IPRC HUYE
Integrated Polytechnic Regional College
RWANDA POLYTECHNIC
Skills for a better destiny

Agricultural Engineering Department

Option: Irrigation and Drainage Technology

Level 6 Year 2/2022-2023

OPERATION OF IRRIGATION SYSTEM (IDTOI601)

Credits: 4 **Learning Hours: 40**

By

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PURPOSE

- This module describes the skills, knowledge and attitude required to operate irrigation system. It is intended for learners pursuing TVET diploma of irrigation and drainage technology.
- At the end of this module the students will be able to carry out pre-start checks, inspect and operate the system.
- Qualified student deemed competent to this competency, may work with others in support of current professional practice in marshland, hillside, small scale irrigation, garden, greenhouses under guidance.

CONTENTS

- ✓ **UNIT 1 - CARRY OUT PRE-OPERATION CHECKS**
- ✓ **UNIT 2 - CONDUCT IRRIGATION SYSTEM OPERATION**

0. INTRODUCTION

- The efficient operation of an irrigation system depends mainly on the ability of the farmer to make the best use of it.
- For every system, depending on the kind and the type of the installation and the way the water is delivered to the farm, there are several steps to be taken and factors to consider in order to ensure the efficient operation and performance of the installation.

0. INTRODUCTION

- Sometimes, the irrigation installation fails to give full satisfaction because of poor design, faulty installation, or equipment that does not conform to specification.
- However, the way both the irrigation system as a whole and its component parts are operated and maintained will determine the success or failure of any properly designed and installed system.

0. INTRODUCTION

- The O&M of the irrigation system is also the key factor for good irrigation management.
- Farmers need a sound knowledge of the O&M procedures of their installation.
- This knowledge should be acquired from complete information, demonstration and written instructions from the designers and the suppliers.

UNIT 1 - CARRY OUT PRE-OPERATION CHECKS

1.1. Identify risks, hazards and accidents in the workplace

1.2. Select and wear Personal protective equipment

1.3. Select and check tools and equipment to be used

1.4. Check water, power, fuel and lubricants

1.5. Perform pump priming

1.6. Check status of irrigation system components

UNIT 1 - CARRY OUT PRE-OPERATION CHECKS

Group work 1: May 4, 2023

Question 1)Types of hazards in the workplace (chemical, biological, mechanical and other health hazards).

Question 2)Identify environmental implications associated with farm machinery and equipment operations.

(40 minutes and 10 minutes for research and presentation, respectively)

1.1: Identify risks, hazards and accidents in the workplace

Types of hazards in the workplace

The six main categories of hazards are:

- **Biological:** Biological hazards include viruses, bacteria, insects, animals, etc., that can cause adverse health impacts. For example, mould, blood and other bodily fluids, harmful plants, sewage, dust and vermin.
- **Chemical:** Chemical hazards are hazardous substances that can cause harm. These hazards can result in both health and physical impacts, such as skin irritation, respiratory system irritation, blindness, corrosion and explosions.
- **Physical:** Physical hazards are environmental factors that can harm an employee without necessarily touching them, including heights, noise, radiation and pressure.

1.1: Identify risks, hazards and accidents in the workplace

Types of hazards in the workplace

- **Safety:** These are hazards that create unsafe working conditions. For example, exposed wires or a damaged carpet might result in a tripping hazard. *These are sometimes included under the category of physical hazards.*
- **Ergonomic:** Ergonomic hazards are a result of physical factors that can result in musculoskeletal injuries. For example, a poor workstation setup in an office, poor posture and manual handling.
- **Psychosocial:** Psychosocial hazards include those that can have an adverse effect on an employee's mental health or wellbeing. For example, sexual harassment, victimisation, stress and workplace violence.

1.1: Identify risks, hazards and accidents in the workplace

Dangerous substance **Common hazardous substances**

- Many industrial, agricultural and medical organisations use hazardous substances. The degree of hazard depends on the concentration of the chemical.
- Common hazardous substances in the workplace include: acids, caustic substances, disinfectants, glues, heavy metals, including mercury, lead, cadmium and aluminium, paint, pesticides, petroleum products, and solvents.

1.1: Identify risks, hazards and accidents in the workplace

Dangerous substance **Substances hazardous to workers**

- Workers in, for example, the cleaning industry, agriculture, healthcare and heavy industry often work with hazardous substances.
- Hazardous substances include:
  - ✓ toxic substances;
  - ✓ explosive substances;
  - ✓ carcinogenic and mutagenic substances;
  - ✓ substances that damage fertility or the unborn child.

1.1: Identify risks, hazards and accidents in the workplace

Identification of environmental implications associated with farm machinery and equipment operations

Are Tractors Bad For The Environment?

- In general, tractors can indeed be bad for the environment. During clearing and working large parts of the land, tractors can release elements that are poisonous to the environment. However, while the environmental implications of tractor usage are extensive, we hold an advantage – the power to adjust our tractor use and abuse. Today's farming methods will translate to tomorrow's ecological forecasts.

1.1: Identify risks, hazards and accidents in the workplace

Identification of environmental implications associated with farm machinery and equipment operations

Are Tractors Bad For The Environment?

How do tractors affect the environment?

- Tractors are high-performance machines capable of clearing and working large parts of the land. In doing so, they release elements that are poisonous to the environment.
- The gas pollutant emissions from tractors affect the air and are also transmitted to the ground through rain and snow.
- Because of that, tractor pollution affects the air we breathe and our water, the flora and fauna that feed off it, and the humans that consume it

1.1: Identify risks, hazards and accidents in the workplace

Identification of environmental implications associated with farm machinery and equipment operations

Are Tractors Bad For The Environment?

How much pollution do tractors produce?

- Tractors are often bulky machines built for big tasks, and they require a lot of energy to produce power. So, although there are fewer tractors around than other types of vehicles, they can produce a relatively large amount of pollution.

1.1: Identify risks, hazards and accidents in the workplace

Identification of environmental implications associated with farm machinery and equipment operations

Are Tractors Bad For The Environment?

- **Is farm equipment bad for the environment?**

- Farm equipment can be bad for the environment, and it can be less bad. It is foremost a question of balance, investing in quality machinery, and responsible handling and servicing of equipment. Much of the negative environmental impact of the use of agricultural equipment can be determined and controlled by its users.

1.1: Identify risks, hazards and accidents in the workplace

Identification of environmental implications associated with farm machinery and equipment operations

Are Tractors Bad For The Environment?

Is farm equipment bad for the environment?

- For example, when a tractor is operated with the correct agricultural equipment, then its maximum torque can be achieved. This way, if the tractor is operated with a too-small load, it will require more passes on the field to accomplish the same work. That leads to higher fuel consumption which then means higher emissions.

1.1: Identify risks, hazards and accidents in the workplace (cont'd)

- Assessing the work environment for health and safety hazards is important to prevent injuries and illnesses from happening.
- There are various methods to identify hazards in the workplace. But the following three will help you begin the process of creating an effective Injury and Illness Prevention Program (IIPP) (Garcia, I. F., 2019).

1.1: Identify risks, hazards and accidents in the workplace (cont'd)

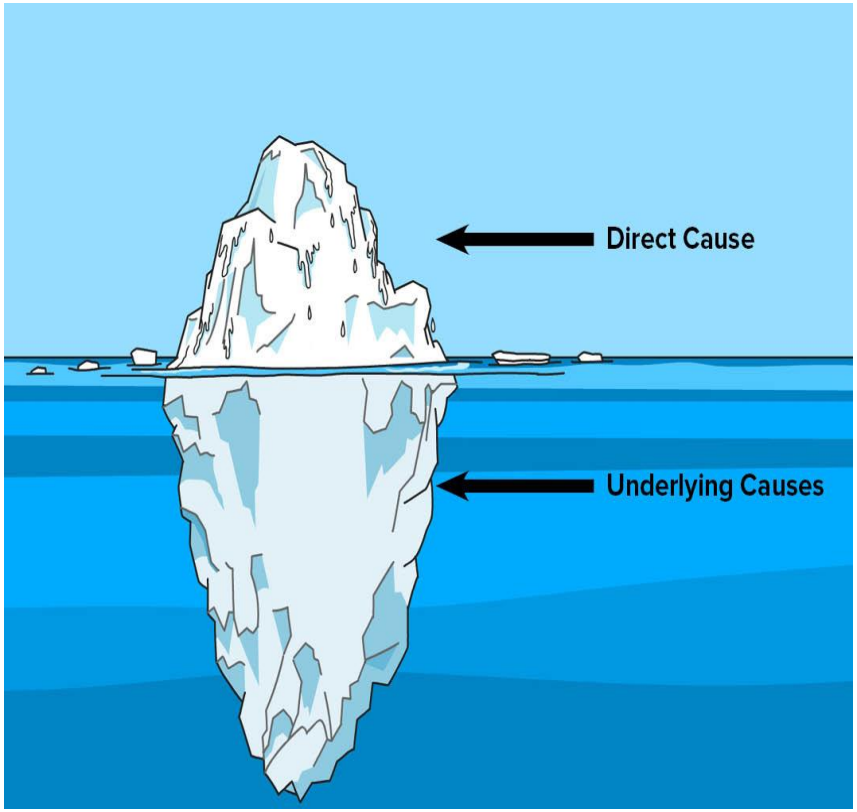
- **3 methods for an effective IIPP:**
- **Conduct regular worksite inspections.** Walk through the worksite and visually assess the types of equipment, work practices, and any potential hazards that could be harmful to workers.
- **Interview workers and managers.** This allows workers to express concerns that may not be as obvious when conducting only worksite inspections. Involving workers in the process of identifying hazards also increases staff morale and compliance with safety practices.
- **Create a hazard map.** Draw a large outline of the worksite(s) and mark existing and potential hazards. Involve workers in this activity to solicit feedback and to increase awareness of the importance of safety in the workplace (Garcia, I. F., 2019).

1.1: Identify risks, hazards and accidents in the workplace (cont'd)

- It is important to have several different methods of identifying health and safety hazards to ensure a safe work environment for employees.
- Taking the necessary steps will make the difference and help to create a health and safety culture that will be beneficial for everyone (Garcia, I. F., 2019).

1.1: Identify risks, hazards and accidents in the workplace (cont'd)

Underlying Causes of Workplace Injuries and Illnesses



- It is important to not only ask ***what*** happened, but also ***why*** it happened to help identify the hidden safety problems that played a role in the occurrence of the accident and might increase the likelihood of the accident occurring again in the future (Garcia, 2020).

1.1: Identify risks, hazards and accidents in the workplace (cont'd)

Underlying Causes of Workplace Injuries and Illnesses (cont'd)

- Many individuals might think that workplace injuries and illnesses happen because workers make mistakes and are careless.
- However, when employers look at an individual incident more closely, it becomes clear that multiple factors contribute to accidents in the workplace (Garcia, 2020).

1.1: Identify risks, hazards and accidents in the workplace (cont'd)

Underlying Causes of Workplace Injuries and Illnesses (cont'd)

It is important to ask:

1. Are there conditions in the workplace that caused this mistake?
2. What is it about these conditions that allowed a mistake to occur?
3. If procedures weren't being followed, why weren't they followed?
4. Is there something wrong with the systems, policies, and/or conditions in the workplace that should be changed? (Garcia, 2020).

1.1: Identify risks, hazards and accidents in the workplace (cont'd)

❑**Underlying Causes of Workplace Injuries and Illnesses (cont'd)**

❑ Often, there are a combination of underlying factors involved in an incident. When looking for underlying causes, you may find problems in one or more of these areas:

- ✓ **Job tasks and procedures:** look at the way they are designed to ensure they are safe and practical
- ✓ **Work environment:** poor work area set up, poor air quality, high/low temperature, etc.
- ✓ **Management and organization:** inadequate safety program, lack of resources, poor communication, no system for reporting problems, or no involvement by management
- ✓ **Individual worker or workforce:** inexperience, inadequate training, fatigue, stress, or problems with communication (Garcia, 2020).

1.1: Identify risks, hazards and accidents in the workplace (cont'd)

- When analyzing a task to identify the hidden hazards, it is important to ask questions such as:

1) Are work processes and equipment designed properly?
2) Are operating procedures adequate and clear?
3) Are work rules realistic?
4) Is training adequate?

- Everyone makes mistakes, but when mistakes happen, it is important to ask ***why***.
- The best way to prevent injuries is by fixing the underlying policies, procedures, and conditions that contribute to them (Garcia, 2020).

1.2: Select and wear Personal protective equipments

- All PPE clothing and equipment should be of safe design and construction, and should be maintained in a clean and reliable fashion.
- Employers should take the fit and comfort of PPE into consideration when selecting appropriate items for their workplace.
- PPE that fits well and is comfortable to wear will encourage employee use of PPE.
- Most protective devices are available in multiple sizes and care should be taken to select the proper size for each employee (OSHA, 2004).

1.2: Select and wear Personal protective equipments

- If several different types of PPE are worn together, make sure they are compatible.
- If PPE does not fit properly, it can make the difference between being safely covered or dangerously exposed. It may not provide the level of protection desired and may discourage employee use (OSHA, 2004).

1.2: Select and wear Personal protective equipments

Key considerations

- PPE size
- PPE compatibility
- Job type

5 Risk Control Measures

5 Risk Control Measures

- The 5 Risk Control Measures are a set of five control measures that should be included in every organization's **safety plan**.
- They are:

1. Elimination
2. Substitution
3. Engineering Controls
4. Administrative Controls
5. PPE

5 Risk Control Measures

5 Risk Control Measures

Elimination

- It is known as the most effective risk control measure. This control measure involves completely removing the hazard from the workplace. That way, workers will not be exposed to the hazard and will not be at risk for injury.

5 Risk Control Measures

5 Risk Control Measures

Substitution

- It is the second most effective control measure, and it involves replacing the hazard with a safer, less dangerous alternative.
- For example, buying newer and updated equipment with better safety ratings than the one your workers are using now is considered a substitution.

5 Risk Control Measures

5 Risk Control Measures

Engineering controls

- It refers to physically isolating people from the hazard if possible. This control measure is often used in combination with other control measures.
- For example, if you can't eliminate or substitute the hazard, you might want to consider implementing engineering controls such as installing a ventilation system.

5 Risk Control Measures

5 Risk Control Measures

Administrative controls

- These are control measures that involve changing the way people work to minimize exposure to the hazard.
- ➢ This control measure might involve changing work hours, implementing safety training, or providing workers with information about the hazard.

5 Risk Control Measures

5 Risk Control Measures

PPE

- Known as Personal protective equipment, is the last control measure on the list. This control measure should be used as a last resort when other control measures are not possible or have been ineffective.

➢ PPE includes items such as gloves, earplugs, safety glasses, and the like.

1.2: Select and wear Personal protective equipments

Recommended Resources

- Personal Protective Equipment (PPE) Introduction: https://www.youtube.com/watch?v=loQ9Dbsy2ag
- How to Correctly Use PPE: https://www.youtube.com/watch?v=KyM9g5oOP6s
- Personal Protective Equipment (PPE): https://www.youtube.com/watch?v=YE-63aeECVs

1.3: Select and check tools and equipment to be used

Irrigation Tools List: With Images & Uses

- Have a look at the Irrigation Tools List: With Images & Uses: https://dreamcivil.com/irrigation-tools-list/

1.3: Select and check tools and equipment to be used

Recommended Resources

- **Tools, Equipment and Materials used for Installation of Sprinkler Irrigation System:** https://www.youtube.com/watch?v=v0rKFjxEazI

1.4: Check water, power, fuel and lubricants

- Basic operation of engine
- Types of engine oil

Recommended Resources

- How a Car Engine Works: https://www.youtube.com/watch?v=ZQvfHyfgBtA
- Car Engine Parts & Their Functions Explained in Details : https://www.youtube.com/watch?v=x70VqMrXrbs

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Pump Station

Electrical:

- Turn off main switch before opening any cabinets
- Visually inspect all wiring for damage and condensation. This should include both wiring in cable trays and in cabinets
- Check for any sign of shorting, burnt cables, hot terminals
- Test starters / drives, ensure they are working
- Test priming system – reprime priming pump if applicable
- Test control systems i.e. pressure switches by shutting valves etc.

