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REACTIVE POWER COMPENSATION: A REVIEW

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Abstract -- **The role of reactive power can be understood as it affects voltage stability, power factor and losses in a power system. Now a day's quality of electrical power in a network is becoming a major concern which must be examined in order to achieve a reliable electrical power system. To realize the goal of qualitative and reliable electrical power system reactive power compensation is one of the solutions. This paper reviews different technology used in reactive power compensation such as synchronous condenser, static VAR compensator, capacitor bank, series compensator and shunt reactor, comparison between them, source of reactive power and different optimization techniques. After observation and conclusion is made the most useful technology and optimization techniques is recommended for future works.**

Keywords - **Synchronous condenser, Static VAR compensator, Capacitor bank, Shunt reactor, Series compensator, Optimization technique's, Source of reactive power**

I. INTRODUCTION

Many researchers has done on reactive power composition or related to load characteristics to solve the problem with voltage stability. F. Dong. et al [1] done on management of dynamic reactive power reserves based on optimal power flow and the Bender's decomposition technique to improve voltage stability. M. Gordon [2] shown stable and unstable system response for different load models and network conditions by chalking Impact of Fault Locations on Induction Motor Responses, Impact of Fault Duration on Induction Motor Responses and impact of generator response.

N. Goel. et al [3] Static Synchronous Compensator (STATCOM) is used to improve voltage stability and The values of the DC link capacitor and battery source were optimized. Also show STATCOM tuned with Genetic Algorithm is best solution by comparing various condition.[4] has shown early solutions with to-days devices, provides decisive factors for the steps in development of arrangements and discusses advantages of the present device. R. Phukan [5] was shown the use of Firefly and Spiral optimization for minimizing the active power loss along with partial compensation of inter bus voltage drop. And evaluate objective function under both static and dynamic loading conditions.

G.Ganesh. et al [6] was proposed a new concept of the UPQC-S approach which is mathematically formulated and analyzed to compensate voltage sag/swell and is integrated with theory of power angle control. S. K. Morya. et al [7] was presented differential evolution based approach has been presented and applied to multi-objective reactive power problem with real power loss and bus voltage deviations based on the characteristics of reactive power optimization. H.S. Su. et al [8] has been improved distribution network reactive power optimization, the cloud particle swarm based on cloud digital features (Ex, En, He), local search and global search.

S. Khalid. et al [9] proposed a novel ANN controlled shunt filter designed for aircraft power system and used Genetic Algorithm, Fuzzy Logic and ANN for optimize the model and increased the ability of conventional model. P.L.Reddy. et al [10] presented approach to solve the single objective OPF problem considering the reactive power loss minimization as the objective function, and show comparison results of load flow with and without particle swarm optimization. P. Panciatici. et al [11] has been presented about paper a selection of advances in the fields of non-convex optimization, in mixed integer programming, and in optimization under uncertainty and the practical relevance of these developments for power systems planning and operation are discussed.

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Vasanthavalli.C.et al [12] develop DSTATCOM Using digital signal processor that satisfactory for various type of loads and a BBT control algorithm is used for the extraction of the fundamental weighted value of active and reactive power components. R. Dastagir. et al [13] effectiveness of dynamic voltage restorer (DVR) in order to mitigate voltage sags and swells in low voltage distribution systems. T. Chakraborty [14] has been done simulation of distribution network substation by introducing SVC at the load ends using the Electrical Transient Analyzer Program (ETAP) and comparative study on FACTS device. D.Charishma. et al [15] Capacitors are placed in the IEEE 14 bus system to compensate the reactive power and use Evolutionary algorithm for optimizing loss and analaysis of bus using Mipower software was done. N. K. Saxena. et al [16] was presented pricing of reactive power compensation under steady state and transient conditions of system with fixed capacitor and STATCOM . Ramakrishna prabu. et al [17] was showed design, modeling and analysis of FACTS device such as SVC and STATCOM interconnected with grid during fault. Performance is analyzed with the help of PI controller and Fuzzy logic using MATLAB Simulink.

W. Sheng.et al [18] has been proposed a reactive power optimization method which done based on historical data and matrix theory to solve the dynamic reactive power optimization problem in distribution network tested on a standard 14 nodes distribution network with three different types of load. N. Goel.et al [19] has showed different techniques used for the solution in finding the optimal location of capacitor. O. A. Karaman [20] proposed three-Phase Parallel Active Power Filter (PAPF) control mechanism to filter out harmonics generated by non-linear loads and carry out reactive power compensation by applying Adaptive Harmonic Injection algorithm.

