A Comprehensive survey on optimal power flow and voltage profile enhancement

Arvind pratap[a], Bindeshwar Singh[b], Varun kumar[c]

[a,b,c] *Kamla Nehru Institute of Technology (KNIT), Sultanpur, Uttar Pradesh, India*

Abstract - *This paper presents a comprehensive survey on optimal power flow and voltage profile enhancement by optimally placed flexible alternating current transmission system (FACTS) controllers such as static VAR compensator (SVC), thyristor-controlled series capacitor (TCSC), thyristor controlled phase angle regulator (TC-PAR), static synchronous series compensator(SSSC), static synchronous compensator (STATCOM), distributed-STATCOM, unified power flow controller(UPFC), generalized unified power flow controller (GUPFC), interline power flow controller(IPFC), generalized interline power flow controller(GIPFC), hybrid power flow controller (HPFC), dynamic voltage restorer(DVR) etc. in the distribution power system networks.*

***Key Words*: FACTS controllers, optimal power flow, static VAR compensator, distribution power system networks and voltage profile.**

1. INTRODUCTION

From last two decade, it is observed that shortage of reactive power in power system environment.

This shortage of reactive power in the system is major causes of the following power system disturbance such as:

- Poor loadability of system.
- Poor voltage profile.
- Poor power factor of system.
- More power system oscillation.
- More real power losses of the system.
- Less available poor transfer capacity of transmission line.
- Poor frequency profile.
- Less power system stability.
- Less reliability and security.
- Less flexibility of operation of system.
- Less bandwidth of system.

Such problems can be solved by FACTS controller in the system [1-108].

The various applications of FACTS controllers are as follows: minimization of real and reactive power loss, maximization of loadability of system, maximization of availability of power transfer capacity, enhance power system stability, enhance power system security, enhance power system reliability, reduce the power system oscillations, improve power factor of the system and improve power quality parameters such as voltage swell and voltage sag etc.

2. RESULT BASED ON COMPREHENSIVE SURVEY OF OPTIMAL POWER FLOW

Table 1 shows result of survey of 33 literatures from optimal power flow viewpoints. FACTS controllers reviewed regarding optimal power flow point of view are shown in Figure 1.

Table 1: No. of literature reviewed regarding FACTS controllers from optimal power flow point of view.

FACTS controllers	FACTS controllers reviewed regarding optimal power flow point of view
SVC	-
TCSC	05
SSSC	02
STATCOM	02
DSTATCOM	-
UPFC	16
IPFC	08
GUPFC	-
DVR	-
Total literature reviewed	33

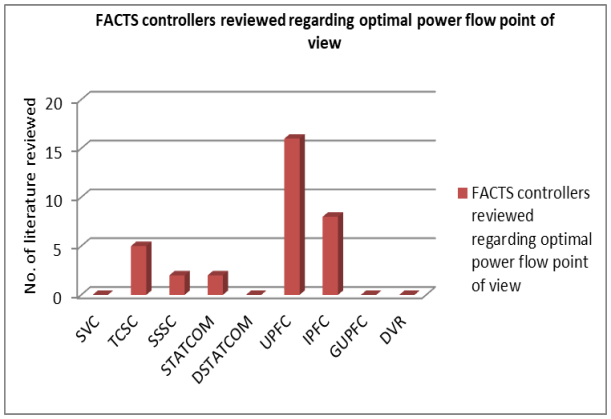

Fig-1: optimal power flow vs. No. of literature reviewed

Figure 1: shows optimal power flow vs. no. of literature reviewed regarding optimal power flow point of view on

FACTS controllers such as SVC, TCSC, TCPAR, SSSC, STATCOM, DSTATCOM, UPFC, IPFC, GUPFC, DVR and multiple-FACTS. The minimum numbers of literature reviewed regarding optimal power flow point of view on FACTS controllers are STATCOM (6%) and SSSC (6%). The maximum numbers of literature reviewed regarding optimal power flow point of view on FACTS controllers is UPFC (49%).So it can be conclude that UPFC is preferred over all other FACTS controller for optimal power flow.

Percentages of no. of literature reviewed regarding optimal power flow point of view out of 33 literatures are shown in Table 2.

Table 2: Percentage of No. of literature reviewed regarding optimal power flow point of view out of 33 literatures.

