

Status Report on PVC Cables & Conductor

Prepared by

Small Industries Service Institute

Ministry of SSI & ARI, Govt. of India

Advisor Choumuhani, Krishnanagar Road, Agartala - 799 001 Tripura

Phone (0381) 232 6570

Contents

Topic	Page No.
Introduction	1

Product Description	1 – 2
Objective of the Reports	2
Methodology	2
Status of industry	2 – 3
Status of Technology (Machinery & Equipments)	3 – 9
Quality Control	9 – 10
Problems of Industry & Suggestions	11 – 12
Status of working PVC Cable units	13

1) Introduction:

PVC insulated cables & wires are the ultimate medium for the distribution of electricity. The PVC cables are used for the power distribution in all types of electric wiring, control cables, telephone cables and signaling in Railways. The PVC cable has mostly replaced VIR and CTS cable in domestic as well as industrial wiring due to its long life, moisture resistance, etc.

The individual insulated conductors are covered with PVC coatings providing additional electrical and mechanical protection. The cables are suitable for use in sub-station, distribution systems, industrial installation, house wiring and street lighting, etc.

House wire is the simplest of cables and most basic in its construction, manufacture and use. It consists of only two components, viz. conductor (mostly copper) and insulation (mostly PVC) involving three operations – wire drawing, stranding, bunching and extrusion. Before the advent and subsequent extensive use of vinyl compound as insulating materials, vulcanized rubber was most commonly used insulating material for domestic wire as it was for other types of cables. It served the industry and the users very well for several decades until replaced by PVC (Poly Vinyl Chloride).

2) Product description:

There are varieties of cables being in present usage depending on specific conditions likely to effect. The manufacturing range covers power and control cables, thermocouple extension and compensating cables that find application in various industries and projects. The various cable ranges in existence are as summarized below:

- i) Single and multicore flexible cables
- ii) Control and power cables,
- iii) Instrumentation, RTD cables,
- iv) Thermocouple extension and compensating cables,
- v) Computer LAN co-axial and data communication cables,
- vi) Security and alarm cables,
- vii) Lead wires and high voltage ignition cables,
- viii) Rubber cables – VIR / TRS / EPR, PCP / CSP silicon rubber cables,
- ix) Welding cables,
- x) Material handling equipment cables, lift cables,
- xi) Marine and offshore cables,
- xii) High temperature cables – FG, Asbestos, Silicon, Teflon Mica and Ceramic Cables,
- xiii) FRL and Zero Halogen LSF fire survival cables,

3) Objective of the Report:

The main objective of this report is to highlight the industry of PVC Cable industry in small scale sector in Tripura and the infrastructural facility available in the state, to estimate the scope of future development, the requirement of industry, to put forth the problems faced by small scale units and to provide basic information to the prospective entrepreneurs who desire to set up such industry in Tripura State and put latest range of product, technological development in the field of cable industry for the existing industries.

4) Methodology:

For preparation of the report assistance was taken from Directorate of Industries, Govt. of Tripura, District Industries Centre of State for collecting the name and address and latest inclusion of new small scale units so that the exact details of PVC cable unit may collected. Efforts were also made to collect data from individual unit but the response was limited. Data collected through DIC and local units through personal visit and observations were analyzed and used for preparation of this report.

5) Status of Industry:

PVC cable industry is one of the oldest and conventional industry in the country. It is dominated by the Manufacturer in organized sector like HMT, Nicco Cable, Bharatcab, Polycab, Finolex, Anchor, Havells, Newcab, *Cable Corporation of India*, Skytone, Phonix, Plaza, etc. and the same is flooded in the market. However, the local small scale PVC cable unit has got a pretty good market to cater the demand. The brand from small scale sectors are also capturing substantial good share of domestic market.

In small scale sector, there are as per record available, five numbers of registered units manufacturing PVC cables in the state of Tripura. Out of five, one cable unit namely M/s. North Hill Wire and Cable Industry, Industrial Estate, Mission Tilla, Dharmanagar is situated in North Tripura and remaining four small scale units are situated in west Tripura. There are two more small scale units i.e. besides five above manufacturing conductors and stranded wires. All the cable and conductor units have come into existence within a last decade only. Most of the cable manufacturers are making PVC unarmoured cables of the range from 1.5 sq.mm to 50 sq. mm in single core to multicore as per the local demand of State Electricity Board. The present units are not sufficient to meet the demand of Power Department only. So none is trying to capture the demand of surrounding states in North Eastern Region rather the local demand of PVC cable is met by Kolkata and Guwahati where the concentration of PVC cable exists in abundance.