II. SOURCE OF REACTIVE POWER

Dynamic source of reactive power have a reactive power capability dictated /dependent on system conditions and as such can be changed instantaneously but static source of reactive power have fixed reactive power capability [54, 58, 60]

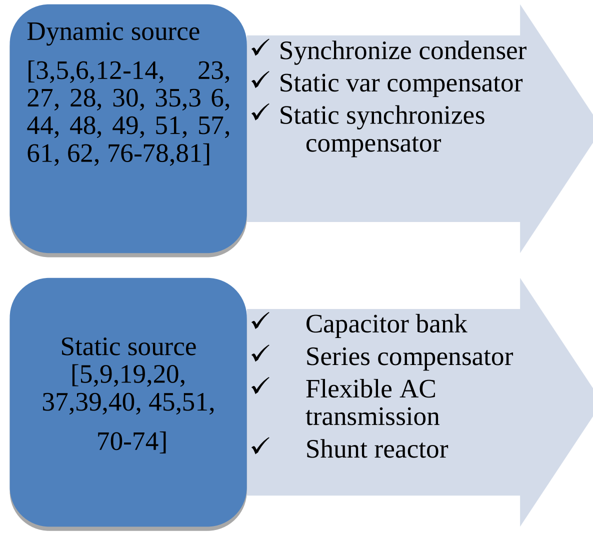

Fig 1: Source of reactive of reactive power

III. OVERVIEW OF COMPENSATOR DEVICES

One of an effective technique to enhance the electric power network is reactive power compensation which can be done either with synchronous condensers, series compensator, capacitor bank, shunt reactor, Static VAR Compensators (SVCs) or Static Synchronous Compensators[22,63]

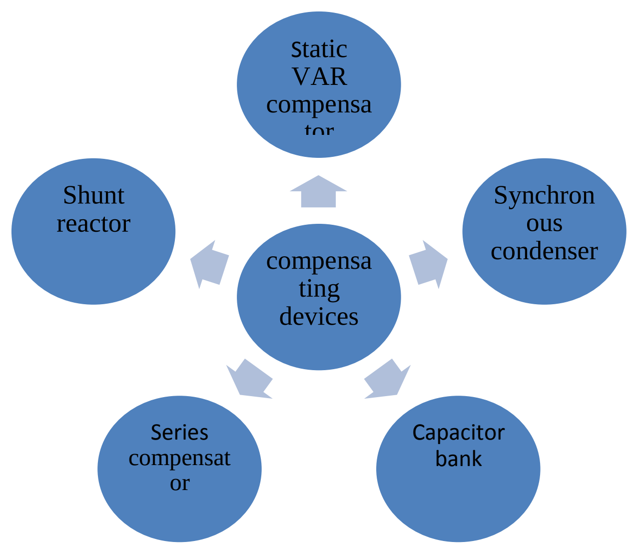

Fig 2: Reactive power compensating devices

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IV. OVERVIEW OF OPTIMIZATION TECHNIQUE'S [24,52,55]

Mathematical formulations of real-world problems are derived under certain assumptions and even with these assumptions, the solution of large-scale power systems is not simple. On the other hand, there are many uncertainties in power system problems because power systems are large, complex, and geographically widely distributed. More recently deregulation of power utilities has introduced new issues into the existing problems. It is desirable that solution of power system problems should be optimum globally, but solution searched by mathematical optimization is normally optimum locally. These facts make it difficult to deal effectively with many power system problems through strict mathematical formulation alone. Therefore, artificial intelligence (AI) techniques which promise a global optimum or nearly so, such as expert systems (ES), artificial neural network (ANN), genetic algorithm (GA), fuzzy logic and so on have emerged in recent years in power systems as a complement tool to mathematical approaches. Various optimization techniques have been applied to solve the power systems reactive power problem and large number of papers has been published as shown in Fig 3 .