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Pump Station

Pump System:

- Clean and inspect foot valve (if applicable)
- Inspect suction and discharge piping for corrosion and leaks
- Fully close and open all valves to ensure they are still functioning
- Ensure air valve on discharge is functioning and sealing

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Pump Station

- On systems drawing from a water source below the pump, ensure the suction assembly rises to the pump flange i.e. ensure there is no high point above the pump flange, this includes the fitting bolted to the pump flange
- Ensure system is primed / priming pump or system working if applicable
- Spin the pump by hand if possible to ensure it is free

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Pump Station

- **Run the pump**:

- Check pressure gauges are working, replace as necessary. If they do get frost damage, consider fitting a drain so you can vent the gauge and only pressurise it when required
- Check it runs up to pressure – note pressure
- Check pump rotation direction – Phase switching can occur with works outside the property
- Check for leaks around pump station and from the pump mechanical seal or gland packing
- Test and control systems
- Check water meter is functioning and check flow rate

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Main Line

- Drive the mainline and check for leaks and damage (particularly after floods)
- Check air valves:
  - ✓ Ensure the isolation valve below the air valve is open
  - ✓ Make sure they are working – listen for air escaping when line filling
  - ✓ Remove and clean if they leak constantly

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Centre Pivots

- Inspect 3 phase supply from ground to pivot / electric motor for damage to conduit, wires and cable glands
- Inspect control cable for damage
- Inspect anchor bolts at centre
- Grease Pivot point
- Inspect main panel – looking for obvious damage, insect nests, water and corrosion

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Centre Pivots

- Remove top and inspect the collector reel for corrosion and water
- Walk the pivot and look for any obvious damage, loose nuts, bent steel work, damaged drops and sprinklers.
- Visually inspect span and motor cables for damage – chewed cables, cables pulled from glands etc.
- Open and inspect tower boxes, check for broken, loose wires, and corrosion

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Centre Pivots

- Check alignment system – ensure all linkages are free, switches are working
- Inspection of gear boxes for correct oil level, and leaks.
- U-joints – check for worn u-joint inserts and ensure driveshaft shields are in place for safety.
- Check control panel configuration to ensure it is correct.

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Centre Pivots

- Start and run pivot:
  - ✓ Check forward and reverse operation
  - ✓ Check alignment – adjust if required to ensure it is running straight
  - ✓ Test centre stops / auto revere systems are working
  - ✓ Test tower stops / reverse is working
  - ✓ Test safety circuit is working (out of alignment circuit)

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Centre Pivots

- ✓ Test pump start system from the Pivot Centre
- ✓ Flush the Pivot by running with the sand trap cap removed. Run until clear water is evident.

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Centre Pivots

- Replace sand trap and run pivot up to pressure
  - ✓ Ensure pivot reaches operational pressure at centre and end of system
  - ✓ Inspect sprinklers, ensure they are all working
  - ✓ Look for leaks, and repair as required

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

Centre Pivots

- Check tyres for correct operating pressure and general condition. Correct pressures are:

Tyre Size	Suggested Running Pressure (psi)*
14.9 x 24	12 to 14
16.9 x 24	11.5 to 14
11.2 x 38	17

*The suggested pressure does vary between manufacturers, therefore it is best to check what is recommended for your brand machine.

1.4: Check water, power, fuel and lubricants

Irrigation Season Pre-Season Check List

- ✓ Fuel
- ✓ Lubricants

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Meaning of Lubrication

When one surface moves over another, there is always some resistance to movement, and the force which opposes movement is called friction. If the friction is low and steady, there will be smooth, easy sliding. At the other extreme the friction may be so great, or so uneven, that movement becomes impossible or the surfaces can overheat or be seriously damaged.

Lubrication is simply the use of a material to improve the smoothness of movement of one surface over another, and the material which is used in this way is called a lubricant. Lubricants are usually liquids or semi-liquids, but may be solids or gases or any combination of solids, liquids and gases.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Meaning of Lubrication

Generally speaking the smoothness of movement is improved by reducing friction, but this is not always the case. There may be situations in which it is more important to maintain steady friction than to obtain the lowest possible friction. Some examples are: the control of chatter in a machine tool slideway or grinding operation, control of strip movement in metal rolling, and elimination of brake squeal or clutch judder in a car.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Meaning of Lubrication

- In addition to reducing or controlling friction, lubricants are usually expected to reduce wear and often to prevent overheating and corrosion (Lansdown, 2003).

A.R. Lansdown.(2003). Lubrication and Lubricant Selection_ A Practical Guide (Tips). **p1-2:**

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Grease vs Oil

- Greases are usually oils with thickener added.
- At room temperature, greases are usually solid, while oils are usually liquid.
- All oils can be turned into greases, but not all greases come from oils.
- Greases are typically only used on machinery, tools, or equipment, while oils have a multitude of other, non-industrial uses.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Greasing Procedure

- An improper greasing procedure can include anything from inadequate or too much grease, incorrect grease, poor grease gun calibration or even greasing oil wetted components.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Greasing Procedure

- Manual grease guns have problems with volume and pressure control and regular calibration of your guns is strongly recommended.
- Grease guns can produce between 1 gram and 1.5 grams per shot which can result in significant over lubrication per point unless the output is known.
- Grease guns are also capable of producing 15,000 – 20,000psi per stroke. Pressures like this are capable of blowing out bearing, and a careless approach can result in over lubrication resulting in a bearings life-cycle being significantly reduced.
- Over greasing of bearings is far more common than under greasing.
- Therefore, it's important to follow a well defined greasing procedure: **the correct lubrication, in the correct amounts, at the correct times.**

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Greasing Procedure: 6-steps and Best Practices

1. Grease type
2. Amount of grease
3. Greasing frequency
4. Grease gun calibration
5. Preventing contamination
6. Housekeeping

Figure 1. Grease gun

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

The Five Rights (5 R's) of Lubrication Procedures

- **Importance of effective lubrication**: Many organizations failed to understand the importance of an effective lubrication procedure and how to apply them.
- The lubrication industry must realize the importance of lubrication and the application of its five basic "Rights" in order to achieve world-class machine reliability.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

The Five Rights (5 R's) of Lubrication Procedures

1. **Right Product:** The determination of the correct lubricant is the initial move towards accomplishing equipment reliability.

- Boundary film formation properties and viscosity grade are the two most important factors that help to select the right product.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Greasing Procedure: 6-steps and Best Practices

2. Right Place: Once we select the right type of lubricant, we need to apply it to the proper location.

- Adding the wrong product to a lubrication point is not uncommon.
- In order to avoid these cases, all the **lubrication points** should be appropriately labelled. **Lubricant manufacturers** provide lube tags for the identification of the appropriate lubricant to be utilized at the lube point.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Greasing Procedure: 6-steps and Best Practices

3. Right Amount: In Lubrication, more isn't better. A lot of lubricant in a framework can be as destructive as not enough.

- Over-greasing your machinery is one of the major failure modes. In the case of grease lubricant, it is more difficult to deal with lubrication. Manual re-lubrication is one of the aspects of lubrication that is difficult to control.
- However, using few formulas and measurements makes it easy to calculate the right amount. It is likewise to consider the entire picture and factors that influence the volume.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Greasing Procedure: 6-steps and Best Practices

4. Right Time: Once we establish our whole program with the right product, place, amount and quality there is a need to establish lubrication intervals.

- Re-lubrication intervals and amounts are affected by many other factors such as operating temperature, environmental conditions, machinery arrangements etc.
- When it comes to the right time these factors play an important role as it impacts re-lubrication intervals.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Greasing Procedure: 6-steps and Best Practices

5. Right Attitude: We have effectively examined the 5 Rights of lubrication procedures and they appear to be more pertinent and significant.

- However, the accuracy in defining the lubrication properties, lubrication intervals, amounts, and different requirements carried out by the individuals plays an important role.
- For example, you have well-defined lubrication practices but are poorly managed. Therefore, it is necessary to have dedicated maintenance and technical team with the right attitude.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

[10 Lubrication Best Practices for Improved Equipment Reliability]

1. **Assessment/Benchmarking**: In this process, you assess the things that you do right as well as the things you need to do better.
2. **Organization and Planning**: Ensuring that all lubrication tasks in the plant are completed at the right time with the right lubricant and the right quantity while using the right processes. Use software to control and report the activity.
3. **Identification**: To ensure that the right lubricant is added to a piece of equipment, a labeling system is needed

1.3. Perform oiling and greasing of the pump engine

Machine oiling and greasing procedures

[10 Lubrication Best Practices for Improved Equipment Reliability]

4. Cleanliness Control: Oil contamination is a major source of component wear and equipment failure. Therefore, it is important that only clean lubricants are used in the equipment operation. Cleanliness-control centers ensure that the lubricant is stored safely, is clean and is transferred in a contamination-free environment

5. In-plant Dispensing: Open and dirty dispensing containers can be a source of contamination entering the machine. Dispensing equipment must be safe, clean and closed. It also should be efficient, easy to use and adapted to the applications being filled.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

[10 Lubrication Best Practices for Improved Equipment Reliability]

6. Grease Lubrication Tools: Adding grease to a machine accounts for the majority of lubrication jobs. Therefore, it's essential to have tools that are efficient and practical.

- Grease guns should be color-coded to ensure that the right lube gets in the right application. Color-coded grease guns, with one color for each different grease, can help in this regard.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

10 Lubrication Best Practices for Improved Equipment Reliability

7. Contamination Control: Controlling the contamination of oil inside the equipment is also critical.

8. Oil Analysis: Analyzing the oil in an application is an important part of a lubrication strategy. Chemical analysis of the oil will determine if it is fit for further use.

9. Environmental Control: If spilled, lubricants can contaminate the environment

10. Knowledge Management: Maintenance workers must be skilled in the benefits of good lubrication practices.

1.4: Check water, power, fuel and lubricants

Technical specification of oils and greases

Standards and Specifications

Lubricants are generally bought or sold by the manufacturers' brand names, such as BP Visco 2000, Shell Rimula X15/40, Esso Dortan 12 or Mobilgrease 28. Once a user has established that a particular brand is satisfactory for the chosen application, the brand name may be a sufficient guarantee of performance. On the other hand, a brand name gives no information on performance to a potential user seeing it for the first time, and it needs to be supported by a document giving properties and performance figures.

1.4: Check water, power, fuel and lubricants

Technical specification of oils and greases

Standards and Specifications

Such a document is a specification, although it may be called a data sheet or a standard. In general data sheets are issued by lubricant suppliers to describe typical properties of one or more of their products. A typical data sheet might list the properties shown in Table 11.11.

A supplier's data sheet may not give the user any direct information showing that the lubricant is suitable for a particular application, but it does two useful things. The first is to indicate to the user the typical properties which the supplier tries to maintain for that brand, and thus give the user some yardstick by which to assess the lubricant. The second is that if data sheets for two different brands list very similar properties, the user can have increased confidence that it is possible to change safely from one brand to another.

1.4: Check water, power, fuel and lubricants

Technical specification of oils and greases

Standards and Specifications

Table 11.11 Typical data sheet properties

	Oil No.1	*Oil No.2*	*Oil No.3*
Viscosity:			
cSt at 40 °C	75	165	240
cSt at 100 °C	8.9	14. 8	18.4
Viscosity index	95	95	95
Pour point (°C)	–20	–10	25
Acidity (mg KOH/g), maximum	0.2	0.2	0.25
Flash point, closed cup (°C)	195	210	215
Specific gravity	0.887	0.894	0.900

1.4: Check water, power, fuel and lubricants

Standards and Specifications

Technical specification of oils and greases

Remember, however, that similar data sheets give no guarantee that the two brands concerned can be interchanged safely, especially in some application not covered by the data sheets. For example, two hydraulic fluids from different manufacturers may have almost identical data sheets, but if no data on cleanliness is given, one of them may work well in a system while the other, being dirtier, causes plugging of valves and complete failure.

To avoid this problem, major users will often draw up their own specifications which cover the performance aspects which are important in their own applications. In the example quoted above, the user might specify limits on the solid particle contamination, and in this way avoid the risk of damage from a dirty fluid.

Technically a specification differs from a data sheet in that it lays down limits for various properties or test results, as shown in Table 11.12, whereas a data sheet normally gives only typical values. A specification is often used as the basis for a purchasing contract, and the specification limits then

1.4: Check water, power, fuel and lubricants

Standards and Specifications

Technical specification of oils and greases

Table 11.12 Typical specification requirements

Test	*Limits*	*Method*
Viscosity, kinematic:		
cSt at 40 °C	60-75	IP71/97*
cSt at 100 °C	8.3-8.5	IP71/97
Flash point, closed cup (°C)	Min. 190	IP34/99
Pour point (°C)	Max. −10	IP15/95
Total acid number (mg KOH/g)	Max. 0.1	IP177/96
Copper corrosion, classification	Max. 1	IP154/2000

* The second number indicates the date of most recent revision. This date can often be omitted in general use, but in specifications it should always be quoted.

1.4: Check water, power, fuel and lubricants

Standards and Specifications

Technical specification of oils and greases

become contractual obligations. For this reason it is usually not possible for a small user to persuade a major supplier to supply a lubricant to meet the user's specification.

Major users, such as Government Departments or large transport undertakings, will often represent a big enough market for them to be able to insist that lubricant supplies meet their purchase specifications. Common examples are the defence departments of most countries, and national railways and utility companies.

In other cases major groups of users, or joint groups of suppliers and users, may produce a specification covering joint needs. Examples of such specifications are those of the ASTM and SAE.

The small user may be able to take advantage of such specifications in one of two ways. If the user's application is similar to one for which a major specification exists, then it may be possible to buy a lubricant certified as meeting that specification. Alternatively if a lubricant supplier advertises a branded product as meeting the specification, it can be purchased with confidence that it does so.

1.4: Check water, power, fuel and lubricants

Standards and Specifications

Technical specification of oils and greases

When a specification becomes so widely used that it comes to represent the normal level of quality or performance expected from a particular class of product, it may become a standard. Standards are generally established at a national or international level.

The older standards-making organizations are all national, the oldest of all being the British Standards Institution. There are now over 80 national standards organizations, of which the more important include the following:

- British Standards Institution (BSI), Britain;
- American National Standards Institute (ANSI), United States;
- Deutsche Institut fur Normalisation (DIN), Germany;
- Association Francaise de Normalisation (AFNOR), France;
- Gosudarstvyeny Standart (GOST), Russia.

The increases in international trade and communications in recent years have brought a need for standardization on an international basis. In the field of lubricant standards, the first important international organization was the Conseil Europeen de Normalisation (CEN), but the most important is now the International Standards Organization (ISO).

1.4: Check water, power, fuel and lubricants

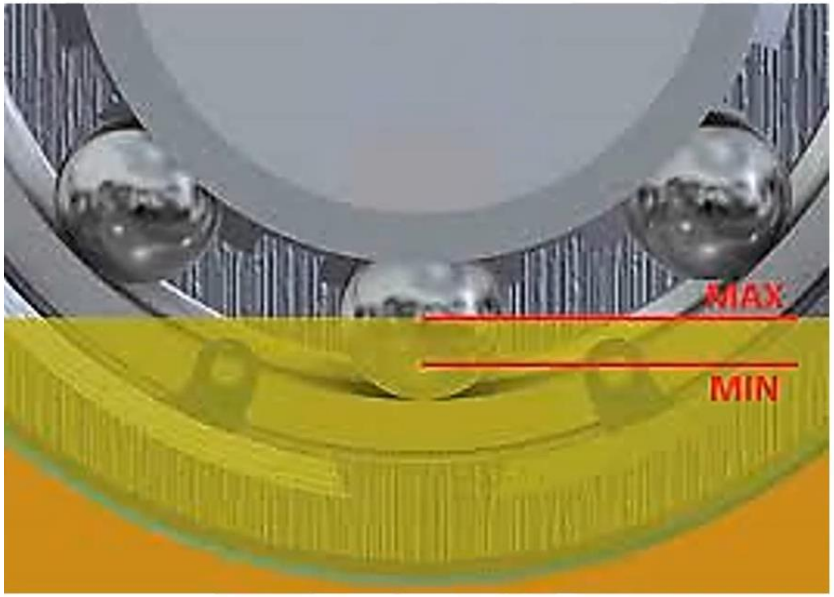
Best practices in lubrication

Technical specification of oils and greases

1.4: Check water, power, fuel and lubricants

Oil level

Technical specification of oils and greases



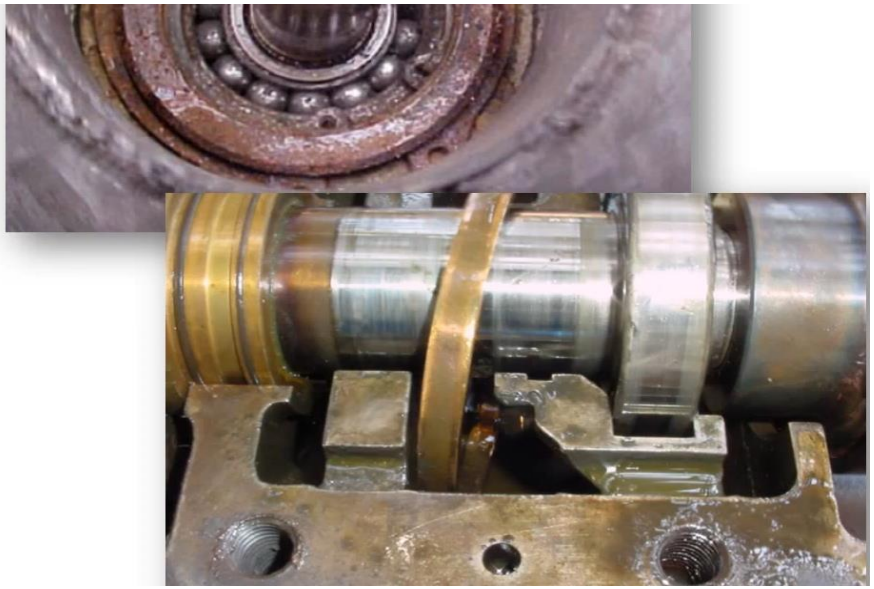
Maintaining the oil level within the acceptable range is vital for continuous bearings lubrication

1.4: Check water, power, fuel and lubricants

Oil level

Technical specification of oils and greases

If the level of lubricant is too high or too low, excessive heat will be generated, accelerating the degradation of the oil and shortening the life of the bearing.



