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DESIGN OF A PIPING IRRIGATION SYSTEM ON SUKKARI'S KURMA PLANTATION

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ABSTRACT

Irrigation using pipes is a common thing found in agriculture. In this research, before designing the pipes, a topographic map is first made to find the points on each water exit route in each pipe. Topographic data is obtained from measurement data in the field, then the data is processed in Auto Cad software. After that, the pipe network was designed using Autocad software with 270 tapping exit points with a service level of 100% for an output time of 1 hour. So it is found that the calculation assumption for the average need for plants is 35 liters/day or 0.00000486 m^3/second/pipe/tree. After obtaining the average results, the pipe needs are planned with a main pipe size of 7 mm, an average distribution pipe of 2.2 mm with a drip hole size of 1.7 mm. Next, the energy loss (Hf) in each pipe was calculated and the result was 0.00000017. The storage uses a capacity of 500 liters with a height of 5 m from the ground, with a value (Hf) of 0.00005398. Pipe planning on date palm plantations can be said to be very helpful to farmers if the design can be implemented and will be more effective.

Keywords:*Piping Irrigation, Dates, Topograhics Maps.*

1. PRELIMINARY

Indonesia is a country with a tropical climate which has two seasons, namely the dry season and the rainy season. In the dry season, the amount of water available is certainly not as large as in the rainy season. It is in the dry season that farmers need to work harder to get water. One way is by building water channels that can irrigate agricultural land. Dates are cultivated on barren land, lack of water is one of the problems faced in date palm plantations.

Water sources are very difficult to find because the study location is located at an altitude of > 300 meters above sea level. Therefore, date palm plants must receive a large supply of water for their survival. In the past, it was difficult for some farmers to distribute water to their date palm plants because the land was hilly and water sources were far away.

The use of pipes is considered a more effective and efficient way of distributing water to date palm plantations in terms of time, energy and the technology used. The varying elevations of the land contour require a strategy in irrigation design, water from the channel is pumped into a tank or reservoir and then channeled by gravity. As a result, the water will drop to its lowest point. In this case, researchers are trying to find out how this water can be distributed evenly and save more time.

The use of pipes as a watering system is considered more effective because the pipes have unlimited flow while the water source is still maintained. This research is very interesting therefore, researchers will examine how to design a water flow piping system for each date palm plant with the help of the Autocad software.

2. THEORETICAL BASIS

Hydrology

Hydrology, as a scientific discipline, is concerned with the study of water in the Earth's atmosphere, on its surface, and within the ground. The field encompasses a broad range of phenomena related to the distribution, movement, and properties of water in various forms. Hydrological processes are crucial for understanding and managing water resources in both natural and human-altered landscapes.

1. Hydrological Cycle

The Hydrological cycle, also known as the water cycle, is a fundamental concept in hydrology. It describes the continuous movement of water between the atmosphere, land, and oceans. The cycle involves processes such as evaporation, condensation, precipitation, runoff, and infiltration. This interconnected system plays a pivotal role in maintaining a balance of water on Earth, sustaining ecosystems, and providing essential resources for human activities.

2. Hydrology Components

Hydrology recognizes various components within the water cycle. These components include surface water bodies such as rivers and lakes, groundwater stored in aquifers, atmospheric water vapor, and the vast reservoir of water in oceans. Understanding the interactions and dynamics among these components is essential for comprehending the complexities of water distribution and availability.

3. Hydrology Modeling

Hydrology modeling is a key tool in hydrology, enabling the simulation and prediction of water-related processes. Models utilize mathematical equations to represent the behavior of different Hydrology components, assisting in the assessment of water availability, flood forecasting, and the impact of land-use changes on Hydrology systems.

4. Human Impacts on Hydrology

Human activities, such as urbanization, deforestation, and industrialization, significantly influence Hydrology processes. Alterations to land cover and the built environment can lead to changes in runoff patterns, water quality degradation, and modifications to the natural flow of rivers. Understanding these anthropogenic impacts is crucial for sustainable water management.

