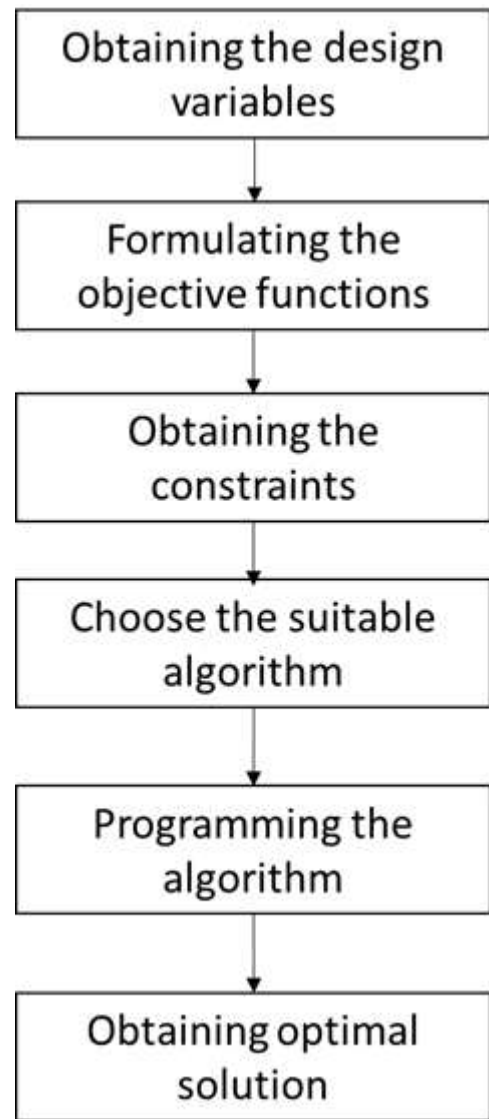


Fig. 2: Optimization Algorithm Methodology

Governing Optimization Equations

The following standard equations (1) and (2) were made use of to analyse the flow Euler’s Equation for incompressible fluid flow:

$$\frac{\partial \rho}{\partial t} = 0 \quad (1)$$

Momentum Equations for incompressible fluid flow.

$$\partial_t g(t, x) = v(t, g(t, x)),$$

$$g(o, x) = \frac{\partial(Xv)}{\partial X_v} = -\frac{\partial p}{\partial x_i} + \mu \left(\frac{\partial}{\partial X_v} \right) \left(\frac{\partial u_p}{\partial X_u} \right) - \frac{\partial (up)}{\partial X_u} + g_o \quad (2)$$

pressure (N/m²), μ - dynamic viscosity (Ns/m²), ρ - density(kg/m³) and g-acceleration due to gravity(m/s²)

Where u_p, u_p and m_i, j_u - mean and fluctuating velocity components (m/s) in corresponding directions respectively, P -

Boundary conditions

Table 1: Parameters

Parameters	Lateral pipe Inlet	Venturi Outlet	Main pipe Outlet	Sprinkler Head Outlet
Inlet velocity (velocity)	Fixed value	Inlet outlet	Inlet outlet	Noslip
Inlet pressure (pressure)	Zero gradient	Fixed value Uniform0	Fixed value Uniform0	Zero gradient
Reduced Flow of Water	Calculated	Calculated	Calculated	Calculated
K-Outlet Sprinkler Velocity	Turbulent Intensity kinetic energy inlet Intensity 0.05	Inlet Outlet	Inlet Outlet	Kraal function Uniform0
c-Outlet Sprinkler Pressure	Turbulent Intensity Length Dissipation Rate Inlet mixing Length 0.0345m	Inlet Outlet	Inlet Outlet	Epsilon wall function

We have considered the boundary optimization conditions, the velocity was specified as fixed Value at the inlet and zero Gradient at the outlet [14]. Conversely, the pressure was specified as zero Gradient at the inlet and fixed Value at the outlet. A no-slip boundary condition was applied to the pipe wall by setting the velocity as zero [17]. Table 1 gives the various boundary conditions used for simulations.

