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Electrical India

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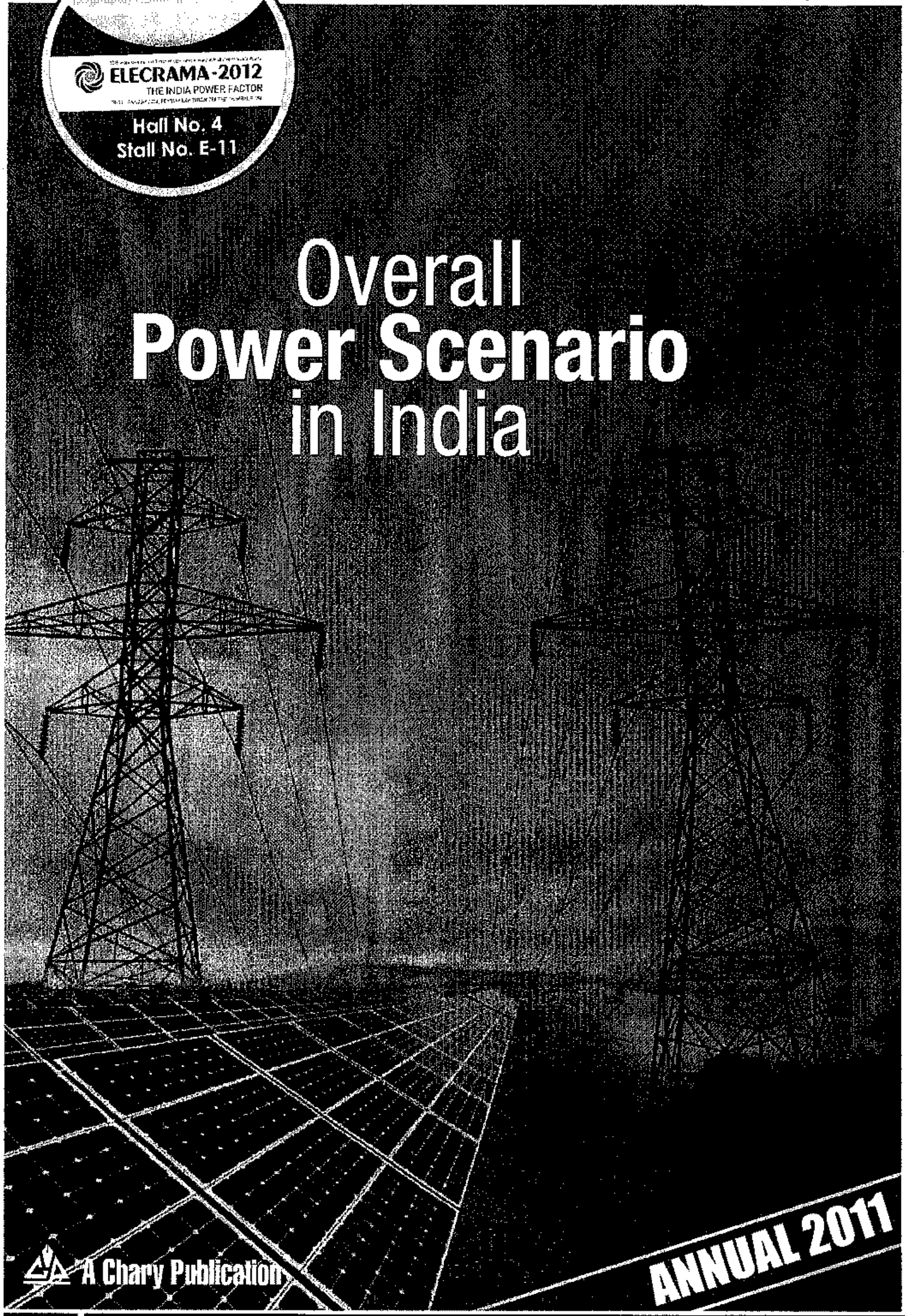
Overall Power Scenario in India



Central Power Research Institute
'CPRI is working in all the area of smart grid frame work including Renewable'
N Murugesan

Bureau of Energy Efficiency
'BEE has also initiated the impact analysis for Standards and Labeling programme'
Dr Ajay Mathur

Larsen & Toubro
'Business plan is to grow – organically and inorganically'
S C Bhargava

