Information Sheet

5. IRRIGATION

5.5 Chemigation: Principles and fundamental equipment

Chemigation is the principle of applying water soluble chemicals e.g. fertiliser, via an irrigation system. In order for chemigation to be feasible and effective, the irrigation system needs to be in a very good working condition to ensure uniform application of the correct volume and concentration of chemicals over the whole field. This is related to quality of design, installation, management and regular maintenance of the system. An expert should be consulted when considering chemigation. In all cases follow the label of agrochemicals and take note of the registered methods of application.

Benefits of Chemigation

- The application of chemicals is more accurate, precise and cost effective relative to aerial or ground application, especially when a number of applications are required per growing season. For example, nitrogen fertiliser dissolved in irrigation water infiltrates into the root zone preventing volatilisation losses normally associated with ground application.
- Chemicals can be applied in smaller doses over a number of irrigation events. This allows for the supply to be better matched to the crop demand. It also minimises the leaching (and resultant pollution) of excessive chemicals.
- The use of chemigation can eliminate obstacles such as wet soils or crops too tall for access.
- Corrective measures, for example from a leaf analysis, can be implemented immediately.
- It reduces mechanical operations, thereby reducing fuel costs and soil compaction.

Considerations for chemigation

Due to differences in how agrochemicals react in water, there are a number of considerations, which include:

- ***Installation.*** Due to the technical nature of chemigation, it is advisable to use a qualified professional to design, install and commission the injection system. When deciding to use chemigation consider the capital cost, maintenance and operation requirements over the lifespan of the system.
- ***Operations.*** Chemigation requires a high standard of management and all staff involved must be well-trained in operating and maintaining the system.
- ***Maintenance.*** Some additional equipment, capital outlay and maintenance programmes may be required. Pipelines need to be flushed more regularly and additional chemicals used to keep bacterial and fungal growth in check. Some chemicals may be corrosive to certain irrigation equipment. With centre pivot and overhead sprinkler systems, corrosion of pipes may occur when the wrong chemical carriers are used.
- ***Application.*** The quantity, uniformity and timing of application must be accurate and according to prescriptions to avoid run-off, limit chemicals/nutrients loss and associated environmental pollution. With drip systems, there is a potential environmental hazard if the backflow of chemicals into a water supply is not controlled properly.
- ***Solubility.*** Not all agrochemicals and fertilisers are suitable for chemigation. The combination of some chemicals/fertilisers can result in the formation of insoluble matter which can clog filters and emitters. Clogging can be a major issue in drip irrigation systems therefore careful attention must be given to the selection of the correct water soluble fertilisers, efficient filtration and the injection of the fertiliser before the filter. The solubility of a mixture will also have an effect on infiltration-rate and infiltration-depth.
- ***Volatility.*** Volatility is the characteristic of a liquid to change into a gas and will be different for different chemicals/fertilisers. The risk of high volatility will increase with a decrease in droplet size. The finer the droplets and the larger the exposed surface area, the higher the risk of volatilisation.

- ***Adsorption.*** This is the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to a surface. Adsorption with surfaces such as leaves and soil particles is important for the chemical/nutrient to be effective. For adsorption by leaves, ideal weather conditions such as no wind or rain is critical. In soil, a chemical/nutrient will typically not move to the same depth as the water it is dissolved in due to adsorption to soil particles. The actual depth will depend on the chemical used and the irrigation volume. If the soil dries out too quickly, adsorption will be affected.

- ***Climatic conditions.*** Occurrences such as wind, heat and evaporation can affect uniformity and volume of application, especially with overhead irrigation systems. For overhead sprinkler systems and centre pivots chemigation must be stopped if the wind speed exceeds 15 km/h as this will affect uniformity of water and chemical distribution. Evaporation of water/chemicals will increase with high temperatures and low relative humidity.

- ***Soil factors.*** Soil texture, moisture status and organic content can influence the infiltration rate, adsorption, leaching and efficiency of nutrients/chemicals.

- ***Nutrition.*** Insufficient attention to the crop's demand for nutrients, and lack of monitoring through leaf and soil analyses, can lead to inefficient fertiliser use, nutrient imbalance and a decline in yields. Soluble fertilisers, in particular P, are marginally more expensive than conventional fertilisers.