The EC grade aluminum wire / copper wire is fed into extruder. As the wire passes through the die in the PVC extruder, an uniform coating of PVC is obtained all round the wire. This is in passed through a cold water which helps to cool the wire. The wire is then passed through spark tester continuously for testing the insulating strength of PVC coating. The name of manufacturer is printed on the cable after its emergence from the extruder and before cooling. The wire is coiled in the length of 100 metres on the take off system and then tested as per standard BIS specification.

The PVC cable are manufactured and tested as per IS – 694: 1990.

6) Status of Technology:

In the manufacturing of PVC cable of different ranges and qualities the basic process of manufacturing adopted by small scale units are almost similar everywhere. Only some units are adopting good and systematic stepwise process which includes annealing and wire drawing process where as most others are adopting extrusion process.

The EC grade aluminum wire / copper wire is fed into extruder. As the wire passes through the die in the PVC extruder, an uniform coating of PVC is obtained all round the wire. This is in passed through cold water which helps to cool the wire. The wire is then passed through spark tester continuously for testing the insulating strength of PVC coating. The name of manufacturer is printed on the cable after its emergence from the extruder and before cooling. The wire is coiled in the length of 100 metres on the take off system and then tested as per standard BIS specification. The PVC cable are manufactured and tested as per IS – 694: 1990.

Machinery & Equipments In Use

The plant and machinery required to carry out the manufacturing process of PVC cables are listed below:

Production Machinery:

- i) PVC extruder 65 MM complete with cooling through, take off and take up system.
- ii) Wire straightening equipment.
- iii) Embossing roll for embossing name of manufacturer, size, voltage, grade, etc.
- iv) Coil winding and length measuring machine,
- v) Extrusion dies and nozzles, etc.
- vi) Annealing pit furnace,

Testing Equipment:

- i) Continuous spark tester 0 to 11 KV, 1 KVA,
- ii) Kelvin's double bridge,
- iii) Insulation tester 500 V DC
- iv) Million Megohm Meter,
- v) Tensile testing machine (50 – 100 – 500 kg)
- vi) High voltage test set (0 – 10 KV AC)
- vii) Ageing test apparatus for shrinkage and hot deformation,
- viii) Fire resistance test apparatus,
- ix) Thermostatically control hot water bath,
- x) Traveling microscope,
- xi) Micrometer (0 to 25 mm),
- xii) Miscellaneous equipment calipers etc.,

House wiring PVC Cable specification is covered by IS – 694 – 1990, BS – 6004 – 1990 (British) and various international specification which are more or less similar except for some dimensional, voltage grade and test parameters.

Conductor :

Copper is the most acceptable metal for conductor as it has got good conductivity, higher tensile strength and higher ductility and it can be drawn into extremely fine sizes. The jointing of copper conductor is also easy. The conductor material is generally electrolytically refined 99.99% pure copper drawn into fine wire and annealed as per IS : 8130 – 1984. The selection of conductor is based on three important considerations – size, stranding and strand construction. There is a recent trend amongst some of the leading manufacturer of house wire to do away with bunching / stranding and insulate the wire in a group, laid side –by-side parallel to each other in an effort to eliminate the process of bunching / stranding and got down the manufacturing cost at the cost of flexibility and advantages that bestows on the conductor.

- a) **Size:** Size is considered with due regard to DC resistance, current carrying capacity and breaking load requirement.
- b) **Stranding / Bunching:** Stranding is related to flexibility and was developed as a means is overcoming the rigidity of solid wires. For any given conductor size, greater the number of strands with corresponding decrease in the individual strand diameter, the more flexibility and more costly the conductor. Flexibility of the insulated finished wire , however, is affected not only by the conductor flexibility, but also by the type and thickness of the insulation.
- c) **Strand construction:** It is influenced by flexibility requirement and generally cover the following two types stranded and Bunched.

