Supporting information

Due to the discrete production behavior of the all gases, produced volume of these components were demonstrated on volumetric basis. It is hard to make a final conclusion due to the lack of specific trend on the production of gases from the blank experiments (except carbon dioxide). However, produced volumes of these gases were demonstrated to show the presence of different types of gases produced in the blank experiments.

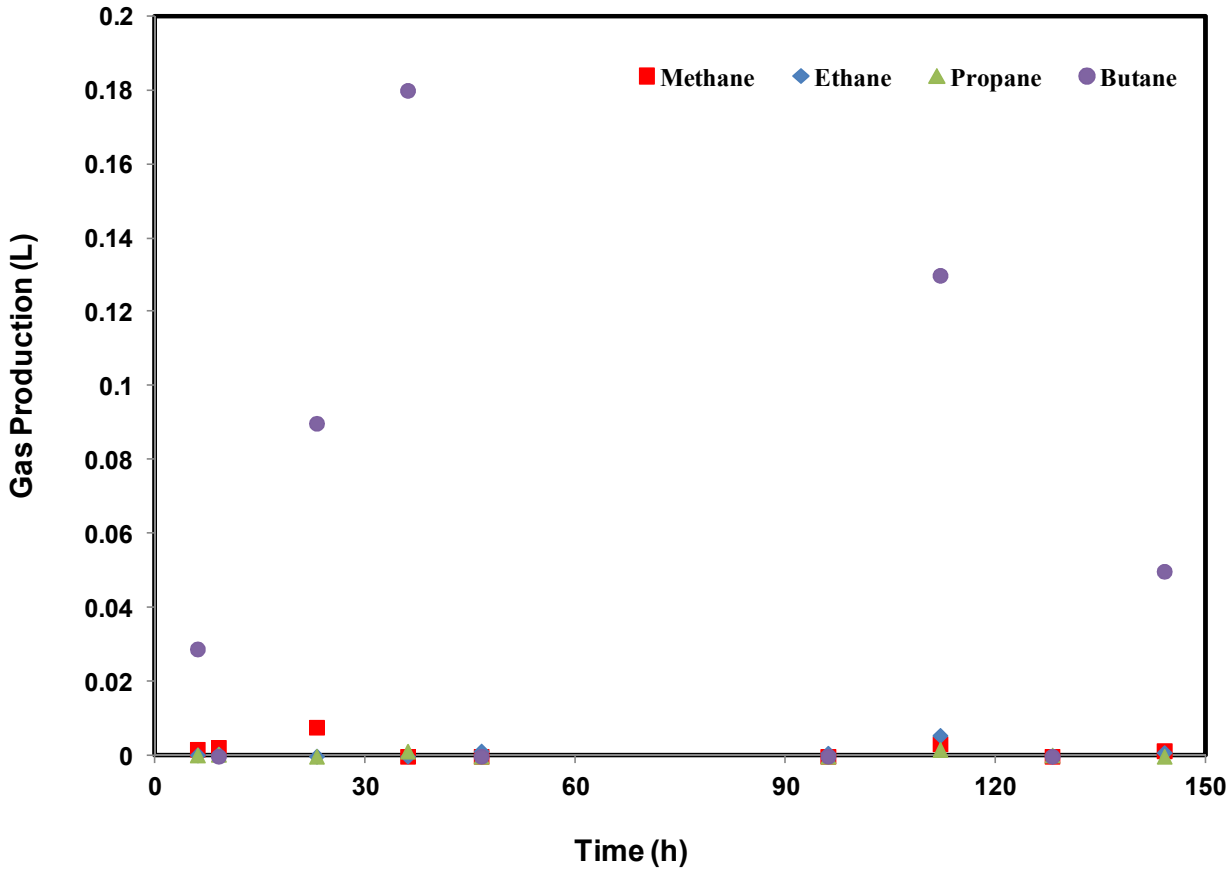

Figure S1. Produced volume of methane, ethane, propane and butane from oil sand porous media at different times and temperatures, in the absence of tri-metallic nanocatalysts. Other experimental conditions include a porosity of 33.1%, pressure of 3.5 MPa, and temperature of 340 °C.