Let YM-Fluctuating sprinkler outlet Pressure rate, w_k and Turbulent Prandtl numbers for k and respectively, Scand So-Sourceterms, Model constants are $C1\varepsilon=1.14, C2=1.34, w_k=1.0, 1.2$

The L-epsilon (l-n) model comprises of two optimized 1st degree differential equations (3) and (4) that represents the optimized flow of the incompressible fluid [10].

$$\frac{\partial(aku_m)}{\partial Y_u} = \left(\frac{\partial}{\partial Y_u} \right) \left[\left(\mu + \left(\frac{t}{w_k} \right) \right) \frac{\partial k}{\partial Y_u} \right] + w_k \quad (3)$$

$$\frac{\partial(Yu)}{\partial X_u} = \left(\frac{\partial}{\partial Y_u} \right) \left[\left(\mu + \left(\frac{t}{Y_u} \right) \right) \frac{\partial \varepsilon}{\partial Y_u} \right] + \rho C_1 S_\varepsilon - \rho C_2 \left\{ \frac{\varepsilon^2}{(k + \nu Y_u)} \right\} + C_{1\varepsilon} (\varepsilon/k) C_{3\varepsilon} G_b + S_\varepsilon \quad (4)$$

where u_p - velocity component in corresponding direction (m/s), k - turbulent kinetic energy/ Outlet Velocity (m²/s²), ε - Dissipation rate (m²/s³), μ - determined viscosity flow(Ns/m²), K_g - generation of turbulence due to the mean velocity gradients and G_b -generation of turbulence kinetic energy due to buoyancy [18].

Outlet Sprinkler Velocity (k) and turbulent dissipation (ε) are the two cognizable variables which determine the optimized flow of the incompressible fluid [19]. The values of “k” and “ ε ” were calculated as 0.00245 m²/s² and 0.00653m²/s³ respectively using the parameters which is found to be under satisfactory boundary conditions, the outlet flow velocity is

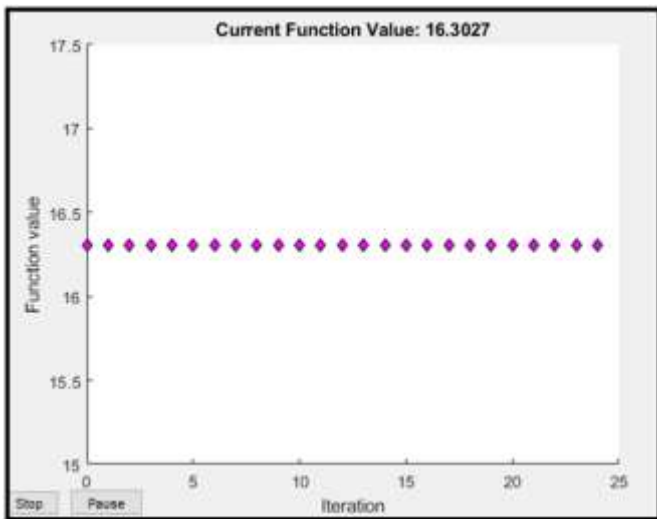


Fig. 3: Current function value for evaluating boundary conditions

optimized to -1.126m/s , viscosity- $0.964\text{e-}6$, The realizable k-turbulence model was selected as it captures the circulating flow regions [19].

Interior Point Method (FMINCON) - it is the nonlinear programming solver provided in MATLAB's optimization toolbox. It performs nonlinear constrained optimization and supports linear and nonlinear constraints [15] [16].

These are the two chromosomes,

Chromosome 1	
-153	16

Chromosome 2	
-23	40

Chromosome representation before and after representation

Before cross over	
-153	16
-23	40

After cross over	
-153	40
-23	16

The current function value is found to be 8.15

IV. RESULTS AND DISCUSSIONS

Condition 1: 90° inlet & 90° outlet

The MATLAB simulated and experimental results of 90° inlet & 90° outlet for all the three cases i.e., 41mm, 55 mm and 65 mm venturi throat diameters are given in Table 3.

