AN IMPROVED CONTROLLER DESIGN FOR TRANSFERRING THE COLOMBO WASTE TO ENERGY POWER PLANT TO THE ISLANDING OPERATION SAFELY DURING THE FAILURES OF THE POWER SYSTEM

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The Colombo Waste to Energy Power Plant, Sri Lanka's First waste-to-energy facility, generates 10 MW of power by utilizing 700 tons of garbage daily. The fuel preparation process involves collecting and sorting municipal solid waste, which is then processed to remove any recyclable materials. The remaining waste is then burned in a boiler to produce steam, which drives a turbine to generate electricity. Since many sub processes are involved in the electrical energy generation process the auxiliary power consumption of this power plant is high when compared with the other fossil fuel fired power plants. The auxiliary power consumption is around 17% of the total power generation. On the other hand, some auxiliary systems are required to run continually even if the power plant is in shutdown state. Therefore, in a case of fault in the grid side the power plant should be transferred into the islanding operation without initiating a shutdown to cater the auxiliary demand. But based on the currently available controller logics it is not automatically transferred into the islanding operation and that causes significant loss of auxiliary power to the power plant during such incidents. Not only that but also most of the thermal power plants which are operating at Sri Lanka are not using automatically islanding transformation facility and all those power plants are using their emergency diesel generators to cater the auxiliary power when the grid power is not available. However, that is somewhat reasonable for the high-capacity power plants which are consuming a lesser amount of auxiliary energy. But in case of the waste to energy power plant, continuity of electricity generation during the grid faults is essential to cater the higher auxiliary power requirements and to run essential axillary systems without any interruption.

To implement automatic islanding operation, the power plant controller logic should be changed. However, that is not a simple task as the incorrect commands can cause undesirable conditions. It can reduce the lifespan of the turbine and generator. Therefore, the aim of this research is to propose a reliable system to transfer the waste to energy power plant into islanding operation safely, during the failures of the power system. This system will be implemented while adhering to manufacturer's specifications.

Keywords: Waste to Energy Power Plants, Automatic Islanded Transformation, Steam Bypass Valve Control

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INTRODUCTION

The Colombo Waste to Energy Power Plant, Sri Lanka's First waste-to-energy facility, generates 10 MW of power by utilizing 700 tons of garbage daily. The fuel preparation process involves collecting and sorting municipal solid waste, which is then processed to remove any recyclable materials. The remaining waste is then burned in a boiler to produce steam, which drives a turbine to generate electricity. Since many sub processes are involved in the electrical energy generation process the auxiliary power consumption of this power plant is high when compared with the other fossil fuel fired power plants. The auxiliary power consumption is around 17% of the total power generation. On the other hand, some auxiliary systems are required to run continually even if the power plant is in shutdown state. Therefore, in a case of fault in the grid side the power plant should be transferred into the islanding operation without initiating a shutdown to cater the auxiliary demand. But based on the currently available controller logics it is not automatically transferred into the islanding operation and that causes significant loss of auxiliary power to the power plant during such incidents. Not only that but also most of the thermal power plants which are operating in Sri Lanka are not using automatically islanding transformation facility. All those power plants use their emergency diesel generators to provide the auxiliary power when the grid power is not available. However, that is somewhat reasonable for the high-capacity power plants which are consuming a lesser amount of auxiliary energy. But in case of the waste to energy power plant continuity of electricity generation is essential during the grid faults to provide the higher auxiliary power requirements and to run essential axillary systems without any interruption.
To implement automatic islanding operation the power plant controller logic should be changed. But that is not a simple task as the incorrect commands can cause undesirable conditions. It can reduce the lifespan of the turbine and the generator. Therefore, the aim of this research is to propose a reliable system to transfer the waste to energy power plant into islanding operation safely, during the failures of the power system while adhering to manufacture's specifications.

METHODOLOGY

Initially, the possibility of operating at a lower power set point such as 1.5MW was confirmed by the manufacturer as many mechanical operations should be complied with the proposed design. Then a study was carried out to investigate the possible reasons through analysing historical data of the power plant. According to the past data it was observed that the steam turbine by-pass valve hasn't opened automatically during every tripping incident. Without opening of the by-pass valve the steam turbine cannot reduce the load and hence the governor valves should be closed immediately initiating plant shutdown. In the case of full load operation of the generator, the system should be able to dump enough steam to reduce the load by 8.5 MW. To achieve that the by-pass valve should be opened immediately after activating the 33kV main circuit breaker.
This system consists of a higher number of mechanical components and therefore there are time constants that should be taken into account when developing the modified controller logics. On the other hand, there are embedded time constants in the system by the manufacturer such as time constant to operate Generator Circuit Breaker. Therefore, overall modified controller

logics were simulated under MATLAB/Simulink to validate the functionality of the modified controller logics. The developed power plant model under the MATLAB Simulink environment is shown below.