Hydrological Cycle

The hydrological cycle can be depicted as follows in Figure 1.

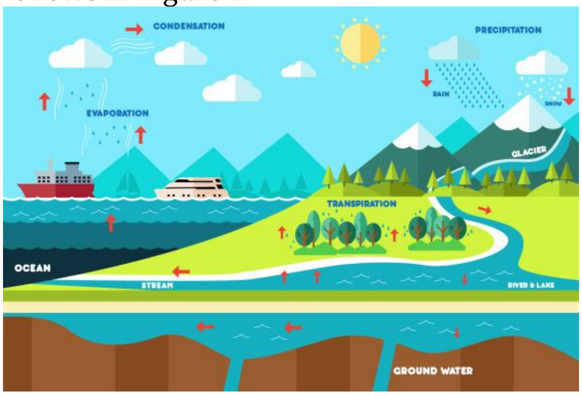


Figure 1 The Hydrological Cycle (Inglezakis, 2016)

The hydrological cycle processes include:

1. Evaporation and Transpiration

The hydrological cycle begins with evaporation and transpiration. Evaporation involves the conversion of liquid water into water vapor from oceans, lakes, and other surface water bodies. Transpiration is the release of water vapor from plants into the atmosphere. Together, these processes contribute to atmospheric moisture.

2. Condensation and Cloud Formation

Condensation occurs when water vapor in the atmosphere cools and transforms back into liquid water. This process leads to the formation of clouds. Clouds play a critical role in the hydrological cycle by facilitating precipitation through processes like coalescence and collision of water droplets.

3. Precipitation

Precipitation involves the release of water from clouds in the form of rain, snow, sleet, or hail. This is a key component of the cycle, as it replenishes surface water bodies, infiltrates into the ground, and contributes to the flow of rivers and streams.

4. Runoff and Infiltration

Runoff occurs when precipitation exceeds the capacity of the soil to absorb water, leading to surface flow into rivers and lakes. Infiltration, on the other hand, is the movement of water into the soil. These processes influence groundwater recharge and the overall movement of water within the landscape. Understanding runoff and infiltration is vital for managing water resources and mitigating flood risks.

Irrigation

Based on Law Number 7 of 2004, what is meant by irrigation is the business of providing, regulating and disposing of water to support agriculture, the types of which include surface irrigation, swamp irrigation, underground water irrigation, pump irrigation and pond irrigation. As for Government Regulation no. 23 / 1998 concerning irrigation, that irrigation is an effort to provide and regulate water to support agriculture. According to PP no. 22 / 1998 irrigation is also included in the definition of drainage, namely managing water especially from plant growing media or plots so that it does not interfere with plant growth or production.

Irrigation System Method

The irrigation system that is widely used is bulk irrigation on the ground surface. This irrigation requires large amounts of water while the level of water use efficiency is low. To overcome water limitations, a drip irrigation system is the right choice to increase water use efficiency.

According to (Hadiutomo, 2012), drip irrigation is a method of giving water to plants directly, both in the plant root area and on the soil surface through continuous and slow drops. The application of drip irrigation technology or often called Trickle Irrigation is irrigation that uses a flow network utilizing gravity. The drip irrigation network consists of main pipes, sub-main pipes and lateral pipes.

Drip irrigation can be divided into 3 types based on the type of water flow, namely:

1. Water seeping along the lateral pipe (viaflow).
2. Water dripping or gushing through application tools installed on the lateral pipe.
3. Water dripping or gushing through the holes in the lateral pipe (Prastowo, 2010)

Drip irrigation is one of the latest technologies in the field of irrigation that has developed throughout almost the world. This technology was first introduced in Israel, and then spread to almost all corners of the world. In essence, this technology is very suitable to be applied in conditions of sandy land, very limited water, dry climate and the commodities cultivated have high economic costs (Pasaribu et al., 2013).