FACTS controllers	Percentage of No. of literature reviewed regarding optimal power flow point of view out of 33 literatures
SVC	0%
TCSC	15%
SSSC	6%
STATCOM	6%
DSTATCOM	0%
UPFC	**49%**
IPFC	24%
GUPFC	0%
DVR	0%

3. RESULT BASED ON COMPREHENSIVE SURVEY OF VOLTAGE PROFILE ENHANCEMENT

Table 3 shows result of survey of 75 literatures from voltage profile viewpoints. FACTS controllers reviewed regarding voltage profile point of view are shown in Figure 2.

Table 3: No. of literature reviewed regarding FACTS controllers from voltage profile point of view.

FACTS controllers	FACTS controllers reviewed regarding voltage profile point of view
SVC	27
TCSC	2
SSSC	0
STSTCOM	**35**
DSTATCOM	3
UPFC	6
IPFC	0
GUPFC	1
DVR	1
Total literature reviewed	75

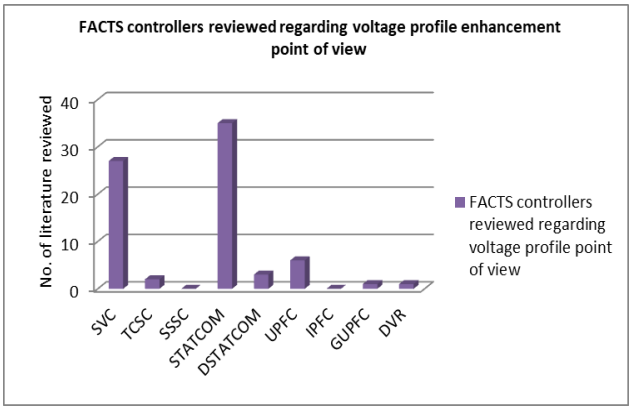

Fig-2: voltage profile vs. No. of literature reviewed

Figure 2: shows voltage profile vs. no. of literature reviewed regarding voltage profile point of view on FACTS controllers such as SVC, TCSC, TCPAR, SSSC, STATCOM, DSTATCOM, UPFC, IPFC, GUPFC, DVR and multiple-FACTS. The minimum numbers of literature reviewed regarding voltage profile point of view on FACTS controllers are GUPFC (1%) and DVR (1%). The maximum numbers of literature reviewed regarding voltage profile point of view on FACTS controllers are STATCOM (47%).So it can be conclude that STATCOM is preferred over all other FACTS controller for voltage profile enhancement.

Percentages of no. of literature reviewed regarding voltage profile enhancement point of view out of 33 literatures are shown in Table 4.

Table 4: Percentage of No. of literature reviewed regarding voltage profile enhancement point of view out of 75 literatures.

FACTS controllers	Percentage of No. of literature reviewed regarding voltage profile enhancement point of view out of 33 literatures
SVC	36%
TCSC	3%
SSSC	0%
STATCOM	47%
DSTATCOM	4%
UPFC	8%
IPFC	0%
GUPFC	1%
DVR	1%

4. CONCLUSIONS AND FUTURE SCOPE OF THE WORK

(a) Conclusions

The following conclusion met from this survey article on optimal location and proper coordination of FACTS controllers in power system from different power system

performance viewpoints are as follows:

- Power system stability improved
- Power system reliability improved
- Power system security improved
- Available power transfer capacity improved
- Minimization of power system oscillation
- Minimization of real and reactive power losses of the system
- Improvement of power factor of the system
- Increase bandwidth of operation of the system
- Improvement of voltage profile of the system buses
- Enhance the loadability of system

(b) Future scope of the work

The future scopes of this work are as follows:

- Various FACTS controllers can be used in a coordinated manner to enhance the different power system performances.
- AI techniques used for optimal placement and properly coordinated control of FACTS controllers with static as well as dynamic load models in power system networks for enhancement of different power system performances.
- AI techniques also used for optimal placement and properly coordinated control of multiple type of FACTS controllers with static as well as dynamic load models in power system networks for enhancement of different power system performances.
- Overall cost of per unit electricity is reduced due to minimization of real and reactive power loss of the system by using FACTS controllers.
- Practical implementations of these things are possible for benefits of society.

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