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The Study of A Power System in A Pulp and Paper Plant in Thailand

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Abstract

At the present time, reliability and stability of electric power have been very important when it comes to electrical systems in any plants, especially in terms of distribution. Phoenix Pulp & Paper PCL (PPPC) in Khon Kaen, Thailand, is currently generating electric power about 90% of its current needed by themselves and buys the rest from Provincial Electricity Authority (PEA). Nonetheless, the protection system should be installed to protect the electrical bus when electrical generating process trips or breakdown. Otherwise, it would cause the shutdown of electrical system and lose all manufacturing. To protect electrical system, PPPC therefore has to use load shedding system for cutting the connection of the machines from the system within few minutes. Power flow of electric power from 115 kV PEA to 11 kV via 2 transformers of 115 kV/11 kV and PPPC's 3 generators are studied in this research by setting the real electric power (P), reactive electric power (Q), current (I) and voltage (V) in the protection relay of load shedding system of 11 kV switchboards. In addition, motor control panel, simulated by SKM Power Tools program, is investigated in this research work. The simulation results: P, Q, I and V will be divided into 4 cases: the trips from TG-PUC, TG2, TG3 (in-house generation) and the one from PEA. In the case that there is a trip from PEA electrical distribution, P, only generated from the first three generators in house, will be insufficient to cover the plant's electric need and require around 6,512 kW more. As a result, the machines would have to be stopped running. However, if there is a trip from its in-house generation (TG-PUC, TG2 and TG3) instead, some P can be directly received from PEA. Thus, the load shedding scheme is important to protect the blackout system from electrical system's trip in distribution.

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1. Introduction

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Phoenix Pulp & Paper PCL (PPPC), located in Khon Kaen, Thailand, is pulp and paper manufacturer that uses Eucalyptus as raw material. Bark and waste from a pulp process, will be taken to the boiler for the electricity process for its own usage. Currently, the plant has three generators: Generator 1 (TG-PUC), Generator 2 (TG-2) and Generator 3 (TG-3) resulting the apparent electric power of 12.025, 26.50 and 36.71 MVA, respectively. In addition, there is 115 kV from Provincial Electricity Authority (PEA) converted to 11 kV via the two of 25 MVA transformers connected in parallel.

According to the record, three generators of the plant had frequently made unexpected breakdown and also shut down maintenance machine at the same time. Furthermore, the electric power from PEA at 115 kV was often shut down as well, and that would also cause the shutdown to the whole plant, because all three generators are not able to generate the electricity just in time. In 2013, there were the breakdown for TG-PUC, TG-2, TG-3 and PEA of 6, 18, 12 and 9 times, respectively. In 2014, there were the breakdowns for TG-PUC, TG-2, TG-3 and PEA of 5, 12, 10 and 11 times, respectively. As a result, the machine was severely damaged due to a breakdown and it required high costs to resume the pulp and paper production and time for maintenance.

Currently, PPPC is finding ways to block off bus power system by installing the load shedding system [1] calculating the flow of electrical current and load flow in the system [2],[3], using SKM Power Tools program to calculate values that have to be set up with power protection system (relay protection system) [4], cutting the electricity to the stopped or less important machines in the production process to prevent the breakdown for all power systems along the way and to stabilize the electricity in the plant [5].

Accordingly, the load flow in the power system to resolve all breakdowns (blackout) is analyzed by the SKM Power Tools. In addition, ways to improve the reliability of the power system and to prevent the damage from the machines are investigated.

Nomenclature

PPPC	Phoenix Pulp & Paper PCL
PEA	Provincial Electricity Authority (Thailand)
P	Electric power (W)
Q	Reactive power (VAR)
I	Current (A)

2. Background Theory

2.1. Power Flow Equations and Gauss-Seidel Theory [6]

Power flow in bus loop – electric power (P), reactive power (Q) and voltage (V) in each bus and three generators connected to bus are calculated by Gauss-Seidel theory. For calculation, we firstly choose and set the unknown quantity values, followed by setting each iterative. The calculation will continue until those quantities in acceptable range.

The voltage of i^{th} bus is

$$V_i^{(k+1)} = \frac{\frac{P_i^{sch} - jQ_i^{sch}}{V_i^{*(k)}} + \sum Y_{ij} V_j^{(k)}}{\sum y_{ij}} \qquad \text{where } i \neq j \qquad (1)$$

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