1.4: Check water, power, fuel and lubricants

Specialized equipment used for oiling and greasing

Lubrication Tools and equipments

1.4: Check water, power, fuel and lubricants

Specialized equipment used for oiling and greasing

Lubrication Equipments

- Lubrication Equipments are used for timely lubrication of different parts of the machine.
- These systems ensure that each part of application on the machine is supplied with adequate lubricant, in order to facilitate its smooth and persistent performance.
- Lubrication equipments generally comprise of Lubrication Injectors, Lubrication Pumps, Hydraulic Pumps, Oil Injectors, Lube Oil Systems, etc.
- The Lubrication process is of vital importance in machine's performance and working & hence a lot of prudence is taken to ensure the lubrication devices are used right.

1.4: Check water, power, fuel and lubricants

Specialized equipment used for oiling and greasing

Lubrication Equipments

- **Lubrication Injectors:** The Lubrication System involves the use of Lubrication Injectors as a vital equipment in the entire lubrication process. These injectors dispense the exact and precise amount of lubricant, be it oil or grease or any other lubricant for that matter; as per the requirement of the bearings.
- These Lubrication injectors can be installed individually or even assembled systematically at various points of outlets. The lubrication injectors are available in a myriad of categories ranging from Oil Injectors to Grease Injectors. These Lubrication Equipments are always available depending on the machine compatibility and attributes.
- The other type of lubrication system that involves the use of injectors is the single line automatic lubrication system, a simple and effective system that offers different solutions for a variety of application requirements. It is suitable for small machines operating in protected environments with a few lubrication points and space limitations.

1.4: Check water, power, fuel and lubricants

Lubrication Equipments

Specialized equipment used for oiling and greasing

- **Lubrication Charts**: Another important aspect of the Lubrication System is the Lubrication Charts. Lubrication Charts are your guide to the entire process and use of the Lubrication system. These charts specify every detail and lubricant requirements of the parts of application in the machine. They specify those hard to reach areas along with the lubricant requirement measures.

➢ The Lubrication Charts enumerate the lubricant compatibility along with other intrinsic details. In the absence of a Lubrication Chart, the process of lubrication is highly inconvenient and troublesome. The systematic indications and measures, helps to adopt a favorable lubrication for the machine at use.

1.4: Check water, power, fuel and lubricants

Oil Lubrication & Grease Lubrication

- The most common lubricant used in the industry are the **Oil Lubrication and the Grease Lubrication**.
- **Oil Lubrication** is one of the most widely used methods in almost all types of machines & industries.
- The conventional and reliable industry based lubrication system is the **Centralized Oil Lubrication System** which ensure apt and timely supply of lubricant to the desired element of the machine at specific temperatures and pressures. This system is ideal for machines that consist of innumerable points of lubricant application.

1.4: Check water, power, fuel and lubricants

Oil Lubrication & Grease Lubrication

- Oil being a universal & natural lubricant, reduces friction and ensures smooth working of the bearings and spare parts on machine.
- Grease Lubrication as well is considered to be quite effective in terms of a lubricant aid for machines. There are two main types of grease lubrication systems: the **Dual line automatic lubrication system** and the **Progressive system**.
- The **Dual Line grease lubrication system** has a modular design that allows for simple configuration and expansion of the system, and it is suitable for industry with large machines and many lubrication points.
- A **Progressive lubrication system** distributes the flow of a grease pump into separate "**progressive outlets**" by the use of a progressive spool arrangement, and the modular concept allows for the **quick replacement** of an element without interrupting the work cycle.

1.4: Check water, power, fuel and lubricants

Importance of oiling and greasing

The Importance of Grease Point Lubrication

- Many joints, linkages and moving parts on your heavy-duty equipment are designed to move on a layer of oil.
- Just as your engine needs oil for proper lubrication and to avoid friction, the moving parts of your equipment need grease for smooth movement and to eliminate wear from heat and friction

1.4: Check water, power, fuel and lubricants

Importance of oiling and greasing

Functions of lubrication

- To lubricate each part of the bearing, and to reduce friction and wear
- To carry away heat generated inside bearing due to friction and other causes
- To cover rolling contact surface with the proper oil film in order to prolong bearing fatigue life
- To prevent corrosion and contamination by dirt

1.4: Check water, power, fuel and lubricants

- A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts.

Figure 1.3.1. Bearing

- Bearing lubrication is classified broadly into two categories: **grease lubrication and oil lubrication**

1.4: Check water, power, fuel and lubricants

Comparison between grease and oil lubrication

Item	Grease	Oil
Sealing device	Easy	Slightly complicated and special care required for maintenance
Lubricating ability	Good	Excellent
Rotation speed	Low/medium speed	Applicable at high speed as well
Replacement of lubricant	Slightly troublesome	Easy
Life of lubricant	Relatively short	Long
Cooling effect	No cooling effect	Good (circulation is necessary)
Filtration of dirt	Difficult	Easy

1.4: Check water, power, fuel and lubricants

Grease lubrication

- Grease lubrication is widely applied since there is no need for replenishment over a long period once grease is filled, and a relatively simple structure can suffice for the lubricant sealing device.
- There are two methods of grease lubrication. One is the closed lubrication method, in which grease is filled in advance into shielded/sealed bearing; the other is the feeding method, in which the bearing and housing are filled with grease in proper quantities at first, and refilled at a regular interval via replenishment or replacement.
- Devices with numerous grease inlets sometimes employ the centralized lubricating method, in which the inlets are connected via piping and supplied with grease collectively.

1.4: Check water, power, fuel and lubricants

Grease lubrication

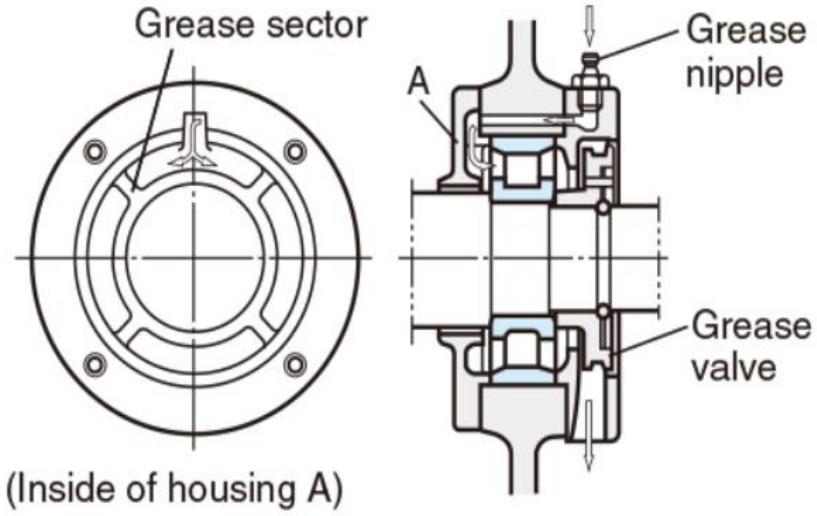


Figure 1.3.2. Example of grease feeding method (using grease sector)

Oil lubrication

- Oil lubrication is usable even at high speed rotation and somewhat high temperature, and is effective in reducing bearing vibration and noise.
- Thus oil lubrication is used in many cases where grease lubrication does not work.

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Greasing Procedure

- 6-step Guide To An Improved Greasing Procedure: https://www.fluidlife.com/blog-6-steps-improved-greasing-procedures/
- Major components of the lubrication system: https://www.grc.nasa.gov/www/k-12/airplane/lubesys.html

1.4: Check water, power, fuel and lubricants

Machine oiling and greasing procedures

Recommended Resources

- The engine lubrication system / How does it work?: https://www.youtube.com/watch?v=9lse1SfDq7M
- Machine Lubrication Best Practices: https://www.youtube.com/watch?v=01p4gGBJQxs
- Rotating Equipment Lubrication: https://www.youtube.com/watch?v=g0jDlEu3Xdc
- Pump bearing housing lubrication: https://www.youtube.com/watch?v=5C-zSiZRxuk

1.4: Check water, power, fuel and lubricants

Types of engine oil

There are four basic varieties of engine oil:

- **Synthetic oil**: This type of oil has gone through a chemically engineered process and has better performance and properties than conventional oil. It has better high and low temperature performance and higher quality additives. It is suitable for vehicles with turbocharged or diesel engines, or vehicles that operate under severe conditions.

1.4: Check water, power, fuel and lubricants

Types of engine oil

- **Synthetic blend oil**: This type of oil is a mixture of synthetic and conventional base oils. It has better resistance to oxidation and low-temperature properties than conventional oil. It is suitable for cars and light trucks without turbocharged or diesel engines, or motorcycles with air- and water-cooled engines.

1.4: Check water, power, fuel and lubricants

Types of engine oil

- **High-mileage oil**: This type of oil is specially formulated for vehicles with over 75,000 miles. It has unique additives and formulation that help reduce oil burn-off and prevent oil leaks that may occur in older engines. It is suitable for late model vehicles or newer vehicles with high mileage.

1.4: Check water, power, fuel and lubricants

Types of engine oil

- **Conventional oil**: This type of oil is the most common and affordable type of oil. It can be formulated in a range of viscosity grades and quality levels. It is suitable for drivers with simple engine designs and regular driving styles.

1.4: Check water, power, fuel and lubricants

Types of engine oil

- In addition to the types of engine oil, there are also different viscosity grades and service ratings that indicate the oil's ability to flow at different temperatures and its performance level. You should always follow the vehicle owner's manual or the original equipment manufacturer's (OEM) recommendation to determine the correct motor oil specification, viscosity grade, and service rating for your engine.

1.4: Check water, power, fuel and lubricants

Types of engine oil

Recommended Readings

- Synthetic Oil Vs. Synthetic Blend Vs. Conventional Oil: https://www.pennzoil.com/en_us/education/know-your-oil/types-of-motor-oil-and-recommended-use.html
- A Handy Guide to the Different Types of Motor Oil: https://www.familyhandyman.com/article/different-types-of-motor-oil/
- Explaining The Different Types Of Motor Oil And Why It Matter: https://www.autozone.com/diy/motor-oil/different-types-of-motor-oil

1.5: Perform pump priming

What is a Pump?

- **Pump** is a machine or mechanical equipment which is required to lift a fluid (liquid, semi-solid, gas, steam etc) from low level to high level or to flow fluid from low pressure area to high pressure area or as a booster in a piping network system.
- Principally, pump converts mechanical energy of motor into **fluid flow energy**.

A small, electrically powered pump

A large, electrically driven pump for waterworks near the Hengsteysee, Germany

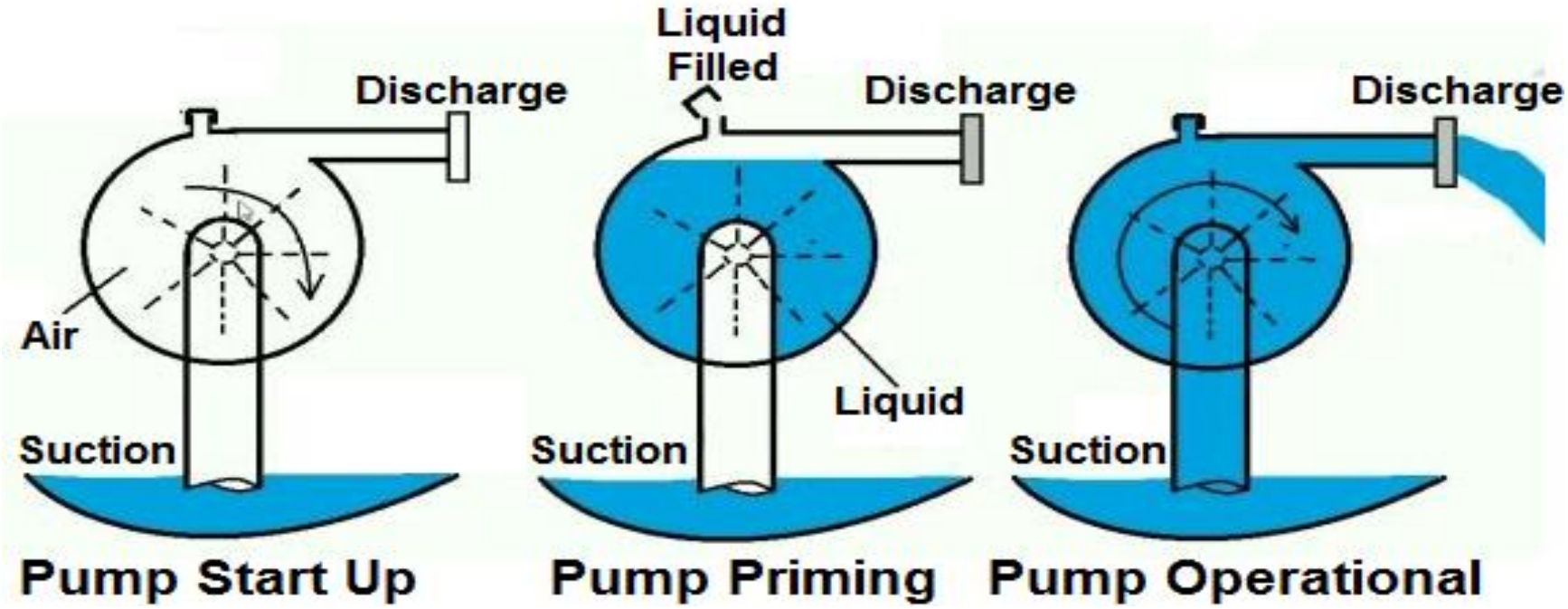
1.5: Perform pump priming

Pump Priming

- **Pump Priming** is the process of removing air from the pump and suction line. In this process the pump is been filled with the liquid being pumped and this liquid forces all the air, gas, or vapor contained in the passage ways of pump to escape out. Priming maybe done manually or automatically.
- Not all pumps require priming but mostly do.
- There are Self Priming Pumps and also some layout situations where priming is not required.

