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Design of the Online UPS for the Cable Manufacturing Industries

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Abstract: In most of the countries (including India) the poor power quality and availability has become the regular phenomenon. It ultimately results into the big challenge in front of the continuous process industries like Cable, FMCG etc. This white paper elaborates the need, design and application of the UPS in the cable manufacturing processes/industries.

1. Introduction:

"Electricity" is the source of power for a nation's economic progress, while power cable is the major arteries for the transmission of electricity. However, there are number of types of cables produced by the cable manufacturers to cater the all kind of applications. Following are the typical examples of the cables generally produced by the different cable manufacturers.

1.1 Plastic Insulated Power Cable: PVC insulated single or multi core cable made with copper or aluminium conductors.

1.2 Control Cable: Co-axial cable made with stranded conductors, metal tape or wire armour.

1.3 Shipboard Cable: Coated or uncoated solid copper, or flexible or nonflexible stranded, braided armour, PVC insulated.

1.4 XLPE High-voltage Cable: Cross-linked polyethylene (PE) insulated, with or without shield or Armour, plastic sheathed cable.

1.5 Communication cable: The communication cable is the major element of the information industry.

1.6 Optical Fiber: Optic communication has low attenuation, wide band and non-induction advantaged character.

All the above mentioned cables go though the different manufacturing processes depending on the type of cable involved.

2. Description of Manufacturing Process

2.1 Drawing:- Bulk Copper is formed into wire of varying diameters by drawing it through a series of dies.

2.2 Annealing :- Since the drawing process causes the copper to become hard and brittle it must be annealed.

2.3 Stranding:- Anywhere from 20 to 100 very fine copper wires are twisted into a single strand.

2.4 Twisting:- Layers of wires (1+6+12+18+20 etc.) are twisted layer by layer into multiple strands of wire. The number of layers is determined by the type of cable being produced.

2.5 Braiding:- Metal or non-metal mesh is braided around the cable.

2.6 Insulation:- The copper conductors, whether they are single or multiple stranded wires, are

insulated with PE or PVC.

2.7 Laying:- A specified number of PVC insulated copper conductors are assembled into power cable.

2.8 CCV Line:- Catenaries continuous Vulcanization for XLPE high voltage power cable (600 V – 35 KV).

2.9 Sheathing: Complete cables are formed by sheathing twin-core or multiple-core PVC insulated copper conductors with PVC.

2.10 Armoring:- Special purpose power cables must be in cased with steel wires in order to increase the strength of the cable. Typical construction of 3C Al Conductor, XLPE cable is as shown in below figure,