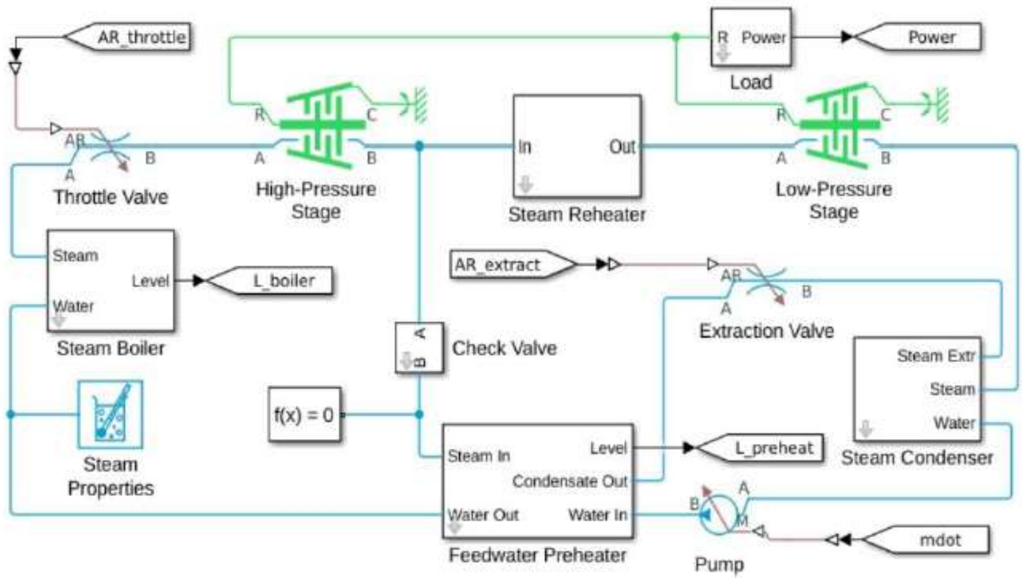

Figure 01: Developed Power Plant Model in the MATLAB/Simulink Platform

The actual parameters of power plant sub systems were determined, and that information was fed to the system to achieve identical operation from the simulation model. Then the modified controller logics were also embedded to the power plant model to validate the functionality. The developed controller model is shown in the figure below.

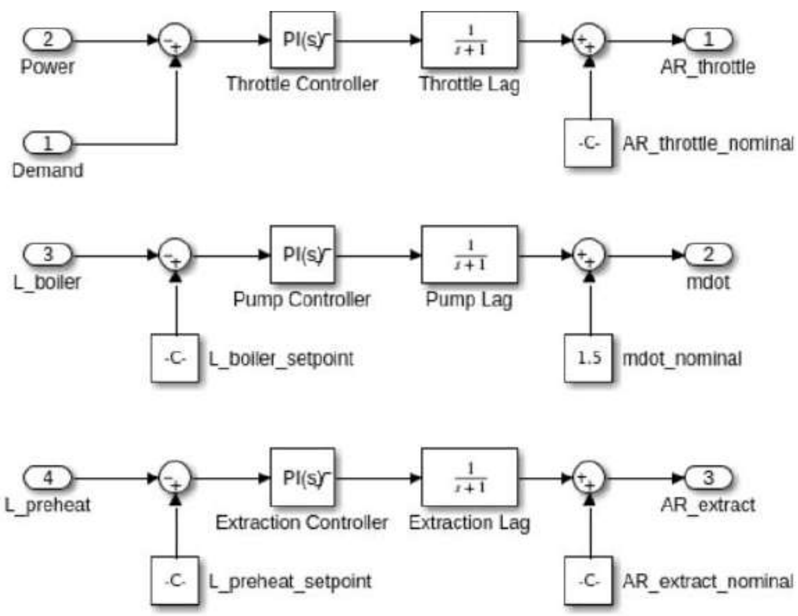

Figure 02: Developed Controller Model

RESULTS AND DISCUSSIONS

Initially the developed MATLAB/Simulink model was tested with normal operating conditions and then a fault was created in the grid side. During the islanding operation, the auxiliary power of 1.5 MW was required and that was also obtained through the developed model. The plant demand and the generated power during the islanding operation is shown in the figure given below.

