**Lecture 21 Standardization and Quality Assurance of Micro Irrigation System Components**

**21.1 The Bureau of Indian Standards**

Standardization of any product process or service in India is carried out by the Bureau of Indian Standards (BIS). The Government of India established Indian Standards Institution (ISI) in January 1947. With fast pace of development and industrialization the existing structure was found to be inadequate. ISI was therefore restructured with statutory authority and Bureau of Standards Act was passed in December 1986. The BIS became functional from April 1987.

Bureau has several technical divisions to look after the Indian Standards, of which one of the important divisions has been Agriculture and Food Division. This division has several technical committees. FAD-35 was one of such committees that formulated the standards for drip irrigation. This was later modified as Irrigation and Farm Drainage Equipments and System Sectional Committee FAD-54.

**Institutions Framing Standards**

At the international level there are several institutions formulating standards for crop irrigation. Some of these are

i) Bureau of Indian Standards (BIS)

ii) British Standards Institute (BSI)

iii) American Society of Testing Materials (ASTM)

iv) International Organization of Standards (ISO)

v) American Society of Agricultural Engineers (ASAE)

vi) American National Standards Institute (ANSI)

**21.2 Testing of Micro-irrigation Components for Standards**

The parameters needed for testing of micro-irrigation components are described below:

**i) Melt Flow Index:**This test is used to determine the right combination of materials used to manufacture laterals and other plastic materials. The melt flow indexer is used to conduct this test.

**ii) Tensile Strength:**This test is carried out for a special shaped piece obtained by a dumb bell and elongation is tested at 27oC temperature by a universal testing machine.  

**iii) Environmental Stress Cracking Resistance:**This test indicates the strength of material against breakage of poly-tube/lateral under various environmental conditions. The water bath with thermostatic control, vernier calipers, ball ended micro meter and forced air circulation oven maintained at 50 oC ± 3 oC capable of reestablishing that temperature in 5 minutes are required for this test.

**iv) Reversion test:**This test is conducted to study the internal stress during processing in the lateral. A pipe of about 200 m long is subjected to a temperature around 100 oC for about an hour and cooling to the room temperature. The changes in the dimensional should not be more than 3%. Thermostatic oven is required for this test.

**v) Carbon Black Content:**The concentration of carbon black is essential to ascertain that the lateral can provide appropriate UV stability. The carbon black should have specified density. The manufacturer is permitted to add carbon black to an extent of 10%. Carbon content analyzer with ultra pure nitrogen cylinder is required to determine the carbon black content.

**vi) Carbon Dispersion:**Proper dispersion of carbon black is essential for good UV stability of lateral pipes. A micro scope with magnifier (200 times magnification) is needed for determining carbon dispersion.

**vii) Hydraulic Characteristics:**Internal Pressure Creep Rupture of poly-tubes is required to conduct hydraulic characteristics of drip pipes. This essentially consists of two important tests: a) Acceptance test and b) Quality test. Acceptance test is carried out at a lower temperature for test duration of a given time (say 1 h) under an induced stress as specified by prevailing standards. The quality test is conducted to test the standard of material and procedure of pipe material and carried out at a higher temperature with longer duration (say 100 h) to stand the specified induced stress of 2.5 MPa and     20 OC for 1 h at induced stress of 6.9 MPa. Pressure Creep Rupture tester is required to conduct this test.

**21.3 Indian Standards for MI Components**

Indian standards published by BIS on various components of micro irrigation system are given in Table 21.1. These standards are prepared based on corresponding International standards with suitable modifications to meet Indigenous requirements.

**21.3.1 Drip Laterals:**Polyethylene pipes for irrigation laterals should withstand the internal pressure creep rupture test which is conducted at a temperature of 700C for 100 h at induced pressure of 2.5 MPa and 200C for 1 h at an induced stress of 6.9 MPa. Maximum longitudinal reversion of the pipe after keeping it at a temperature of 100 ± 20 C for 1 h shall be in the range of ± 3%. Similarly tensile strength and elongation at break at 27 ± 20 C and testing speed of 100 mm/min. ± 10 mm/ min shall not be less than 10 MPa and 350% respectively. Pipe for laterals shall also withstand the accelerated test for susceptibility to environmental stress cracking.

Melt flow index and density are two properties that control the uniformity of compounds used for the manufacture of laterals. Tensile strength and resistance to internal pressure are the major properties to be tested for laterals. Tensile strength indicates the strength of material and elongation shows extension of the material under load. The Indian standard for quality assurance of drip lateral is IS: 12786-1989.