3C Aluminium conductor, XLPE insulated, Armoured

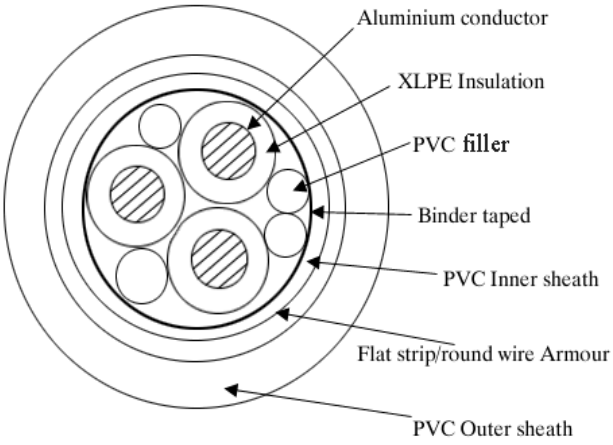

Figure 1

2.11 Single Line Diagram of Manufacturing Process:

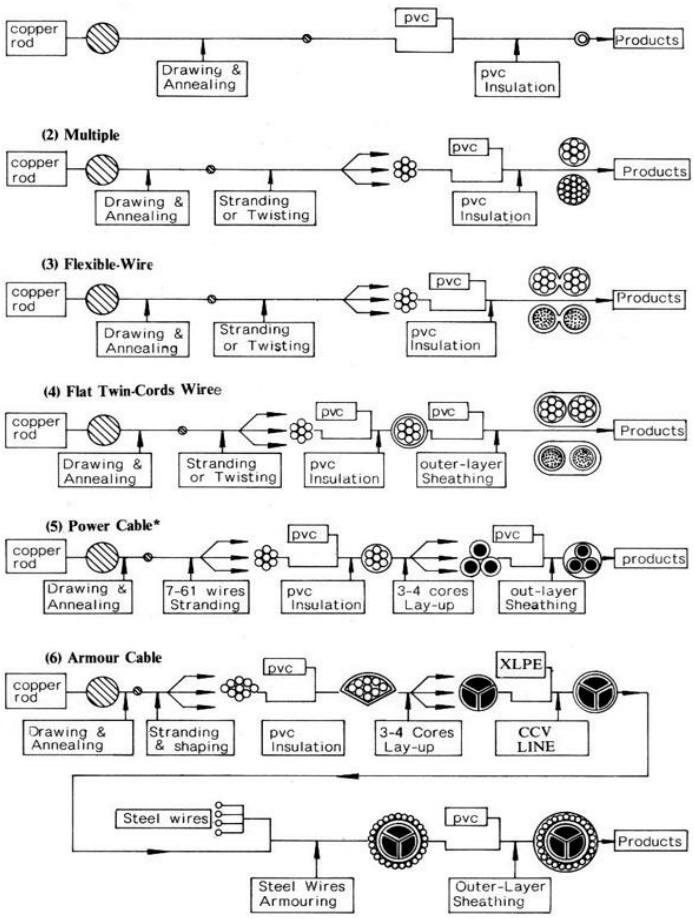

Figure 2

Finally quality control procedure taking in the laboratory and guaranteed cable is ready for retail. For further information on the typical cable plant, kindly refer the enclosed document.

3. UPS Application:

3.1 **Extrusion Process**: In extrusion process is divided in to following different types,

- Insulation material extrusion: where a covering is applied with insulating characteristics on to the conductor.
- Filling material extrusion: where the interstices that are between the conductors are covered.

- Base material extrusion: This consists of applying a covering with mechanical characteristics.

All the above three processes required continuous quality power to ensure the defect free cable in absence of the losses will be very high.

3.2 Cable design department:

For computers and data storage system used in the R & D, administrative department etc. the UPS is required.

4. UPS Necessity:

4.1 Extrusion process:

In extrusion process if power supply fails then melted covering material (thermoplastic and thermo stable covering) will become solid. This will result in possibility of poor insulation and finally whole lot of wire become defective. Also, the material inside the extruder may become solid resulting in the time and labor loss to restart the process.

4.2 Cable design department:

In design department various computers and data storage system are used for testing and developing the new design. Hence the uninterruptible power supply is necessary.

5. While sizing the UPS following two important points should be considered along with the other PQ parameters,

5.1 Notching

5.2 Battery Sizing

5.1 Notching:- Normally in the cable manufacturing industries extruders are employed with the DC drives. These DC drives may result into voltage notching. Notching is nothing but the irregularity in the voltage waveform as shown in the below figure,

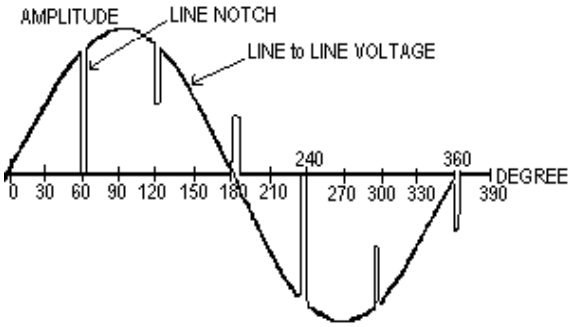

Figure 3

Notching is typically present in the waveform during SCR commutation. Commutation occurs when an SCR in one phase is turned on to turn off an SCR in another phase. For this very small duration of time, a short circuit is created between the two phases. With a short circuit, the current increases and the voltage decreases. The decrease in voltage is defined as a line notch.