Werner Global Holdings Limited
'To establish manufacturing facilities to support the requirement of the regions'
Joachim Schloesser

KEC International Ltd
'We are Synergizing our strength in Transmission'
Ramesh Chandak

Saran Renewable Energy Pvt Ltd
'We are growing energy crops in wastelands'
Vivek Gupta

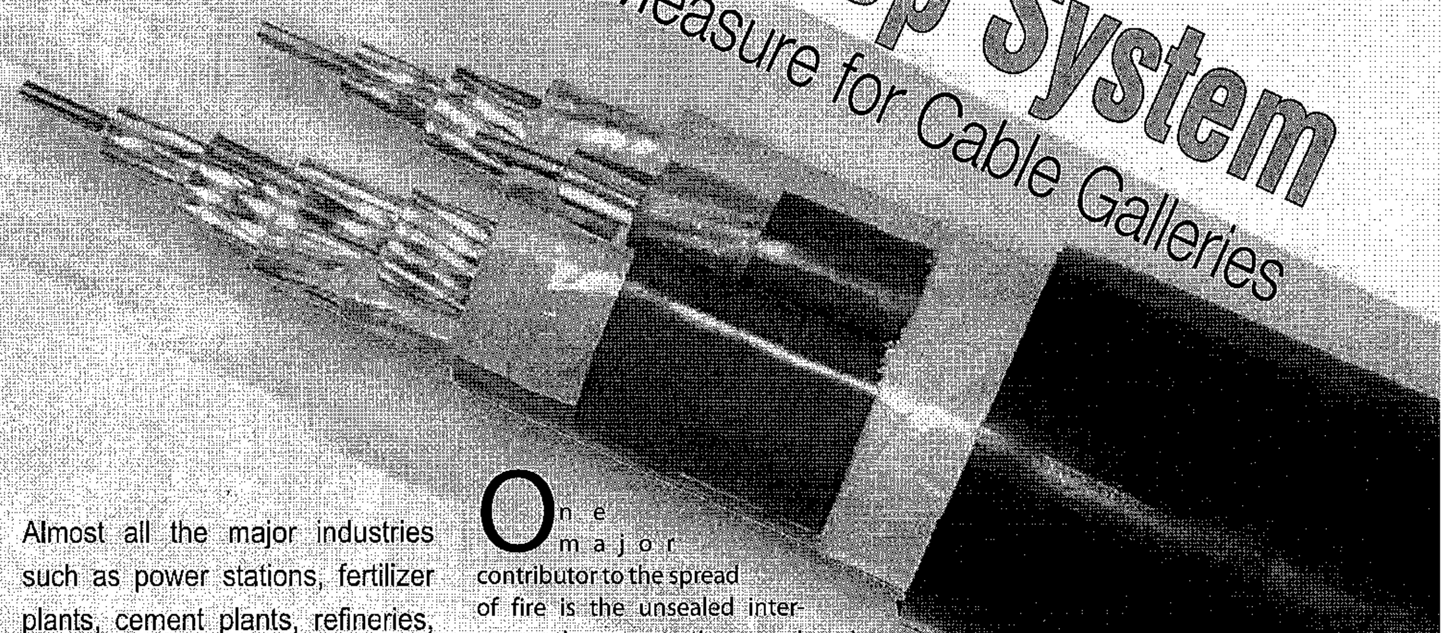
Woodward Governor India Ltd
'We see India as a crucial market for Woodward'
Hiru Keswani

EI

- Energy Security India's Demand Supply Position & Sustainable Measures
- Renewable Energy A best option to overcome India's energy crunch
- Pollution Control in Thermal Power Plants
- Hydro Power Scenario in Uttar Pradesh

Cable Fire Stop System

A Fire Protection Measure for Cable Galleries



Almost all the major industries such as power stations, fertilizer plants, cement plants, refineries, petrochemicals etc. use insulated electric cables extensively in bulk and long runs. Poly vinyl chloride (PVC) occupies a premier position in the field of cable insulation and sheathing on account of its economy and its excellent electrical and handling properties. Although it is self extinguishing by nature, in case of fire it may burn with copious amount of smoke and fumes of corrosive and toxic nature. Thus, these industries are immensely prone to fire accidents.

