LIFE OF MICROIRRIGATION COMPONENTS

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ABSTRACT

Application of Micro irrigation for different crops has increased globally in the last few decades. Being an expensive system and requiring periodic replacement, there is a need to determine the life of its components. This is also necessary to calculate the comparative economic advantages with other prevailing systems. Although it has several components, the lateral pipes are required in large quantities. Not much literature is available on this subject. However, an attempt has been made to discuss various aspects on laterals and the feasibility of a novel method known as Artificial weathering to estimate the life of LLDPE plastic pipes.

INTRODUCTION

For any Irrigation Equipment or system it is necessary to know about its economic life beyond which its repair and maintenance becomes prohibitive. After its estimated life, the equipment would require replacement and a new investment
Micro irrigation is also an expensive system and needs periodic replacement and reinstallation due to its limited life. This is needed both by the farmer user and also by financing agency. Where the government assists the farmer through subsidy there also it becomes essential to know the economic life of equipment.
Micro irrigation is not single equipment. It consists of different parts, such as laterals, drippers, filters pumps etc... Regarding pumps their standard life is well established. The filters however require some time limit, depending on the types used. The emitters have several variations and on average need replacement every 3-5 years.

The main component are the laterals, which have large quantity of use and need periodic replacement depending on the type. This thus requires fixation of its economic life.
Laterals are important component of micro irrigation used as branch supply lines for conveying water which is made of polyethylene with diameter varying from 12-32 mm.
Carrying out open field experiments does not make tube feasible, because of different varieties, prevailing regional climate and differences in handling
Hardly any literature exists on scientific or field determination of Micro irrigation equipments, especially laterals. Which are used in large quantities and require periodic replacement?

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The objective of the present paper is generating discussion to arrive at some consensus of getting at meaningful life based on accelerated experiments practiced in some institutions

GENERAL ASPECTS

Plastics used in Drip System

The following plastics are commonly used

Poly Vinyl Chloride (PVC) They are used for Mains sub mains and fittings etc and have low friction losses, no deposits and less corrosion. They are made from Vinyl chloride monomer and have low material and installation cost. They have easy jointing to PVC and other materials they are affected by Ultra violet radiations and so laid underground

Low Density Polyethylene (LDPE)
They are used for making laterals, canal, and pond lining, mulching green houses and low tunnels This is a thermoplastic material, very light in weight and affected by Ultraviolet radiations

High Density Polyethylene (HDPE)
They are used in mans sub mains and sprinkler systems as well as pipes for tubewellsThe are more rigid than LDPE and more brittle at high temperatures They are less affected by Ultra-violet radiations and therefore laid over ground

Linear Low Density Polyethylene (LLDPE)
They are most commonly used for laterals
They are more protected from Ultraviolet radiations and so have longer life.

Poly Propylene
They are used for making emitters (besides acetals and polyethylene)
They are greater heat resistant to environmental stress and cracking than polyethylene; they are also good for moulding

Type of Pipes Used in Micro irrigation

Lateral pipes
These are water delivery pipe lines that supply water to the emitters from manifold pipelines. These are pipes with diameters 12-33mm and wall thickness sufficient to stand pressures 4-6 atmospheres, to which the emitters are connected.
These pipes should be flexible, non corrosive, resistant to solar radiation and able to stand temperature fluctuation normally pipes are made of 10, 12, 16 and 20 mm, of 1-3 mm thickness, and generally laid above the ground. They are commonly manufactured from low density polyethylene (LDPE) or linear low density polyethylene (LLDPE) The LLDPE provides better protection from ultraviolet rays of the sun.