Table 2: Experimental Vs MATLAB Optimization Results for 90°

EXPERIMENTAL		MATLAB SIMULATION			
Main pipe Pressure drop (kg/cm ²)	Suction Rate (l/h) 41 mm	Suction Rate in 41 mm (l/h)	Throat Velocity (m/s) 41 mm	Throat Velocity (m/s) 55 mm	Throat Velocity (m/s) 65 mm
0.1	16.3	70.89	4.13	3.46	3.99
0.2	310	435.64	6.41	3.2	4.46
0.3	605	789.56	9.1	7.4	6.9
0.4	716	901.23	9.7	9.3	9.67
0.5	880	986.34	1.1	11.1	10.43

The experimentation was carried out initially using a setup with 41 mm venturi throat diameter. As the pressurized water enters the venturi inlet, it converges toward the throat section of the venturi resulting in a high velocity stream. This increase in velocity at the throat section creates pressure drop due to the differential pressure across the venturi. This pressure drop enables the fertilizer liquid to be sucked through the throat section. The outcome of the experimentation is given in Table 3 and validated by simulation under the identical parameters selected for study.

In simulation, at equilibrium condition, three cases of venturi points are selected for study. Therefore, the ball valve was turned to 30°, 55°, 65° and 60° to attain the pressure rise of 1.24, 0.23, 0.98, 1.36, 0.89 kg/cm² respectively. The Outlet velocities

of 70.89, 435.64, 789.56, 901.23, 986.34m/s were attained for the pressure differences of 0.1, 0.2, 0.3, 0.4 and 0.5 kg/cm² respectively in 41 mm diameter throat. Even though the throat velocity increases linearly there exist a noticeable difference as shown in the Table.

In both the simulated and experimental results, the outlet pressure rate increases linearly with increase in pressure and it remains closer for all the pressure drops. The 0.1 kg/cm² pressure drop creates the lowest suction rate in both the computation and experimentation. This is due to the lowest flow separation efficiency observed in 90° inlet & 90° outlet pipe which is attributed to the added effect of minor losses in pipe fittings. The maximum difference between the simulated and experimental result is 23.6% at 0.1 kg/cm² pressure drop

which is at acceptable limit. Hence, the simulation results are validated with experimental results and further extended for the conditions 2 and 3.

The velocities attained in 55 mm and 65 mm venturi inlet for the various pressure drops are given in Table 2. It is observed that the outlet velocity increases linearly with increase in pressure drop. It is also pragmatic that the throat velocity remains higher in 41mm diameter throat for all the pressure drops. The increase in pressure difference from 0.1 to 0.2

kg/cm² creates a phenomenal increment in suction rate of 66.3 l/h to 443.9 l/h. This is attributed to minimum flow diversion that occurs due to dynamic inertia of the fluid in the main pipe at 0.1 kg/cm². From 0.2 kg/cm² onwards, the flow diversion increases in direct proportion to the pressure drop [9, 25].

Condition 2: 45° inlet & 90° outlet

The MATLAB simulated and experimental results of 45° inlet & 90° outlet for all the three cases i.e., 41mm, 55mm and 65 mm venturi throat diameters are given in Table 3.

Table 3: Experimental Vs MATLAB Optimization Results for 45°

EXPERIMENTAL		MATLAB SIMULATION			
Main pipe Pressure drop (kg/cm ²)	Suction Rate (l/h) 41 mm	Suction Rate in 41 mm (l/h)	Throat Velocity (m/s) 41 mm	Throat Velocity (m/s) 55 mm	Throat Velocity (m/s) 65 mm
0.1	67	110.7163	4.54	3.56	4.67
0.2	455	570.25	6.2	3.56	4.53
0.3	580	865.32	8.3	7.87	6.89
0.4	890	990.25	9.2	9.65	9.81
0.5	921	1110.23	1.6	11.9	10.65

Suction rate measured for 41 mm diameter throat opening in both simulation and experimentation at all the pressure drops indicate a maximum variation of 18.8% at 0.1kg/cm², whereas the remaining lies below 2.2%. Similar to the previous condition, the throat velocity increases linearly with increase in pressure drop but with a moderate variation in the flow distribution between 0.1 kg/cm² and other pressure differences as observed in Table 3. But, 0.1 kg/cm² pressure difference creates a suction rate of 98l/h, which is better than simulated value of condition1 (45.21 l/h). This is due to a relatively higher flow separation efficiency observed in 45° inlet & 90° outlet pipe during experimentation, where there is reduce defect in the minor losses.

Condition3: 45° inlet & 45° outlet

MATLAB simulated and experimental results of 45° inlet & 45° outlet for all the three cases i.e., 41mm, 55mm and 65 mm

venturi throat diameters are given in Table 4. Throat velocity remains higher in 41 mm diameter throat for all the pressure drops. It is imperative to note here that unlike the previous conditions, the variation in the flow distribution between 0.1 kg/cm² and other pressure differences are trivial as shown in Fig. 3 (g-I). This could be a precursor for achievable better suction rate during real time experimentation at lower pressure differences compared to the previous conditions.