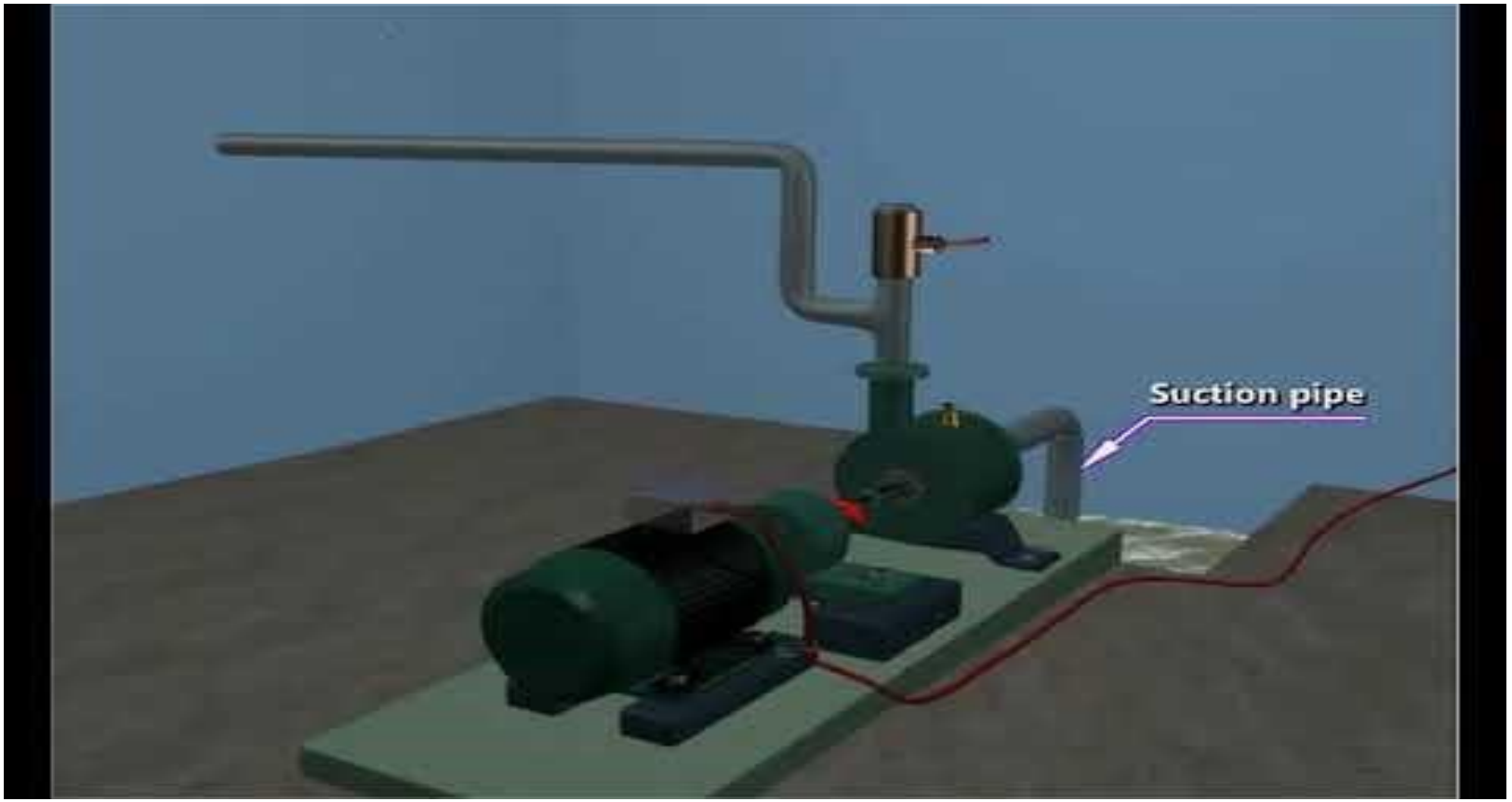
1.5: Perform pump priming

Pump Priming



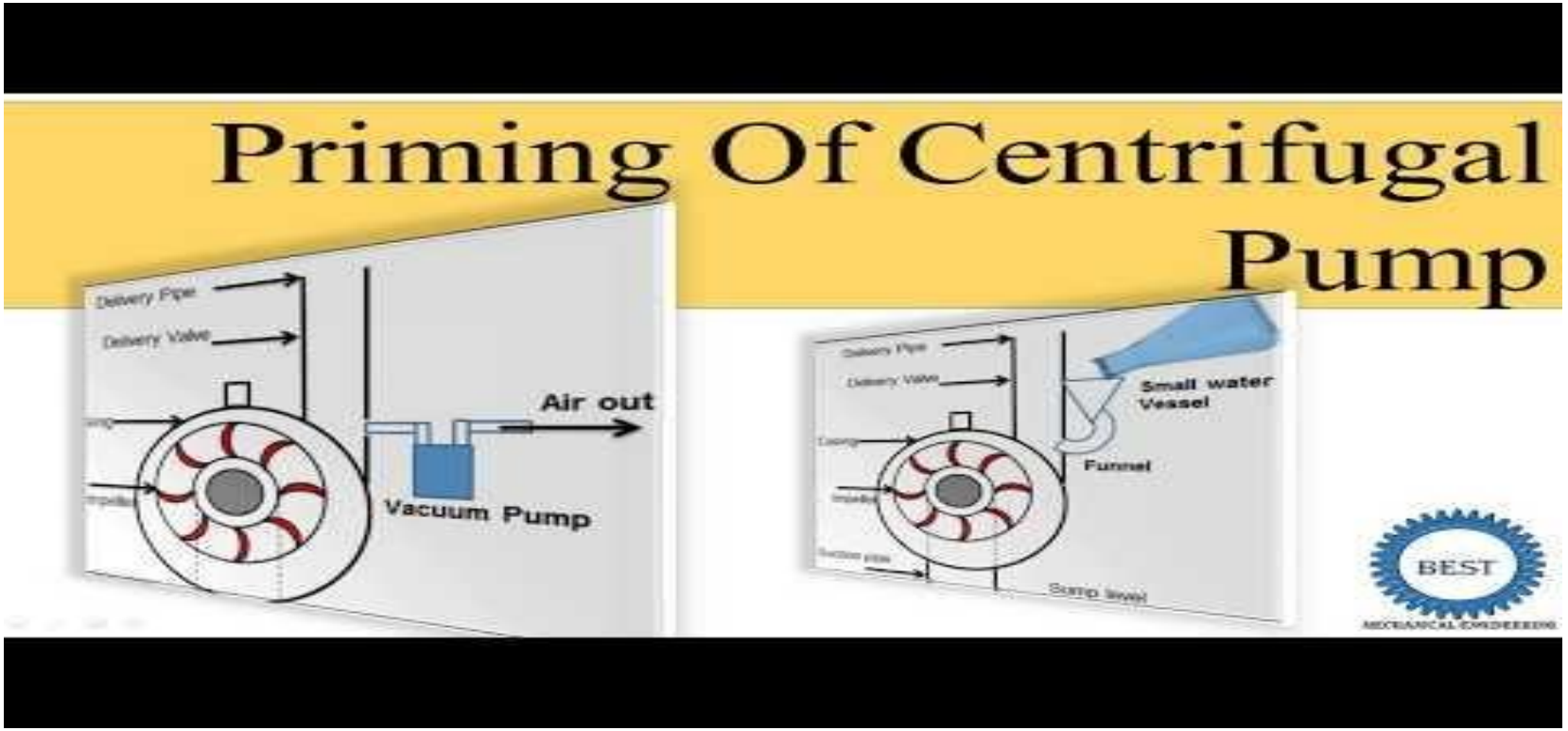
1.5: Perform pump priming

Priming of Centrifugal Pump - Animation



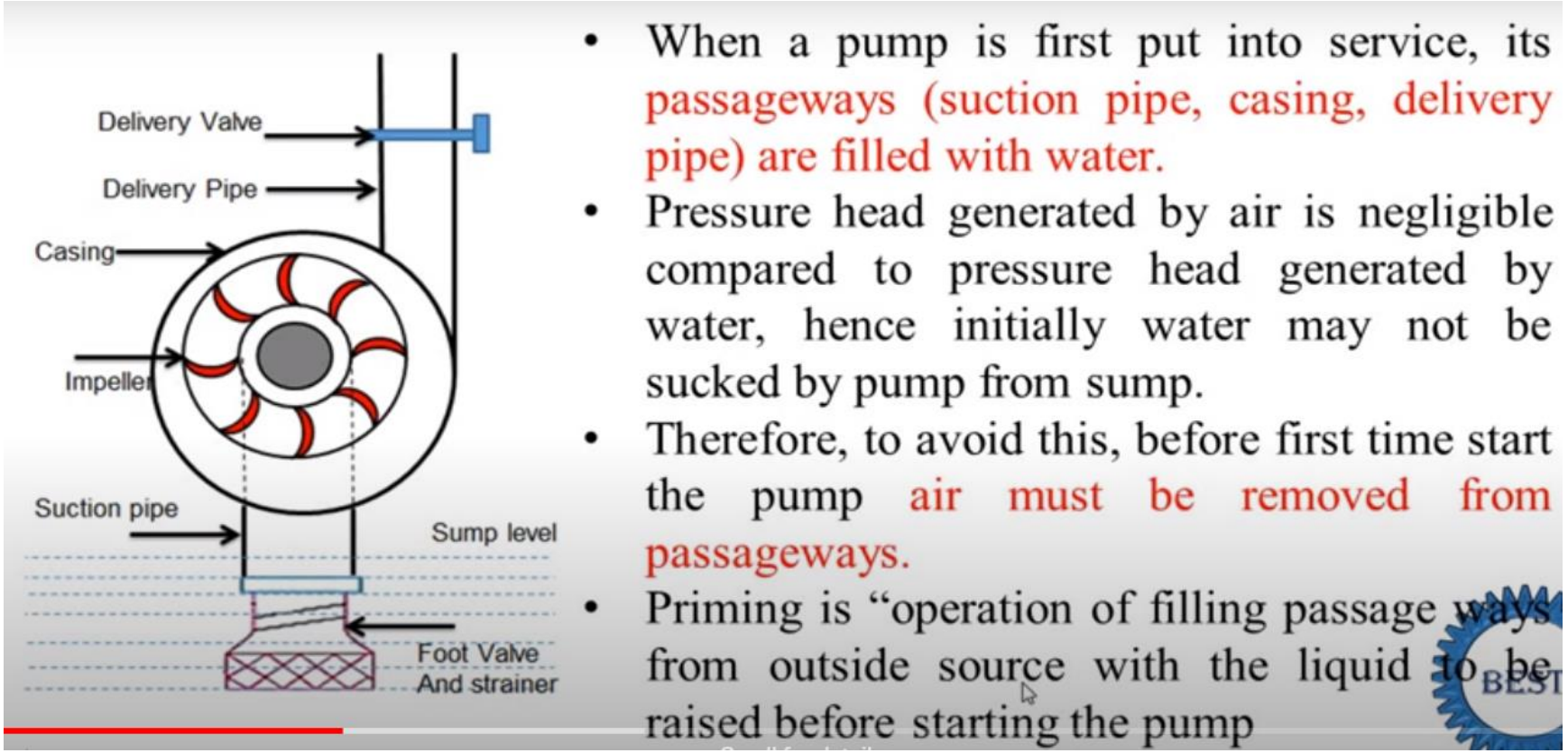
1.5: Perform pump priming

Priming of centrifugal Pump introduction various method priming



1.5: Perform pump priming

Priming of centrifugal Pump introduction various method priming



- When a pump is first put into service, its passageways (suction pipe, casing, delivery pipe) are filled with water.
- Pressure head generated by air is negligible compared to pressure head generated by water, hence initially water may not be sucked by pump from sump.
- Therefore, to avoid this, before first time start the pump air must be removed from passageways.
- Priming is "operation of filling passage ways from outside source with the liquid to be raised before starting the pump

1.5: Perform pump priming

Why Priming is Required?

- Priming reduces the risk of pump damage during start-up as it prevents the pump impeller to becomes gas-bound and thus incapable of pumping the desired liquid.
- For reliable operation, pumps must first be primed; that is, air or gases to be expelled from the suction and impeller eye area and replaced with liquid to be pumped.
- The pump would not function properly when not completely filled with liquid. Along with compromised performance, not priming the pump and allowed to run without fluid, it will overheat the pump system and there will be a danger of damage to critical internal pump components.

1.5: Perform pump priming

Priming – Centrifugal Pump vs Positive Displacement Pump

- In principle, all Positive Displacement Pumps are self-priming. In particular, this includes different type of rotary and reciprocating pumps.
- The priming of Positive Displacement Pump is required only at the time of first starting as under dry running conditions the pump may overheat. But in a Centrifugal Pump (except Self Priming Pump) priming is required in starting after every shutdown.

1.5: Perform pump priming

When Priming is Not Required?

- Priming is only not required when the pump is **either capable of removing air and gases from itself (also known as Self Priming Pumps) or the layout conditions are so much favorable that the pump will be always completely filled with the liquid to be pumped.**

1.5: Perform pump priming

When Priming is Not Required?

- Few such conditions are detailed out below:
  - ✓ Priming is not required when pump is submerged (Submersible or Vertical Sump Pumps).
  - ✓ Priming is not required when the pump is at a lower elevation than the supply and this ensures that pump suction will be completely filled with liquid at all times (known as “Flooded Suction Condition”).
  - ✓ Self Priming Pumps.

1.5: Perform pump priming

Recommended Readings

- **Introduction to Priming in Pumps**: https://www.theprocesspiping.com/introduction-to-priming-in-pumps/

1.6: Check status of irrigation system components

Components of irrigation system

An irrigation system is a system that delivers water to crops or plants in a controlled manner.

1.6: Check status of irrigation system components

Components of irrigation system

According to FAO, an irrigation system consists of five main components:

- **A main intake structure or main pumping station** that directs water from the source (such as a reservoir, river, or well) into the irrigation system.
- **A conveyance system** that transports water from the main intake or pumping station to the fields through canals, pipes, or ditches.
- **A distribution system** that delivers water to the fields through smaller canals, ditches, or sprinklers.

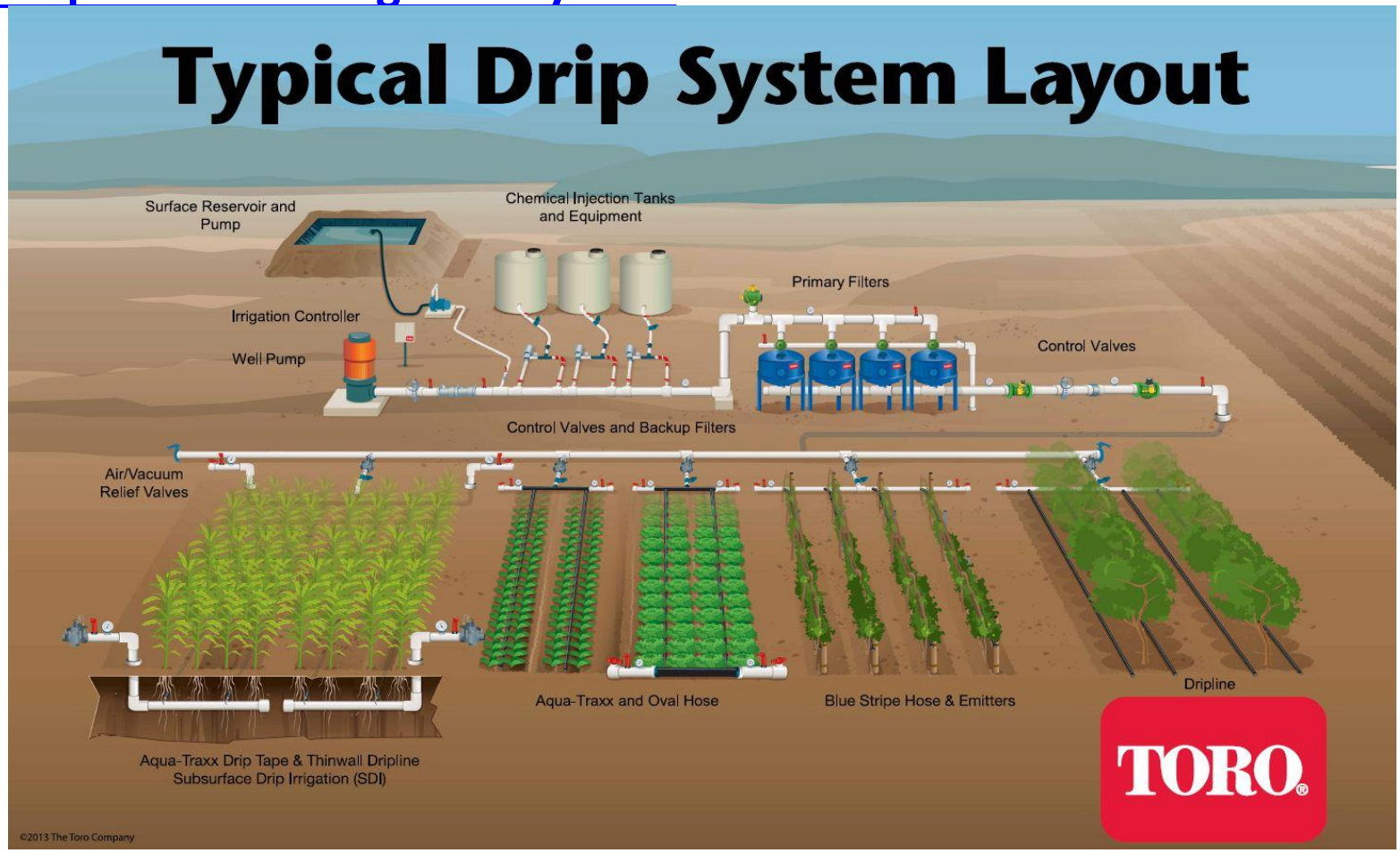
1.6: Check status of irrigation system components

Components of irrigation system

- **A field application system** that applies water to the crops or plants through various methods such as surface irrigation, sprinkler irrigation, drip irrigation, or subsurface irrigation.
- **A drainage system** that removes excess water from the fields due to rainfall or irrigation.