Main and Sub-main pipes

These are water delivery pipes that convey the water from the control stations to the manifold. They are placed below the ground and supply water to the laterals. They are made from rigid PVC, or High Density polyethylene. The pipes may be 65 mm or more in diameter, which can withstand pressures of 6kg /sqcm. These pipes are laid underground for a long life. For sub mains, rigid PVC, HDPE or LDPE pipes are generally used, with diameters 32-75 mm, which are able to stand pressures 2.5kg/sq cm
They are commonly laid over ground

Salient Aspects Related to Laterals

Salient aspects associated with laterals were classification material, outer diameter (OD) or inner diameter (ID) basis, life, temperature working hours and marking of pipes. No uniform materials were available for fabrication of laterals for all manufacturers. Some firms were importing plastics of different grades. Others were fabricating on the basis of material made available by other government sources. Therefore a consensus was evolved to select the standard material as PE 25. When improved grades of PE are openly and conveniently available, the standards could be revised. In specifying diameter of tubes, there were differing views.

Classification

The pipes may be categorized in 3-4 classes according to pressure ratings. The normal working pressures may range from 0.25 –0.60MPa or more

Materials

Different grades of Polyethylene are used in different countries. In India BIS used to recommend raw material Polyethylene of grade PE25, which according to local requirements catered for10 years life at a maximum of 800 working hours per year at $350^0 C$ and having a minimum design creep rupture stress of 2.5MPa.The life of the product is important for determining replacement time, working out cost economics, and assisting financing agencies in giving loans for installation. But it is difficult to obtain life by direct straight calculation. Also it is difficult to get much experience of real life experience of different grades and varying conditions of field handling. It was therefore arrived at by extrapolation the material is made of an appropriate mixture

ID versus ODsystem

Both systems ID control and OD control have their own merit and are used in different parts of the world. In the USA, ID control is used, as the flow capacities are better expressed based on ID control and the tolerances are much less than OD control. However, in India most plastic pipes were designated by OD. So to avoid a confusion for consumers, an OD basis was selected. Otherwise specifying tolerances, probably both systems could be used.

Life of laterals

This is important both from the point of durability as well as calculation of economics as well as subsidies given by the Govt. Specification of equipment life is a complex issue, because in addition to the quality of material and fabrication, it is also a function of level of handling in field conditions by a farmer. It is difficult to design an experiment for such an issue in other countries it may not be that important, but in Indian conditions this becomes important for computing economics of system and giving subsidies. The standards were based on BIS 8779 pipes conveying irrigation water at 45^o C. The life of 10 years was provided at 35^o C. Under note to clause 2.1 and Appendix 8.1 of this document the possibility of use at 45^o C was also covered. Regarding working hours it was selected as 800 hours/year.

Marking on pipes
Some manufacturers using sophisticated grades of plastic and better extrusion technology, experienced difficulty regarding marking of pipe. With better materials and technology, higher rates of extrusion say 80-100 meters/minute could be achieved.
With different grade material and technology and lesser extrusion speed this difficulty is not faced. It is useful to discuss the marking technology at higher speeds of extrusion without reducing the strength of laterals. There are a number of other issues related to the material composition and strength, which could also be covered.

Review of Artificial Weathering to Determine Life of LLDPE

According to Strong andTurley( )the usage of Linear low Density Polyethylene LLDPE started in late 70s and grew to38% in1986 wit the likelihood of further expansion in future.

Difference from HDPE
HDPE has very few side branches and hues packs well resulting in high crystallinity and strong intermolecular forces which makes it the stiffest of PE resins. It also has a higher melt point than non crystalline PE. Both these thermal characteristics the high melting point and narrow melting range cause problem in extrusion processing
HP- LDPE has many short and long branches and therefore does not pack well. Due to low molecular packing it is softer and more flexible plastic. De to broad melting range it is easier to process. . Because of its easier to processing it also reduces its other properties. It has to be made thicker to have the same strength and thus requires more material
The LLDPE combines the linear molecular structure of HDPE with short chain branching iof HP-LDPE. The abundance of short chain branching. Which are just enough to prevent crystalline? Parts made of LLDPE can be made 10%- 40% thinner than those made of HP-LDPE and therefore more economical

UV stabilisation.
Because of outdoor applications UV stabilisers have been developed to protect these plastics from degradatin. The ideal UV stabiliser should absorb the UV radiation and dissipate it in a harmless manner. Carbon black has been found to be one such stabiliser
There are many bodes which suggest concentrating of 2-3 CB for best results
The second variable introduced is cross linking of the polymer which is achieved by irradiating the finished product

Development f Artificial weathering methods for testing Life of Plastics
Artificial weathering methods have been developed. Such methods accelerate the weathering process and give predictability to the weathering process. Many $t_a = B + t_n K$ manufacturers experiment with additives and coatings to prolong the service life of items intended for outdoor use like micro irrigation laterals. Without existence weathering accelerators of such experiments would tae life time it would take life time.

