Reactive power management tagare pdf

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I Year II Sem.Prerequisite: Power Systems – IICourse Objectives:To identify the necessity of reactive power compensationTo describe load compensationTo select various types of reactive power compensation in transmission systemsTo contrast reactive power coordination systemTo characterize distribution side and utility side reactive power management.Course Outcomes: Upon the completion of the subject, the student will be able toDistinguish the importance of load compensation in symmetrical as well as un symmetrical loadsObserve various compensation methods in transmission linesConstruct model for reactive power coordinationDistinguish demand side reactive power management & user side reactive power managementUNIT-I: Load Compensation: Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.UNIT-II: Steady – State Reactive Power Compensation in Transmission System: Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation –examples Transient state reactive power compensation in transmission systems: Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation – compensation using synchronous condensers – examples UNIT-III: Reactive Power Coordination: Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency –Harmonics, radio frequency and electromagnetic interferencesUNIT-IV: Demand Side Management: Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels Distribution side Reactive power Management:: System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banksUNIT-V: User Side Reactive Power Management: KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnaceTEXT BOOKS:Reactive power control in Electric power systems by T.J.E. Miller, John Wiley and sons, 1982.Reactive power Management by D. M. Tagare, Tata McGraw Hill, 2004.REFERENCES:Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just "Reactive Power Compensation: A Practical Guide, April, 2012, Wiely publication.For all other M.Tech 1st Year 2nd Sem syllabus go to JNTUH M.Tech Electrical Power Systems/ Power System Control And Automation/ Electrical Power Engineering 1st Year 2nd Sem Course Structure for (R17) Batch.All details and yearly new syllabus will be updated here time to time. Subscribe, like us on facebook and follow us on google plus for all updates.Do share with friends and in case of questions please feel free drop a comment. Power System BasicsAn in-depth discussion on how to manage reactive power in a utility network. This is an important basic concept to know in times of increasing EV and solar renewables penetration. Anupam RastogiMarch 24, 2022Most of the loads in a modern power distribution system are inductive in nature. Typical examples being, loaded overhead lines, motors, transformers, cables, drives, and fluorescent lights. These inductive loads consume both active and reactive power. Active power is required to meet real output requirements and inductive reactive power is required to maintain the magnetic field in the core. Phasor diagram of these parameters is shown in Fig 1.1(a) and 1.1(b). The phasor diagram is described below. Cos Φ = Power factor, kW = Active power, kVAri = Reactive power kVA = Apparent power = (kW2 + kVAri2)1/2 Given this, the power supply system should be capable of supplying both active and inductive reactive power. Presence of inductive reactive power results in the power factor being less than unity and lagging in nature, which in turn results in the following ill effects on a power distribution system. Higher current flow from the supply side. Higher losses in loaded overhead lines, transformers, and cables. Reduced efficiency of the power distribution system. Higher kVA demand from the supply side. Higher electricity bills due to the increase in fixed charges based on kVA demand. Levy of penalty by DISCOM if power factor < 0.9 lagging. Thus, we need to reduce the reactive power to reduce all of the above ill effects. The most effective method for this is increasing the power factor of a power distribution system. The methodology used to achieve a higher power factor under modern application conditions is REACTIVE POWER MANAGEMENT. It can also be said that "REACTIVE POWER MANAGEMENT" is a tool for improvement in the power factor of a distribution system. Hence, both of these are two faces of the same coin. The methodologies used for power factor improvement are mentioned below Installation of fixed type power capacitors Installation of Automatic Power Factor Correction System using multiple power capacitors. Automatic Power Factor Correction System uses the technique of automatic switching of capacitor banks based on the