A stranded conductor is of true concentric configuration composed of a central wire surrounded by one or more layers of helically laid wire with two director lay reversed for successive layers. Unless otherwise specified the direction of the lay of the other layer is right hand. For House Wire the stranded conductor is a 7 wire strand composed of layer of 6 wires around the central wire bunch conductor is composed of any number of wires twisted together in the strand direction without regard to geometrical arrangement of individual wire.

Bunching of standing imparts following distinctive characteristics to the conductor.

- Greater cohesiveness of individual wire strand,
- Greater flexibility,
- Marginal increase in DC resistance.

d) Greater Cohesiveness:

Bunched / stranded conductors provide easy termination and good contact because of twisted wires acting as an single conductor. In the case of straight wires without bunching / stranding as soon as the insulation is stripped off to bare the conductor, wires false up and there is a need to twist them together before inserting in the terminal hole. It is time consuming and does not ensure uniform twisting and hence proper electrical contact. An electrician not careful enough may do a bad termination job. Improper / loose contact can cause sparking and localized heating / temperature rise leading to short circuit. Its importance can be judged by the simple fact that and more housewiring is now done in concealed conduits. Any short circuit / cable failure can cause building fire, as witnessed in recent times resulting in loss of human lives and crores of worth properties.

e) Flexibility:

It means, when the bunch / strand is bent, individual strand will stay in place without getting disturbed because of the bending radius. So, greater the flexibility, shorter the bending radius. A bunched or stranded conductor can be handled with greater care during the various operations in the manufacture of cable and the subsequent installation without any effect on the shape distortion, flaring of individual strand, kink etc. It is of particular importance while putting the cable through conduct during installation as flexibility tends itself to easy and faster pulling through conducts and around corners.

As per IS: 8130 the degree of flexibility is defined by class number which determines the conductor construction. Flexible copper conductor for house wire is either class 2 or 5 and the size most commonly used are 1.0 to 6.0 mm²

f) DC Resistance:

It is directly related to the stranding factor resulting in an increase in the length of the individual strand. The increase being generally of the order of 1 to 2% is depending on the lay length of wires. In bunches, the increase is 0.5% to 1.0% and in the case of strand it is upto 2%. The resulting increase in DC resistance of the same proportion, however, is negligible compared to other advantages further conductor resistance as per IS, BS, IEC, ISO, etc. have been standardized considering the stranding factor.

g) Insulation:

PVC is the most accepted plastic material for cable insulation the low / medium voltage grade as it has got better mechanical, electrical, weather proof, flame retarding and chemical resisting properties. Polyethylene has better electrical properties than PVC but because of certain shortcoming viz. Flame supporting characteristic and poor resistance of radiation, it cannot be used. These draw backs are overcome in some international specifications by using polyethylene as insulation and PVC as outer sheath of particular significance is flame retarding characteristic of PVC considering the extensive use of electrical appliances and electronics gadgets in household now a days.

PVC insulation material as per IS – 5831 is type A. the specification laid down by Bureau of Indian Standards (BIS) sufficiently guarantees electrical and physical properties for safe insulation. However, PVC is a very versatile material and its electrical and physical properties can be manipulated a wide range of compounding ingredients. Thus a particular PVC formulation may pass in all the tests and meet performance characteristics but its insulation resistance value may not be sufficiently higher to ensure high reliability and long life. High grade PVC insulation provides safety, reliability and long life to the cable. It is here that role of

reputed manufacturers like Anchore, Incab, NICCO comes to the fore who ensures that the electrical and physical properties of PVC insulation are much more higher than the minimum values specified by IS:694-1990 with special emphasis on flame retarding and minimum smoke emission properties.

FRLS (Flame Retardant Low Smoke) cables are insulated with specially designed PVC compound which has extra ordinary flame retardants and low smoke emission characteristic with higher oxygen contents of more than 32% against the minimum specified value of 29% in the surrounding environment for the wire to combust or alternatively the temperature of the surrounding environment must be very high (up to 400 degree centigrade against the minimum FRLS wire would not catch fire even at elevated temperatures under normal atmospheric oxygen contents.

