A PQ CASE STUDY

POLYPROPYLENE PLANT

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Case Study 07

POLYPROPYLENE PLANT – EXPANSION OF DRIVES

Abstract

The DC drives with six-pulse rectifier, generate significant 5th and 7th harmonics and appear as a stress and skin effect on cable leading to insulation failure. A generally accepted method of coping with these problems is to de-rate all the electrical component even by 50%. This study highlights how the selection of a large capacity source transformer relative to the non-linear loads connected to it, would bring higher benefits in dealing with issues of not only harmonics but also voltage drops and heating of cables

Industry Background

The Indian petrochemical based industry sector suffered a number of setbacks in the first half of 2008, which will make it harder for the country to plug the shortfall of 5mn tonnes per annum (tpa) of ethylene and 4mn tpa of polymer that the government anticipates by 2012, according to BMIs latest India Petrochemicals Report.

India's demand for petrochemical based products has grown at a rate of 13-14% annually since the late 1990s, prompting rapid expansion of capacity. BMI forecasts of 14-16% average annual growth over 2007-2011.

The Indian polypropylene industry is well established over the years. The plant under study had an annual capacity of nearly 4000 tons, with main products of polypropylene fabric and liners*.

Demonstration Site

A leading manufacturer of various types of polypropylene woven fabrics & sacks situated in South India, the unit desired to have an audit of their plant for performance. The manufactured product was being catered to various industries such as cement, sugar and other related use for packing the products.

(SOURCE:"BUSINESS MONITOR" 2008)

Plant Details

The plant is in operation since 1986. It has two hangars, the new expansion hangar was added during 1998. However, there were several operational problems consequent to addition of new area requiring thorough examination of power supply issues due to addition of non-linear loads.

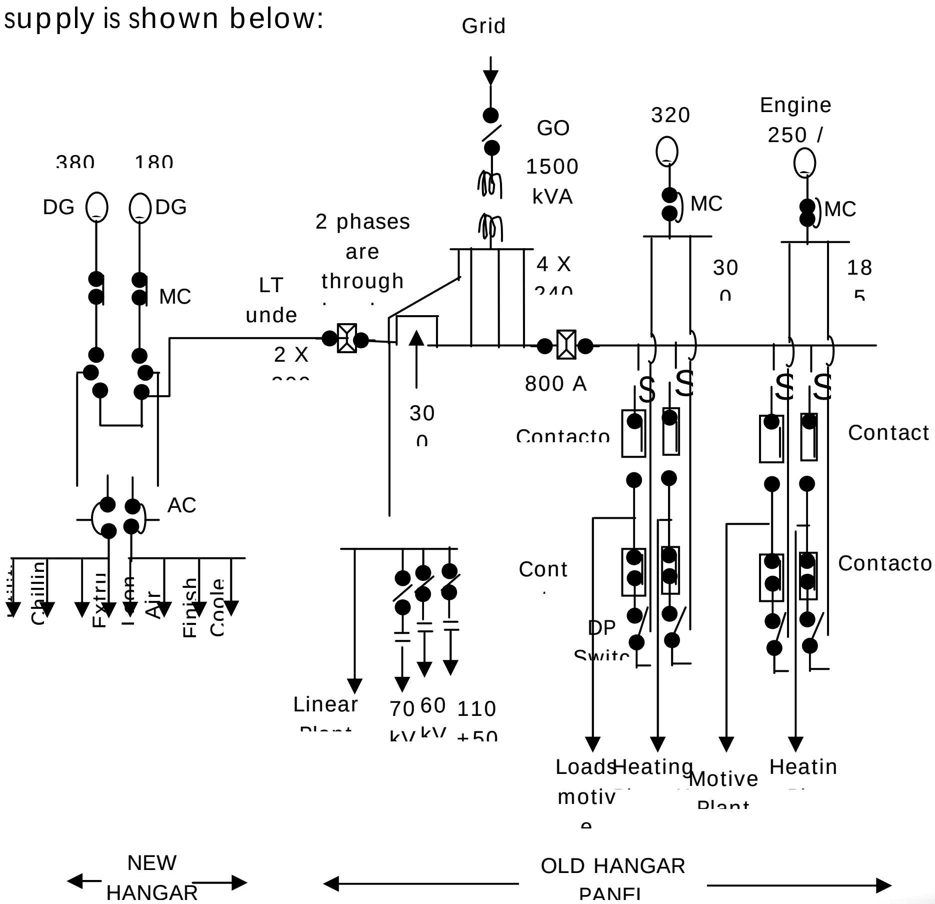
The major production and associated auxiliaries mostly consist of extruders, winders, looms, refrigeration chillers and compressors etc.