Solution for notching:

It is important that we understand and consider where other sensitive equipment connects to that same voltage source. In order to protect the sensitive equipment, we must reduce the notches before they get to that equipment. We will do this through the creation of a simple voltage divider network as shown in following figure,

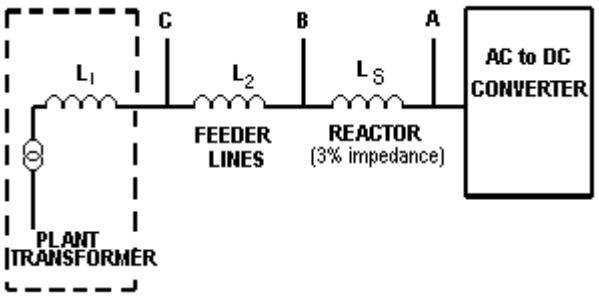

Figure 4

5.2 Battery Sizing: Battery is an important part of the UPS system which needs to be designed precisely. Under sizing may result into the operational loss of the load and over sizing results into the unnecessary expenditure. Hence for the

battery sizing, maximum running load observed during the normal operation from the power trend is to be considered with some design margin. e. g. The following power trend shows the maximum of 119.8kW of running load against the connected load of 237.8kW. Hence while sizing the battery for such application; 132kW (10% margin) of load needs can be considered.

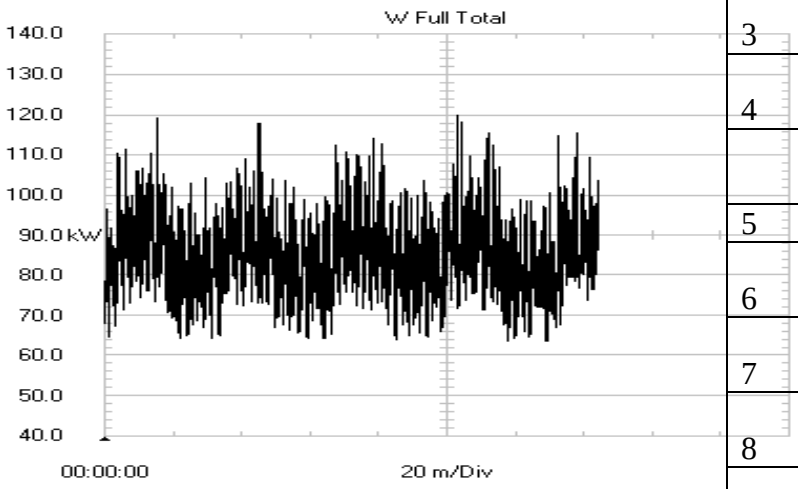

Figure 5

Generally 10 to 15 minutes battery backup time is recommended considering two interruptions per day. However, if the interruptions are more then we need to have the larger battery capacity to meet the charging and discharging cycle requirement.

6.1 Conclusion: From the above text, we conclude that the Uninterruptible Power Supply (UPS) can play the important role in the cable manufacturing process. However, the utmost care needs to be exercised while designing the UPS for particular application. The wrong sizing may lead in the operational difficulty and the down time.

Case Study: UPS requirement for the XLPE Division of the ABC cable industry.

Sr. No.	M/C Name	K.W.	R.P.M	Type	Typeof Starter
	G.S.60 Extruder				
1	Main Motor	24	2300	D.C.	Drive
2	Main Motor Blower	0.09	2800	A.C.	D.O.L
3	Gear Oil Pump motor	0.55	1400	A.C.	D.O.L
4	Conveyor motor	3	2800	A.C.	D.O.L
	G.S.90 Extruder				
5	Main Motor	47	2000	D.C.	Drive
6	Main Motor Blower	0.37	2800	A.C.	D.O.L
7	Gear Oil Pump Motor	O.55	1400	A.C.	D.O.L
8	Conveyor motor	3	2800	A.C.	D.O.L
	G.S.150 Extruder				
9	Main Motor	150	1500	D.C.	Drive
10	Main Motor Blower	1.5	2820	A.C.	D.O.L
11	Gear Oil Pump Motor	0.55	1400	A.C.	D.O.L
12	Conveyor motor 1	3.7	2800	A.C.	D.O.L
13	Conveyor motor 2	3.7	2800	A.C.	D.O.L
	Water pump (Dry Cure)				
14	High Pressure Pump 1	30	2915	A.C.	Star-Delta
15	High Pressure Pump 2	30	2915	A.C.	Star-Delta
16	High Pressure Pump 3	30	2930	A.C.	Star-Delta
	Compressors				
17	Air Compressor	7.5	1440	A.C.	D.O.L