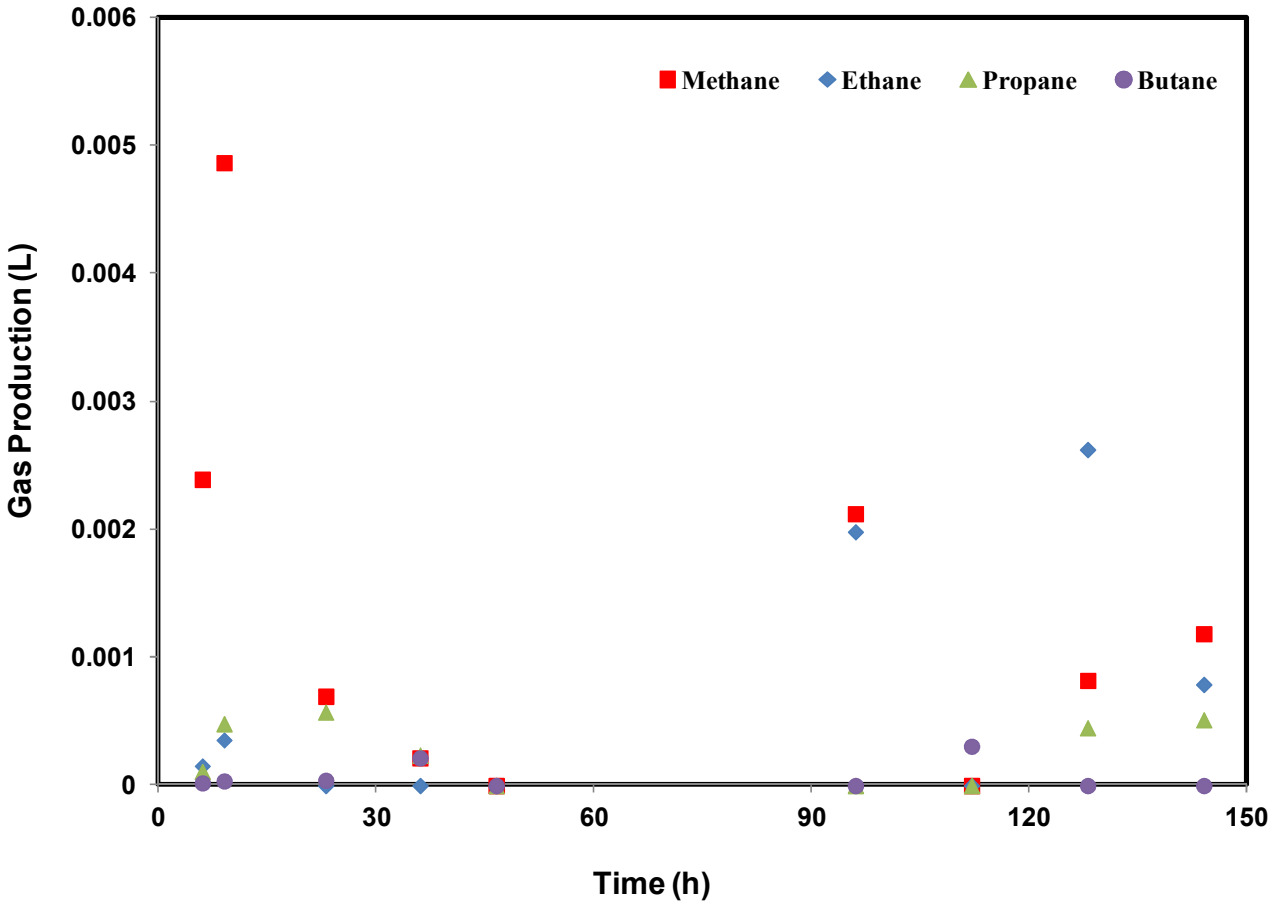

Figure S2. Produced volume of methane, ethane, propane and butane from oil sand porous media at different times and temperatures, in the absence of tri-metallic nanocatalysts. Other experimental conditions include a porosity of 33.2%, pressure of 3.5 MPa, and temperature of 320 °C