The advantage of applying drip irrigation is that it can reduce the danger of salinity to plants because the accumulated salt around the roots can be washed away (leached) effectively. One irrigation system that can be applied in areas that have limited water is drip irrigation. Drip irrigation is a method of providing water by dripping water through pipes around plants or along plant lines. In a drip irrigation system, only part of the root area is wetted but all the water given can be absorbed quickly under conditions low soil moisture (Ekaputra et al., 2016)

The watering technique using drip irrigation is the provision of water in a limited manner using a container/place that is used as a temporary water storage device with a drip hole at the bottom. The water will come out slowly in the form of droplets into the ground which will slowly wet the soil. This drip hole will later be arranged in such a way that the water will be sufficient to wet the soil around where the plant lives. In principle, providing water using drip irrigation is needed to ensure efficient use of water so that it can be used reduces perceived rapid water loss due to evaporation due to high temperatures.

According to (Haryati et al., 2011) the efficiency of water use on agricultural land can be optimized through the use of irrigation techniques. In addition, drip irrigation is able to maintain groundwater conditions in the plant root zone within the capacity range airy and permanent lay point (Afriyana et al., 2012).

The watering method using drip irrigation can be an option that can be applied on land that has very limited water availability and the physical conditions of the land are less supportive, because with the drip irrigation method the water is directly absorbed by plant roots and will not experience a phase of excessive evaporation.

Benefits Of Drip Irrigation

Water shortage is one of the main problems in dry land where agricultural processes cannot be carried out without the availability of irrigation water. Efficient irrigation water is important for sustainable development and efforts to manage water resources in the region.

The use of drip irrigation in agriculture has many benefits, including saving water because in the process of giving water to plants according to the needs of the plants themselves, saving time, because watering is done automatically, there are examples of tools that resemble timers that can regulate the water irrigation process. so that water can flow at certain times,

With this irrigation technique using drip irrigation, it is hoped that it will be able to help meet the water needs of plants in the dry season by maintaining efficient water use so that later it will also increase the use of soil nutrients, reduce water pressure on the soil and speed up

adaptation of the seeds, and will also increase the success of plant growth, (Simonne et al., 2010) also said that water use efficiency with a drip irrigation system can reach 80 - 95%.'

Pipe Irrigation

According to (Banks, 2012), pipe irrigation is a method of providing plant water that reduces excessive water use by allowing the water to flow slowly dripping towards the plant roots which can be through the soil surface or directly to the root zone. This pipe irrigation channels water to plants through valves and pipes. There are many advantages to this pipe irrigation, including saving water, reducing runoff and evaporation, reducing weed growth and can be designed for all land conditions. Pipe irrigation is a system of providing water to plants using an software tool (applicator, emission device) which can supply water with low discharge and at a continuous frequency in the plant root zone, pipe irrigation is one type of low pressure irrigation system (Sapei, 2016).

Pipe

Pipes function to convey fluids from one place to another. The fluid can be gas, water, or vapor which has a certain temperature. Meanwhile, the connection can be a fixed cross-section connection, a changing cross-section connection, a bend (elbow) or a T-shaped connection (Tee). The filter is equipped with a foot valve whose function is to prevent flow from returning to the initial location or reservoir.

Material selection is very crucial because it determines the reliability of the entire system, cost factors, safety, service life, which code standards are suitable to be applied to the piping system to be designed.

In pipe networks, a lot of connections are needed, both connections between pipes using pipes and connections between pipes using the tools needed, including valves, instrumentation, nozzles and tools or connections to change the direction of flow. fluid.

Piping System

The gravity drainage system is used if the water source has a higher elevation than the service area, as a result it can form high pressure which can flow water without using a pump. Gravity drainage is relatively economical because it utilizes the height to the service area (Kusuma, 2011). To distribute clean water by piping, there are several distribution systems, depending on topographic conditions, location of raw water sources, differences in height of drainage areas or service areas. Among the distribution systems are the gravity method, the pumping method and the combined method.

Water sources

Water, a critical component for sustaining life on Earth, exhibits diverse origins and sources across the planet's surface. One major classification is based on the location of these sources, resulting in four distinct categories: sea water, rainwater, surface water, and groundwater.