1.6: Check status of irrigation system components

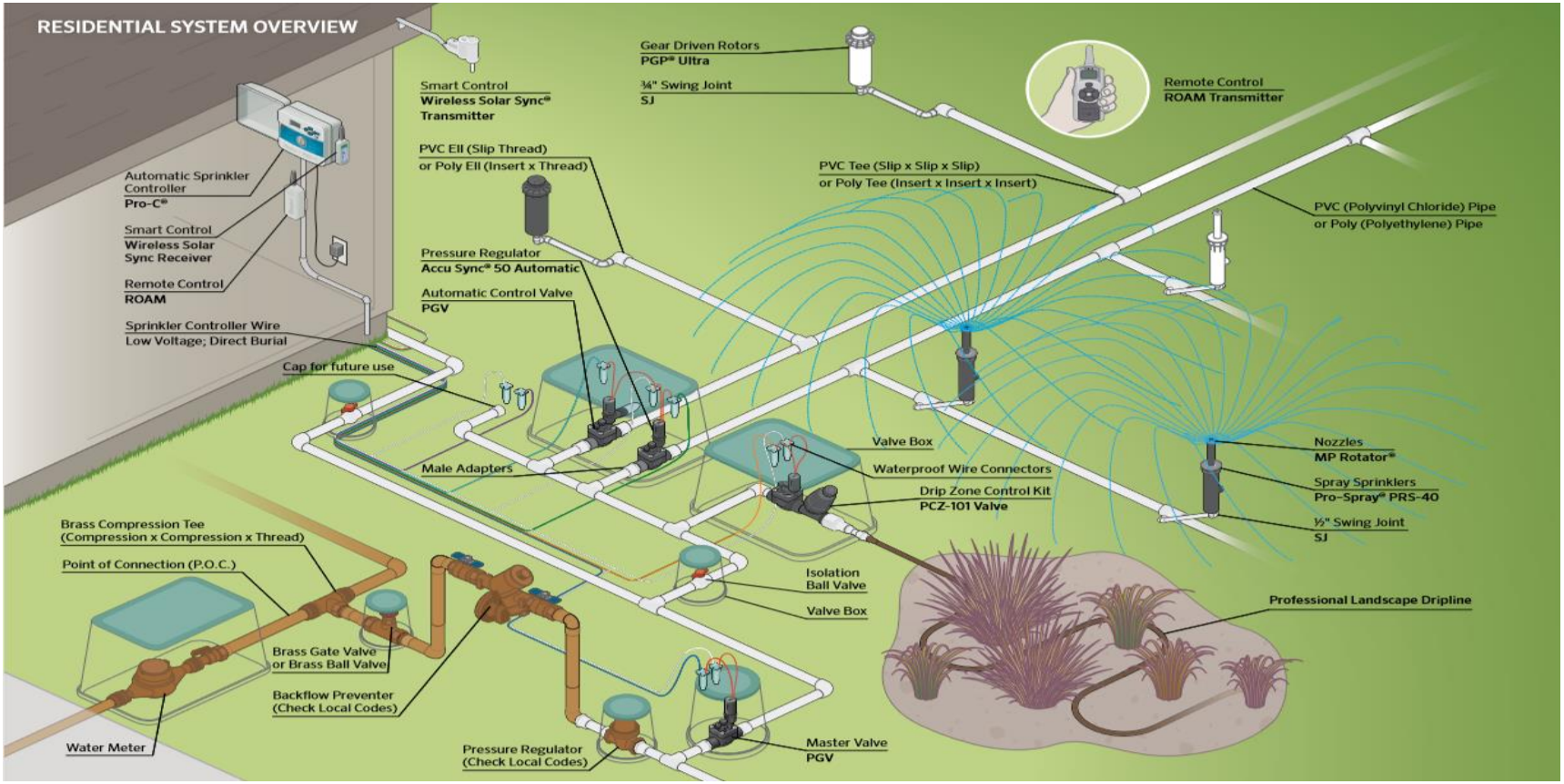
Components of irrigation system



1.6: Check status of irrigation system components

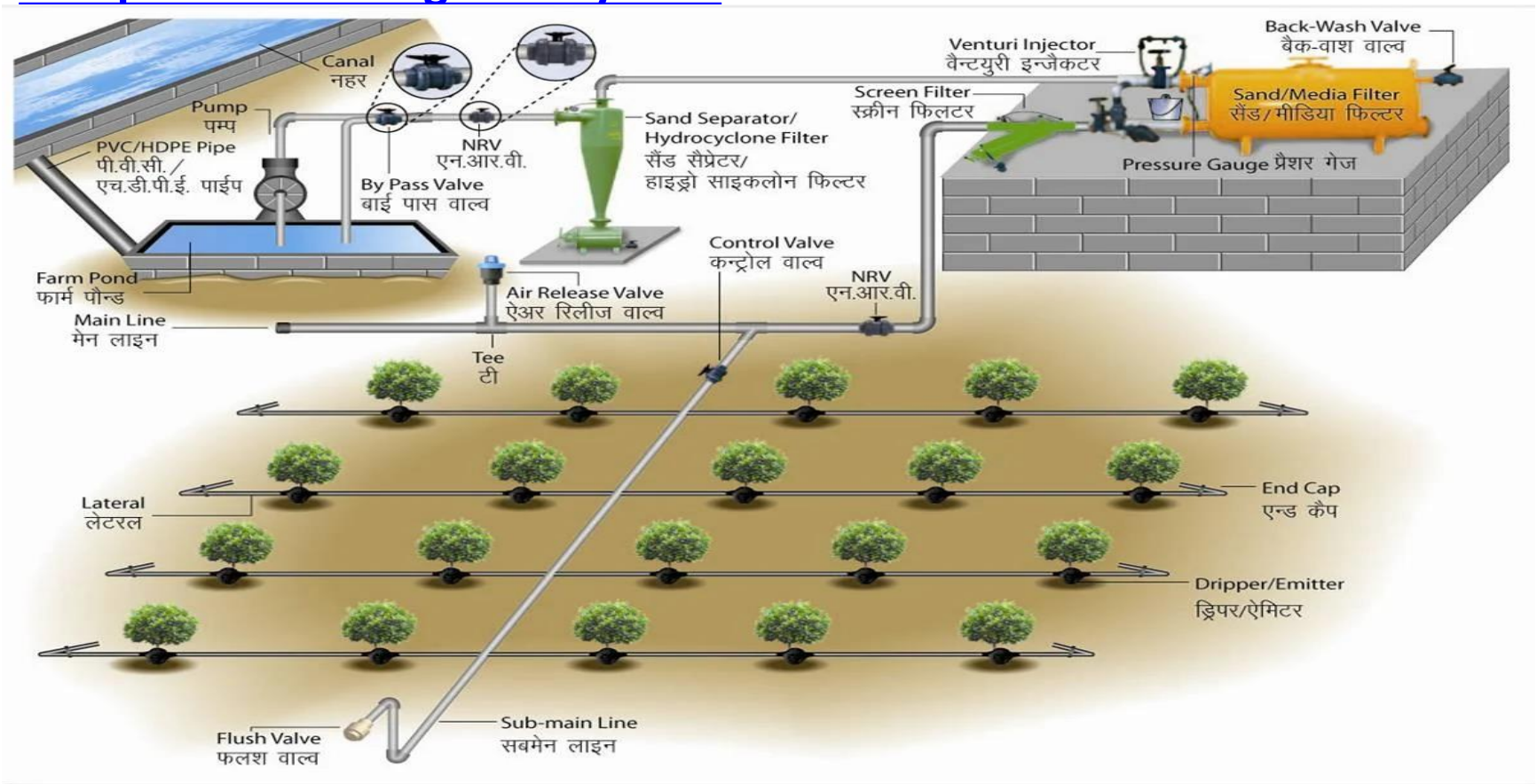
Components of irrigation system

Typical components in an irrigation system



1.6: Check status of irrigation system components

Components of irrigation system



Layout of Drip Irrigation System (ड्रिप सिंचाई पद्धति का रेखाचित्र)

1.6: Check status of irrigation system components

Components of irrigation system

10 components of an irrigation system

- **Water source**: This could be a well, irrigation pond, irrigation ditch, river, etc.
- **Pump**: Depending on location and volume/pressure requirements, this can vary.
- **Backflow prevention**: This prevents any foreign material, fertilizer or contaminants from flowing back into the water source.
- **Pressure regulator**: Depending on the type of emitters, the pressure that this device regulates to can vary widely. This not only reduces the pressure, but can work to keep pressure consistent.

1.6: Check status of irrigation system components

Components of irrigation system

10 components of an irrigation system

- **Filter**: There are varying types of filters, but all serve to remove particulates from the water that could plug emitters.
- **Injector**: These are used to apply water-soluble fertilizers through the irrigation kit.
- **Adapters**: These vary, but are used to connect various different types of equipment and irrigation lines.

1.6: Check status of irrigation system components

Components of irrigation system

10 components of an irrigation system

- **Distribution lines**: These move water from the water source to the location of application.
- **Submain lines/headers**: These water lines enter the field and distribute water to the emitters.
- **Emitters**: Drip tape or overhead sprinklers apply the water to the crop.

1.6: Check status of irrigation system components

Recommended Readings

- IRRIGATION SYSTEM: CHAPTER 5 - IRRIGATION SYSTEM (fao.org)
- Parts of a Sprinkler System (List of Components with Photos): Parts of a Sprinkler System (List of Components with Photos) – Upgraded Home
- What are the five components of irrigation system?: https://atrohouse.com/what-are-the-five-components-of-irrigation-system/

1.6: Check status of irrigation system components

Recommended Readings

- **Sprinkler Irrigation Design: https://www.youtube.com/watch?v=tZ1K3PFF0NU&list=PLbRMhDVUMngdyecGEkCH8BmO8N78lCVqh&index=23**
- **Drip Irrigation system: https://www.youtube.com/watch?v=aMPRw71MIyw**
- **Surface Irrigation: https://www.youtube.com/watch?v=kVLuIKTIBK4**

1.6: Check status of irrigation system components

Normal functioning of components of irrigation system

Parameters to verify the correct operating status of the drip irrigation system

- Verifying the correct functioning of the drip irrigation system is a fundamental step to ensure its proper operation over time.

1.6: Check status of irrigation system components

Normal functioning of components of irrigation system

Parameters to verify the correct operating status of the drip irrigation system

- In order to diagnose any problems with the drip irrigation system, it is necessary to take some basic readings of the pressure gauges and flow meters, as a considerable part of the irrigation system is often buried underground. These are taken after verifying the proper functioning of the system components and allow specific problems to be identified and resolved promptly.

1.6: Check status of irrigation system components

Normal functioning of components of irrigation system

Parameters to verify the correct operating status of the drip irrigation system

- To take basic readings of the entire system, it is necessary to record the values of all pressure gauges and flow meters upstream downstream of pumps, pipe control valves on the surface, inlet and outlet from drip tapes or drip lines

1.6: Check status of irrigation system components

Normal functioning of components of irrigation system

Parameters to verify the correct operating status of the drip irrigation system

- The main parameters to analyse are:

1) Flow rate of the drip irrigation system: knowing the flow rate of the system allows us to make decisions regarding the correct zoning of the irrigation system. The range of values in which the drip irrigation system flow rate must be included is between 30 l/min and 200 l/min depending on the characteristics of the system and the water requirements of the irrigated area.

1.6: Check status of irrigation system components

Normal functioning of components of irrigation system

Parameters to verify the correct operating status of the drip irrigation system

- Moreover, knowing the flow rate allows, considering the diameter of the pipes, to calculate the speed of the water in the system (expressed in m/sec): the higher the speed of the water inside the pipe system, the higher the pressure drops that can compromise the correct functioning of the system. In this regard, it is advisable to maintain a water speed below 3.5 m/sec;

1.6: Check status of irrigation system components

Normal functioning of components of irrigation system

Parameters to verify the correct operating status of the drip irrigation system

2) Pump pressure: ensures the movement of water within the system. The most used pumps in drip irrigation systems have a pressure between 3 and 6 bar;

3) Filter inlet pressure: provides an important indication of the force with which the water to be filtered is pushed into the filtration system. Verifying that the inlet pressure to the filter conforms to the specifications provided by the system designer allows us to verify the correct operation of the filtration system;

1.6: Check status of irrigation system components

Normal functioning of components of irrigation system

Parameters to verify the correct operating status of the drip irrigation system

4) Filter outlet pressure: allows you to check the pressure losses suffered by the water when crossing the filter. When the difference between filter inlet pressure and outlet pressure is too marked, it is necessary to arrange appropriate backwashing operations in order not to affect the operation of the system;

5) Main control valve outlet pressure: provides an average indication of the systemic water pressure values of the entire system.

1.6: Check status of irrigation system components

Normal functioning of components of irrigation system

Parameters to verify the correct operating status of the drip irrigation system

- An advice to overcome these problems is to follow the specifications given by the system designer in order to avoid pressure drops.
- An important indication of the correct basic functioning of the system is given by the appearance of the purging water coming out of the filter. If the water is clean and has no sand or soil residue it means that both the filtration system and the backwash valve are working properly.

1.6: Check status of irrigation system components

Normal functioning of components of irrigation system

Parameters to verify the correct operating status of the drip irrigation system

- Once the above basic readings have been taken, it will be necessary to check the operation of all other components by measuring the pressure at the inlet and outlet of the valves, the hose and the appearance of the purging water from the lines.
- The stabilization time of the system to reach the correct pressure and flow rate will be determined.

1.6: Check status of irrigation system components

Common causes of irrigation system malfunctioning

- Some of the common causes of irrigation system malfunctioning are (The Spruce, 2022; Rain Bird, n.d.; Gardening Solutions, n.d.):
- **Broken valves**: Valves are the devices that control the flow of water to different zones of the irrigation system. They can break due to wear and tear, freezing, corrosion, or debris. Broken valves can cause leaking, flooding, low pressure, or no water at the sprinkler heads.

1.6: Check status of irrigation system components

Common causes of irrigation system malfunctioning

- **Clogged nozzles**: Nozzles are the devices that spray water from the sprinkler heads. They can get clogged by dirt, sand, algae, insects, or other foreign objects. Clogged nozzles can cause inaccurate spray patterns, reduced coverage, misting, or dry spots.
- **Damaged pipes**: Pipes are the conduits that transport water from the valves to the sprinkler heads. They can get damaged by tree roots, rodents, digging, freezing, or aging. Damaged pipes can cause leaking, low pressure, wet spots, or no water at the sprinkler heads.

1.6: Check status of irrigation system components

Common causes of irrigation system malfunctioning

- **Faulty timer**: Timer is the device that controls the timing and duration of each watering session. It can malfunction due to power outage, battery failure, wiring issues, or programming errors. Faulty timer can cause overwatering, underwatering, irregular watering, or no watering at all.
- **Malfunctioning sprinkler heads**: Sprinkler heads are the devices that distribute water to the plants. They can malfunction due to physical damage, improper installation, misalignment, or wear and tear. Malfunctioning sprinkler heads can cause uneven watering, overspray, runoff, erosion, or wasted water.