**Table 21.1. Indian standards published by BIS on various components of micro irrigation system (Source: Singh and Kumar, 2001)**

|  |  |
| --- | --- |
| **1) Drip irrigation system components** | **Standards** |
| i) Main and sub-main pipes  a) PVC pipes  b) HDPE pipes | IS 4985 : 2000  IS 4984 : 1995 |
| ii) Lateral: High quality PE lateral in 12 mm and 16  mm | IS 12786 : 1989 |
| iii) Emitting pipe system | IS 13488 : 1992 |
| iv) Emitters/drippers (Pressure and non pressure compensating types) | IS 13487 : 1992 |
| v) Micro-tubes | IS 14482 : 1998 |
| vi) Micro-sprayers | IS 14605 : 1998 |
| **2) Filteration system**  i)   Strainer type filters  ii)  Media filters  iii) Hydro-cyclone filters | IS 12785 : 1994  IS 14606 : 1998  IS 14743 : 1999 |
| **3) Fertigation**  i) Fertilizer and chemical injection system part I Venturi injectors | IS 14483(Part I):1997 |
| **4) Others**  i)   Pressurized irrigation equipments terminology  ii)  Design, installation and field evaluation of        micro-irrigation system- code of practices  iii) Recommended criteria for adoptability of different irrigation methods  iv) Prevention and treatment of blockage problem in drip irrigation system- code of practice | IS 14178 : 1994  IS 10799 : 1999    IS 11711 : 1986    IS 14791 : 2000 |

**21.3.2 Emitting Pipe:** Uniformity of emission of emission rate should not deviate from declared value by more than ± 5% for category A and ± 10% for category B pipes. Emitting pipe shall withstand the hydrostatic pressure 1.8 times the recommended working pressure at ambient temperature for 1 h and at temperature of 60 ± 20C for 48 h without any leakage and any permanent deformation or damage. Emitting pipe shall also bear the tensile forces of 180 N when applied for 15 minutes at elevated temperature of 50 ± 20 C joint between fitting and emitting pipe shall not come out on pull of 180 N when applied for 1 hour.

**21.3.3 Main and Sub-main pipe**

The material used for pipe is polyvinyl chloride (PVC). The different grades of resins are available for various usages and these are selected according to the essential properties such as density, melt flow index/K-value, molecular weight distribution, etc.  The BIS specifications of plastic materials in various applications are given in Table 21.2. For PVC pipe, the base material density of the resin should be between 1.40 and 1.46 g/cc, and K-value minimum 64 and other additives which may help the manufacturing process and good finish. For HDPE pipes, base material density of 0.9405 to 0.9460 g/cc and Melt Flow Index 0.4 to 1.1 g/10 min at 1900C/5 kg/load are desired. Carbon black should be added to the tune of 2-3% and should be well dispersed for long service life of lateral. The pipe shall not have any detrimental effect on the composition of the water flowing through these pipes.

The extrusion is carried out under strict quality control conditions to ensure that the internal and external diameters remain with specified tolerances. As the strength of the plastics are stress and time dependent, the short-term hydraulic test has been specified to detect the manufacturing defect periodically and the long term hydraulic test to assess the durability of pipes. For the safe use of PVC pipe for drip irrigation it should meet all the requirements as per IS: 4985-2000. Similarly, for HDPE pipes, the applicable standard is IS: 4984-1995.

**Table 21.2. BIS standards & criteria of plastic materials in various applications (Source: Kumar, 2007)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Material characteristics** | **Value** | | |
| PVC pipe  IS:4985-2000  IS: 12818-1992 | HDPE pipe IS:4984-1995  IS:14151-1999 | LDPE/LLDPE Laterals  IS: 12786-1989  (Drip laterals) |
| Density (g/cc) | 1.40 – 1.46 | 0.9405 - 09464 | 0.920 – 0.930 |
| K-value | Min.64 | -- | -- |
| MFI (G/10) | -- | 0.4 – 1.1 | 0.9 – 1.0 |
| Carbon black content (%) | -- | 2 - 3 | 2 - 3 |
| Carbon black dispersion | -- | should be well dispersed | should be well dispersed |
| Mechanical Properties Tensile strength at break (kg/cm2) | Minimum 45 Mpa | Minimum 19 Mpa | Minimum 10 Mpa |
| Elongation at break (%) | -- | Minimum 600% | Minimum 350% |

**21.3.4 Emitters (IS 13487 : 1992):**The smallest measured flow path dimension shall not be smaller than the dimension declared by the manufacturers. Emitters shall be tested to resistance to hydrostatic pressure and leakage at pressure twice the maximum working pressure. The mean emission rate of 25 randomly selected emitters shal not deviate from the nominal discharge rate by more than ±5% for category A and ±10% for category B emitters. When inserted on the lateral emitter shall also bear a pull of 40 N for on-line emitters and a radial force of 500 N for inline emitters.

**21.3.5** **Micro-tubes (IS 14482 : 1997):**Micro tubes shall conform to the requirements for longitudinal reversion, tensile strength and environmental stress cracking test for polythene laterals. In addition micro tube shall also withstand hydrostatic pressure 1.2 times the maximum operating pressure for 1 h without suffering damage and pulling out from assembly.