Irrigation systems

- The characteristics of the irrigation system will not only determine the choice of chemicals which can be applied, but also the type of injectors, injection rate and duration of injection. For successful chemigation it is critical that the irrigation system is effective, in good working order and good irrigation management is applied.

- Good uniform distribution is critical for effective chemigation (refer to Information sheet 5.6). Irrigation systems must be evaluated in-field to ensure that the system conforms to the acceptable performance norms (flow rates, operating pressure and distribution uniformity) before chemigation is applied.

- Static irrigation systems such as micro-sprinklers, drip, portable, semi-permanent and permanent systems irrigate the field at a constant irrigation rate. The required quantity of chemicals can be mixed and dosed over the standing time of the irrigation system. Keep in mind that the volume and standing time will determine the depth to which the chemicals are washed into the soil. Flood irrigation will in most cases not be suitable for chemigation.

- Moving systems such as pivots and linear systems have a varying application rate. The injection rate of the chemicals must be synchronised with the running speed.

Equipment required

Chemigation can deliver huge returns on investment provided If it is implemented correctly. The choice of equipment will depend on:

- *type of irrigation system,*
- *type of chemigation (fertigation, herbigation, etc.),*
- *level of expertise and training of staff,*
- *management style of grower, and*
- *the availability of products, parts and back-up service.*

Due to the potential loss of income resulting from crop and equipment failure, it is advisable to use the most suitable and best quality equipment possible.

Application methods

There are generally three types of injector methods:

- Passive apparatus that uses the energy present in the irrigation system (water from the irrigation pump) or atmospheric energy to inject the chemical into the water,

- Active apparatus that uses an external energy source such as electricity to inject the agrochemical into the water, and

- A combination of the two types where the injection pump is driven by the energy in the pipeline and some external source.

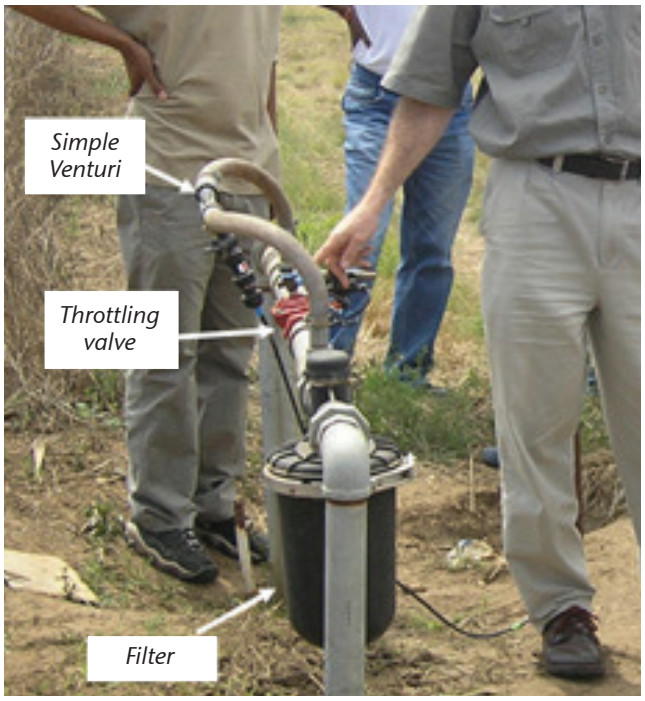
Passive injectors

Passive injectors are mostly suitable for injecting fertiliser mixtures only (Figure 1).

- *Inlet on the suction side of an irrigation pump.* The negative pressure generated in the suction pipe of a centrifugal pump can be used to suck fertiliser mixtures into the irrigation system. Although it is a very economical method, fertilisers can corrode and damage pump components. A non-return valve should be installed in the line from the fertiliser tank to prevent possible backflow.

- *Injection by means of a venturi.* Water flowing through a venturi in an irrigation pipeline causes a pressure reduction in the venturi (which can drop below the atmospheric pressure). The atmospheric pressure in the fertiliser tank, therefore, forces the fertiliser into the pipeline. Although simple to operate, it is sensitive to pressure variation and needs close supervision, making it better suited to small, intensive production units.

- *Injection through pressure tank.* If the pressure in a fertiliser tank is higher than that in the irrigation pipeline fertilisers will flow from the tank to the pipeline. The positive pressure in the tank can be created by using the pressure in the irrigation system with the use of a Pitot tube. This system is only suitable for static irrigation systems.