1.6: Check status of irrigation system components

Recommended Readings

- The Spruce. (2022). How to Troubleshoot Your Lawn Irrigation System. Retrieved from https://www.thespruce.com/irrigation-troubleshooting-bad-valve-symptoms-2718892
- Rain Bird. (n.d.). Irrigation Troubleshooting Guide. Retrieved from https://www.rainbird.com/sites/default/files/media/documents/2018-05/IrrigationTroubleshootingGuide.pdf
- Gardening Solutions. (n.d.). Irrigation System Maintenance. Retrieved from https://gardeningsolutions.ifas.ufl.edu/care/tools-and-equipment/irrigation-system-maintenance.html

1.6: Check status of irrigation system components

Recommended Resources

- Drip Irrigation system: https://www.youtube.com/watch?v=aMPRw71MIyw&list=PLbRMhDVUMngdyecGEkCH8BmO8N78lCVqh&index=25
- Surface Irrigation: https://www.youtube.com/watch?v=kVLuIKTIBK4&list=PLbRMhDVUMngdyecGEkCH8BmO8N78lCVqh&index=20
- Sprinkler Irrigation: https://www.youtube.com/watch?v=tZ1K3PFF0NU&list=PLbRMhDVUMngdyecGEkCH8BmO8N78lCVqh&index=23
- Water Application Methods: https://www.youtube.com/watch?v=dtJf7kvNkxw

1.6: Check status of irrigation system components

Group Work, 15/05/2023

- Briefly discuss types of engine oil
- Briefly discuss irrigation water quality and quantity

(20 Minutes for research & 5 minutes for presentation)

UNIT 2 - CONDUCT IRRIGATION SYSTEM OPERATION

2.1. Perform startup sequence

2.2. Check water application systems

2.3. Adjust water flow devices

2.4. Clean filters

2.5. Fix leaks and blockages

UNIT 2 - CONDUCT IRRIGATION SYSTEM OPERATION

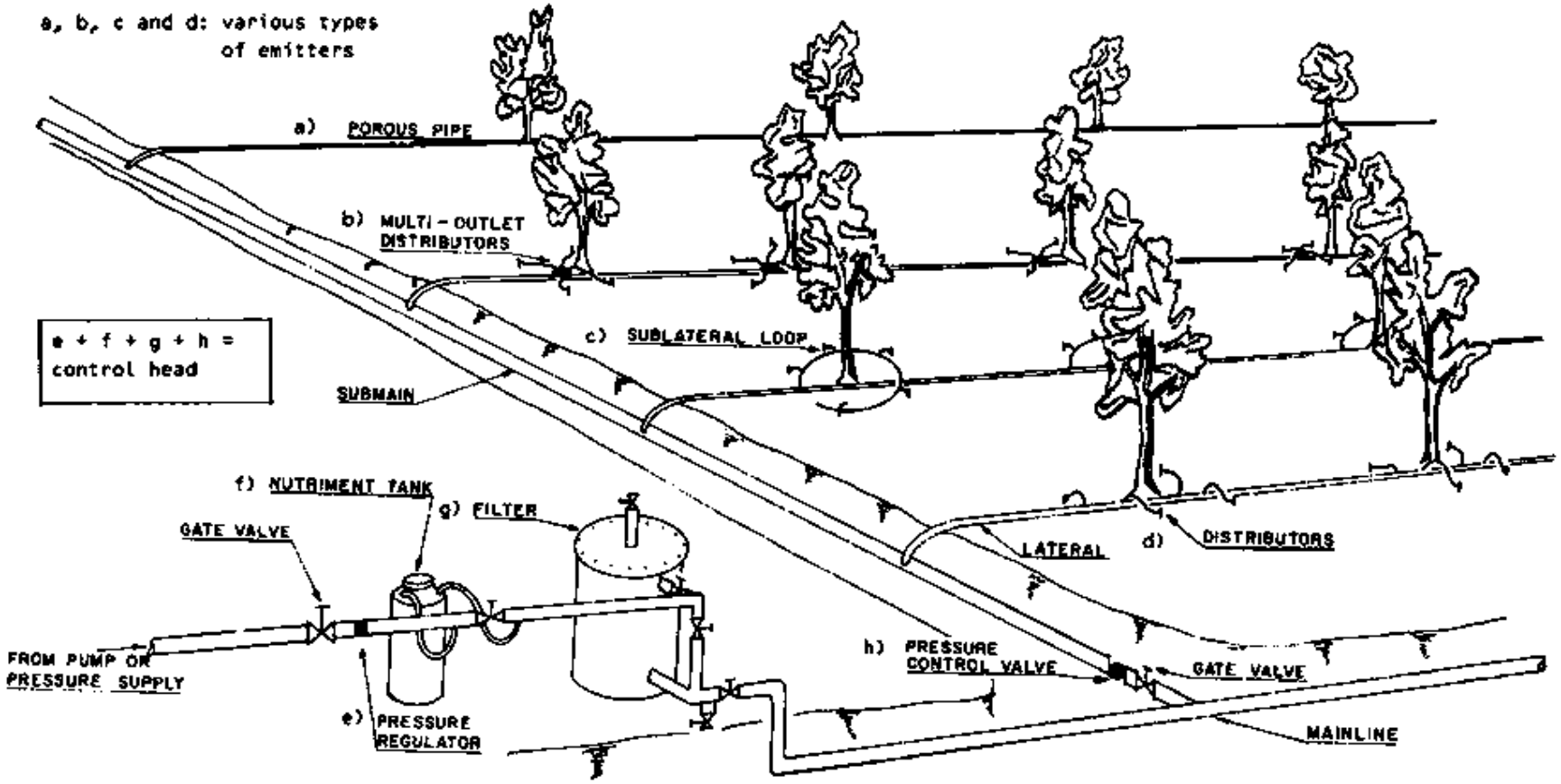
Group work: 11/05/2023

1. Discuss how to perform startup sequence (Group 1)
2. Discuss how to check water application systems (Group 2)
3. Discuss how to adjust water flow devices (Group 3)
4. Discuss how to clean filters in irrigation (Group 4)
5. Discuss how to fix leaks and blockages (Group 5)

2.1: Perform startup sequence

Components of small irrigation system

Drip irrigation components



2.1: Perform startup sequence

Components of small irrigation system

Sprinkler irrigation components

2.1: Perform startup sequence

Components of small irrigation system

Sprinkler irrigation components

2.1: Perform startup sequence

Components of small irrigation system

- Simple & Quick Drip Irrigation System for Growing Tomatoes:

https://www.youtube.com/watch?v=7898F6ous7A

2.1: Perform startup sequence

Demonstration on how to
Operate the irrigation system

- How an Irrigation System Works: https://www.youtube.com/watch?v=UADXcEJTcso
- How water flows through a sprinkler system & how to turn off water to your sprinkler system: https://www.youtube.com/watch?v=vYV7Oac5T98
- How to start up your sprinkler system: https://www.youtube.com/watch?v=r70Hbtkuwu8
-

2.2: Check water application systems

Water application systems

- ✓ Basin irrigation
- ✓ Furrow irrigation
- ✓ Border irrigation
- ✓ Flooding irrigation

- ✓ Sprinkler irrigation
- ✓ Drip irrigation
- ✓ Manual irrigation

2.2: Check water application systems

Basin irrigation

- Basin irrigation is suitable for many field crops. Paddy rice grows best when its roots are submerged in water and so basin irrigation is the best method to use for this crop.

2.2: Check water application systems

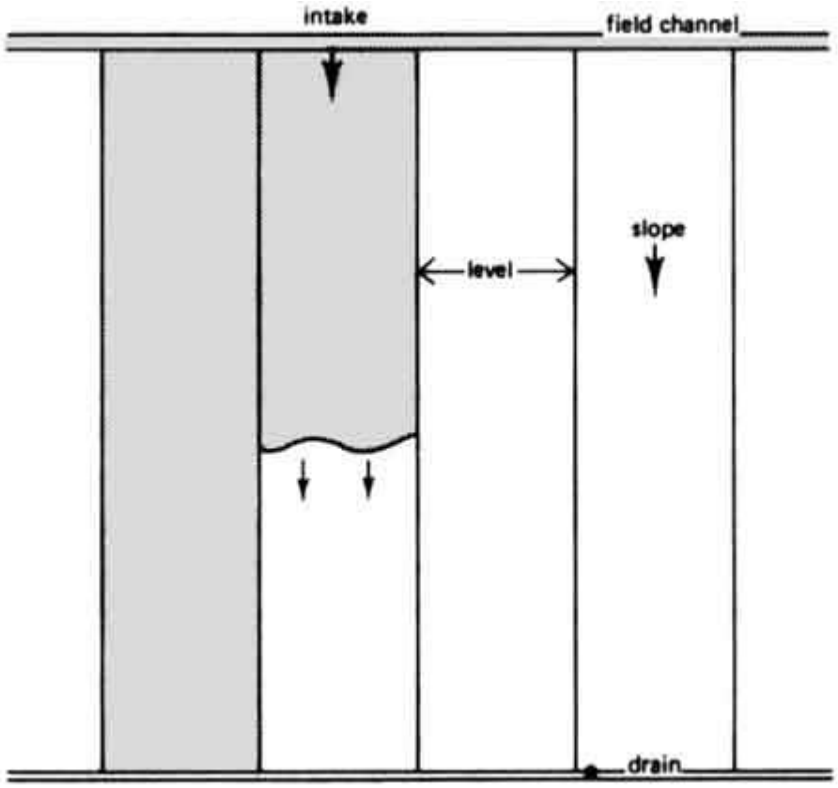
Furrow irrigation

- Furrows are small, parallel channels, made to carry water in order to irrigate the crop. The crop is usually grown on the ridges between the furrows.

2.2: Check water application systems

Border irrigation

- Borders are usually long, uniformly graded strips of land, separated by earth bunds. In Contrast to basin irrigation these bunds are not to contain the water for ponding but to guide it as it flows down the field.



2.2: Check water application systems

Flooding irrigation

- Flood irrigation is the oldest and most popular irrigation system in the world.
- Flood irrigation, also called surface irrigation, is any method of irrigation that delivers water to croplands using gravity.

2.2: Check water application systems

Flooding irrigation

2.2: Check water application systems

Flooding irrigation

2.2: Check water application systems

Recommended Readings

- **Surface irrigation systems: https://www.fao.org/3/T0231E/t0231e04.htm**

2.2: Check water application systems

Sprinkler irrigation

- Sprinkler/spray irrigation is the method of applying water to a controlled manner in that is similar to rainfall.
- The water is distributed through a network that may consist of pumps, valves, pipes, and sprinklers. Irrigation sprinklers can be used for residential, industrial, and agricultural usage.

2.2: Check water application systems

Drip irrigation

- Drip irrigation involves placing tubing with emitters on the ground along side the plants.
- The emitters slowly drip water into the soil at the root zone. Because moisture levels are kept at an optimal range, plant productivity and quality improve.
- Drip Irrigation is the most efficient irrigation system.

2.2: Check water application systems

Manual irrigation

- A manual irrigation system involves hand watering with hoses, nozzles, or sprinklers.
- While using these products tends to cost less money than installing an automatic system, it requires significantly more time as you will need to operate the equipment yourself.

2.2: Check water application systems

Recommended Resources

- Surface Irrigation Systems: https://extension.okstate.edu/fact-sheets/surface-irrigation-systems.html

2.2: Check water application systems

Differences in water application

- ✓ Wetting patterns,
- ✓ Water application efficiency,
- ✓ Water distribution uniformity,
- ✓ Operating conditions

2.2: Check water application systems

Wetting patterns

Wetting Patterns in Drip Irrigation

- A major difference between drip irrigation and other irrigation methods is that drip irrigation applies water to only a portion of the soil.
- This works great for vegetables grown on the plastic mulch, since no irrigation water is applied between the row middles; water applied to row middles encourages weed growth. So, does the soil under the plastic evenly wet? In some cases, as we will examine below, the soil does not become evenly wet.

2.2: Check water application systems

Wetting Patterns in Drip Irrigation

- Water moves downward by gravity and horizontally by capillary action when dripped onto the soil.
- Fine-textured soil has a greater ability to hold and retain water than coarse-textured soil. Thus, water is more likely to move horizontally in clay soils than in sandy soils.
- Water discharge rate of drip tapes also affects the wetting pattern. In general, water is more likely to move horizontally with high flow-rate (high discharge) drip tapes than low flow-rate (low discharge) drip tapes (Figure 1 and 2).

2.2: Check water application systems

Wetting Patterns in Drip Irrigation

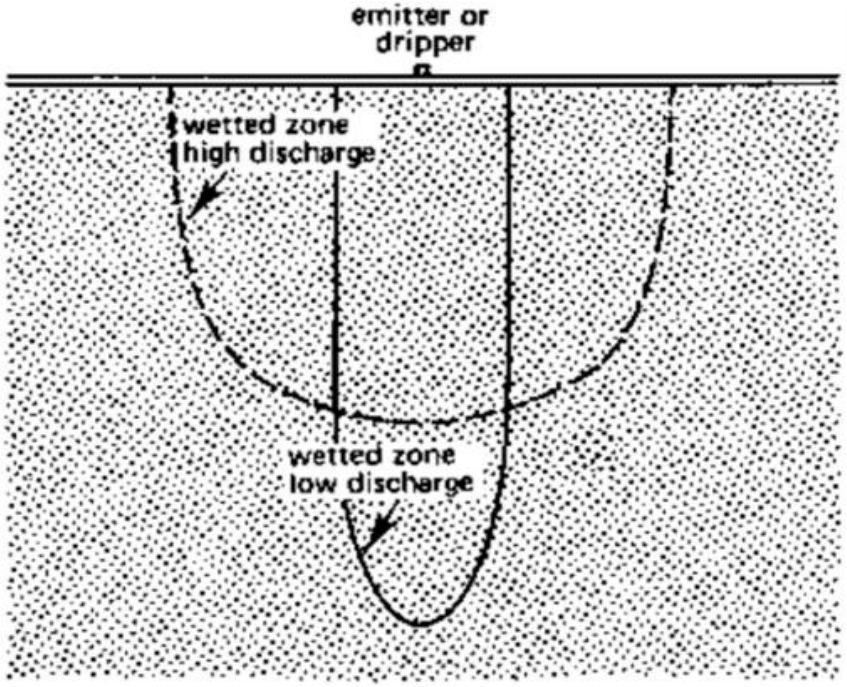


Figure 1. Wetting patterns for sandy soils with high and low flow-rate drip tapes

2.2: Check water application systems

Wetting Patterns in Drip Irrigation

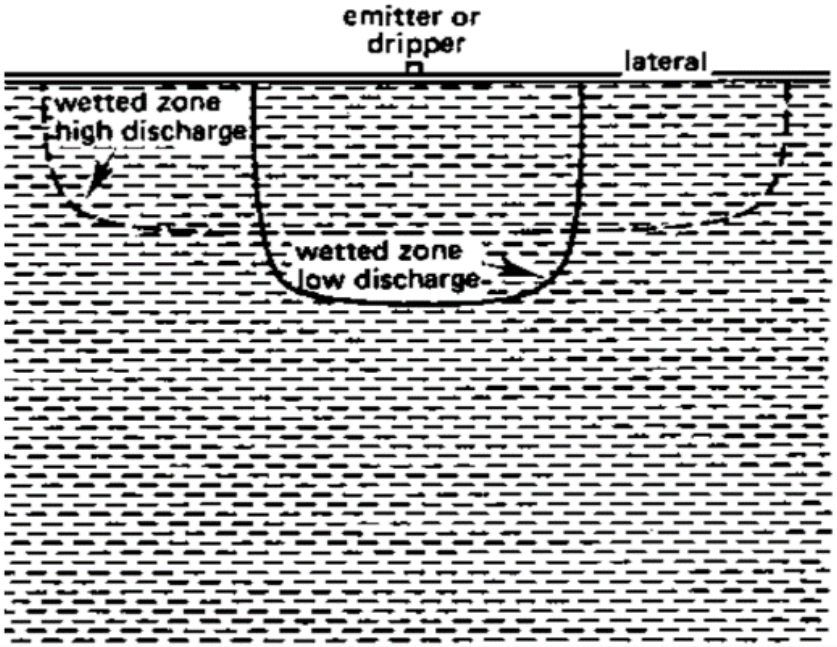


Figure 2. Wetting patterns for clay soils with high and low flow-rate drip tapes

2.2: Check water application systems

Wetting Patterns in Drip Irrigation

- Unlike surface and sprinkler irrigation, drip irrigation only wets part of the soil root zone.
- This may be as, low as 30% of the volume of soil wetted by the other methods.
- The wetting patterns which develop from dripping water onto the soil depend on discharge and soil type. The figures 1 and 2 show the effect of changes in discharge on two different soil types, namely sand and clay.

2.2: Check water application systems

Wetting Patterns in Sprinkler Irrigation

- The wetting pattern from a single rotary sprinkler is not very uniform (Figure 3). Normally the area wetted is circular (see topview). The heaviest wetting is close to the sprinkler (see sideview). For good uniformity several sprinklers must be operated close together so that their patterns overlap (Figure 58).
- For good uniformity the overlap should be at least 65% of the wetted diameter. This determines the maximum spacing between sprinklers.

