Calculation of The Maximum Transmission Capacity Based on OPF

Limei Yan, Wangqing Song

College of Electrical Information & Engineering, Northeast Petroleum University, Daqing, 163318, China

Abstract

In the trend of power market gradually opening, if the power system wants to ensure the safe and steady operation, it should avoid transmission lines appearing congestion. Transmission congestion will bring a series of problems to the power system, such as adding unnecessary power cost, affecting the price of electricity commodity substantially, increasing the risk the users take, and these problems will threaten the safety of the power system. So, how to effectively manage congestion of transmission lines, constructing mathematical models comply with all the conditions can provide safeguard to improve the reliability of power system operation. The traditional method of transmission congestion management has been unable to effectively eliminate the congestion, interruptible load as a generator backup power resources, is paid more and more attention in the transmission congestion management.

Keywords

Transmission congestion; Circuit overload capacity; FengYun transformer substation

1. Introduction

In the electricity market environment, the transmission congestion management of interruptible load is the important measure to improve system reliability and operating economy. The gradual opening of demand side has become an important part of congestion management (M. E.BARAN, 2000). The transmission congestion of power system means that the requirements of power transmission can't be satisfied because of the limitation of its transmission capacity, which usually includes transmission lines or transformer active power flow exceeding the permitted limit and the node voltage off-limit, etc. In order to eliminate the congestion, the management mode of congestion presents diversification. In the traditional congestion management mode, power grid companies adjust power plant power plan, and generator outputs to invoke a high power. This kind of congestion management usually concentrates on the side of power generation. Literature (ZH. NAIBO, 2011) proposes a congestion management model of joint mode; its essence is to consider all kinds of security constraints of the Optimal Power Flow (OPF) problems. Due to the fluctuation of node electricity price under this model is very big, and trade surpluses can be produced, which produce wrongful stimulate to the Independent System Operator (ISO). Therefore the PJM energy market in the United States and electricity market in the New England use financial transmission rights to solve the transmission congestion (C.Xiang-wei,2010). User demand elasticity is also used to solve the transmission congestion. Under the market structure of both sides of supply and demand quoting at the same time, the load of each node is a decision variables affected by price, ISO can control electricity to ease congestion flexibly. Literature (H. CHAO,2010) structures congestion management model with the method of sensitivity analysis. Literature (C. WEI, 2009) uses generator rescheduling to solve the congestion, and provides a kind of congestion cost allocation method.

2. The Solution to Objective Model Based on Constructing Evaluation Function Method

It is expressed as follows:

$$\min \lambda^T f(x) = \sum_{j=1}^{m} \lambda_j f_j(x) \tag{1}$$

$$\begin{cases} \sum_{i=1}^{m} f_{ij}\omega_i = \alpha, \ j = 1, 2, \ldots, m \\ \sum_{i=1}^{m} \omega_i = 1 \end{cases} \tag{2}$$

$$\begin{cases} (\omega_1, \omega_2, \ldots, \omega_m)^T = \dfrac{e^T (f_{ij})^{-1}}{e^T (f_{ij})^{-1} e} \\ \alpha = \dfrac{1}{e^T (f_{ij})^{-1}} \end{cases} \tag{3}$$

After determining the weight coefficient, then the evaluation function in multi-objective programming problem can be transformed into a simple single objective problem, which can be solved by an improved simple line available method (K. XIANGQING, 2012).

3. The Application of Grid Congestion in Fengyun Transformer Substation

This paper applies the result verifying the IEEE-49 bus system to transmission lines of the grid in an oil field, the node roadmap of torch variable region in this oil power grid of FengYun transformer substation is shown in figure 1.

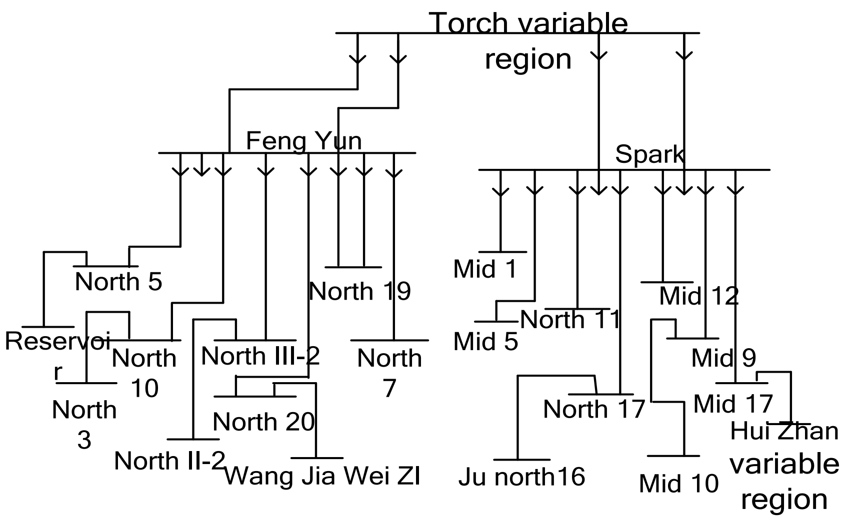

Figure 1. Node roadmap of torch variable region

The condition of load of each substation provided by power company is the maximum load of the whole grid between 2012-2013, namely the date at 18:00 on the January 15,2012, which was enlarged to 300%, to simulate the condition appearing circuit congestion, partial load data as shown in table 1.

Table 1.Torch part of load condition

Substation Name	Measuring Position	Power	
Tou Tai Once Substation	110KV Inlet Wire Name	Active Power (KW)	Reactive Power (KVAR)
	Source Line A 01106	48	15
	Source Line B 01107	48	15
	35KVInlet Wire Name		
	Tai Zhao Line A 01137	33	9
	Song Yi Line 01140	3	1.5
WangJiaWeiZi	Ao Nan Line A 01139	3	1.5
	Ao Nan Line B 01142	33	0.6
	No. 1 Main Transformer 6(10)KV Switch	24	12
	No. 2 Main Transformer 6(10)KV Switch	0	0

4. Conclusion

(1) The mathematical model constructed in this paper has a total of three objective functions to optimize: interruptible load match with brand circuit overload, the minimum number of interruptible load users and the minimum number of total interrupt amount.

(2) After simulating the IEEE-49 bus system, analyzing its calculation result: no matter which optimization objective alone as the objective function of the model, the final selected scheme of interruptible load is not ideal. But the mathematical model presented in this paper can take into account the conditions of the three objectives, making three objective functions achieve an optimal state at the same time.

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