7) Latest trend:

With more and more high rise building coming up and as a rule concealed wiring in vogue, the importance of safety against fire hazards caused by cable failure. Short circuit is more than ever before. Awareness to use FRLS PVC insulated cable has met with success. Even the normal type PVC formulation has been designed to have better flame retardant (FR) properties the low smoke and less fumes. Halogen Free Flame Retardant (HFFR) wire is also available which is insulated with non vinyl based compound that retards fire and does not emit halogen gases when it catches fire. This is the only advantages but at a prohibitive cost. It is 40 – 50 % costlier than FRLS wire considering the real situation not only cost versus benefit ration is very high but practically no benefit across. Wiring is done in conduct or casting and capping manufactured out of ordinary PVC which is neither fire retardants nor non smoking. In fact, being ordinary low cost PVC compound, in case of electrical fire, it is most prone to catch fire and dense toxic smoke nullifying the halogen free characteristics of HFFR. Again telephone LAN, coeval and appliances cables installed in a building are insulated with normal PVC compound. In the event of fire, these too burn and emit smoke and halogen gases. So, the kind of safeguard one expects by wiring HFFR wire reality is not available. The only common characteristic of FRLS and HFFR wire that offers protection is flame retardants property and this is available equally in both types of cables. In the final analysis, no additional benefit in real terms by using 40 to 50% costlier HFFR wire. In an example given is a better conductor than copper in house wire or other most commonly used cables because of its prohibitive cost.

Profibus Cables with Integrated Supply Cores:

A Chainflex CF11 profibus cable with integrated supply cores is another special cable for mobile energy supplies. The advantage of hybrid cable is in addition to the shielded bus elements four more power supply cables can be integrated. These additional supply cores have a cross section of 1.5 mm² each “Chain flex typical” is the special design of the profibus cable.

The profibus elements must be stranded is a very short pitch length then equipped with a pressure extruded inner-jacket and a two shields and finally stranded again with 4 addition supply cores in a very short pitch length.

This is important to avoid failures caused by corkscrews and core ruptures. This often happens, when its design is asymmetrical or where the structure is filled with fillers and foils. For this reason the extremely abrasion fire TPE outer-jacket is extruded under high pressure into all intermediate spaces of the stranding – this is another stabilization of chainflex cable.

The PVC and halogen free profibus hybrid cable is DESINA- conforming and releases under most difficult applications energy chain bending radius of only 125 mm.

This corresponds to 10X D outside diameter at high accelerations and long travels. The CF11.02.02.15.0.40 PBA L.C.D- so the precise product is like other 634 tested of cables ex-works.

8) Quality Control:

The PVC cable for domestic purposes is manufactures and tested as per IS specification No. 694 – 1977 with latest amendments. PVC insulated (Heavy duty) electric cables are tested as per IS 1554 (Part I) – 1988 with latest amendments.

The following are the tests carried out as per respective specification:

Type test: Tests carried out to prove conformity with this standard. These are intended to prove the general requirements, qualities of a given sample selected from a lot of production.

Routine test: Tests carried out on all the PVC cable to check requirement which are likely to vary during

Acceptance test: Tests carried out on samples taken from a lot for the purpose of acceptance of the lot

The following shall constitute type tests:

Sl. No.	Tests	For requirement Ref. to IS	For test method Ref. to IS:10810(Part No.)
a)	Test on conductor		
1	Annealing test (for copper)	IS: 8130 – 1984	1
2	Tensile test (for aluminum)	IS: 8130 – 1984	2
3	Wrapping test (for aluminum)	IS: 8130 – 1984	3
4	Conductor resistance test	IS: 8130 – 1984	5
b)	Test for armouring wires/strips	Table 5 & IS3975-1979	36 to 42
C)	Test for thickness of insulation and sheath	9,12,14 Table 2,4,7	6
d)	Physical test for insulation & outer sheath		
1)	Tensile strength and elongation at break	IS-5831-1984	7
2)	Ageing in air oven	IS5831-1984	11
3)	Shrinkage Test	IS5831-1984	12
4)	Hot Deformation	IS5831-1984	15
5)	Loss of mass in air oven	IS5831-1984	10
6)	Heat Shock Test	IS5831-1984	14
7)	Thermal Stability	IS5831-1984	IS5831-1984
e)	Insulation Resistance Test	IS5831-1984	43
f)	High Voltage Test(water immersion)	16.3	45
g)	High Voltage test at room temp.	16.2	45
h)	Flammability Test	16.4	53