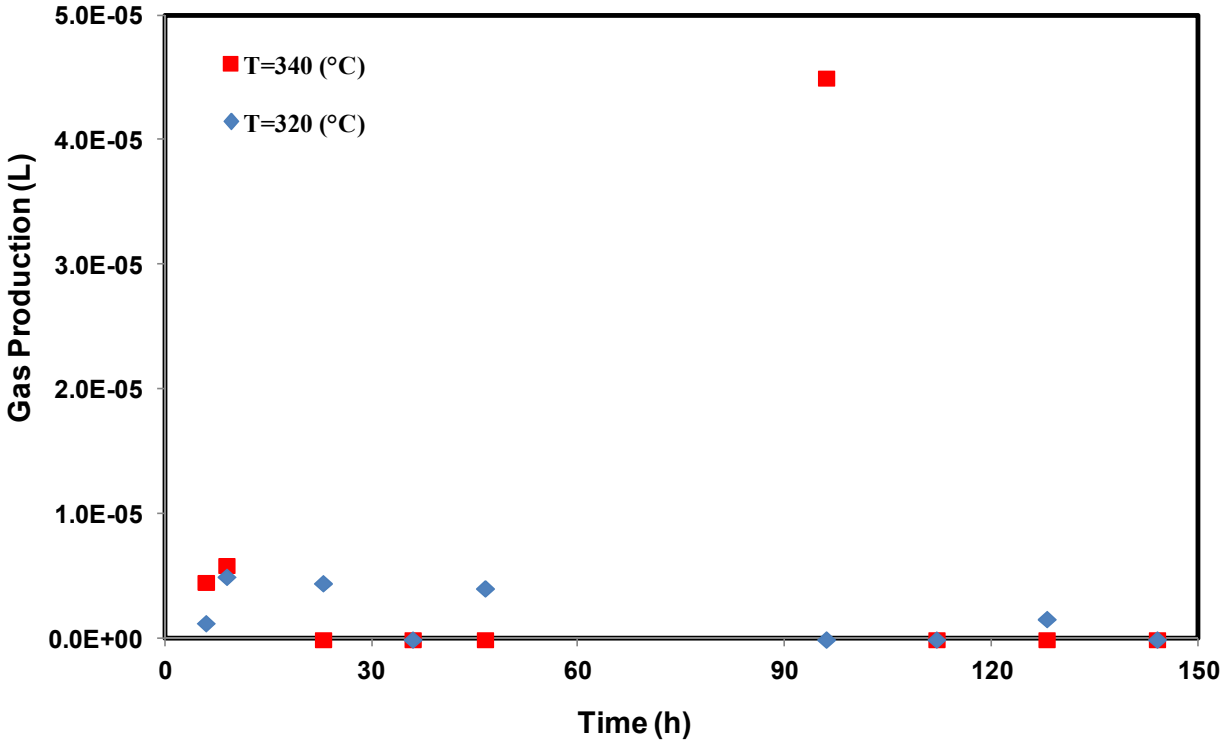

Figure S3. Produced volume of pentane from oil sand porous media at different times and temperatures, in the absence of tri-metallic nanocatalysts and test pressure of pressure of 3.5 MPa.