Sea water, constituting the largest volume of water on Earth, is found in the vast expanses of oceans and seas. It is characterized by its high salinity due to the presence of dissolved salts. Desalination processes are employed to make sea water potable, addressing freshwater scarcity in some regions.

Rainwater, another significant source, originates from atmospheric moisture. When air masses are saturated with water vapor and encounter temperature changes, precipitation occurs in the form of rain. This natural process replenishes water resources, contributing to surface water bodies such as rivers, lakes, and reservoirs.

Surface water encompasses water bodies that are visible on the Earth's surface, including rivers, lakes, ponds, and reservoirs. These sources play a crucial role in supporting ecosystems, providing habitats for various species, and serving as essential resources for human activities such as agriculture, industry, and recreation.

Groundwater, the fourth category, refers to water stored beneath the Earth's surface within soil and rock formations. It accumulates through percolation, the downward movement of water from the surface. Wells and aquifers serve as extraction points for groundwater, supplying drinking water and sustaining ecosystems.

In conclusion, understanding the diverse sources of water on Earth is fundamental for effective water resource management and environmental conservation. Each category, from sea water to groundwater, plays a unique role in sustaining the planet's intricate hydrological cycle and meeting the varied needs of both ecosystems and human societies.

3. RESEARCH METHODS

Data collection technique

Used to find reference theory that is relevant to the case or problem found. The literature study consists of: Final Project, Book, Journal.

Field Observation Data

Researchers find out the condition of the existing location, then identify the source discharge, find out the condition of the water source and then record the pipe lines that will be installed.

Planning Analysis

Looking at the need for water used and to plan the water network development system, then an analysis of the planning of the water distribution pipe network system is carried out by calculating pipe dimensions and pipe types.

Number of Date Palm Tree Plants

In this study, there were 135 date palm trees on an area of 2,151 m2.

Date Palm Tree Water Requirements

The water requirement is used for watering date palm plants. The amount required is calculated as the average water requirement per plant age per day. Plant water requirements per day are adjusted to the age of the plant. The following amount of water needed by date palm plants can be seen in table 1.

Table 1. Water Discharge Requirements in Date Palm Plants

Age (Months	Need (ℓ)	Period

5-12	20	1 day
12-18	30	1 day
18-24	30	1 day
24-32	35	1 day

Law of Continuity

Branching pipes also have flow where the law of continuity applies where the discharge entering and leaving a pipe has the same result.

$$Q = A.V \qquad (1)$$

Where Q = Discharge flowing through a pipe cross-section (m^3/sec); A = cross-sectional area (m2); V = Flow Speed (m/sec).

Flow Area

To calculate the flow area on a pipe, use the circular calculation formula.

$$A = \frac{1}{8}(\pi - sin\pi)D^2 \quad (2)$$

Where A = Flow area; = constant in mathematics which is the ratio of the circumference of a circle to its diameter (3.14); D = Diameter of the circle.π

Wetted Perimeter

To calculate the Wetted Perimeter of a pipe, use the circular calculation formula.

$$P = \frac{1}{2}\pi D \qquad (3)$$

Where P = Wetted Perimeter; = constant in mathematics which is the ratio of the circumference of a circle to its diameter (3.14); D = Diameter of the circle.π

Energy Loss

The principle of energy loss due to friction in pipelines can be explained in the following equation.

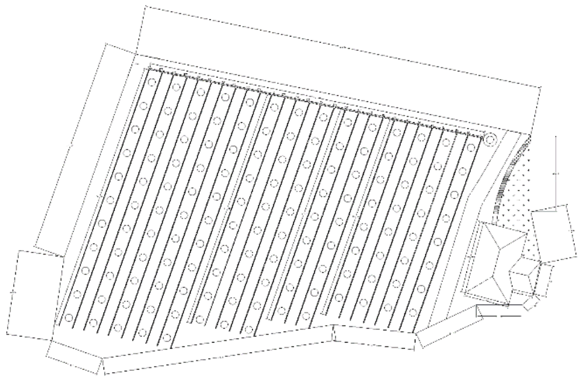
$$hf = f\frac{L}{D} \cdot \frac{v^2}{2g} \qquad (4)$$

Where hf = energy loss (m); f = friction factor; L = pipe length (m); v = flow velocity in the pipe (m^3/s); D = Pipe diameter (m); g = Gravitational force.