requirement of reactive power to be fed by capacitors to maintain power factor at some predetermined value say 0.99. The concept of power factor improvement is shown in Fig 1.2(a). Here it is shown that kVAR1 is reactive power fed by the supply-side before the installation of capacitors. (kVAR1 - kVAR2) is reactive power fed by the capacitor. kVAR2 is new resultant reactive power to be fed by the supply system after the installation of capacitors. It can be seen that kVAR2 < kVAR1. In Fig 1.2(b) also, it is shown that kVARc is reactive power fed by the capacitors.Benefits of REACTIVE POWER MANAGEMENTDecrease in current flow from the supply side. Higher efficiency due to decrease in losses in loaded overhead lines, transformers, and cables. Reduction in fixed charges in electricity bill due to lower kVA demand. Incentive in electricity bill by 10% of energy charges for every 0.1 increase in power factor above 0.95 lagging. Elimination of penalty in electricity bill due to power factor < 0.9 lagging. Improved voltage at receiving end side of the power system. Increased life of transformers, cables, and switchgear due to lower operating temperatures. Due to the reduction in kVA demand, additional loads can be added to the same capacity distribution system. Fig 2.1(a) shows a simplified distribution system with a power factor of 0.75 without using capacitors. Fig 2.1(b) shows the same distribution system with a power factor of 0.95 by using capacitors. kVA = kW + kVAR Modes of capacitor compensation3.1 – Providing compensation at the main incomer to power distribution system bus bar is called central compensation. This is shown in Fig. 3.1. Here capacitor is installed at position No. 1. 3.2 – Providing capacitor compensation at Main incomer – Central compensation (position No.1). At power distribution boards – Group compensation (position No.2) This is suitable for installations where there is a number of power distribution boards for various load feeders. This is shown in Fig. 3.2. 3.3 – Providing capacitor compensation at all positions as described below. At the main incomer bus – Central compensation (position No.1) At Power distribution boards – Group compensation (position No.2) At individual load terminals – Individual compensation (position No.3) This is suitable for installations consisting of the main receiving station, substations, several load feeders, and a variety of loads. This is shown in Fig. 3.3. Calculation of kVAr requiredThe estimation of kVAr required for compensation to achieve desired power factor is generally done depending on the type of loads to be compensated. For this purpose, the tables and formulae given in this section may be used. 4.1 – Capacitor kVAr for AC induction motors. Table 4.1 gives the recommended ratings of power capacitors, which are to be used directly with 3 ph. AC induction motors as at position No. 3 of fig 3.3 Note : It is considered uneconomical to improve power factor (pf) for motors of ratings below 15 hp in power distribution systems. For motor ratings above 250 hp, the capacitor kVAr rating would be about 25% of the motor rating in hp. In all cases, it should be ensured that the capacitor current at rated voltage is always less than 90% of the no-load current of the motor. This is necessary to prevent excessive surge voltages in the event of an interruption in the power supply. This is harmful to both motor and capacitor. The capacitor kVAr values indicated in Table 4.1 are after taking into consideration the condition specified in note 3 and assuming motor loading > 80%. 4.2 Capacitor kVAr for Power distribution systems – For power distribution systems, the capacitors are to be installed at position No.1 of Fig. 3.1. Initial pf, final pf, and multiplying factors are shown in table 4.2. The operating load kW and its average pf can be obtained from the electricity bill. Else, it can also be calculated from the following formula. Average pf = kWh/kVAh, operating load kW = kVA demand X average pf. The average pf is considered as initial pf and the final pf is the pf to be achieved by "REACTIVE POWER MANAGEMENT". This can be calculated using multiplying factor given in table 4.2, This is shown in the example given below. Example – Calculate the required kVAr compensation for a 500 kW installation to improve the pf from 0.75 to 0.96. kVAr = kW X multiplying factor from table 4.2 = 500 X 0.59 = 295 kVAr Note – The table 4.2 is based on following formulae. Multiplying factor = (tan Φ1 – tan Φ2) kVAr required = kW (tan Φ1 – tan Φ2), where Φ1 = Cos-1(pf1), Φ2 = Cos-1(pf2) pf1 and pf2 are initial and final power factors respectively. 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