상용급 석탄가스화플랜트 최적설계에 관한 연구

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A study on the engineering optimization for the commercial scale coal gasification plant

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This study was conducted for engineering optimization for the gasification process which is the key factor for success of Taean IGCC gasification plant which has been driven forward under the government support in order to expand to supply new and renewable energy and diminish the burden of the responsibility for the reduction of the green house gas emission. The gasification process consists of coal milling and drying, pressurization and feeding, gasification, quenching and HP syngas cooling, slag removal system, dry flyash removal system, wet scrubbing system, and primary water treatment system. The configuration optimization is essential for the high efficiency and the cost saving. For this purpose, it was designed to have syngas cooler to recover the sensible heat as much as possible from the hot syngas produced from the gasifier which is the dry-feeding and entrained bed slagging type and also applied with the oxygen combustion and the first stage cylindrical upward gas flow. The pressure condition inside of the gasifier is around 40~45Mpg and the temperature condition is up to 1500~1700℃. It was designed for about 70% out of fly ash to be drained out throughout the quenching water in the bottom part of the gasifier as a type of molten slag flowing down on the membrane wall and finally become a byproduct over the slag removal system. The flyash removal system to capture solid particulates is applied with HPHT ceramic candle filter to stand up against the high pressure and temperature. When it comes to the residual tiny particles after the flyash removal system, wet scurbbing system is applied to finally clean up the solids. The washed-up syngas through the wet scrubber will keep around 130~135℃, 40~42Mpg and 250 ppmv of hydrochloric acid(HCl) and hydrofluoric acid(HF) at maximum and it is turned over to the gas treatment system for removing toxic gases out of the syngas to comply with the conditions requested from the gas turbine. The result of this study will be utilized to the detailed engineering, procurement and manufacturing of equipments, and construction for the Taean IGCC plant and furthermore it is the baseline technology applicable for the poly-generation such as coal gasification(SNG) and liquefaction(CTL) to reinforce national energy security and create new business models.

Key words : IGCC(Integrated Gasification Combined Cycle), Coal Gasification(석탄 가스화), Syngas(합성가스), Gasifier(가스화기), HPHT Ceramic Candle Filter(고온고압 세라믹 필터), Wet Scrubber(습식세정기), Poly-generation(복합생산)

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PRO/II를 사용한 가스화기 모델링

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Modeling of Gasifier with PRO/II

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서부 발전 태안화력발전소에 건설 예정인 IGCC Demo plant의 설계 자료를 근거로 석탄 가스화기의 정상 상태 전산모사를 PRO/II를 사용하여 수행하였다. 석탄을 PRO/II가 받아들일 수 있는 성분으로 바꾼 후 가스화기를 버너와 가스화기 본체의 두 부분으로 나누어 모델링하였다. 버너는 단열조건의 Gibbs Reactor로 모델링하였다. 모사 결과 산소가 완전 소진될 때까지 반응이 진행되는 것을 확인하였다. 가스화기는 char gasification 반응은 kinetic reaction equation으로, gas phase reaction은 equilibrium reactor로 모사하는 알고리듬을 개발 하였으나 PRO/II의 기능에 한계가 있어 간단한 Gibbs Reactor로 모사하였다. 가스화기는 membrane wall에 의하여 냉각되는 것을 고려하여 1550℃의 균일한 온도에서 반응이 일어나는 것으로 고려하였다. 전산 모사 결과 주요 성분의 조성이 실제 syngas의 조성과 5% 정도 오차가 있는 것으로 나타났다.

Key words : gasifier(가스화기), coal gasification(석탄 가스화), modeling(모델링), simulation(전산 모사)

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