**21.3.6 Micro-sprayers (IS 14605 : 1998):**Micro-sprayers shall bear the hydrostatic pressure of 1.2 times the maximum working pressure for a period of    1h without any damage, leakage and pull out from assembly. Threaded connections shall withstand a torque of 20 Nm for metal to metal contact and 4 Nm for plastic to plastic or plastic to metal contact without showing any sign of damage. Upper and lower specification limits for uniformity of flow rate are ±10% for regulated sprayers and ±7% for non regulated sprayers. In case of regulating type micro sprayer, the maximum and minimum flow rates shall not deviate by more than ±10% from the nominal flow rate within the regulation range and average flow rate shall not deviate by more than ±2.5% from the nominal flow rate, the effective diameter of coverage shall conform to the value supplied by the manufacturer within a permissible deviation of ±10%. After operating the micro sprayer for 1500 h, the measured flow rate of test sprayer shall remain within ±10% of the initial flow rate and sprayer shall not show any visible defect.

**21.3.7 Strainer type filter (IS 12785 : 1994):**Strainer should withstand internal hydrostatic pressure at ambient as well as elevated temperature (60 ± 20 C) conditions. In addition, test for resistance of filter element to buckling or tearing or tightness of filter element should also be conducted at nominal pressure. The measured clean pressure drop should not be more than 10% greater than the pressure declared by the manufacturer.

**21.3.8 Media filter (IS 14606 : 1998):**Test of hydrostatic pressure are same as for strainer filter. In addition guidelines for sand media bed selection and recommended design flow rates have also been specified.is between  Sand used by the media is graded by mean effective size (size of opening which will pass 10% of representative sample of sand) and uniformity coefficient (D60/D10). Uniformity coefficient between 1.4 to 1.6 has been recommended. Recommended design flow rates for media filter are given in Table 21.3.

**Table 21.3. Recommended design flow rates for media filter (Source: Singh and Kumar, 2001)**

|  |  |  |
| --- | --- | --- |
| **Contaminant level** | **Contaminant concentration, mg/L (ppm)** | **Recommended design flow rate range (m3/hr/m2)** |
| Light | 0-10 | 63-76 |
| Medium | 11-100 | 50-63 |
| Heavy | 101-400 | 43-50 |

**21.3.9 Venturi Injector (IS 14483(Part 1): 1997):**The application of fertilizers and or chemicals with irrigation water has added advantage of improved application efficiency. Venturi injector should withstand a hydrostatic pressure equal to 1.6 times the maximum operating pressure when applied for one minute. Motive flow water suction rate of test liquid should not vary by more than ±10% from the declared values. Similarly minimum pressure drop at which the water is drawn through the suction port in relation to inlet pressure specified by the manufacturers.

**21.4 Code of Practice for Design, Installation, Operation and Field Evaluation of Micro-irrigation System (IS 10799 : 1999)**

This Indian Standards establishes minimum recommendations for design, installation, operation and field evaluation of micro-irrigation system. Provision of this code of practice primarily those that affect the adequacy and uniformity of water application, filtration requirement, water treatment, water amendments and field performance. As for as design installation and performance are concerned, this standard covers recommendations for system capacity, emitter discharge rate, number and spacing of emitters, operating pressures, manufactures coefficient of variation (Table 21.4), design emission uniformity (Table 21.5), allowable pressure variation, filtration system requirements (location, size and type) chemical water treatment, fertilization system, injection system, flow monitoring and safety requirements. For comparison with recommendations given in the standard it also defines field evaluation uniformity, water application efficiency and efficiency of micro irrigation system.

**21.5 Code of Practices for Prevention and Treatment of Blockage Problem in Drip Irrigation System (IS 14791 : 2000)**

Irrigation water may contains suspends solids, chemicals, minerals, dissolved solids and other foreign materials. If proper care is not taken during operation of drip irrigation system, severe blockage problem may occur which can cause the system failure. This standard covers recommendations for testing of quality of irrigation water, chemical treatment devices, types and causes of blockage problems, method of assessment of blockage problems, physical and chemical treatments for prevention of blockage problems. It also covers recommended doses of chlorine and acid treatment.

**Table 21.4. Recommended classification of manufacture’s coefficient of variation (Cv) (Source: Singh and Kumar, 2001)**

|  |  |  |
| --- | --- | --- |
| **Emitter type** | **Cv range** | **Classification** |
| Point source | < 0.05 | Excellent |
| 0.05 to 0.07 | Average |
| 0.07 to 0.11 | Marginal |
| 0.11 to 0.15 | Poor |
| > 0.15 | Unacceptable |
| Line sourec | < 0.10 | Good |
| 0.10 to 0.20 | Average |
| > 0.20 | Marginal |

**Table 21.5. Recommended ranges of design emission uniformity (EU) (Source: Singh and Kumar, 2001)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Emitter type** | **Spacing (m)** | **Topography** | **Slope (%)** | **EU range (%)** |
| Point source on perennial crops | > 4 | Uniform steep or undulating | < 2  > 2 | 90 to 95  85 to 90 |
| Point source on perennial or semi permanent crops | < 4 | Uniform steep or undulating | < 2  > 2 | 85 to 90  80 to 90 |
| Line source on annual or perennial crops | All | Uniform steep or undulating | < 2  > 2 | 80 to 90  70 to 85 |