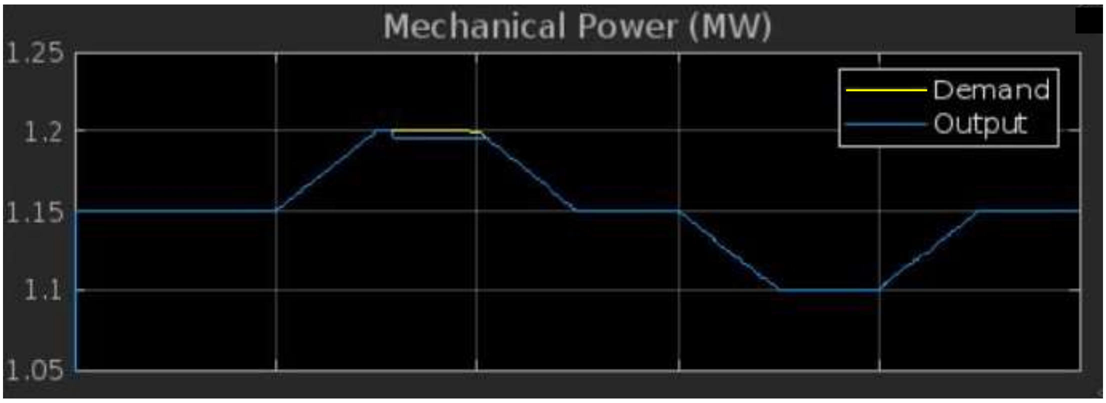

Figure 03: Mechanical Power Output of the Generator Vs Plant Load during the Islanded Operation

Once the functionality of the modified controller logic was confirmed with the MATLAB Simulink model, the plant controller modifications were done. Based on the operation requirements, the generator over frequency protection set value was updated as 52Hz for 10 seconds as it was confirmed by the simulation and the values lie on the manufacturer specified limits. That modification was done to make sure the generator will not be tripped by activating the over frequency fault by premising the excess amount of superheated steam to the turbine. Then the bypass valve logic was updated as required while considering associated time constants. The figure given below shows the updated Distributed Control System (DCS) logic based on the proposed modifications.

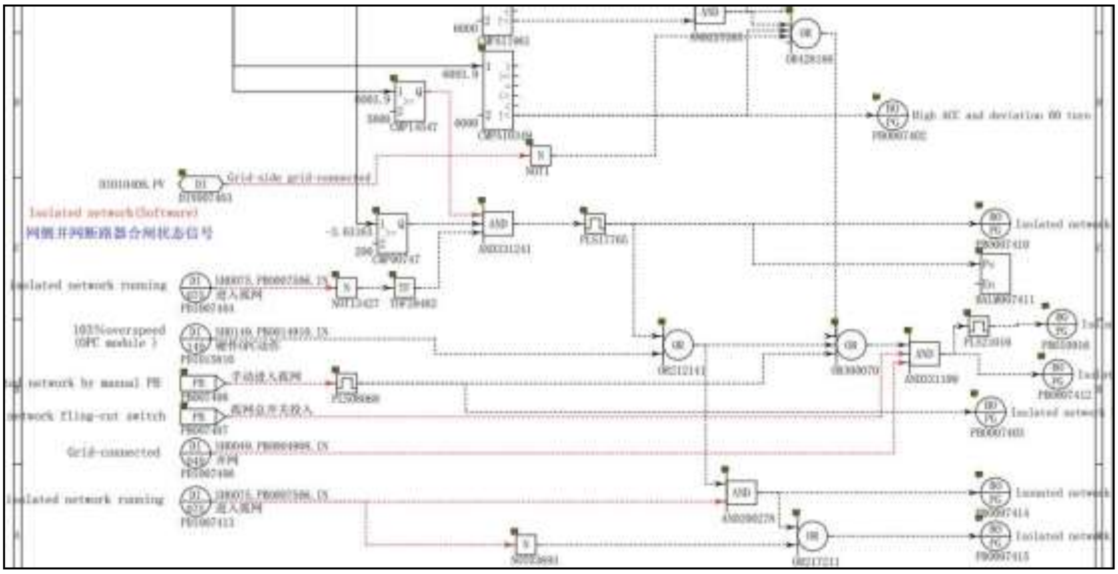

Figure 04: Modified Distributed Control System Logics

CONCLUSIONS/RECOMMENDATIONS

The aim of the research was to design a reliable system for transferring the waste to energy power plant to the islanding operation safely during the failures of the power system. Initially, the possibility of operating at a lower power set point was confirmed by the manufacturer as many mechanical operations should be complied with the proposed design.
To develop the proposed modifications, the existing controller logics were required to change significantly. In that case, the time constants of different subsystems as well as externally added time constants in the controller system should be matched properly. Before updating the actual controller logics, the proposed modifications were checked, and the required functionality was verified under the MATLAB/Simulink platform. The time constants in the system make significant influence on the proposed modifications. However, some of the time constants which were used for the simulation were not the exact values since some system related information was not available. In that case some empirically determined time constants were used for the simulation. Hence, the proposed modifications may not be the optimum modifications.

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