Thermal decomposition/gasification technology utilizes an energy conversion technique from various waste resources, such as biomass, solid waste, sewage sludge, etc for generating syngas. However, in thermal decomposition of gases during the process tar might cause the damage and create operating problems to the facility. In this study, a gliding arc plasma reformer was developed to solve the previously acknowledged issues. In addition, the experiments were conducted to authenticate the optimal operating conditions on the variables that can affect the removal efficiency.

The optimal operating conditions are 5.3 of Steam/Carbon ratio for steam input amount, 0.17 kWh/m³ of SEI for specific energy input, 16.7 L/min of a total gas amount, 0.12% of initial benzene concentration, 1.5 mm of nozzle diameter, 3 mm of electrode gap distance and 125 mm of electrode length. In this case, the maximum benzene decomposition efficiency and energy efficiency are about 82.6% and up to 20.9 g/kWh, respectively. Gas analysis results showed 50.5% of H₂, 21.9% of CO, and 7.7% of CO₂. Regarding the diameter and electrode gap for optimal design, the ratio of electrode gap and nozzle diameter should be higher than 1. And the electrode should be as long as possible when discharge is formed.

**Keyword:** tar, benzene, plasma, gliding arc