	No.1					
18	Air Compressor No.2	7.5	1430	A.C.	D.O.L	
19	Soft water pump No 1	2.2	2900	A.C.	D.O.L	
20	Soft water pump No 2	2.2	2900	A.C.	D.O.L	
	Total connected Load (KW)	277.16				

The power trend of the above given Extruder load is as follows,

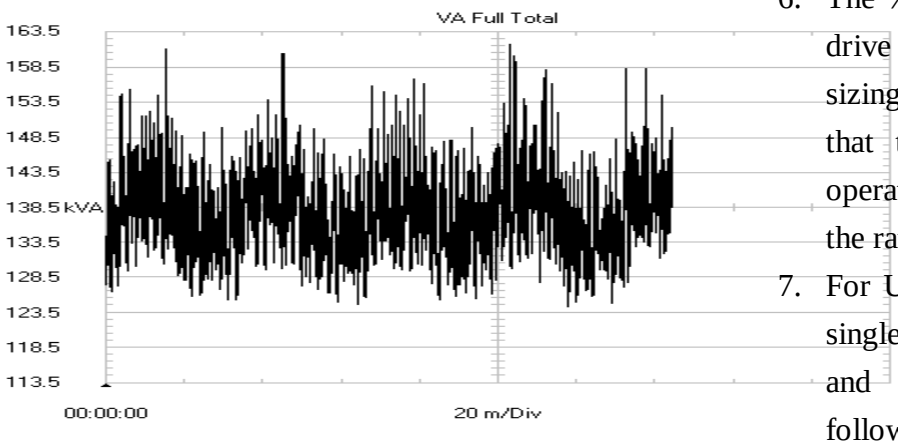

Figure 6

UPS Sizing Calculations and Recommendations:

1. Total running load= Compressor + Extruder + pump house. The calculations follows, Total running load in kVA= 11.5 (From rating) + 161.8 (Refer above power trend) + 37.5 (From rating) = 210.8 kVA (Say 211kVA)
2. All the motor loads to be started sequentially. As mentioned in the connected load list, most of the motor loads are continuously running once started. If on/ off of motor is involved in the process then the UPS sizing need to be done accordingly.
3. The 30kW motor (High pressure pump) load should be started on mains via UPS bypass. After some time, once the motor reaches its operating speed the Inverter is allowed to take over the load. During starting, if mains fail then there may be an interruption for all the loads. It depends upon the actual inrush drawn by the motor at that instant.
4. The customer should not start 30kW motor load when the UPS is drawing power from batteries.
5. A single point UPS solution is proposed to provide higher reserve power for the motor starting current requirements.
6. The % change in the operating speed of the drive also plays the major role in the UPS sizing. In this case customer has confirmed that there is not much variation in the operating speed of the drive with respect to the rated speed.
7. For UPS sizing, UPS is expected to start a single 7.5kW motor of air compressor over and above the base load, calculations follows:

   Base load= 201.6 kVA (Subtracting 7.5kW i.e. 9.4kVA motor rating from total load)

   - 7.5 / 0.8= 9.4kVA; Motor rating in kVA
     - x14= 132kVA; for inrush current handling
     - + 201.6kVA= 333.6kVA; with running load
     - X1.25= 417kVA; considering the design margin
8. Hence, with slightly lesser design margin than 1.25, the 400kVA UPS is recommended for this application.

Battery Sizing: As explained earlier, the battery sizing should be done for the running load and not for the maximum or connected load. Hence in this

case, the battery can be designed for 160kW (Extruder-120kW + Water Pump-30kW + Compressor-10kW) instead of 320kW as per the UPS rating.

References:

1. Uninterruptible Power Supplies by Alexander King. McGraw-Hill Publication
2. Electrical Power Systems Quality by Roger C. Dugan. McGraw-Hill Publication
3. www.google.co.in