9) Problems of Industry & Suggestions:-

- a) The non-availability of raw materials locally is major problem of all the small scale sector PVC cable manufacturing units in the State of Tripura.
- b) The PVC cable industry is capital intensive and they have to compete with large scale and reputed branded manufacturer of Kolkata, Delhi. So finance is a problem in running a unit on day to day basis. The unit for want of working capital and due to heavy competition on one side from large houses and another from branded items from surrounding west Bengal are not in position to organize regular selling network,
- c) Tripura Govt. is purchasing 35% of its requirements from outside the state supplier and 65% from local SSI of the State, in spite of unutilized capacity of local SSI in spite meeting quality requirements. Hence, it results in sickness of PVC cable unit. This is as per Tripura Incentive Scheme – 2002.
- d) The PVC cable units are to pay 4% CST on procurement of raw material primarily Aluminum from NALCO, BALCO, and HINDALCO besides transport charges from remote location. Hence, face problems in competing the rates quoted by others in the state as well as in other state competition.
- e) For transportation of Aluminum from NALCO (Orisa) to Tripura, the cost comes to Rs. 5.50 / kg. under transport subsidy. It is because the rates have not been revised since long.
- f) There is no recognized / BIS accredited test house to render type testing facilities for PVC cable units. Hence the SS units have to rush to Kolkata only.
- g) The delay in payment by Govt. Departments is the foremost problem of small scale units. There are cases where payments have not been made to SS units even after one year or more from date

of supply.

h) Shortage of skilled worker is also problem of local units.

There should be an single agency like Tripura Small Industries Corporation for procurement of basic raw material i.e. Aluminum / Copper for distribution among SS units as per their production capacity which will certainly reduce the burden of stocking of raw material by SS units and in turn reduce the overhead cost thus it will make to units a healthy situation to fight the stiff competition (inter state competition). At least there should be a policy that state requirements will be filled by local manufacturer so that optimum capacity may be utilized.

For North Eastern Region a specific testing laboratory should be installed which may cater the need of small scale units besides training of manpower and maintenance Otherwise for small components and wear and tear, One has to rush for Kolkata and in turn increasing the overall cost.

STATUS OF PERMANENT SSI REGISTERED PVC CABLE UNITS IN TRIPURA

Sl. No.	Name and address of unit	SSI registration no. & date	Product	No. of worker	Investment		Remarks Production
					Plant & Machinery	Working Capital	
1	M/s. Arundhuti Cables, Industrial Estate, A. D. Nagar, Agartala Partners : Shri R. N. Das, Shri Kanak Jain	00793, dated 25-4-90	PVC insulated & sheathed cable	12	5.5 lakhs	20 lakhs	4 sq.mm-3600Km 2.5 sq.mm 5000Km
2	M/s. North Hill Wires Cable Industry, Industrial Estate, Mission Tilla, Dharmanagar, North Tripura Prop. Shri Ajit Nandi	19010076, dated 04.9.93	PVC Insulated cable	12	8 lakhs	2 lakhs	No production then declared closed by State Govt.
3	M/s. Tripcon Dukli Industrial Estate, Madhuban, Ports Kamer Tripura West. Partner: Shri P. P. Goel, Shri Ajai Goel.	00851, dated 30.6.90	All Alluminium conductor, ACSR Conductor	-	-	-	-
4	Basanti Cables & Conductor(P) Ltd., 60/5, Central Road,	19030186 dated 15.5.93	ACC / ACSR conductor	20	-	-	-

	Agartala Prop. Shri Basant K. Jain,						
5	Maharishi Udyog, Dhukli Industrial Estate, Agartala, Prop. Shri P. P. Goel	190301180 dated 30.4.94	ACC / ACSR conductor	12	-	-	-
6	M/s. Abhinandan Enterprises, Industrial Estate, A. D. Nagar, Agartala	190301456 dated 10.7.2000	ACC / ACSR conductor	7	-	-	-