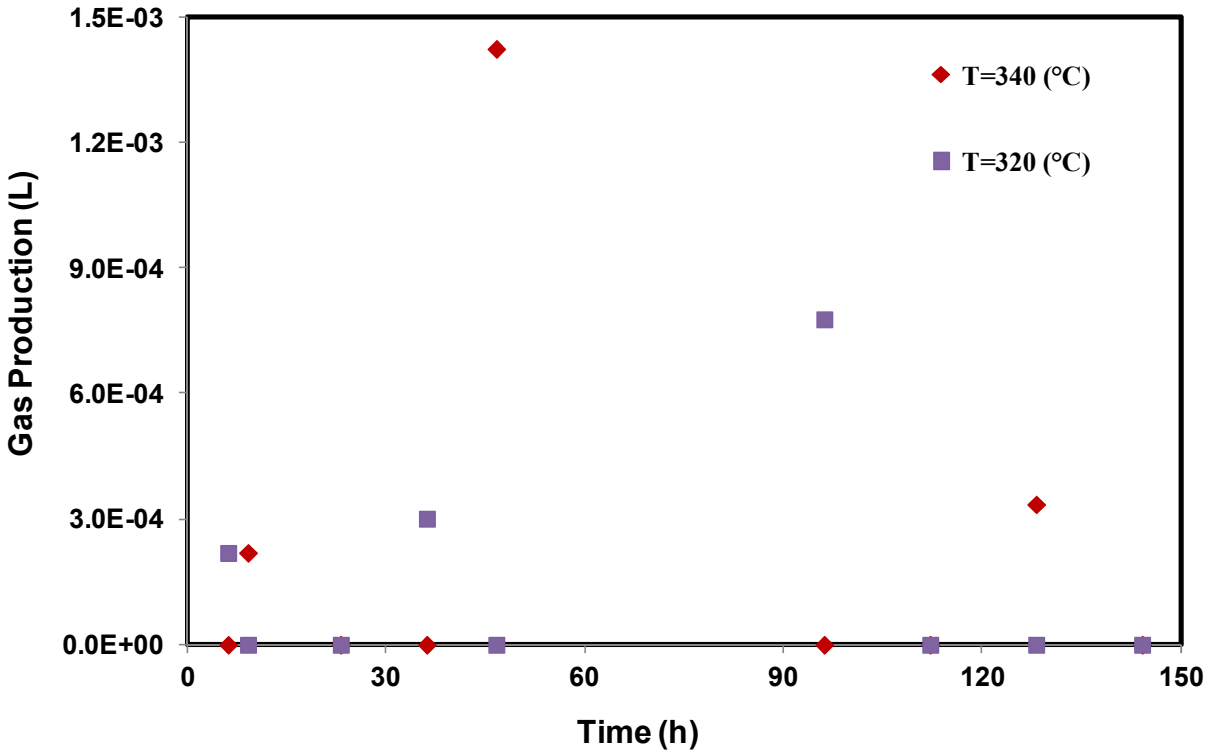

Figure S4. Produced volume of carbon monoxide from oil sand porous media at different times and temperatures, in the absence of tri-metallic nanocatalysts and test pressure of pressure of 3.5 MPa.

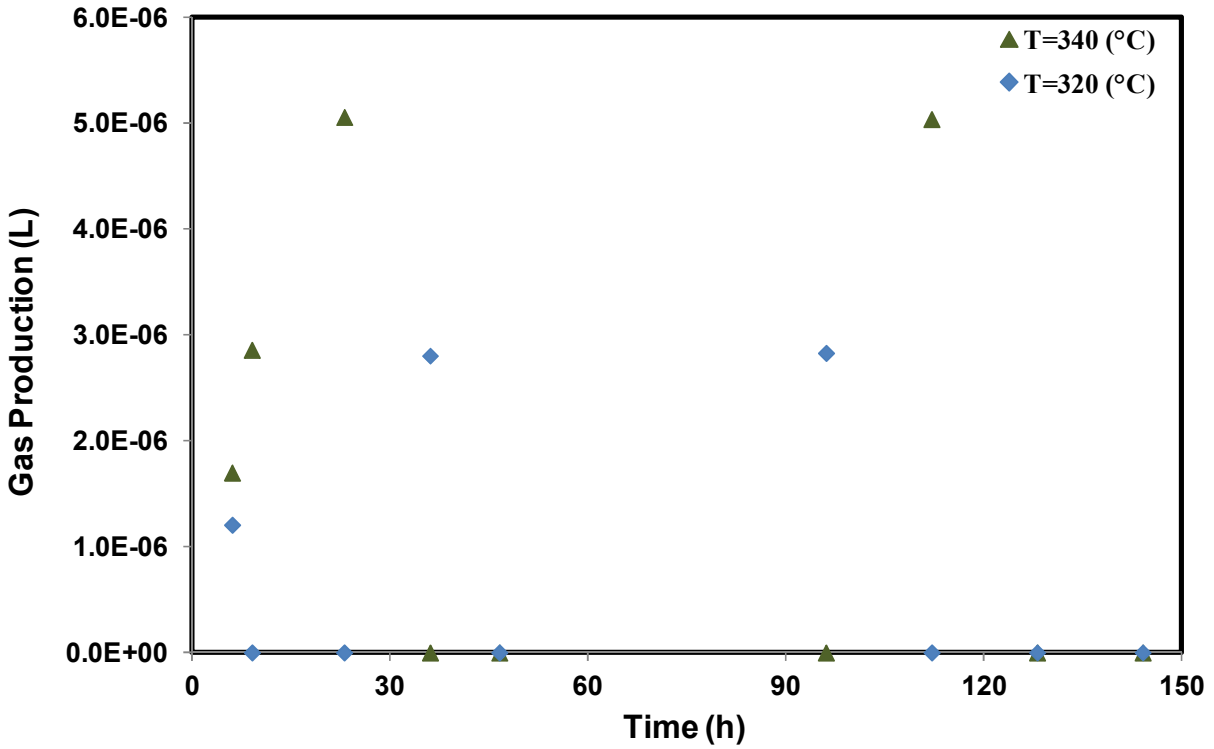

Figure S5. Produced volume of hydrogen sulfide from oil sand porous media at different times and temperatures, in the absence of tri-metallic nanocatalysts and test pressure of pressure of 3.5 MPa.