2.2: Check water application systems

Wetting Patterns in Sprinkler Irrigation

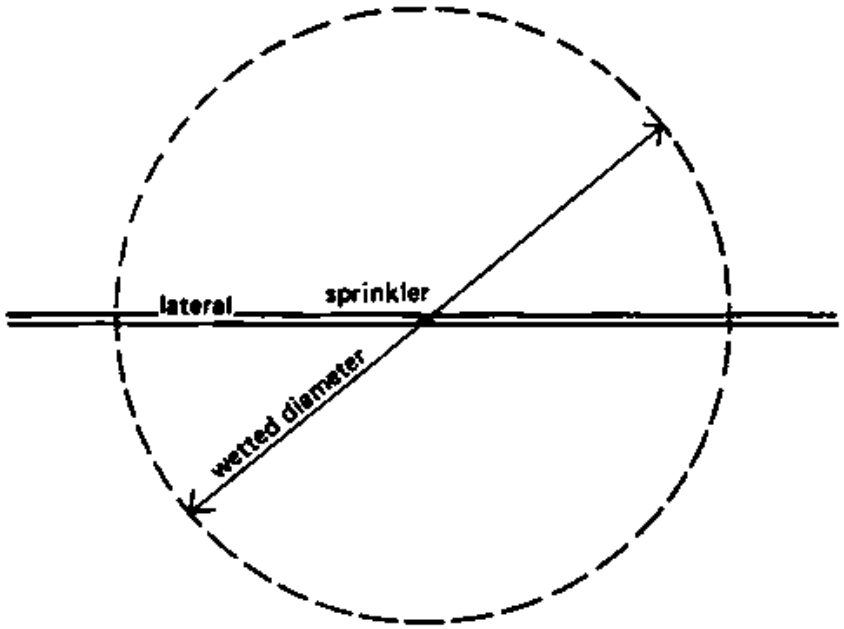


Figure 3. Wetting pattern for a single sprinkler (TOP VIEW)

Figure 3. Wetting pattern for a single sprinkler (SIDE VIEW)

2.2: Check water application systems

Wetting Patterns in Sprinkler Irrigation

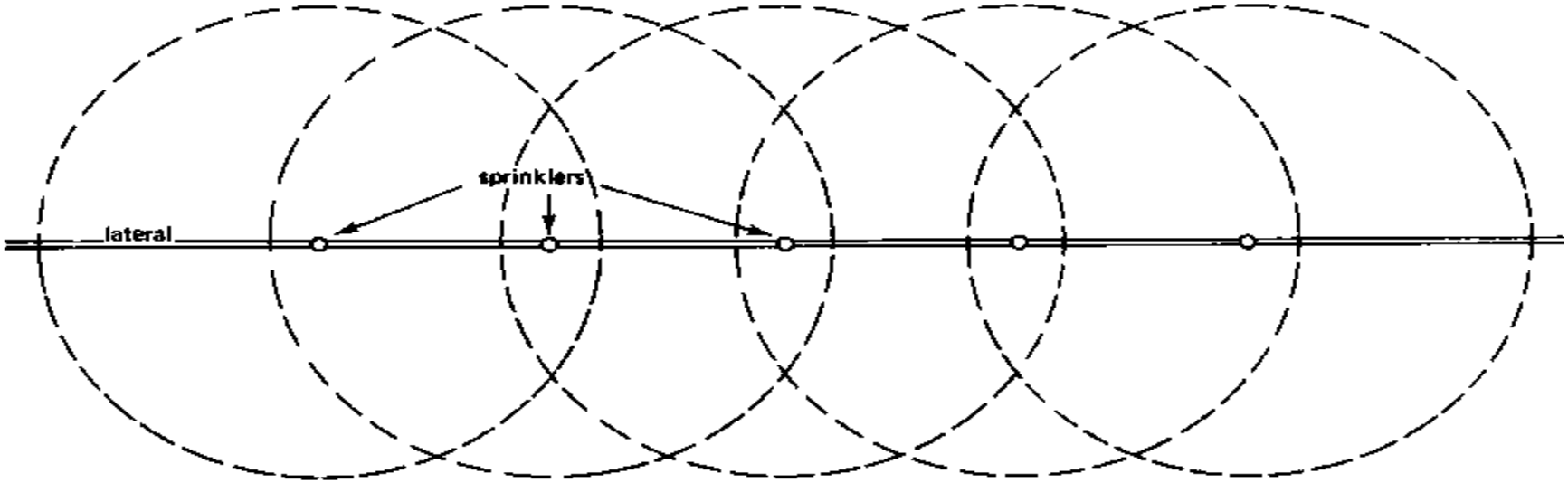


Figure 4. Wetting patterns for several sprinklers (TOP VIEW)

2.2: Check water application systems

Wetting Patterns in Sprinkler Irrigation

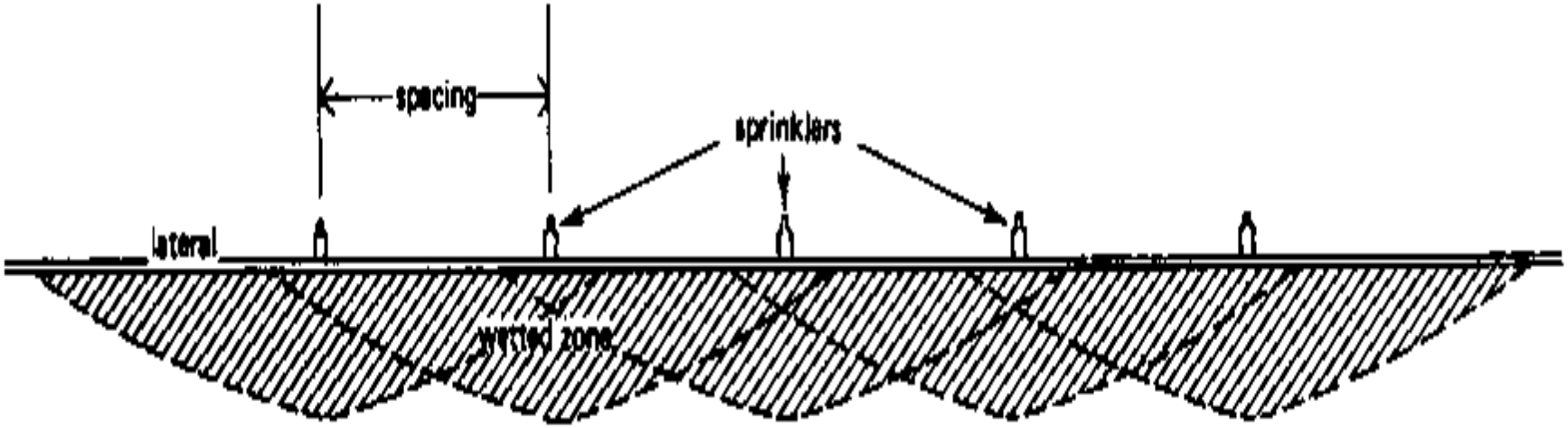


Figure 4. Wetting patterns for several sprinklers (SIDE VIEW)

2.2: Check water application systems

Wetting Patterns in Sprinkler Irrigation

- The uniformity of sprinkler applications can be affected by wind and water pressure.
- Spray from sprinklers is easily blown about by even a gentle breeze and this can seriously reduce uniformity. To reduce the effects of wind the sprinklers can be positioned more closely together.

2.2: Check water application systems

Wetting Patterns in Sprinkler Irrigation

- Sprinklers will only work well at the right operating pressure recommended by the manufacturer. If the pressure is above or below this then the distribution will be affected.
- The most common problem is when the pressure is too low. This happens when pumps and pipes wear. Friction increases and so pressure at the sprinkler reduces. The result is that the water jet does not break up and all the water tends to fall in one area towards the outside of the wetted circle.
- If the pressure is too high then the distribution will also be poor. A fine spray develops which falls close to the sprinkler.

2.2: Check water application systems

Water application efficiency

- Application Efficiency (AE) is a performance criterion that expresses how well an irrigation system performs when is operated to deliver a specific amount of water.
- AE is defined as the ratio of the average water depth applied and the target water depth during an irrigation event.

- The **average water depth** is the average height of water applied in a field during an irrigation event.
- The **target water depth** is the desired water to be supplied in a field during an irrigation event.

2.2: Check water application systems

Irrigation system (Project) efficiency, E_p

$$E_p = W_{pl}/W_{OHW} = E_t E_c E_a$$

- **Conveyance (transportation) efficiency** :

  $$E_t = W_{ib}/W_{OHW}$$

- **Field channel efficiency, E_c** :

  $$E_c = W_{if}/W_{ib}$$

- **Field application efficiency, E_a** :

  $$E_a = W_{pl}/W_{if}$$

W_{OHW}= water released at the headwork

W_{ib} = water received at the inlet of the block of field

W_{if} = water received at the field inlet

W_{pl} = water actually made available to crop

2.2: Check water application systems

Irrigation system (project) efficiency (cont'd)

Water distribution efficiency, Ed

$E_d = E_t.E_c$

Farm efficiency

$E_f = E_c.E_a$

2.2: Check water application systems

Recommended Resources

- Irrigation Efficiency: https://www.youtube.com/watch?v=rZ4c-nB0ukQ&list=PLbRMhDVUMngdyecGEkCH8BmO8N78lCVqh&index=60

2.2: Check water application systems

Water distribution uniformity **Irrigation Uniformity**

- Irrigation uniformity is a measure of how evenly water is applied to a field (figure 3). It is commonly referred to as distribution uniformity (DU) and expressed as a percentage.
- When an irrigation system applies water at a high uniformity, it is possible to achieve a high irrigation efficiency.

2.2: Check water application systems

Water distribution uniformity **Irrigation Uniformity**

- Similarly, when irrigation is uniform, crop production and quality is often higher and boosts revenue potential.
- Extra water is usually applied to assure that the crop in the areas of the field receiving the least water have enough to grow and produce well which elevates the importance of achieving high irrigation uniformity.
- Low irrigation uniformity cannot be overcome by management of irrigation frequency or duration.

2.2: Check water application systems

Water distribution uniformity **Irrigation Uniformity**

- No irrigation system can apply water perfectly uniform across a field. A DU less than 70 percent is considered poor for pressurized systems. Ideally, the DU of a pressurized system should be maintained at 85 percent and preferably higher.

2.2: Check water application systems

Water distribution uniformity **Irrigation Uniformity**

- After the field data are gathered, the water volume or pressure are ranked from lowest to highest.
- The average volume or pressure for the lowest 25 percentile of measurements is calculated and the average for all of the measurements is also calculated.
- Distribution uniformity (DU) is calculated using equation 1:

2.2: Check water application systems

Water distribution uniformity **Irrigation Uniformity**

$$DU\ (\%) = \frac{\text{Average volume or pressure of lowest 25 percentile}}{\text{Average volume or pressure of all measurements}} \times 100$$

Equation 1. Calculating percent distribution uniformity (DU)

2.2: Check water application systems

Recommended Readings

- **Irrigation Distribution Uniformity – Why and How?:** http://www.northvalleyagservices.com/public/uploads/Irrigation_Distribution_Uniformaity_-_Why_and_How_Allan_Fulton.pdf

2.2: Check water application systems

Operating conditions

- Khedr (2020) investigated the optimum operating conditions for impact sprinkler to study the effect of different operating pressures and riser heights to determine optimum operating conditions that achieve high application efficiency and wheat production in impact sprinkler system. The coefficient of uniformity (CU,%) was evaluated within the operating pressure range from 100 to 350 kPa, riser heights 1.0, 1.5 and 2.0 m, overlapped from 100 to 20% under square and triangular layouts sprinkler.

2.2: Check water application systems

Operating conditions

- It was concluded that the operating conditions that achieved high CU was operating pressure of 250 kPa and 1.5 m riser height for impact sprinkler. Information from individual sprinkler test was established to carry out the corresponding overlapping ranged from 20 to 100% in square and triangular layouts sprinkler. Optimal spacing between sprinklers was found to be as 50 to 70% from diameter of throw in square layout (Khedr, 2020).

2.2: Check water application systems

Operating conditions

- It was found in range of 50 to 80% from diameter of throw in triangular layout sprinkler. The wheat yield was highly affected by water requirements (100, 80 and 60% ETc). The results showed that the average values of total grain and straw yield/fed, increased with increasing ETc from 60 to 100%. The highest yield was achieved with 100% ETc, while, WUE with 80% ETc was the highest value (Khedr, 2020).

2.2: Check water application systems

Operating conditions

- It could be recommended to apply irrigation water to 100% ETc that has the highest yield of wheat under operating pressure of 250 kPa with good CU for impact sprinkler. On the other hand, adding 80% ETc applied gave the highest values was preferred when the priority to save on the applied water and increase water productivity. Also, layout spacing ≥ 50% from diameter of throw was recommended (Khedr, 2020).

2.2: Check water application systems

Operating conditions

- The pump supply system, sprinklers and operating conditions must be designed to enable a uniform application of water.

2.3: Adjust pressure and water flow testing equipment

- ✓ Pressure gauge components
- ✓ Water flow meter components
- ✓ Pressure gauge function
- ✓ Function of water flow meter

Group Work, 16/05/2023

- Discuss flow meter components

2.4: Clean filters

Types of filters :

- ✓ Screen
- ✓ Disk
- ✓ Sand media filters

2.4: Clean filters

Filter cleaning methods

- ✓ Backwashing the system
- ✓ Clean accumulated particles and debris.
- ✓ Filter Cleaning Manual
- ✓ Filter cleaning procedures
- ✓Filter dismantling and assembling

2.4: Clean filters

Group Work, Group Work, 16/05/2023

- Discuss stock requisition format and details

2.4: Clean filters

Factors to consider for requisition

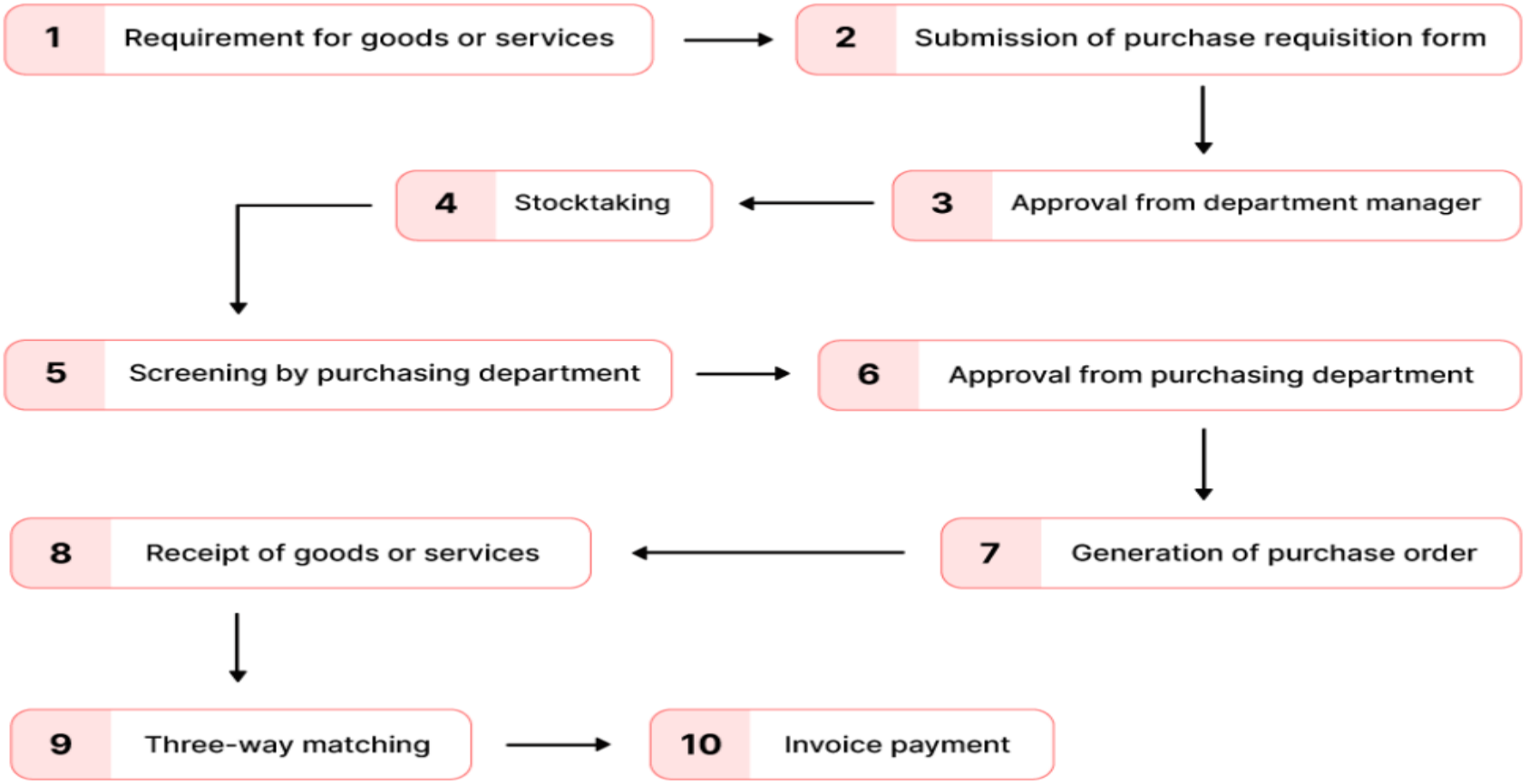
Contents of a purchase requisition form

- Purchase requisition forms generally require the following information:
  - ✓ Name and department of the requestor
  - ✓ The date of request
  - ✓ The products or services requested
  - ✓ Item description, quantity, and price
  - ✓ Reason for purchase
  - ✓ Legal name of the supplier