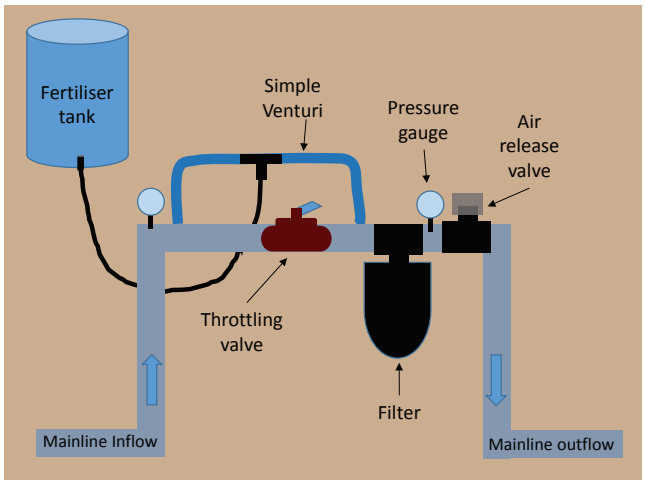
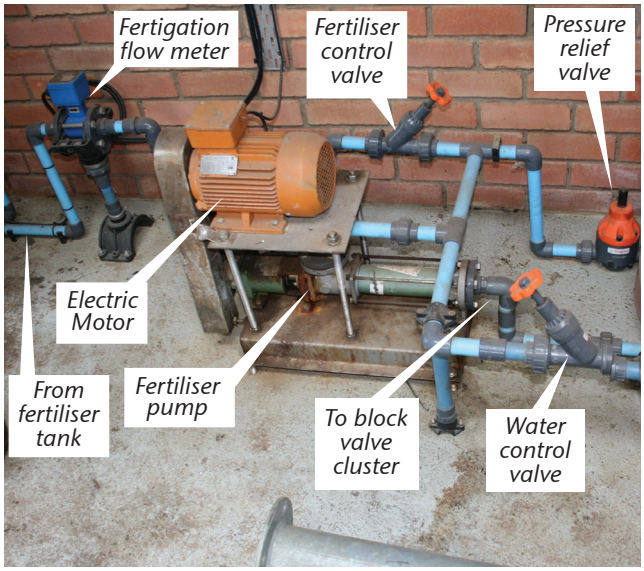


Figure 1. A pressure differential (simple venturi) chemigation system. (passive injector)

Active injectors

- Active injectors (Figure 2) are most commonly used especially where very accurate injection is required such as with expensive chemicals. Active injectors typically comprise of a pump that injects chemicals into the irrigation pipeline at pressure higher than the operating pressure of the irrigation system. The energy source for the pump can be electric, hydraulic or pneumatic. The overriding advantage of active injection methods is the precision and control that can be obtained in the application of chemicals. This is an essential requirement for large scale field operations. The flow rates of the pumps must be easily adjustable and it must be able to withstand long exposure to corrosive material. Always flush the irrigation system for at least 30 minutes after chemigation.

- In addition, a number of other items are required for effective chemigation. These include valves, flow sensors, pressure sensors, fertiliser/chemical tanks, mixers, agitators, filters and control equipment. Consult professionals in the field for advice on equipment.



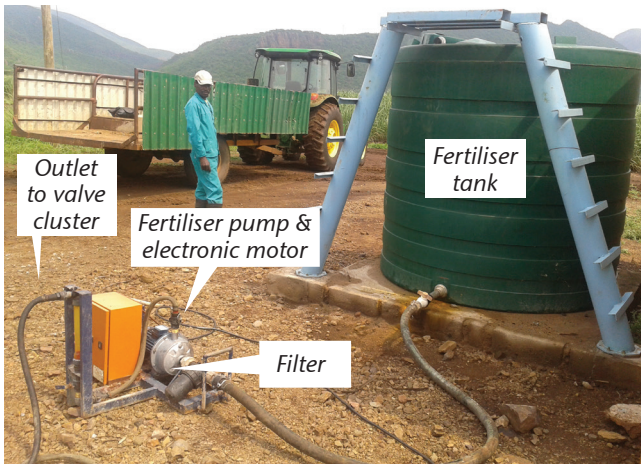


Figure 2. Examples of fixed and mobile active chemical injection systems.

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