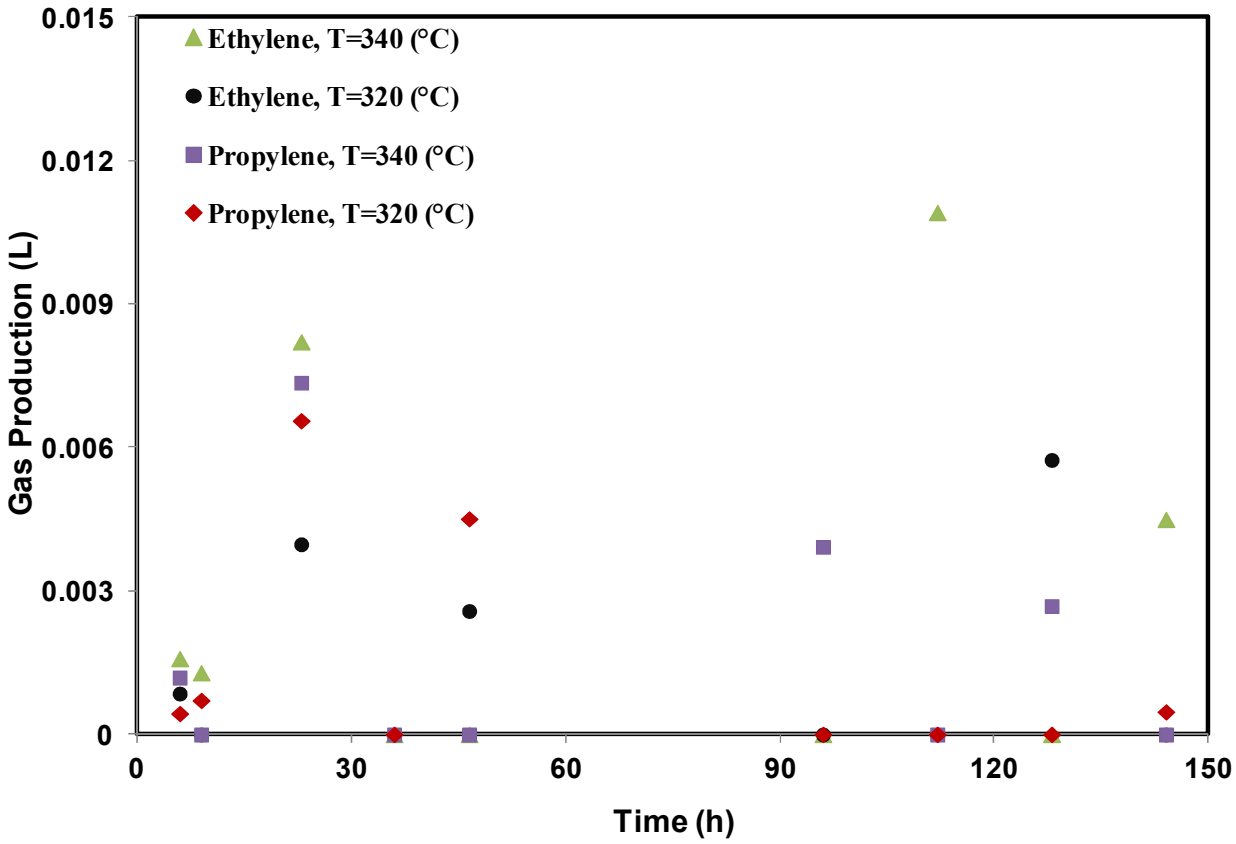

Figure S6. Produced volume of ethylene and propelene from oil sand porous media at different times and temperatures, in the absence of tri-metallic nanocatalysts and test pressure of pressure of 3.5 MPa.