Geophysical Research Abstracts
Vol. 15, EGU2013-5816-1, 2013
EGU General Assembly 2013

Investigation of CO_2 release pressures in pipeline cracks

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The CCS (Carbon Capture and Storage) technology can prevent or reduce the emissions of carbon dioxide. The main idea of this technology is the segregation and collection of CO_2 from facilities with a high emission of that greenhouse gas, i.e. power plants which burn fossil fuels. To segregate CO_2 from the exhaust gas the power plant must be upgraded. Up to now there are three possible procedures to segregate the carbon dioxide with different advantages and disadvantages. After segregation the carbon dioxide will be transported by pipeline to a subsurface storage location. As CO_2 is at normal conditions (1013,25 Pa; 20 °C) in a gaseous phase state it must be set under high pressure to enter denser phase states to make a more efficient pipeline transport possible. Normally the carbon dioxide is set into the liquid or supercritical phase state by compressor stations which compress the gas up to 15 MPa. The pressure drop makes booster stations along the pipeline necessary which keep the CO_2 in a dens phase state. Depending on the compression pressure CO_2 can be transported over 300km without any booster station.

The goal of this work is the investigation of release pressures in pipeline cracks. The high pressurised pipeline system consists of different parts with different failure probabilities. In most cases corrosion or obsolescence is the reason for pipeline damages. In case of a crack CO_2 will escape from the pipeline and disperse into the atmosphere. Due to its nature CO_2 can remain unattended for a long time. There are some studies of the CO_2 dispersion process, e.g. Mazzoldi et al. (2007, 2008 and 2011) and Wang et al. (2008), but with different assumptions concerning the pipeline release pressures. To give an idea of realistic release pressures investigations with the CFD tool OpenFOAM were carried out and are presented within this work.

To cover such a scenario with an accidental release of carbon dioxide a pipeline section with different diameters and leakage release holes were modelled. This pipeline section is 10m long with the leakage hole in the middle. Additionally a small environment subdomain is simulated around the crack. For computation a multiphase solver was utilised. In a first step incompressible and isothermal fluids with no phase change were assumed.