- NK Saxena, Sunil K Sharma & Sushil Kumar

One major contributor to the spread of fire is the unsealed interconnecting penetration openings in walls and floors. Improperly sealed openings in walls and floor create a chimney effect and cause spread of flame and smoke very rapidly. Due to high smoke, corrosive fumes and toxic gases it is very difficult to control such fires effectively. Consequently, damage to equipment machinery as well as the structural units may result. The resulting loss in terms of property, and production is huge and may run over several hundreds crores of rupees.

As modern production facilities demand long runs of power and control cables all over the plant area a fire incidence in the vicinity of the cables may result in the initiation of fire which may spread along the cables laid in the tray. Electrical fires are a cause of concern today because of the difficulty in fire fighting and controlling such fire. To reduce fire spread through electrical cables all openings in wall, ceilings or floors through which cables or cable tray penetrate should be provided with effective non-combustible insulating materials called "fire stop."

The present paper deals with the development & evaluation of exfoliated mineral based cable fire stop system.

Firestop System

Fire stop is a specific construction consisting of materials, which fill the openings around penetrating items such as cables, cable trays conduits. Ducts and pipes and their means of support through the wall or other openings to prevent spread of fire. There are many types of seal systems available but these are proprietary products of different industries. The materials used for seal systems are not available indigenously. Literature reveals that existing cable firestop systems have certain limitations as far as site requirements related to ageing water permeability & other operations like removal and insertion of cables are concerned. Therefore, it is worthwhile to develop a suitable fire stop with indigenously available material in order to reduce the fire hazard in electric cables.

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Construction of firestop system

A concrete slab (100 x 100 x 20 cm) for fire stop system was constructed with cast able refractory containing mainly silica, alumina and cement with reinforcement of 6 mm diameter M.S. rods having lifting bolts on both sides. An opening of 50x50x20 cm was incorporated in the slab for fixing the cable tray and filling materials. The constructed slab was cured for 28 days.

A ladder type M.S. tray of size 197 x 31.5 x 6.5 cm was prepared. 21 number PVC insulated electric cables of 11 mm and 15 mm diameter and 2 core Single strained, aluminium conductor were fixed in the tray in different layers. The tray thus prepared was passed through the center of aperture such that these penetration items protruded approximately 32.5 cm from exposed face on one side and 144.5 cm on the other side of the concrete block. After fixing the cable tray a shuttering of non- combustible board was provided at lower side to retain the filling materials.

A slurry of exfoliated minerals having composition SiO_2 (39-48%), Al_2O_3 (14-20%), MgO (15-20%), K_2O (4-7%), Fe_2O_3. FeO (6-11%), CaO (1-2%), TiO_2 (1-2%) and cement in the weight ratio of 4:1 was prepared with appropriate amount of water. The slurry thus prepared was then filled in the cavity between slab and cable tray. The opening was filled completely with above prepared slurry and then dried completely under atmospheric condition. Subsequently, a non-combustible board was also fixed on the top of the cable fire stop system. The construction details are shown in Fig. 1.