Energy Details

The Annual energy consumption of the plant was 14.30 Lakh units with in-house D.G. set generation of almost 44% of the demand, in view of the problems faced in maintaining the power quality after the expansion of the unit.

Power System Details

The main source of electricity to the plant was from single circuit 11kV line of utility feeder with 1500kVA, 11kV/415V transformer. The old hangar has a power supply from 4x240 sq.mm. underground cable. The new hangar was nearly 300 mtrs away from the old hangar area through 2x300 sq.mm. underground cables. The single line diagram of power supply is shown below:



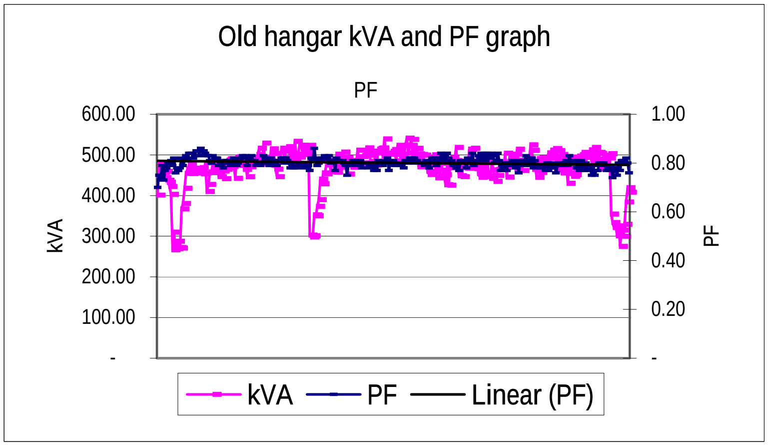
The old hangar had two sets of 320kVA and 250kVA D.G.sets to cater to heating and motive loads, which were normally in operation during grid failure. Also, there were 380kVA and 180kVA D.G. sets to cater to heating and motive loads of hangar-2, but 380kVA D.G.set is in continuous operation due to voltage dips seen at Extruder-III of hangar-2, if operated on grid supply.

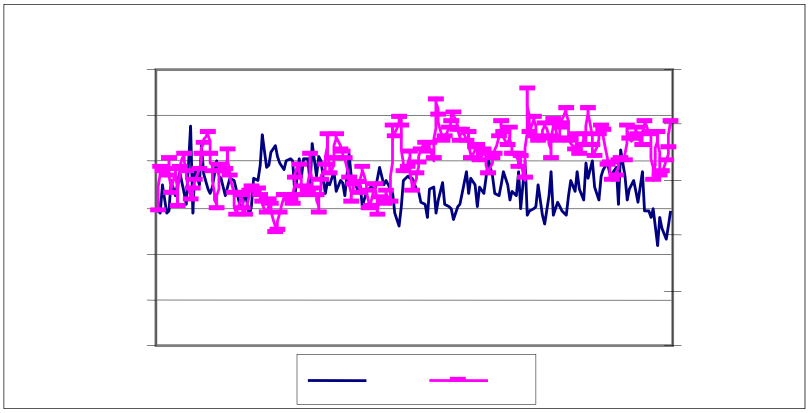
Plant Load Details

The plant has DC drives for main extruder motor drives & DC/AC variable drives, with two extruders at the old hangar and one at the new hangar. The capacity of these extruders are 200/250/250 kg/hour respectively for unit 1,2 & 3. Here the polypropylene granules fed into hopper are heated to 250oC, the hot material is forced through the die using DC drive of 60kW. The extruded plastic sheet is fed through cold water and on to the hot plate or hot air oven. Apart from extruders, there are loom section for fabric of various sizes in both the hangars.

