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农作物秸秆热解多联产技术的应用

Application of cogeneration technology of gas-liquid-solid products pyrolyzed from crop straw

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中文摘要:

农作物秸秆是重要的可再生能源，开发先进高效的秸秆利用技术，有助于缓解能源危机，增加废弃物资源的二次化利用，降低环境污染。该文介绍了一种新型的农作物秸秆固定床干馏釜气固液联产技术，并以湖北省天门市杨林办集中供气示范站为商业化运行典型案例进行了经济效益分析。农作物秸秆固定床干馏釜气固液联产技术可以同时产出中等热值（8～12 MJ/m3）的民用燃气和低位发热量达到28 MJ/kg的生物质焦炭，此外还有一定应用潜力的木焦油和木醋液。现有规模商业化运行，电价和用工成本的大幅上升降低了集中供气示范站的经济效益。

英文摘要:

Abstract: To improve the standard of living in rural areas, many distributed gas stations were constructed in Hubei province, and these stations were based on the biomass-polygeneration technology which could produce charcoal, fuel gas and bio-oil simultaneously. This paper presented a theoperational process and the character of products of a typical station. The gas station consisted of a biomass pretreatment system, retort equipment, condensation and purification system, gas storage tank, and pipeline. At first, agricultural straws were dried until their moisture content was below 12%. Subsequently, the dried straws were briquetted, and these briquettes were placed in an orderly manner in the retort equipment. The fuel gas or straws were combusted to supply heat for the pyrolysis process of the briquettes. A complete pyrolysis process would take above 8 hours. At the beginning of 2-3 hours, a large amount of water was formed from external water and bound water when the temperature was controlled below 250℃. At this stage, the gas product consisted of CO2, CO, and water vapor, and the heat value was rather lower, therefore, these gases would combust. After the gas product was heated about 5~6 hours, the temperature of the retort was up to 600℃, then, the straw briquettes degraded rapidly, and a large amount of volatiles generated which would be removed from the retort equipment to a condensation and purification system. Simultaneously, charcoal was formed and the residue volume was only 30% to 40% of the original briquette because of the released volatiles. At the last 2-3 hours, the retort was retained at 600℃, then the charcoal would be further upgraded and a small amount of liquid product and gaseous products would be generated. The temperature of fresh volatiles out of the retort was up to 450℃, and then these fresh volatiles would cool down to room temperature by condensation and purification. The bio-oil and fuel gas were separated from the volatiles, and the bio-oil was further separated into wood tar and wood vinegar that was stored in the liquid tanks. The fuel gas was stored in a gas storage tank and transferred to users by pipeline. Charcoal was naturally cooled to 60-80℃ in a retort and then collected to package and place in storage.For biomass-polygeneration technology, 1 ton agricultural straws can produce 230-310 m3 of fuel gas, 250-300kg of charcoal, 50 kg of wood tar, and 250 kg of wood vinegar. The main components of fuel gas are CO, CO2, H2, CH4, and other incondensable light hydrocarbons, such as C2H2, C2H4, C2H6, and so on, and its heat value (LHV) reaches to 12 MJ/m3 due to the volume fraction of hydrogen and methane being up to 25% and 18%, respectively. The characteristics of charcoal are similar to anthracite, which has a small volatile content and high fixed carbon, and the heat value (LHV) is around 28 MJ/kg. The porosity of charcoal is well developed, and can be used as an industrial adsorbent and soil conditioner. The yield of wood tar is generally from 4.5% to 7%, and wood tar is composed of a large amount of macromolecules, such as anthracene, naphthalene, and some 10 carbon aliphatic chain hydrocarbon. Wood vinegar has high water content, more than 85%, and the organic component is composed of acetic acid and a small amount of phenol. Meanwhile, this paper analyzed the economic benefits of the typical gas station. It found that the sharp rise of electricity and labor costs reduces the economic benefits of the station.

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