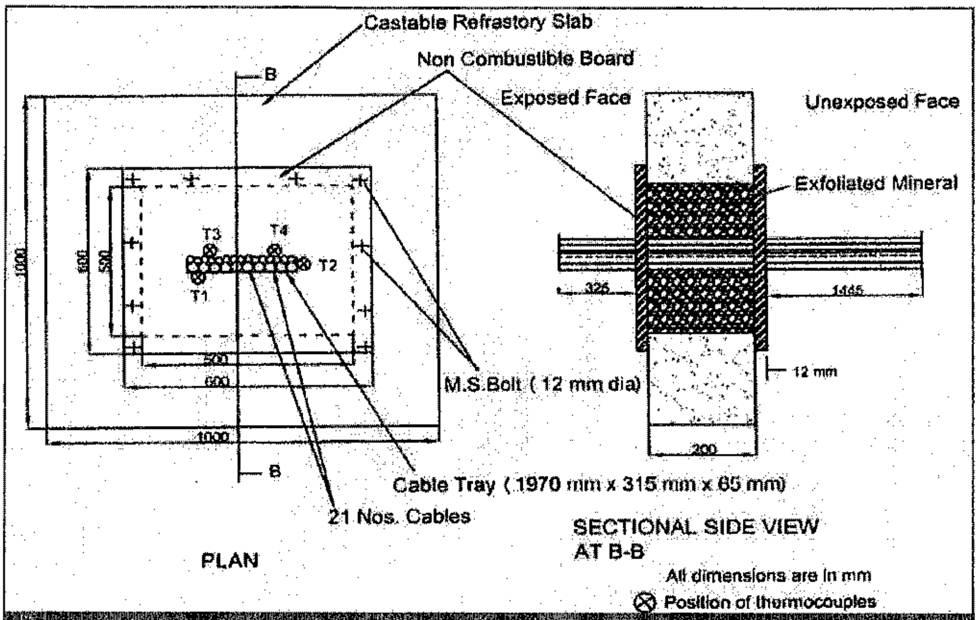

Fig. 1: Construction Details of Cable Firestop

Evaluation of fire stop system

Temperature Measurement

The fire performance of cable fire stop system was evaluated following UL: 1479-1983, ASTM E -814, ISO: 834-1975, BS: 476 part -8: 1972 standard procedures [2-5]. The

Thermocouple No.	Position
T_1	25 mm away from Fire stop material on the board
T_2	25 mm away from unexposed face material on the cable tray
T_3	25 mm away from unexposed face material on 15 mm dia. 2 core Single strained, aluminum conductor, PVC insulated power cable
T_4	25 mm away from unexposed face material on 11 mm dia., 2 core Single strained, aluminum conductor, PVC insulated power cable

Table 1: Position of Thermocouples on Unexposed Face

Time Min.	Unexposed Face Temp.°C T_1	T_2	T_3	T_4	Avg.
00	21.1	23.3	22.5	22.3	22.30
15	23.1	23.6	24.1	23.3	23.52
30	23.3	23.8	30.6	26.8	26.12
45	25.8	25.6	41.4	32.2	31.25
60	30.4	28.3	52.8	37.7	37.30
75	34.6	30.4	63.6	42.6	42.80
90	38.9	31.8	69.6	46.9	46.80
105	45.7	36.5	78.6	51.6	53.10
120	55.6	40.6	85.6	57.0	59.70
135	78.0	66.4	112.8	84.2	85.35
150	104.5	95.8	168.5	108.6	119.35
165	154.0	129.6	185.5	149.8	154.72
180	178.0	159.8	201.8	188.2	181.95

Table 2: Unexposed Face Temperature at Different Thermocouples

fire stop specimen was mounted in the furnace such that the 32.5 cm side of cables was towards the furnace (the hot side) and 144.5 cm side was towards the atmosphere side (the cold side). The specimen was exposed to the test conditions in a furnace which is capable of producing a positive pressure & standard heating conditions. The temperature of the furnace was controlled to vary with time. It was maintained as close as possible to the standard time temperature curve. The actual temperature verses time recorded during test is represented graphically (Fig. 2). The accuracy of the

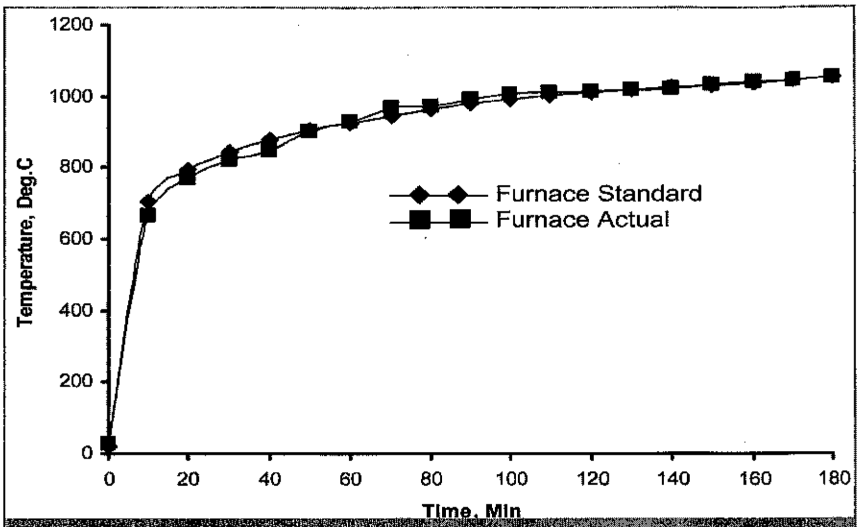

Fig. 2: Furnace Time-Temperature Curve

temperature was controlled within the tolerance limit according to the standard. Temperature was measured at different position on the unexposed side of the cable fire stop specimen. Position of thermocouples is given in Table 1 and Fig. 1. The temperatures at different positions recorded during evaluation are given in Table 2. The physical observations were also carry out at different time intervals following ISO: 834-1975 standard procedure. The data of physical observation is recorded in Table 3.