2.4: Clean filters

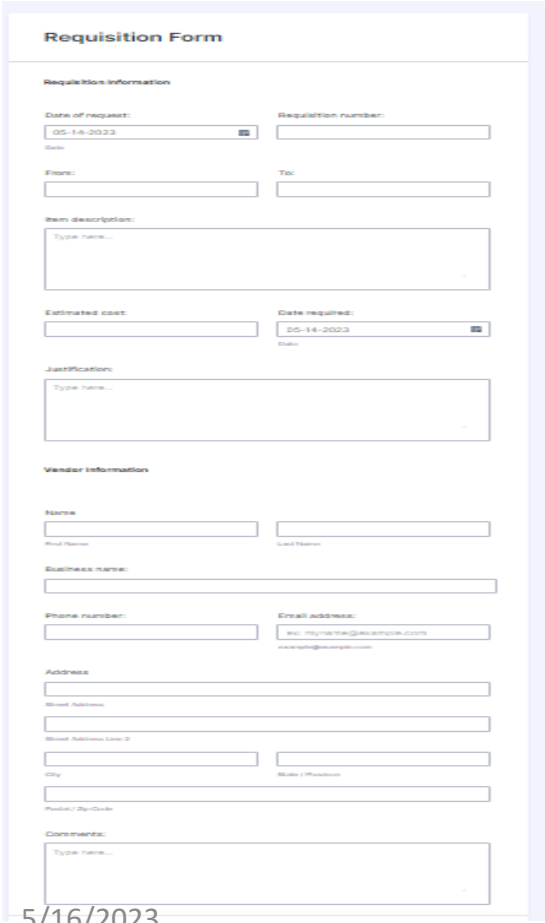
Factors to consider for requisition

Steps involved in the purchase requisition workflow



2.4: Clean filters

Factors to consider for requisition



Requisition Form

Requisition Information

Date of request:

05-14-2023

Date

Requisition number:

From:

To:

Item description:

Type here...

Estimated cost:

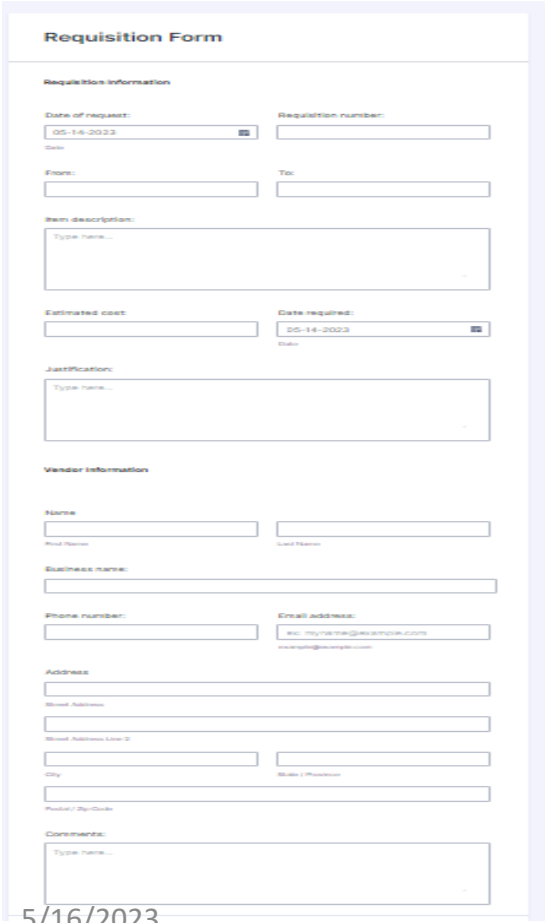
Date required:

05-14-2023

Date

2.4: Clean filters

Factors to consider for requisition



Estimated cost:

Date required:

05-14-2023

Date

Justification:

Type here...

Vendor Information

Name

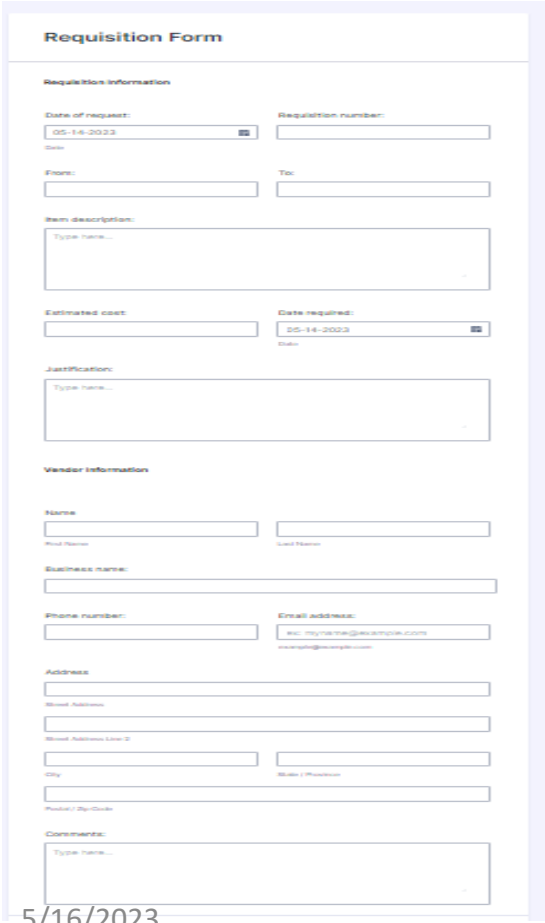
First Name

Last Name

Business name:

2.4: Clean filters

Factors to consider for requisition



Business name:

Phone number:

Email address:

ex: myname@example.com

example@example.com

Address

Street Address

Street Address Line 2

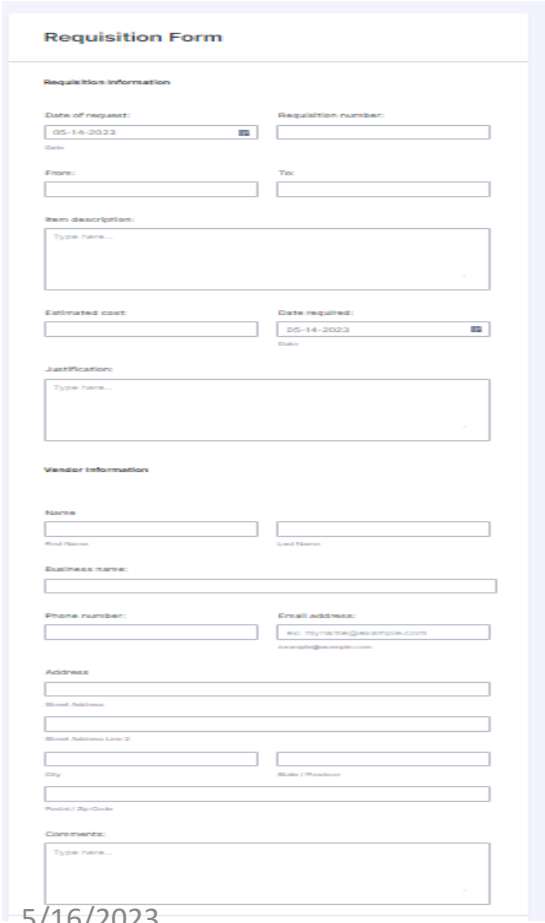
City

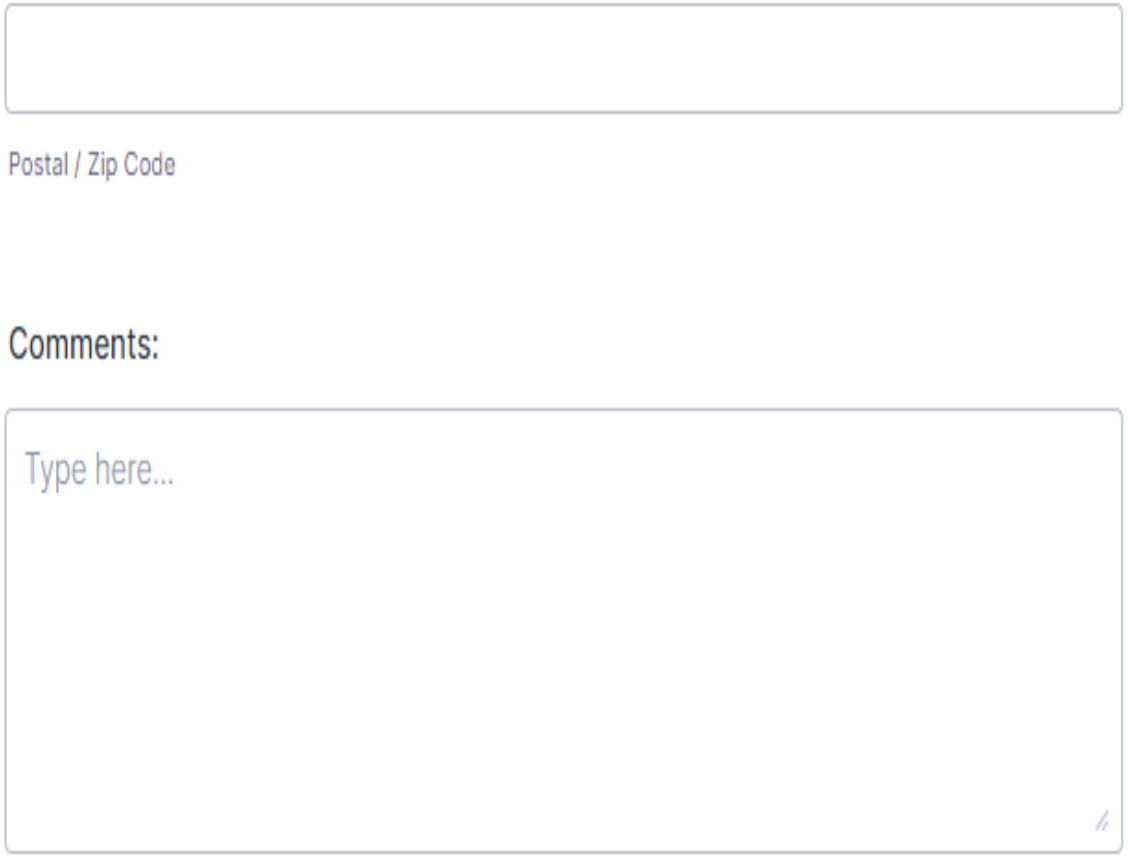
State / Province

Postal / Zip Code

2.4: Clean filters

Factors to consider for requisition





2.4: Clean filters

- Water filtration is very important to almost any irrigation system. Appropriate filtration can help to extend the life and improve the maintenance of any irrigation system. For drip or micro sprinklers emitters, filtration is a basic need to avoid clogging.

2.4: Clean filters

Filtration area, or effective filtration area

- When discussing filter efficiency, the focus has always been on the size of the filtration area, or effective filtration area. This area is defined as the total area of the filter medium exposed to the water flow and which participates in the filtration process.

2.4: Clean filters

Automatic Self Cleaning Screen Filters SIGMA Amiad

Disk Filters - Manual Cleaning

2.4: Clean filters

Semi Automatic Screen Filters
Amiad

Filtomat Automatic Screen Filters

2.4: Clean filters

Screen Filters - Manual Cleaning

T Filters - Drinking Water & Special Applications

2.4: Clean filters

Automatic Back Flushing Spin Klin disk filters Arkal Amiad

Hydro-Cyclone, Centrifugal Sand Separators

2.4: Clean filters

Media Filter Water

TAF Self-cleaning Fine Screens Water Filters

2.4: Clean filters

Screen Filters - Low Pressure Tagline

Manual Steel Filters - Water & Irrigation

2.4: Clean filters

ABFT heavy duty High flo Filters

Omega Water Treatment Multi Layer Screen Filtration

2.4: Clean filters

Alfa Series Disc Filtration self cleaning backwash

2.4: Clean filters

Recommended Resources

- How To Clean A Sprinkler Filter: https://www.youtube.com/watch?v=RdVNLwUwMhY
- How To Clean The Drip Irrigation Y Filter for Maximum Efficient Water Flow: https://www.youtube.com/watch?v=EO4J6uSPzWo
- How to clean and maintain Drip irrigation filters? (Not English): https://www.youtube.com/watch?v=P09rLEtoLKw
- How to Clean Sand Filter in Drip, Back wash Sand Filter (Not English): https://www.youtube.com/watch?v=8JDHYyoJjhg

2.4: Clean filters

Recommended Readings

- Maintaining filter efficiency in irrigation systems: https://www.netafim.co.za/blog/maintaining-filter-efficiency-in-irrigation-systems/#:~:text=Start%20by%20closing%20the%20water,brush%20for%20more%20efficient%20cleaning.

2.5: Fix leaks and blockages

Drip Irrigation System Simple Maintenance & Repair

- The ability to make fast and complete repairs to your Drip Irrigation system immediately, saves time and money.
- Keeping a few spare parts on hand also saves down time which will keep your plants happy and healthy.

2.5: Fix leaks and blockages

Drip Irrigation System Simple Maintenance & Repair

Head Assembly Components

- The Head Assembly (backflow preventer, filter and pressure regulator) are vital to a properly operating drip system. Remember, nothing lasts forever. Even with top notch maintenance, high quality parts wear out. Leaks are the most noticeable sign of something wrong with your head assembly components.

2.5: Fix leaks and blockages

Drip Irrigation System Simple Maintenance & Repair

Head Assembly Components: Maintenance & Repair Tips:

- All **head assembly components** should be protected from freezing temperatures, especially where temperatures drop below 37° F.
- **Rubber washers** get dry and no longer compress to seal the threaded components together to prevent leaks. It is recommended to replace the rubber washers in female hose threaded connections every year when you hook up your head assembly to your irrigation system. Keep a small supply of 3/4" washer seals on hand.

2.5: Fix leaks and blockages

Drip Irrigation System Simple Maintenance & Repair

Head Assembly Components: Maintenance & Repair Tips:

- Do not over-tighten! Hose thread components make their leakproof seal with a rubber washer compressed between the two (a male and a female) threaded connections. Over-tightening can distort the washer or create tiny fractures in the plastics (and even in brass) that will cause premature failure. Hand tighten only, no tools!
- **Mismatched threads or cross threading** can damage the threads and cause leaking. Be sure you have matching thread types before screwing two pieces together

2.5: Fix leaks and blockages

Drippers/Emitters

- Clogging is the number one issue with drip emitters. The very tiny opening in most drip and micro-irrigation emitters can get clogged even in clean water. Minerals in the water or even the chemicals and fertilizers we use on our systems can build up and clog the emitter.

2.5: Fix leaks and blockages

Drippers/Emitters

Drippers/Emitters: Maintenance & Repair Tips

- Proper filtration is pertinent to optimal operation of any drip irrigation system. Make sure your mesh size correlates to your emitter type. Almost every filter has a screen that can easily be removed for cleaning.

Irrigation Product Type	Minimum Filtration Needed
Rotors, Sprinkler Spray Nozzles	80 Mesh
Drip Emitters, Sprayers, Spray Jets	120 Mesh
Drip Tape	155 Mesh

2.5: Fix leaks and blockages

Recommended Resources

- How To Use an Automatic Flush Valve End Cap: https://www.youtube.com/watch?v=SMnEcnAU-Uo
- Drip Irrigation System - Repair (Tubing): https://www.youtube.com/watch?v=Zg8lDoomebw
- How To Fix A Drip Irrigation System: https://www.youtube.com/watch?v=jg5w81OXfqg
- Drip Irrigation Repair: https://www.youtube.com/watch?v=9lLnp5MKSVk

2.5: Fix leaks and blockages

Recommended Readings

- Leak Detection in Your Irrigation System: 8 Signs Not to Ignore: https://www.hydropoint.com/blog/leak-detection-in-your-irrigation-system-8-signs-not-to-ignore/

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