Electrical Loading Parameters

Detailed study was undertaken in the two plants to examine the issues.It was observed that the loading pattern for old hangar was in the range of 230~541 kVA and was 123kVA~204kVA for the new hangar depending upon the requirements of products. A typical loading pattern at hangar-1 is shown below. Further, D.G.set hangar -2 had additional independent loading of nearly 200kVA~239kVA which was mostly extruder – III loading. Thus the plant demand was between 553~984kVA.





Major issues at Plant

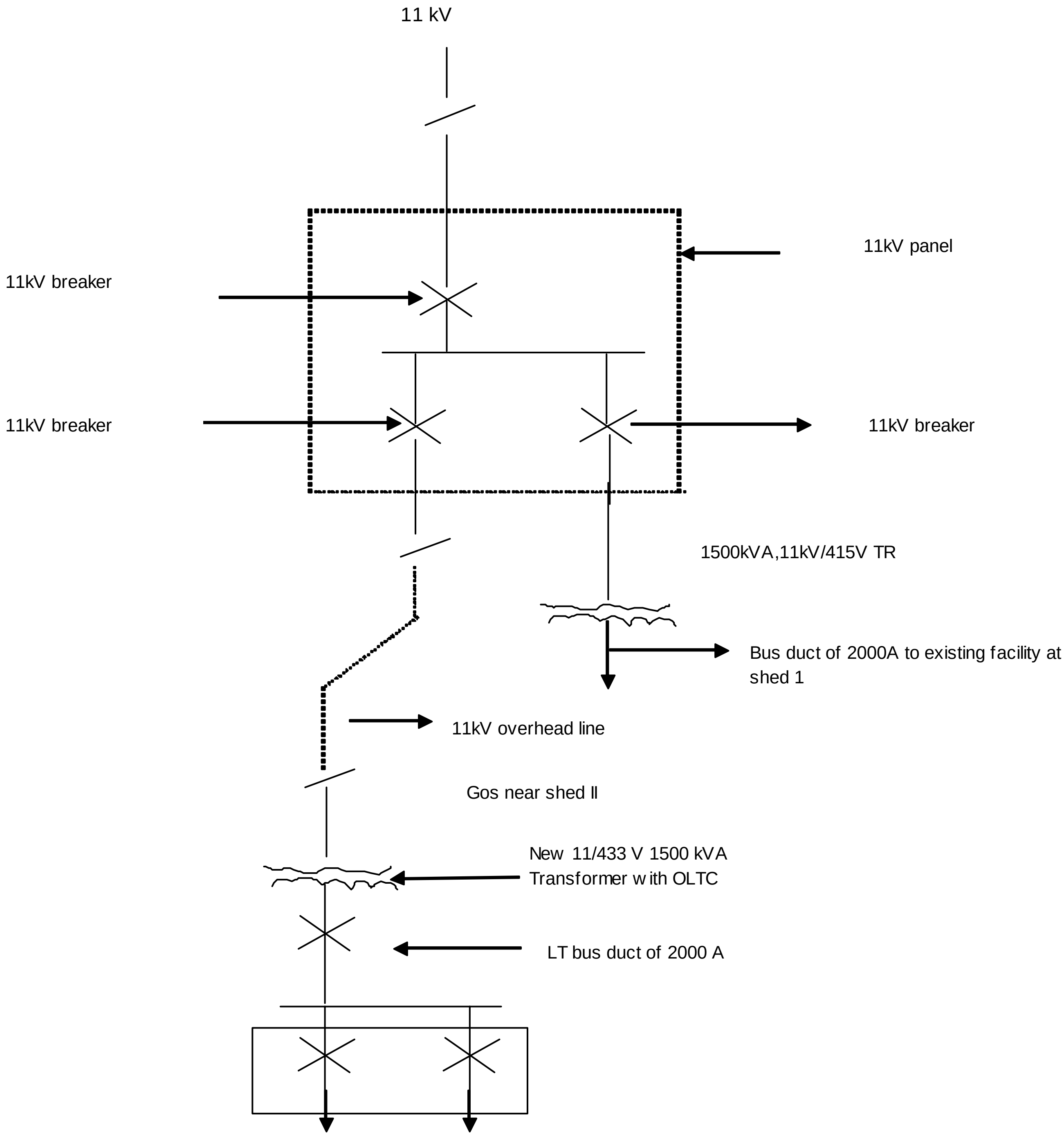
The majority load was that of extruders and of which unit I and II were with DC drives(which are with six-pulse rectifiers) and also DC/AC variable drives. The unit-III had an AC motor with drive control, which was operating at low pf, rich in harmonics and creates additional heating and sometimes even fire at power distribution circuit of switch gear, cables, transformers etc. From the closer auditing of the above areas, it was found that the DC drives of extruders – I and II could be replaced with more rugged AC motor designs with PWM technology drive due to lesser maintenance of AC motor, better response time, high overload capability and very wide constant torque speed achievement possibilities.