Hose Stream Test

The intention of the hose stream test is to ascertain whether the fire stop assembly maintains its ability on application of water jet after withstanding the fire for the specified fire rating duration. During hose stream test the furnace and time temperature curve used was exactly similar to the one used for carrying out the fire-rating

Time (Min.)	Observations
00	Furnace was started at a pressure of -1.5mm Wg.
15	No smoke observed on unexposed face.
45	Furnace pressure was noted 0 mm Wg and no smoke was observed on unexposed side.
60	Maximum temperature on unexposed face noted 52.8°C at T_3 thermocouple.
90	Furnace pressure noted 0.5 mm Wg. No smoke observed on unexposed face. No change during cotton pad test was noted.
120	Furnace pressure recorded +1 mm Wg. Maximum temperature 85.6°C was recorded at thermocouple position T_3. No smoke was observed. No change in colour of cotton noted during cotton pad test.
135	Very small amount of smoke was observed on the unexposed face. No change in colour of cotton pad noted during cotton pad test.
150	Rise in temperature at all thermocouples was very rapid. Maximum temperature reached was 168.5°C at thermocouple position T_3. Quantity of smoke also increased but no change in cotton pad test was observed.
165	Dense smoke generation was noted however, no appreciable change in cotton pad test was observed. Temperature was increased up to 185.5°C at thermocouple position T_3.
180	Vigorous smoke evolution observed. Rate of rise of temperature found very fast. Some change in colour of cotton pad noted during cotton pad test. Maximum temperature observed at thermocouple position T_3. Furnace shut off and hose stream test was carried out. During hose stream test no opening was noted that would permit any projection of water.

Table 3: Phycal Observation During Evaluation

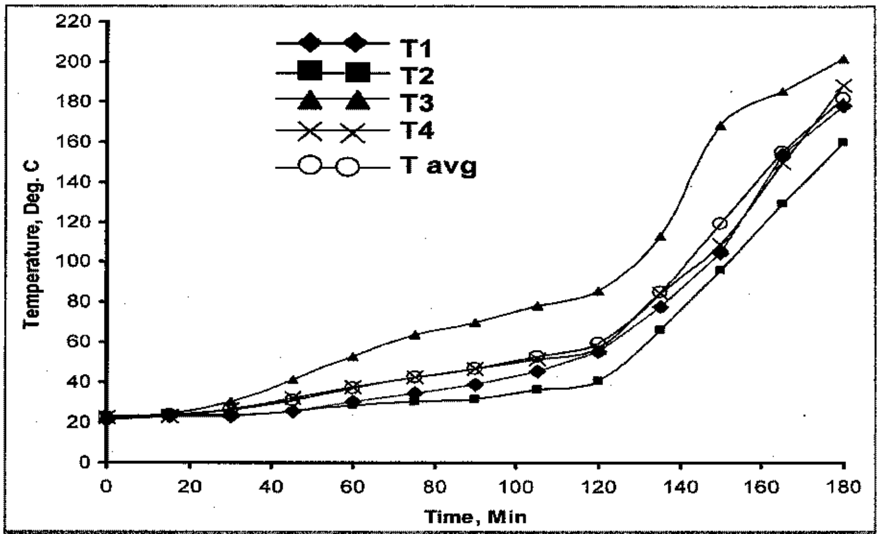

Fig. 3: Unexposed Face Time-Temperature Curve

test. The fire stop was subjected to the action of hose stream test within five minutes after the furnace was shut off. The stream was delivered through 63 .5 mm hose and discharged through a 28.6 mm discharge tip of the standard taper, smooth bore pattern without a shoulder at the orifice. The nozzle orifice during test was kept at 6.1 m from the center of the exposed surface of the fire stop. The water pressure and duration of application was maintained according to the standard.