In 1950 researchers established that 100 hours of accelerated weathering was equivalent to one year of natural outdoor exposure. Some such experiments in New Jersey showed that samples with 16 yeas of outdoor exposure were equivalent to merely 400 hours of accelerated exposure. Relating the same Howard and Gilroy in 1968 developed a relationship between natural and artificial weathering as

$$t_a = B + t_n K$$

Where
at=time in hours of accelerated exposure
tn= time in years of natural exposure
B and K = constants specific to weather apparatus outdoor location and material being tested
The methods fail because of failure of the environment to simulate consistent leathering conditions
Variables to consider natural outdoor exposure are

Location
. Shorter wave length UV light is very susceptible to absorption by air. If sun is low in the sky it passes through more air than if sun is directly overhead. S plastics exposed near equator degrade faster. Altitude has also some effect. Sunlight found at high altitude passes through less atmosphere than at lower altitude, thus exposed to more intensive radiation

Season variation
Samples at same location exposed at different times f the year will yield different results
Temperature variation is the othe major factor contributing degreaser photo degradation. A 10 degree increase in exposure temperature nearly doubles the rate of photo degradation. Moisture also affects different plastics in different ways. It could be absorbed by polymer molecules and server as modifier of UV energy
Yearly variation. Random year to year weather in the same location can cause degradation vary as much as 2 to 1 in successive years
Machine variation. One withering machine although capable of consistent exposure will vary in exposure results from another machine... given an infinite combination of UV intensity , exposure temperature and humidity capable with most modern weathering machines, there are almost as many variables involved in accelerated weathering as natural exposure. Thus it is not fair to speak of conversion of hours of artificial weathering to natural exposure. His only means that al data obtained from any exposure method (artificial or natural0 can be used only for comparison
Conclusion
The relative nature of all withering tests shows the real advantage of artificial weathering, consistency, which is .also much more consistent than natural weathering. If one sets weather accelerating machine for a specific temperature, humidity and UV intensity one can be reasonably constant that specified environment will be reasonably constant. Thus artificial weathering is far superior to natural weathering in scientific studies.
Based on there studies they concluded that 2.55 CB can bemused LLDPE tubing

SUMMARY AND CONCLUSIONS

In the above paper, Plastics used in Drip System, Type of Pipes Used in Micro irrigation, Salient Aspects Related to Laterals Review of Artificial Weathering to Determine Life of

LLDPE have been done. Based on the above discussion the following summary and conclusion have been arrived at

1) It is useful to know about the life of Drip Irrigation components in view of its being an expensive proposition and prior information regarding its replacement.

3) As per available knowledge other seems to be no standardisation on life of drip irrigation laterals

2)Although there are several components like ,various type of filters drippers, control valves and conveyanse pipes main as well as branch pipes and laterals, the largest quantity of a single components are laterals.

3) Late pipes have many variations like online systems, inline systems, bewails and drip tapes required for over ground lay as well as subsurface drip systems.Therfore besides variation of their hydraulic configuration they are required of different and different thinness. This will cause change in their lives, and therefore require individual determination.

4) Because of micro irrigation being practised for more than two decades it should be possible to get information of their useful life for various crops in different regions at appropriate locations for open field exposure through systematic surveys. This should be explored

5).Artificial weathering systems are a new innovation which give good comparable results of weathering of LLDPE pipes it will be useful to investigate life of standard usage laterals for identified regions specifying temperature, humidity and Eradiation exposure to get values comparing naturally exposed systems