But it was noticed that incoming 11kV level was found to be varying in the range of 10.5kV to 11kV, thereby resulting in LT voltage between 398~415V for hangar-1 area. However, for hangar-2 area, it was further reduced by 10 to 12V due to drop in the long cable length of 300 mtrs. With voltage level of 380V from the grid most of the time, the Extruder-III plant could not be started due to further dip in voltage.

On examination of external grid supply feeder, it was found that this installation was the last consumer for the utility's 11kV feeder. One of the options was to have new 11kV line exclusively for the plant with extended tap & a 11kV line for hangar-2 also with its transformer. It was also necessary to up-size the main transformer and existing and new distributory cable networks such that they are loaded not more than 50% always, since the majority of the loads were of non-linear load(drives). In fact the existing cables sheathing at MCC drive units of extruders were already burnt due to skinning effect due to high frequency content of harmonics. This led to increased resistance value, as only a portion of the conductor was used, leading to heating effect on the cable. Apart from this, the present LT cables also causing heavy distribution losses due to low p.f. of 0.73~0.85 during the day. The Annual losses on this account could be estimated at 15,000 units costing around INR 72,000.

Proposed Solution

It was recommended to draw a new 11kV overhead line for hangar-2 also, with installation of additional transformer of 1500kVA with on-load-tap-changer facility for voltage adjustment with new investment of INR 30 Lakhs. The network of distribution suggested is shown below:



Note: DG integration to be shown separately

Conclusion

While dealing with non-linear loads such as six-pulse type large DC drives where harmonic contents are very large, it is necessary to de-rate all the electrical systems/components/equipments etc. by 50%, to accommodate impact due to harmonics. This would avoid un-necessary burning of sheath and voltage drop at tail end user points.

About the Author and Company

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Mr. Halpeth has a Master's degree from University of Roorkee, India and over 39 years experience in Energy, Energy Generation, Distribution Management. He is presently working on energy efficiency issues since more than 13 years. He has led several projects for energy efficiency and conservation projects for various types of industries and industrial applications, including power quality studies.

Established in 1974, TERI has grown substantially over the years, and has created an environment that is enabling, dynamic and inspiring for the development of solutions to global problems in the fields of energy, environment and current patterns of development, which are largely unsustainable.

The TERI's SRC (Southern Regional Centre) was set up at Bangalore in 1990 with its main objective to promote concepts and practices for improving industrial energy efficiency. Over the years, the Centre has grown as a specialist organization on energy efficiency and successfully executed innumerable efficiency projects for various eminent Indian and multinational organizations, corporates, state and government departments, public and private sector enterprises, and international financial and aid agencies.

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