Oxygen Index Test 6

When fire retardant materials are subjected to a test to evaluate their flammability it becomes almost impossible to rate them in order of their performance because in each case the specimen is found to perform in a similar fashion. They do not burn and so cannot be graded. Oxygen Index test is a method that allows fire retardant materials to be thus graded. Basically this method was developed for assessment of combustion of plastics but now it is often used as an R&D tool in case of Fire retardant/resistant materials. Specimens are subjected to a test flame under artificially created atmosphere where the concentration of oxygen can be varied; in O_2-N_2 atmosphere; from 0-100%. The higher the concentration of oxygen required for a material to burn, the greater is its flame retardancy. The only limitation is the size of the test specimen.

Oxygen Concentration	Flame length (mm)	Flame Duration (sec.)
21.0	Nil	Nil
30.0	Nil	Nil
40.0	Nil	Nil
50.0	Nil	Nil
60.0	Nil	Nil
70.0	10-12	22-24
80.0	15-17	25-26
85.0	16-18	26-28

Table 4: Observations of Limiting Oxygen Index Test

Since a 11mm dia. Sample can not be subjected to test in the Oxygen Index test apparatus, specimens were prepared by using cable of 6-8 mm diameter. Sufficient quantity of exfloliated vermiculite and cement slurry was applied so as to achieve a dry thickness of 2 mm. Specimens were subjected to test under oxygen rich O_2-N_2 mixture which was allowed to flow upwards through a glass chimney. Oxygen concentration was increased in small steps from 21% onwards and a test flame applied to the top edge of the specimen till a sustained flaming for three minutes duration or 75 mm length was observed (Table 4).

Results and Discussions

The actual course of furnace temperature-time pattern is very important from the fire resistance evaluation point of view for any specimen. Therefore, actual temperature time pattern of furnace during evaluation of fire stop was recorded. It is observed that actual furnace temperature was found well within the limit of standard furnace temperature (Fig. 2). The cable fire stop specimen was exposed in the calibrated furnace for 180 minutes duration. Temperatures on unexposed face at different positions (Table 1) at different time intervals were recorded in Table 2. Data states that the temperature on the unexposed face is rising steadily in a nonlinear fashion up to 30 minutes and onwards up to 120 minutes it rises slightly faster and attain linear pattern with average temperature rise approximately 60°C. After this period, very quick rise in temperature is observed.

From Table 2 it is observed that maximum temperature 85.6°C recorded at T_3 thermocouple at 120 minutes which is far below the failure temperature that is 163°C above its initial temperature. However, failure temperature reached within 165 minutes of exposure. The sudden rise in temperature may be due to either insulation failure or by attainment of the uniform temperature gradient across the thickness of the material.

During hose stream test, no opening that could permit a projection of water from the stream beyond the unexposed side is noted. Physical observations were also carried out along with the instrumental observations. The course of physical observation makes the thing as clear as crystal as to study the relevant physical parameters in depth with the understanding that the course of experimental events has occurred in variance to time.

It is noted from the physical observations that no smoke was evolved up to 120 minutes exposure and no change in cotton pad test was noted. After this exposure, little quantity of smoke was observed on unexposed face of fire stop system. However, cotton of the cotton pad did not catch flame during cotton pad test when conducted following standard procedure. Maximum temperature rice was noted at the T_3 thermocouple position with no change on cotton pad test, however, vigorous smoke evaluation was observed on unexposed side of specimen at 165 minute. It may be due to the burning of some cable after failure of insulation.

When the specimens were exposed to Oxygen Index test it was observed that they were resistant to any flaming for quite high concentrations of oxygen in the O_2-N_2 mixture. At a concentration of 85 and higher small flame were observed but they were not able to sustain for sufficient duration to help in arriving at any conclusion. Experiments were conducted up to an oxygen concentration of 92% as now the mixture becomes very rich. Small explosion takes place when flame is introduced into the chimney to ignite the specimen. However, till the end of experimentation no flaming for 3 minute duration or 75 mm length was observed (Table-4). In fact as the oxygen concentration increases beyond 85% the flame becomes blue & its size decreases hence results were not reported beyond this oxygen concentration.

Conclusion

To reduce the fire hazards in electric cables exfoliated mineral based cable fire stop have been studied. The experimental studied on the fire resistance evaluation of specimen have demonstrated that the specimen is found to be quite effective for at least two hours fire resistance rating. ■

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