It can also be stated that the total friction loss in a pipe with 45° Tee is the result of internal friction in the flowing fluid. This is due to the formation of recirculation zones, flow separation nearby the junction and friction between fluid and pipe wall which is slightly less contributory than the 90° Tee [12] as noticed in Fig.3 at the enlarged views of branch entries.

Table 4: Experimental Vs MATLAB Optimization Results for 45°

EXPERIMENTAL		MATLAB SIMULATION				
Main pipe Pressure	Suction Rate (l/h)	Main pipe Pressure	Suction Rate	Throat Velocity	Throat Velocity	Throat Velocity

drop (kg/cm ²)	41 mm	drop (kg/cm ²)	(l/h) 41 mm	(m/s) 41 mm	(m/s) 55 mm	(m/s) 65 mm
0.1	234	0.1/30°	356	2.43	3.21	4.23
0.2	458	0.2/55°	548	4.6	4.56	5.1
0.3	600	0.3/65°	765	9.8	11.24	13.45
0.4	997	0.4/55°	830	9.9	13.24	15.34
0.5	991	0.5/60°	1465	1.24	16.7	17.12

In all the conditions studied, simulated results given in Tables 2, 3 and 4 indicate that the throat velocity drops down in most of the 55 mm and 65 mm diameter venturi inlets when compared to the 41 mm diameter. In case of 41 mm diameter, reducer of 69×44 mm inner diameter was used and 69×57mm inner diameter reducer was used in 55-mm and 65-mm diameter. This larger reducer diameter in 55 mm and 65 mm has dropped the venturi inlet velocity leading to fall in suction rate. In Table 4, certain uncertainties have been noticed at 0.4 kg/cm² pressure drop, i.e., throat velocities increase with increasing diameter which could be due to acceptable simulation error.

Experimental results recorded in Table 4 for validation purpose with 41 mm diameter throat setup, follows the same linearly increasing trend of suction rate as that of the simulated results. Maximum flow gets diverted into the branch pipe and thus a better suction rate of 1465 l/h is achieved in the 0.1 kg/cm² pressure difference itself. This is in line with the findings of an earlier research that for the discharge ratio (Q1/Q3), two vortices were formed at the entrances of the main and branch pipe. The main vortex becomes smaller for the branching angle 45° when compared to the branching angle 90°. The loss coefficient decreases and flow separation efficiency increases for the branching angle 45° whereas it is contradictory in 90°. The flow distribution analysed for all the three conditions along the axial distance of the venture at 0.1kg/cm² reveals that maximum velocity exists in the 45° inlet & 45° outlet conditions.

V. CONCLUSION

Maximum suction rate shall be achieved within 0.59 kg/cm² pressure difference as per the to avoid energy loss and to improve the pressure head at the sprinkler head. In experimentation, the water flowing the rough the main pipe has no impact on the flow separation at the branch pipe without

inducing a resistance to the flow in the main pipe. The flow separation was observed as the resistance to flow along the main pipe is induced by controlling the ball valve which creates a pressure drop ranging from of 0.1kg/cm² to 0.6kg/cm². This flow separation efficiency plays a major role in the suction effect by developing a higher velocity at the throat region. This integration can help to provide irrigation to any seasonal crops.

As the venturi inlet diameter increases to 55 and 60 mm, there is no remarkable effect in the suction rate for all the conditions. This is due to the effect of drop in throat velocities in both the cases. At 0.6 kg/cm² pressure drop, 45° inlet & 45° outlet branch pipe coupled with the venturi of inlet diameter 41 mm, maximum fertilizer suction rate of 986.34 l/h is achieved experimentally when compared to the other conditions. Hence, this integrated design is recommended as the best choice to achieve better suction in the irrigation setup taken and can be used to provide better yield.

VI. FUNDING STATEMENT

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VII. ETHICS STATEMENT

This study was conducted in accordance with the ethical standards of the institution and with accepted scientific research practices. The authors confirm that the work is original, has not been published previously, and is not under consideration for publication elsewhere.

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