4. RESULTS AND DISCUSSION

Pipe System Creation

The planning of the piping system consisting of main pipes and distribution pipes can be seen in figure 1 using AutoCad software.



Figures 2. Plantation Pipeline Design

Water Needs Analysis

The water requirement for date palm trees is taken as the highest water requirement, namely 35 liters per day which is converted to 0.00000486m^3/s/pipe/tree in an output duration of 1 hour.

Pipe Discharge Calculation

Flow planning for PVC type piping networks in this research resulted in different results, even though the average requirements for each plant were the same, the length and elevation of each distribution pipe had different values. The differences in discharge and pipe diameter can be seen in the following table 2.

Table 2. Discharge and Width of Each Pipe

Type	L	D	A	V	Q
Drip holes		0.0017	0.0000011	4.43	0.0000048
P1	29	0.0022	0.0000019	20.18	0.0000381
P2	29	0.0022	0.0000019	20.18	0.0000381
P3	29	0.0022	0.0000019	20.18	0.0000381

P4	29	0.0022	0.0000019	20.18	0.0000381
P5	29	0.0022	0.0000019	20.18	0.0000381
P6	29	0.0022	0.0000019	20.18	0.0000381
P7	29	0.0022	0.0000019	20.18	0.0000381
P8	29	0.0022	0.0000019	20.18	0.0000381
P9	32	0.0022	0.0000019	22.36	0.0000428
P10	32	0.0022	0.0000019	22.36	0.0000428
P11	32	0.0022	0.0000019	22.36	0.0000428
P12	32	0.0022	0.0000019	22.36	0.0000428
P13	34	0.0022	0.0000020	24.06	0.0000476
P14	34	0.0022	0.0000020	24.06	0.0000476
P15	34	0.0022	0.0000020	24.06	0.0000476
P16	34	0.0022	0.0000020	24.06	0.0000476
P17	34	0.0022	0.0000020	24.06	0.0000476
P18	34	0.0022	0.0000020	24.06	0.0000476
P19	38	0.0023	0.0000021	24.93	0.0000523
P20	38	0.0023	0.0000021	24.93	0.0000523
P21	38	0.0023	0.0000021	24.93	0.0000523
P22	38	0.0023	0.0000021	24.93	0.0000523
P23	38	0.0023	0.0000021	24.93	0.0000523
P24	38	0.0023	0.0000021	24.93	0.0000523
P25	38	0.0023	0.0000021	24.93	0.0000523
P26	38	0.0023	0.0000021	24.93	0.0000523
P27	38	0.0023	0.0000021	24.93	0.0000523
P28	38	0.0023	0.0000021	24.93	0.0000523
P29	48	0.0070	0.0000192	6.40	0.00012

Water Storage Analysis

With a total demand of 0.00012 m^3/s, if converted into liters/hour, a value of 432 liters/hour is obtained. So for storage, use a tower with a volume of 500 liters with a height of 5m from the ground and use a 1 inch pipe.

Energy Loss Analysis

The principle of energy loss due to friction in pipelines can be explained in the following equation

$$\text{hf} = 0.019\,\frac{5}{0.025}\,.\frac{2.789}{19.6}$$

The value obtained is hf = 0.00005398 or HL = 5.0005398.

5. CONCLUSION

Based on the results of the analysis above, several conclusions can be obtained, including:

1. The drip hole exit points are 270 tappings with a service level of 100% during the output time of 1 hour.
2. Calculation of the average need for plants is 35 liters/day or 0.00000486 m^3/second/pipe/tree.
3. After obtaining the average results, the need for PVC pipes is planned with a main pipe size of 7 mm, an average distribution pipe of 2.2 mm with a drip hole size of 1.7 mm.
4. The storage uses a capacity of 500 liters with a height of 5 m from the ground, with a value (Hf) of 0.00005398

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