Ⅳ. 英文アブストラクト

Regional Circular Livestock System Based on Large Improvement of Power Generation Efficiency Using Ammonia Derived from the Livestock Waste

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[Abstract]

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To solve the problems of local feedlot farmers such as bad smell and waste treatment and to realize local circulation and symbiosis where renewable energy utilization is promoted, we proposed a local circulation feedlot system that enables large improvement of power generation efficiency using ammonia derived from feedlot manure and conducted experimental study for its realization. In the system, ammonia is produced by treatment of feedlot manure hydrothermally in hot compressed water that is fed to the high-temperature biomethanation to run methane fermentation with suppressed ammonia inhibition while recovering ammonia into gas phase separated from the liquid phase, and the produced biogas is fed to a gas engine for power generation. Ammonia separated and recovered is converted into nitrogen and hydrogen by electrolysis and by supplying thus obtained hydrogen to the gas engine so that combustion is stabilized and lean burn operation is made for high-efficiency power generation. Quantitative determination of ammonia generation rate in hot compressed water using both batch and flow reactors. In high-temperature biomethanation, ammonia gas removal into gas phase was made by circulating biogas and characteristics of adsorptive removal was studied. As for hydrogen generation by electrolysis of ammonia, by making the electrode surface covered by black metal, catalytic performance was improved so that electrolysis can be made with low overvoltage. As for lean-burn, small gasoline engine was modified so that methane could be fed together with the hydrogen supply system under different conditions, and was operated and thermal efficiency was measured. In addition, basic calculation was made for combustion with which system development was made. Combined operation of each unit was also made so that feedstock that includes hydrothermally treated pig manure was fed to biomethanation reactor, whose product gas was burned in the engine. As the result, ammonia generation rate was determined and it was found that the total reaction can be expressed by decomposition of uric acid and protein. High-temperature biomethanation was successfully run to produce biogas while recovering ammonia, expressed by first-order reaction model. For ammonia electrolysis, modification of the electrode surface resulted in efficient electrolysis. As for lean burn, experiment was made under conditions in wide range, showing higher efficiency with hydrogen addition. Additional runs for direct injection of hydrogen showed that hydrogen addition was effective to further improve the efficiency. Combined operation was made. As a result, the initial target was successfully achieved, and demonstrative operation should be made.