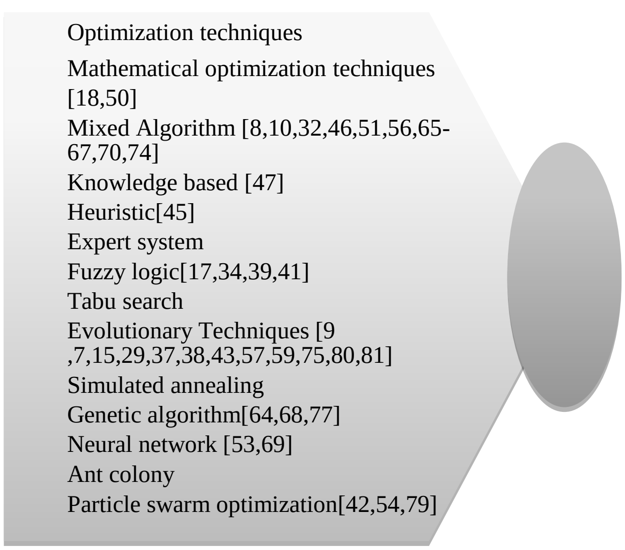

Fig 3: optimization technique's

V. FACTORS AFFECTING PRICING OF REACTIVE POWER [16]

Reactive power problems are always related with the voltage profile, power factor, losses and stability on power systems. And the system price affected are listed in Fig 4. with related published papers.

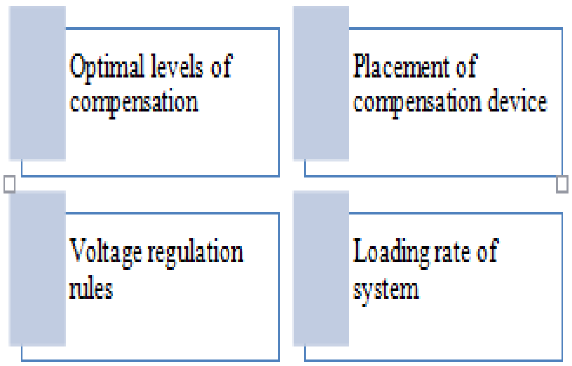

Fig 4: Factor affecting pricing of reactive power

VI. OBSERVATION

- More RPC installations are probably required in the near future to overcome system limitations which is seen an important contribution to increase system stability and prevent blackouts Prediction based procedures for modeling the weather impacts, daily-seasonal and other factors[2][4].
- Var compensators having better grid controllability which allow utilities to reduce investment in the transmission lines [21].
- Number of hidden layers in the system are the disadvantages of BBT control algorithm [12].
- A voltage-dependent load model provides more realistic power flow results than a constant P-Q model by more accurately representing the actual behavior of the loads in response to voltage variations [33].
- A linear power flow formulation results in an improvement of at least four times in execution speed compared to the implicit Z-bus algorithm [33].
- AI in control methods is easy to calculate and implement and also very effective in reducing harmonics [38].
- The intelligent algorithm techniques are more efficient and accurate than the conventional

algorithm in finding the optimal firing delay angles of TCR [38].

- Real time pricing of generator real power and minimizing the system real power transmission losses are important consideration. To control frequency, stability, security and voltage profile of the system and to ensure the generation and transmission, ancillary services like frequency control, network control and system restart are needed [47].

VII. CONCLUTION AND RECOMMENDATION

A. Conclusion

By applying capacitors adjacent to loads, several advantages are obtained some of them are improved power factor, reduced transmission losses, increased transmission capability, improved voltage control, improved power quality. Methods and equipment for measurements of load characteristics are include Enhancement in dynamic performance analysis, such as discharge lighting, low voltage motor behavior, long term dynamics, thermostatic type loads etc are used to improve reactive power performance. Generally optimization methods with related to active filter is the best reactive power improvement method.

B. Recommendation

- The combination of dynamic and conventional switched RPC often results in cost effective solutions for steady state and transient system operation. VSC based FACTS are expected to be more widely used especially in the lower and medium power range.
- We suggest that the research community should further focus on the proper formulation of power system optimization problems with the help of power system experts, and develop more intensively fruitful collaborations with researchers in applied mathematics and computer science to determine the most effective solution strategies for these problems.
- More systematic investments in a more effective use of modern information technologies, especially in the context of high-performance computing and massive data exploitation should be made by the power systems industry.
- AHI algorithm recommended for successful suppresses current harmonics under different load conditions.
- Synchronous condenser technology is the most adequate and the best solution for reactive power correction in power system network.
- Fuzzy-heuristic combination is a new idea leads to results better than previous methods for loss reduction and improving voltage profile.

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